THIRD EDITION

Understanding Architecture

Its Elements, History, and Meaning

LELAND M. ROTH
AND
AMANDA C. ROTH CLARK

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Louis I. Kahn, The Phillips Exeter Library, Phillips Exeter Academy, New Hampshire, 1965–1971. A good example of what Louis Kahn meant when he said "architecture is what nature cannot make." Photo: Carol M. Highsmith Archive, Library of Congress, Prints and Photographs Division.

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Routledge
Taylor & Francis Group
New York London

First published 2014 by Westview Press

Published 2018 by Routledge
711 Third Avenue, New York, NY 10017, USA
2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN

Routledge is an imprint of the Taylor & Francis Group, an informa business

Design and composition by Trish Wilkinson
Set in 9.5-point Goudy Old Style

Photo research by Sue Howard

Library of Congress Cataloging-in-Publication Data

Roth, Leland M.
Understanding architecture: its elements, history, and meaning / Leland M. Roth and Amanda C. Roth Clark.—Third edition.
pages cm
Includes bibliographical references and index.
ISBN 978-0-8133-4903-9 (pbk.)
1. Architecture. 2. Architecture—History. I. Title.
NA2500.R68 2013
720.9—dc23 2013028188

ISBN 13: 9780813349039 (pbk)

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Preface

This book is about learning to understand our human-made environment. It is about architecture as a physical vessel, a container of human activity. But since architecture is a social activity, building is also a social statement and the creation of a cultural legacy. Moreover, every building, whether a commanding public structure or a private shelter—whether a cathedral or a bicycle shed—is constructed in accordance with the laws of physics in ways that crystallize the cultural values of its builders. This book is an introduction to the artistic urge that impels humans to build, as well as to the structural properties that enable buildings to stand up. It is also an introduction to the silent cultural language that every building expresses. This book, then, might be thought of as a primer for visual environmental literacy.

I should clarify that this is not a *history* of architecture in the normal sense of the word. There is historical information in the second part of the book, but the first part focuses on how the aesthetics of architecture influence our perception.

The first edition of *Understanding Architecture* was published in 1993, and numerous additions were made in 2005 for the second edition. In this third edition, the material is brought up to date, including developments since the opening of the new millennium. This restructuring, however, necessitated rethinking how to tell the story of twentieth-century architecture. Hence, there are now revised chapters on the development of Modernism: how it was defined in Europe in the first third of the twentieth century, then how it was exported around the globe in the second third of the century, and, finally, how reactions to Modernism proliferated and have diverged in the last third of the century and have continued into the opening of the twenty-first century. Up to the mid-twentieth century, architects tended to work primarily in their native countries, aside from those who were obliged by political or religious persecution to flee their homelands and seek refuge elsewhere, such as Walter Gropius, Mies van der Rohe, and Erich Mendelsohn.

Discussion of this late-twentieth-century international dimension to contemporary architectural practice has brought into focus the realization that global cultural influences have been in effect for more than twenty-five hundred years—a period in which early trade and exploration brought various parts of the world together. As it seems appropriate to examine these global interactions and the architecture outside of the Western world, we have interspersed the main text with special essays that sketch how other cultures first began to interact with Western culture. And just as the original chapters with their Western focus never aimed to examine the full breadth of architectural history, even less do the new essays try to cover the breadth of architecture outside the West; rather, the endeavor has been to explore the encounters and interchanges, conflicts and accommodations between the disparate global communities. Since limited space precludes providing an illustration of every building mentioned, readers are encouraged to avail themselves of the various encyclopedias and search engines available online to locate images for review.

Since the Protestant Reformation, the West has preferred to stress the written cultural record, whether historical or literary, and to give little serious attention to the meaning of visual imagery. In the United States, in most community schools (other than some private academies) there are no courses in the history of art, much less on architectural history. It is usually not until college that students first encounter art history and perhaps the history of architecture. Hence, very few young people are taught how to "read" or otherwise interpret the physical environment in which they will live and work. In a very few secondary schools, students are offered classes in the visual arts, music, and dance, even though only a fraction of them will put such knowledge to use explicitly when they enter the work world. In fact, because of worsening public budget constraints, even these few classes are increasingly being cut. As a result, most people are taught next to nothing about the architecture they will encounter throughout life; they learn very little about the history of their built environment or how to interpret the meaning of the environment they have inherited. What they know is—literally—what they learn "in the street." This environmental illiteracy has long been accepted as the normal state of affairs.

This book seeks to bridge the gap. It is aimed at the inquisitive student or general reader interested in learning about the built environment and the layered historical meaning embodied mute within it. In short, it is intended not as a comprehensive historical survey tracing the entire evolution of built forms but rather as a basic introduction to how the environment we build works on us physically and psychologically, and what historical and symbolic messages it carries.

The basic structure of this book grew out of my outline for the architecture section of a telecourse, "Humanities Through the Arts," produced in the 1970s by the Coast Community College in Fountain Valley, California, and by the City Colleges of Chicago. The idea was that architecture should be examined not only as a cultural phenomenon but also as an artistic and technological achievement. The content of the book was subsequently developed in introductory courses on architecture that I taught at The Ohio State University, Northwestern University, and the University of Oregon.

The assumption behind the book's form and organization is that the reader knows little in either a technical or historical sense about the built environment. Hence, Part I of the book deals with the basic properties of architecture. It is here that basic design and technical concepts are outlined and a working vocabulary is introduced. Then, in Part II, the historical evolution of architecture is explored through an examination of basic cultural themes, with selected buildings as case studies. Such a division enables the reader of, say, Chapter 12, on Roman architecture, to focus on the symbolic image presented by the vast dome of the Pantheon, since the essential structural properties of domes have already been dealt with in Chapter 3.

Part I, then, begins with a definition of what architecture is and continues with chapters that explore space, function, structural principles, and elements of design. Individual chapters deal with how architecture affects and is affected by climatic elements, what the role of the architect has been over time, and what has been considered good or economical architecture. The discussion in Part I is illustrated by building examples drawn from all parts of the world, past and present.

Part II is a historical survey of architectural development in the West, from prehistoric times to the present. In all these chapters, the focus is on architecture as a cultural artifact, as a systematized statement of values. This leads to the concluding argument that what we build today, whether privately or on a grand public scale, is an embodiment of our values. Interspersed are new essays on interactions between Western architecture and other cultures: the architecture of India, Islam, the Americas, China, Japan, and Africa.

In writing this book, I have been influenced by numerous studies, including detailed general works, specialized monographs, and theoretical studies. Initially, the most informative were Niels Luning Prak's *The Language of Architecture* (The Hague, 1968) and Steen Eiler Rasmussen's classic *Experiencing Architecture* (Cambridge, MA, 1959; 2nd ed., 1962). Other influential sources are listed in the Suggested Readings for each respective chapter.

A historical survey such as that found in Part II cannot help but be influenced by Nikolaus Pevsner's *An Outline of European Architecture* (Harmondsworth, England, 1943; 7th ed., 1963), which, despite its date, is still in print and considered one of the most important books of its kind. Many other broad and comprehensive histories have followed—but, unlike those encyclopedic surveys, the present compact book examines architecture as a cultural expression and focuses on selected examples or case studies as types rather than trying to trace in detail the chronological intricacies of historical development.

Whatever I may have absorbed from reading all these studies was modified and enlarged in the classroom. And I must acknowledge, too, the contributions made by my students over the years through their questions, expressed both verbally and in furrowed brows. It is impossible to thank adequately my professional colleagues, who offered comments in their areas of expertise; my special gratitude is extended to Professors G. Z. Brown, Deborah Hurtt, Jeffrey Hurwit, Charles Lachman, Andrew Morrogh, John Reynolds, Richard Sundt, and Akiko Walley.

A word should also be said about the plans illustrated throughout the book, for here, too, students contributed significantly. Aside from those drawings that I prepared myself, many others were

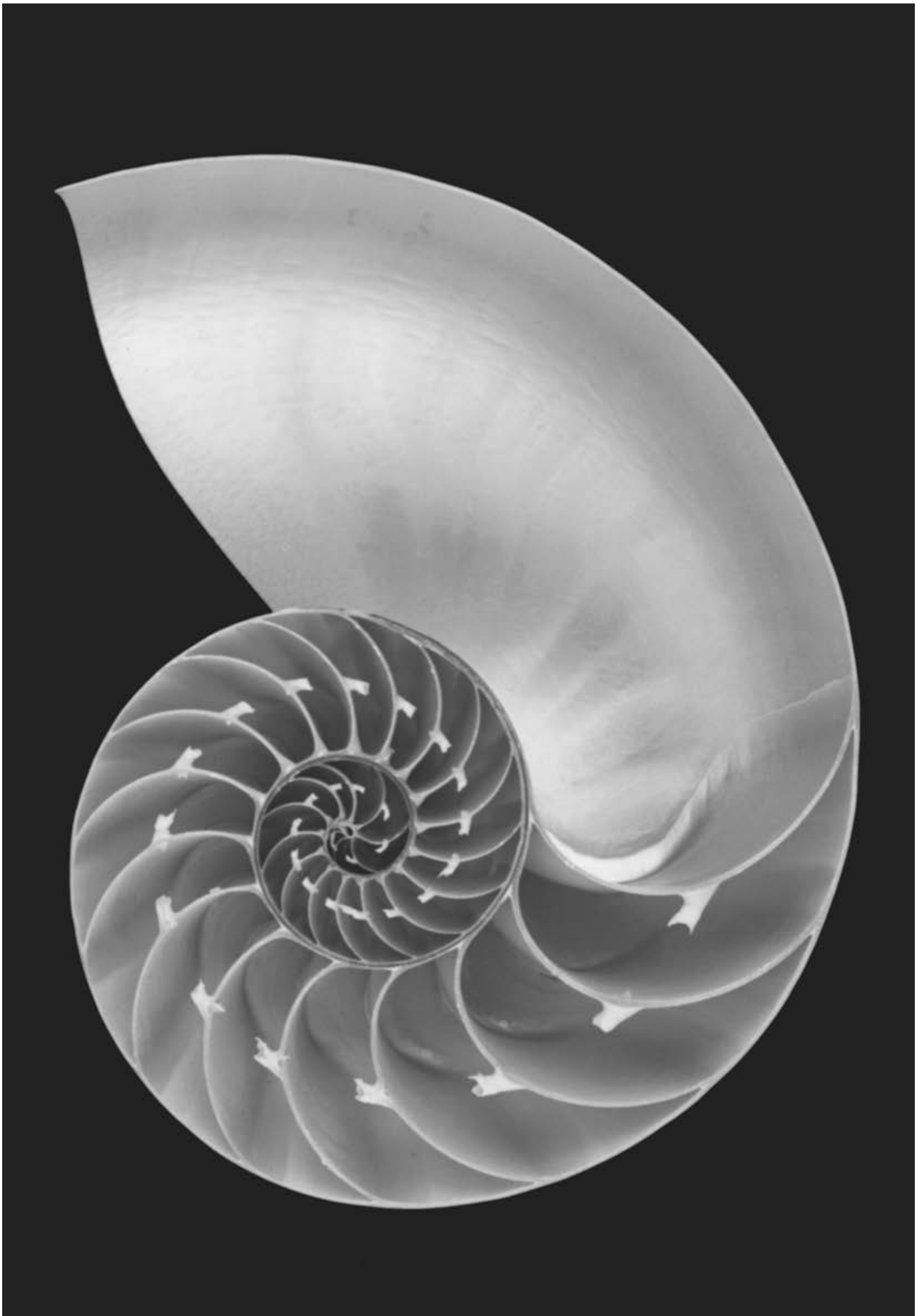
drawn to uniform conventions by architecture students in several special media courses that I taught during 1985–1986. The students are individually identified in the List of Illustrations.

For more than a quarter-century, my writing and publishing endeavors were greatly encouraged by Cass Canfield Jr., my original editor at Harper & Row and then HarperCollins. He provided boundless support and initiated both the first and second editions. Following a transfer of HarperCollins' collegiate text division to Westview Press, the second edition was completed under new editors Sarah Warner, and then Steve Catalano and Cathleen Tetro, who were especially supportive.

The impetus for this third edition was a request by Priscilla McGeehon, but following her departure from Westview the project was taken up with great enthusiasm and support by Cathleen Tetro. One important initial undertaking was to engage long-time editor Marcus Boggs as the initial reader and critic who provided me with invaluable advice and encouragement. A book like this, with its many illustrations, entails the help of numerous individuals, and they deserve particular thanks. Among them are Stephen Pinto at Westview/Perseus, who directed the final production of the book; Trish Wilkinson, who designed this new edition; Sue Howard, who located many of the new images; and Cisca L. Schreefel, Christine J. Arden, and the many others whose dedication to the details of producing this book is acknowledged with grateful appreciation.

Special thanks are due to Carol, who sustains me always, who read the drafts of the earlier editions with a critical eye, and who painstakingly, analytically, and dispassionately read this third edition, ensuring the logical and graceful continuity of each chapter. And a unique thanks must be rendered to Amanda, to whom, when an infant, my books were first dedicated. Now grown, and having started on a life's career in the history of the visual arts, she has co-written the most recent changes in the book with me, bringing to it the benefits of her perspective as a student, teacher, critic, and, now, colleague.

Leland M. Roth
Eugene, Oregon



2. Section view of the shell of a chambered nautilus. The nautilus shell, incrementally built by means of an unconscious biological process, is the record of the life of its inhabitant. Photo: L. M. Roth.

Introduction

Architecture is what nature cannot make.

—Louis I. Kahn

Architecture is generally something people take for granted, moving toward it, around it, through it, using it without a thought. It is simply there, an unassuming backdrop, a mute, utilitarian container. Architecture is much more, however; it is the crystallization of ideas. It has been defined many ways—as shelter in the form of art, a blossoming in stone and a flowering of geometry (Ralph Waldo Emerson), frozen music (Goethe), human triumph over gravitation and the will to power (Nietzsche), the will of an epoch translated into space (architect Ludwig Mies van der Rohe), the magnificent play of forms in light (architect Le Corbusier), a cultural instrument (architect Louis I. Kahn), and even inhabited sculpture (sculptor Constantin Brancusi). More recently, architectural critic Ada Louise Huxtable framed a rather clinical definition, calling architecture a "balance of structural science and aesthetic expression for the satisfaction of needs that go far beyond the utilitarian."[1]

Architecture is the unavoidable art. Almost every moment of our lives, awake or asleep, we are in buildings, around buildings, in spaces defined by buildings, or in landscapes shaped by human artifice. It is possible to deliberately avoid looking at paintings, sculpture, drawings, or any other visual art, but architecture constantly touches us, shapes our behavior, and conditions our psychological mood. The blind and deaf may not see paintings or hear music, but they must deal with architecture. Moreover, aside from being shelter or a protective umbrella, architecture is also the physical record of human activity and aspiration; it is the cultural legacy left to us by all preceding generations.

The architect Louis I. Kahn wrote that "architecture is what nature cannot make."[2] Humans are among several animals that build, and indeed some structures built by birds, bees, and termites, to name but a few, demonstrate human-like engineering skill in their economy of structure. One particular bird, the rufous-breasted castle builder of South America, weaves two chambers connected by a cantilevered tube between the two, creating a double-chambered nest in the form of a dumbbell [1]. Certain blind termites build soaring arches of mud, starting at two distinct springing points, pushing their sections upward until they meet in the air.[3] Mollusks, such as the chambered nautilus, construct their protective houses around them, creating a hard shell of calcium carbonate [2, facing page]. As the nautilus grows, it adds a new and somewhat larger chamber to its curved shell, the vacated chamber then being filled with nitrogen gas to add buoyancy to the enlarged mass; the older parts of the shell, however, remain as a record of the history of the animal. Architecture is the chambered nautilus shell of the human species; it is the environment that we build for ourselves, and that, as we grow in experience and knowledge, we change and adapt to our expanded condition. If we wish to understand ourselves, we must take care not to eliminate the "shell" of our past, for it is the physical record of our aspirations and achievements.

It was once customary to think of architecture as consisting only of those buildings that we deemed important, the great church and state buildings that involved substantial expenditure of energy and funds. Perhaps this viewpoint came about because, in past centuries, histories of architecture were written largely by architects, princely patrons, or court historians who wished to sharpen the distinction between what they had achieved and the surrounding mass of vernacular buildings. In his compact *Outline of European Architecture,* first published in

1. Nest of the South American rufous-breasted castle builder. This nest exemplifies deliberate construction in the animal kingdom, largely driven by genetic programming. From P. Goodfellow, Birds as Builders *(New York, 1977).*

1943, Nikolaus Pevsner began by making the distinction that "a bicycle shed is a building; Lincoln Cathedral is a piece of architecture" [3, 4].[4] Conventional wisdom often makes the same distinction, as demonstrated in this now-folkloric story: A metal-building manufacturer who made barn structures offered buyers a wide choice of historically themed clip-on door frames as embellishment—American Colonial, Mediterranean, and Classical, among many others. After a severe windstorm damaged many barns in one area, the factory representative telephoned customers to find out how the structures had fared. One customer, whose Colonial door frame had been stripped off while the barn itself survived, replied, "The building's fine but the architecture blew away."[5]

We cannot, however, focus solely on the "Architecture" of Lincoln Cathedral or Notre-Dame in Amiens, France, or any medieval cathedral, for that matter, without taking into account the scores of "mere buildings" among which it sits. If we ignore all the humble houses that made up the city around the massive cathedrals, we would misinterpret the position occupied by the church in the social and cultural context of the Middle Ages, and we would forget all the townspeople and local artisans who had built them.

We must consider both the "architecture" and the "buildings," the cathedral and the ordinary houses surrounding it, for all the buildings as a group constitute the architecture of the Middle Ages. So, too, if we wish to understand the totality of the architecture of the contemporary city, we must consider all its component elements. For example, to understand Eugene, Oregon, we would need to examine the bicycle sheds and the bus transfer shelters that are an integrated part of the public transportation system. In this city, bicyclists can lock their bikes under a roof and transfer to motorized public transit. The bicycle sheds are part of a municipal ecological response, an effort to enhance the physical living environment by encouraging modes of transportation other than private automobiles.

Pevsner's emphatic distinction between architecture and building is understandable, considering the limits of his compact book, for it made the material he needed to cover more manageable. His view grew out of the extended influence of the nineteenth-century critic John Ruskin, who made the same distinction in the second sentence of his book, *The*

3. Lane Transit District Bicycle Shed, Eugene, Oregon,1984. Far from being an undistinguished shed, the bicycle cover here is part of a citywide network of shelters designed to encourage the use of bus transportation. Photo: L. M. Roth.

Seven Lamps of Architecture (London, 1849): "It is very necessary, in the outset of all inquiry," wrote Ruskin, "to distinguish carefully between Architecture and Building." Ruskin wanted to concentrate his attention on religious and public buildings, but at the same time he recognized that architecture was a richly informative cultural artifact. In another of his many writings, the Preface to *St. Mark's Rest* (London, 1877), he cautioned that "great nations write their autobiographies in three manuscripts—the book of their deeds, the book of their words, and the book of their art. Not one of these books can be understood unless we read the other two; but of the three, the only quite trustworthy one is the last."[6] As Ruskin correctly recognized, to understand the architecture of the past, of any period or culture not our own, we must absorb the history and literature of that period and place, the record of its acts and thoughts, before we can understand fully what message the architecture conveys. Architecture, then, is like written history and literature—a record of the people who produced it—and it can be "read" in a comparable way. Architecture is a nonverbal form of communication, a mute record of the culture that produced it.

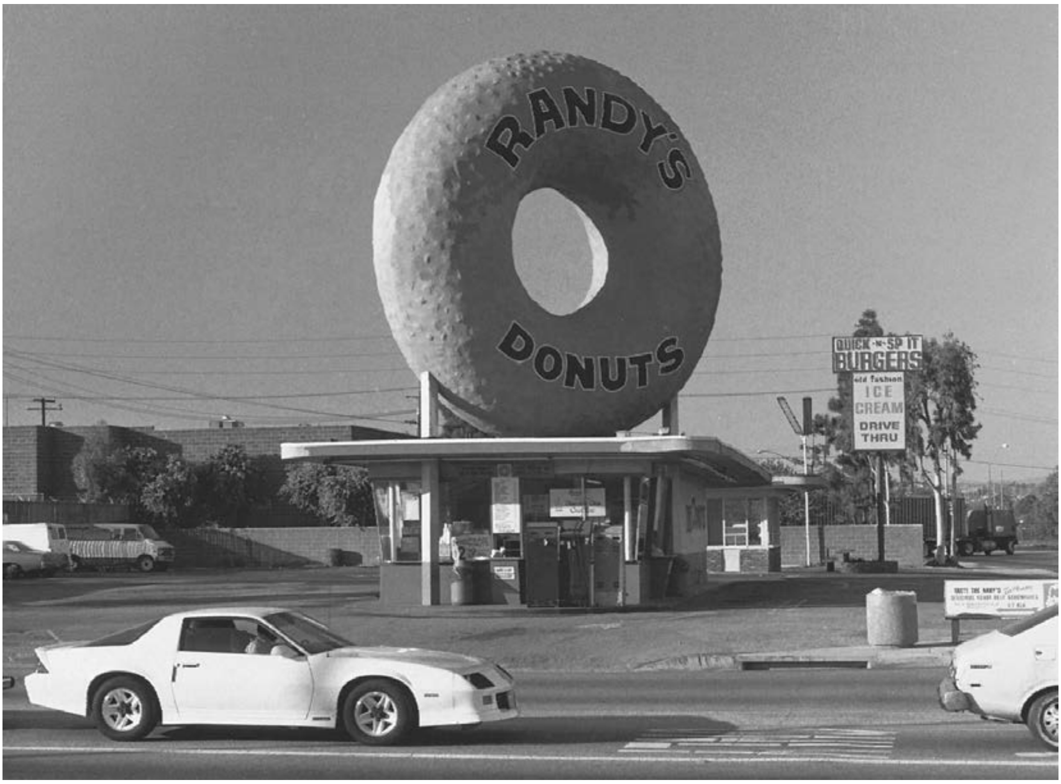
These ideas—the totality of the built environment as architecture, and the environment as a form of dialogue with the past and future—underlie this book. Architecture is understood to be the whole of the human-built environment, including buildings, cities, urban spaces, and created landscapes. And while it is not possible in a book of this size to examine in detail all types of buildings in all ages, the reader needs to keep in mind the idea that the broad spectrum of building of any period, and not just a few special buildings, constitutes its architecture.

Building is a conscious act that embodies countless reflective, evaluative choices. These choices are what distinguish human building from birds' nests and beehives, for these animals build as the result of genetic programming. It could be said, as a counterargument, however, that male bower birds build their elaborate courting enclosures by making deliberate choices of what colorful or light-catching embellishments to add. Humans also build to satisfy a felt need, but even as they do so, they give expression

4. Lincoln Cathedral, Lincoln, England, 1192–1280. This building was constructed as a public demonstration of both church power and civic pride. Photo: Edwin Smith, London.

to feelings and values; they are expressing in wood, stone, metal, plaster, and plastic what they believe to be vital and important, whether it is a bicycle shed or a cathedral. It may be a message clearly understood and deliberately incorporated by both client and architect, or it may be an unconscious or subconscious statement, decipherable by a later observer. Hence, the US Capitol in Washington, DC, has as much to tell us about the symbolism of republican government in the nineteenth century as the World Trade Center in New York City once told us about American capitalism and soaring urban land values in the twentieth century. But equally important as a cultural artifact and as architecture is the Big Donut Shop in Los Angeles, built in 1954 by Henry J. Goodwin [5], for it reflects Americans' love of the private automobile and their desire for instant alimentary gratification.

Architecture is the unavoidable art. We deal with it every waking moment when not in the wilderness; it is the art form we inhabit. Perhaps this familiarity causes us to think of architecture as only a utilitarian agent, as simply the largest of our technical contrivances, requiring of us no more thought than any other appliance we use throughout the day. And yet, unlike the other arts, architecture has the power to affect and condition human behavior; the color of walls in a room, for example, can help determine our mood. Architecture acts on us, creating in some buildings a sense of awe such as one might feel while walking among the huge stone columns of the hypostyle hall of



5. Henry J. Goodwin, Big Donut Shop, Los Angeles, California, 1954. Photo: L. M. Roth.

the Egyptian temple at Karnak [p. 186]; or being pulled forward, as if by gravity, to the center of the vast space covered by the dome of the Pantheon in Rome; or sensing the flow of space and a connection to the earth as in Frank Lloyd Wright's Fallingwater [1.8, 4.24, 10.21].

Part of our experience of architecture may be based largely on our innate enjoyment of these physiological responses—which the skillful architect knows how to manipulate to maximum effect. But the fullest experience of architecture comes from expanding our knowledge of a building, its structure, its history, and its meaning, while reducing our prejudices and ignorance.

We should remember, too, that architecture, besides providing shelter, is symbolic expression. As Sir Herbert Read wrote, art is "a mode of symbolic discourse, and where there is no symbol and therefore no discourse, there is no art."[7] This symbolic content is most easily perceived in religious and public buildings, where the principal intent is to make a broad and emphatic proclamation of communal values and beliefs. If a building seems strange to someone, it is likely because the symbol being presented is not in that person's vocabulary. To those of us who have no Gothic architectural heritage, the reconstruction of the Houses of Parliament in London in the mid-nineteenth century in the medieval Gothic style might seem at first puzzlingly anachronistic. Yet it becomes more understandable when we remember that actual Gothic buildings were to be incorporated into the new Parliament complex and, more importantly, that Gothic architecture was perceived by nineteenth-century Englishmen as inherently English and thus had a long connection with parliamentary government. The argument could be made that, for them, Gothic was the *most* appropriate style.

Architecture is the science and the art of building. To understand more clearly the art of architecture and its symbolic discourse, we are best served by first gaining an understanding of the science of architectural construction. So, in the following chapters of Part I, the pragmatic concerns of space, function, structure, and design are explored. Then, in Part II, the symbolism of architecture as a nonverbal means of discourse is taken up. Interspersed throughout are six brief essays on world architecture, placed within the text where intersections between differing traditions are discussed.

Stonehenge, 2600–2400 BCE. Salisbury Plain, Wiltshire, England. One of the trilithons ("three stones"), with uprights standing 13 feet high, emblematic of the essence of architectural construction. Photo courtesy of Marian Card Donnelly.

Part I

The Elements of Architecture

1.12. Salisbury Cathedral nave, Salisbury, England, 1220–1266, Interior, nave. The repeated bays and strong horizontal layering draw the eye strongly along the axis, illustrating directional space. Photo: Anthony Scibilia/Art Resource, NY.

Architecture

The Art of Shaping of Space

The history of architecture is primarily a history of man shaping space.

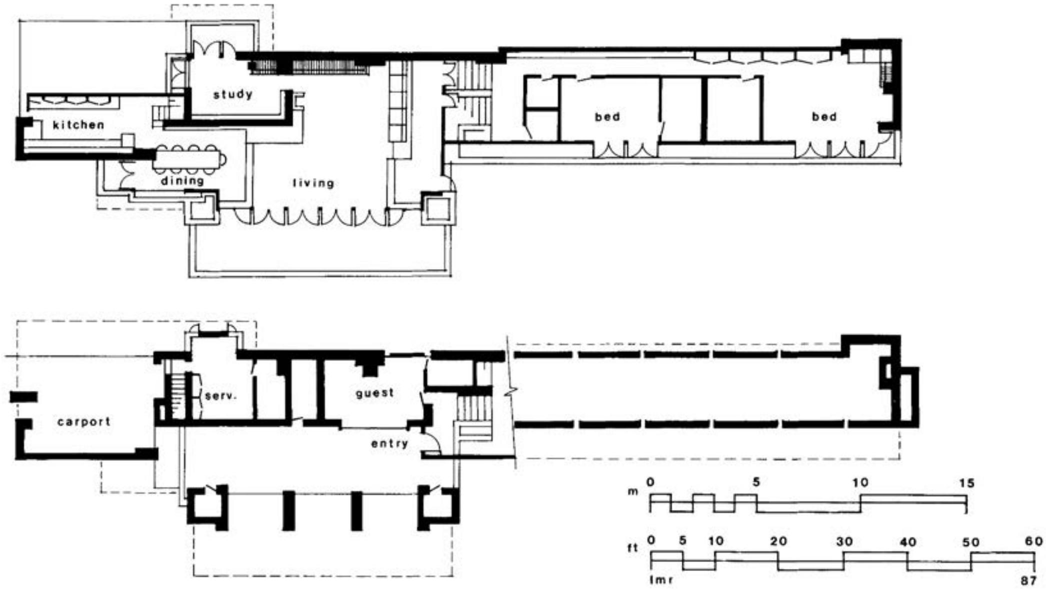
—*Nikolaus Pevsner,* An Outline of European Architecture, *1943*

Today, at the dawn of the twenty-first century, digital artists can create a virtual image of the inside of a building. This is a most useful operation, suggesting what a building will be like long before costly construction is begun. But the total physiological, kinesthetic, sensory, and psychological experience is missing. Architecture must be experienced by walking around and into it.[1]

Architecture is the art into which we walk, the art that envelops us. Besides making a distinction between "architecture" and "building"—a concept with which there might be disagreement—Nikolaus Pevsner's further observation that architecture is the shaping of space is undisputed.[2] As he notes, painters and sculptors affect our senses by creating changes in patterns, and in proportional relationships between shapes, through the manipulation of light and color, but only architects shape the space in which we live and through which we move. Frank Lloyd Wright believed space was the essence of architecture and, early in his career, discovered that the same idea had been expressed centuries earlier by Laozi (Lao-Tse) and paraphrased in 1906 by Okakura Kakuzo in *The Book of Tea*. The reality of architecture, Kakuzo observed, lay not in the solid elements that seem to make it but in the empty space defined by those elements: "The reality of a room, for instance, was to be found in the vacant space enclosed by the roof and walls, not in the roof and walls themselves. In just the same way, the usefulness of a water pitcher dwelt in the emptiness where the water might be put, not in the form of the pitcher or the material out of which it was made."[3]

The architect manipulates space of many kinds in many ways. There is first the purely ***physical space***, which can be imagined as the volume of air bounded by the walls, floor, and ceiling of a room. This can be easily computed and expressed as so many cubic feet or cubic meters. But there also is ***perceptual space***—the space that can be perceived or seen. Especially in a building with walls of glass, this perceptual space may extend well beyond the boundary of the glass and may be impossible to quantify. Related to perceptual space is ***conceptual space***, which can be defined as the mental map we carry around in our heads, the plan stored in our memory. We navigate through our house, workplace, or community by referring to our mental map of its conceptual space. Buildings that work well are those whose plans and spatial arrangements can be easily grasped and held by users in their mind's eye and through which they can move about easily with a kind of inevitability; such buildings can be said to have clear conceptual space. The architect can also decisively shape ***behavioral space***, or the space we actually move through and use. Behavioral space can be imagined as a clearly defined room with four walls, a ceiling, and a floor—an easily calculated volume. But now picture a large hole that has been cut into the floor, with the opening covered by a cloth. The physical space has not changed at all, but a person now must walk around the periphery of the room instead of diagonally across it. The behavioral space has been changed.

All the types of space just mentioned can be illustrated by examining the Lloyd Lewis House in Libertyville, Illinois, 1939, by Frank Lloyd Wright [1.1]. From within the living room, as we look toward the fireplace, the view is defined by the built-in bookcases, the brick of the fireplace mass, the floor, and the ceiling [1.2]. All the surfaces are opaque and suggest a clear sensation of confinement and protection; the physical space is evident. As we look left, however, the view stretches out through a



1.1. Frank Lloyd Wright, Lloyd Lewis House, Libertyville, Illinois, 1939. Plans of the lower level and the upper living level. Drawing: L. M. Roth.

1.2. Lloyd Lewis House. View of the living room, looking toward the fireplace; from this vantage point, the space is sharply defined and suggests comforting enclosure. Photo by Hedrich Blessing. Chicago History Museum, negative HB-19240-C.

1.3. Lloyd Lewis House. View of the living room, looking toward the screen of French doors; from this direction, a person's view can pass into the countryside, into a large perceptual space. Photo by Hedrich Blessing. Chicago History Museum, negative HB-06485I.

broad bank of glazed French doors to the meadow and woodland beyond [1.3]. From this vantage point, the perceptual space reaches out across the field and to the sky, as far as the eye can see. Moving toward the dining area, we see the built-in dining table, fastened to a brick pier [1.4]. To move from the living room through the dining area and into the kitchen, we must move around that built-in table, since it cannot be moved. In purely physical terms, the table takes up very little volume, a very few cubic feet compared to the many hundreds of cubic feet in the combined living and dining space, but in behavioral terms, it determines in a decisive way how we can move about in that space.

Architectural space, in all its various forms, is a powerful determinant of behavior. Winston Churchill understood this well when he addressed the House of Commons in 1943, noting that first "we shape our buildings, and afterwards our buildings shape us."[4] What prompted his observation was a debate on rebuilding the severely burned House of Commons. The chamber in which the Commons had been meeting for nearly a century was gutted by a German bomb in 1941, and Parliament was considering alternative ways of reconstructing the chamber. When Parliament had first begun to meet in the thirteenth century, it had been given the use of rooms in medieval Westminster Palace and had occupied the palace chapel. A typical Gothic chapel, it was narrow and tall, with parallel rows of choir stalls facing each other on either side of an aisle down the center. The members of Parliament sat in the choir stalls, dividing themselves into two groups: on one side the government in power and on the other the loyal opposition. Seldom did members take the brave step of crossing the aisle to change, and hence visibly declare, their new political allegiance. When the Houses of Parliament had to be rebuilt after the catastrophic fire of 1834, the old Gothic archetype had been followed, and Churchill argued that this ought to be done again in 1943. There were those who advocated rebuilding

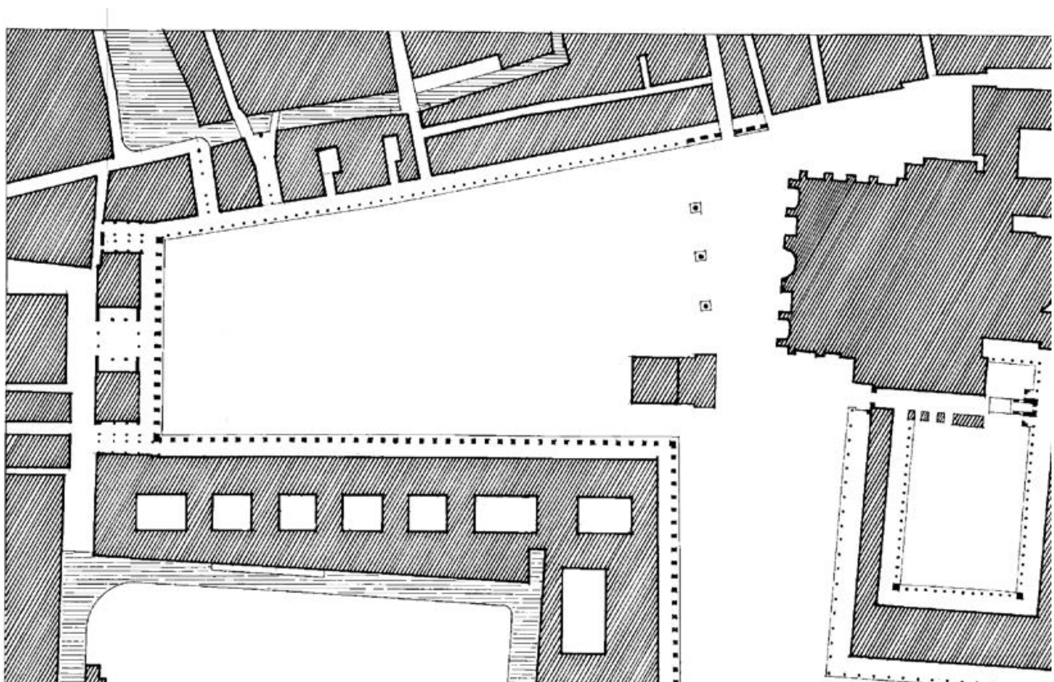
1.4. Lloyd Lewis House. View of the dining area, showing the built-in table; the fixed table clearly determines how a person is directed through this space, thereby determining behavior. Photo by Hedrich Blessing. Chicago History Museum, negative HB-06485i.

the House with a fan of seats in a broad semicircle, as used in legislative chambers in the United States and France. But Churchill convincingly argued that the essence of English parliamentary procedure had been permanently shaped by the physical environment in which it had first been housed: to so fundamentally change that environment, to give it a different behavioral space, would be to change the very nature of parliamentary discourse and government. The English had first shaped their architecture, he said, and that architecture in turn had shaped English government and history. Through Churchill's persuasion, the Houses of Parliament were rebuilt with the old arrangement of parallel seats looking across a central aisle [1.5].

These concepts of *physical, perceptual,* and *behavioral* space have been applied here to spaces within individual buildings. With slight redefining, such terms can be used to describe experiences in large outdoor spaces as well. Consider the huge outdoor living room in Venice—the Piazza di San Marco [1.6, 1.7]. From the middle of the piazza as one looks west, the space is clearly defined and enclosed by the walls of the buildings on either side and straight ahead. Much the same is true if one turns around and faces east, toward the Church of San Marco, but with this perspective the light coming from the right gives a hint of an opening. Moving eastward, approaching the front of the church, one must move around the soaring tower of the Campanile, which stands in the piazza and determines one's walking behavior. Once around the Campanile, one sees the smaller piazzetta, which extends toward the south. Past the pair of freestanding columns that mark the boundary of the piazzetta, one's view crosses the canal, and the enclosed physical space opens up in a virtually boundless perceptual space.

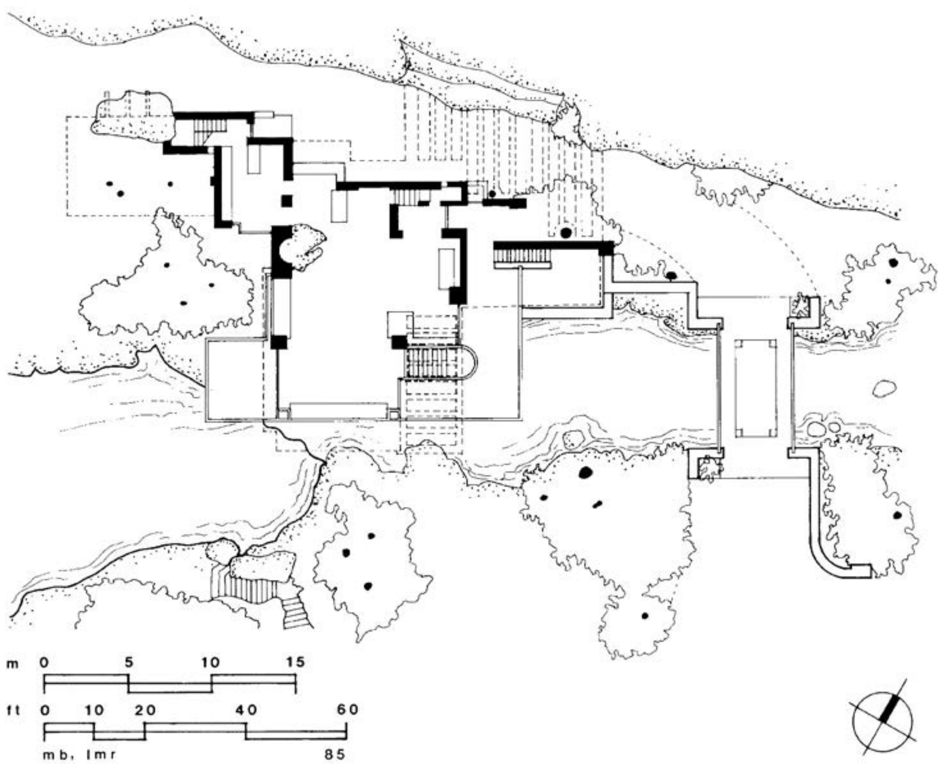
The plan of the Lloyd Lewis House also illustrates clearly the possibility of fluidity of space—***interwoven spaces*** as contrasted with ***static spaces***. Wright was a master of interweaving connected spaces, creating what has been described as fluid or flowing spaces, beginning in his Prairie Houses of 1900 to 1910 and continuing in Fallingwater, near Mill Run, Pennsylvania, built for the Kaufmann family in 1936–1938 [1.8]. In these houses, there is no isolation of the living and dining rooms or the library alcove; all are loosely defined as component areas of a larger fluid space. Wright developed this

1.5. Sir Charles Barry and A. W. N. Pugin, House of Commons chamber, Houses of Parliament, London, England, 1836–1870; restored 1946. Following extensive damage after being hit by a German bomb, the House of Commons chamber, an example of the impact of behavioral space, was rebuilt at the urging of Winston Churchill nearly exactly as it had been, since to have changed it, he argued, would change the operation of parliamentary governance. Photo: © Richard Bryant/ Arcaid/Corbis.



1.6. Piazza di San Marco, Venice, Italy, 830–1640. Plan of piazza. Drawing: L. M. Roth.

1.7. Piazza di San Marco. This exterior enclosure contains aspects of physical, perceptual, and behavioral forms of space. Photo: © Yann Arthus-Bertrand/Corbis.

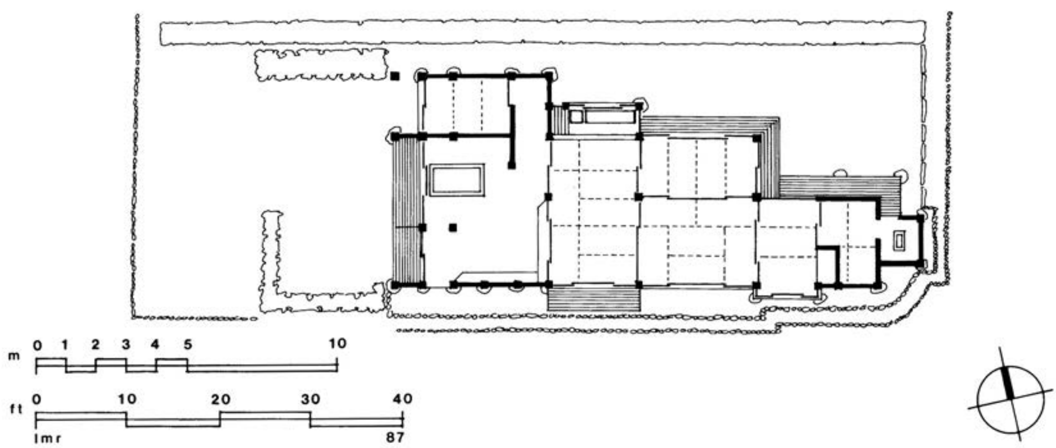


1.8. Frank Lloyd Wright, Edgar Kaufmann residence, Fallingwater, near Mill Run, Pennsylvania, 1936–1938. Plan. Here space is molded in a fluid way; it opens out through the banks of glass on the south to the wooded ravine. Drawing: M. Burgess and L. M. Roth.

1.9. Shokin-tei (Pine-Lute Pavilion), Imperial Villa of Katsura, near Kyoto, Japan, 1645–1649. View from inside the pavilion out toward the Middle Islands. This view indicates the sense of difference between internal enclosed space and the expanding external space in the garden. Photo from: Akira Naito, Katsura: A Princely Retreat *(Tokyo, 1977).*

conception of space as a result of studying Japanese architecture. In the traditional Japanese house, a wooden structural frame supports rails along which screens slide. These screens define the "rooms" of the Japanese house by being closed, or they permit the house to be opened up by being pushed back [1.9, 1.10, Plate 1]. In the traditional Japanese house, there are no solidly enclosed rooms in the conventional Western sense. The influence of Wright's earlier decompartmentalized Prairie House plans on European architects is illustrated in Ludwig Mies van der Rohe's German Pavilion for the international exposition held in Barcelona in the summer of 1929 [19.20]. There are no rooms in the ordinary Western sense here, either, but rather a series of planes arranged in space, capable of defining a group of interrelated areas.

Conversely, more traditional European or American houses of the turn of the century were subdivided into discrete rooms, each intended to accommodate a clearly understood function: for lounging, dining, reading, receiving guests, and so forth. One example is the William F. Fahnestock House at Katonah, New York, 1909–1924 (now demolished), by Charles A. Platt, with its cluster of individual rooms [1.11]. This was similar in many ways to Platt's Harold F. McCormick House in Lake Forest, Illinois, 1908–1918. Originally, a different house had been designed for the McCormicks in 1908 by Frank Lloyd Wright (it would have been



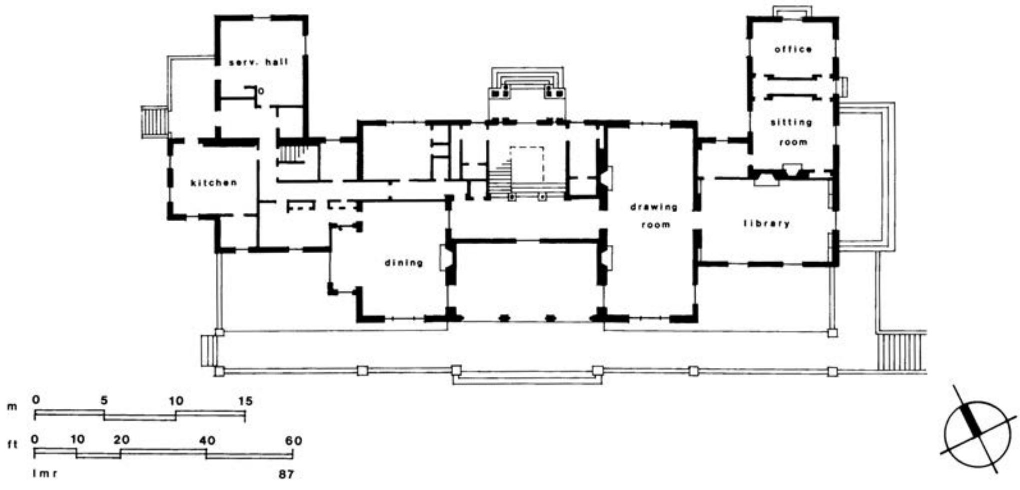
1.10. Shoi-ken (Laughing Thoughts Pavilion), Imperial Villa of Katsura, 1645–1649. Plan. The plan arrangement, based on the module of the tatami floor mat, and the use of sliding wall screens, allows for many spatial arrangements. Drawing: L. M. Roth.

his largest Prairie House ever), and in it, he devised a number of broad, interwoven spaces that opened up and flowed into one another. As it happened, Mrs. Edith McCormick wanted a more formal and traditionally compartmentalized lifestyle, and for that, Platt's compartmentalized plan proved more suitable.

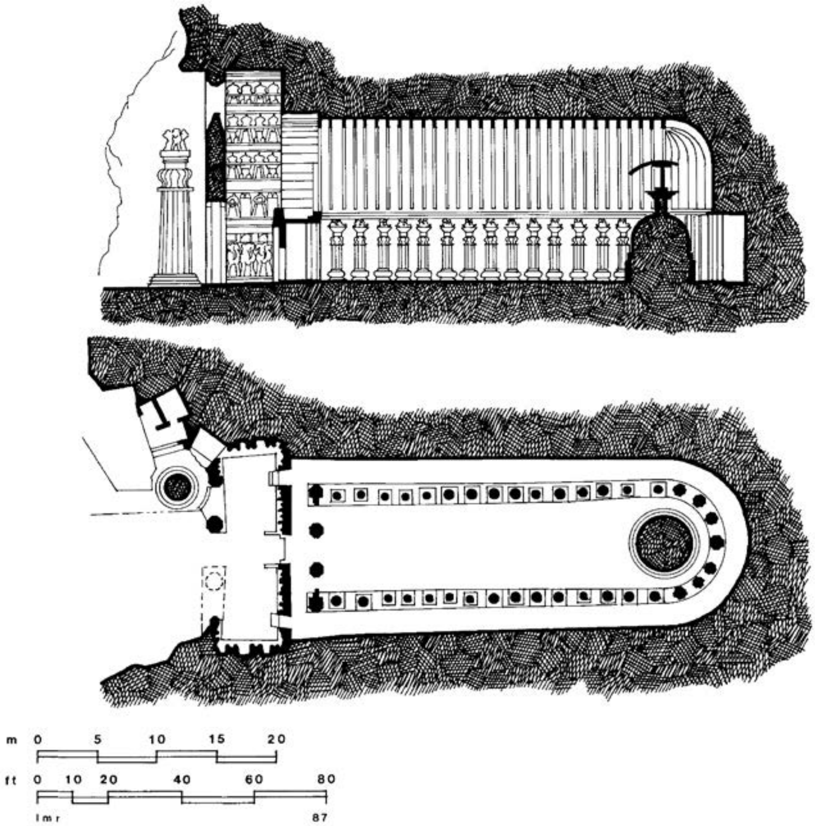
Space can determine or suggest patterns of behavior by its very configuration, regardless of barriers or hindrances. We speak of ***directional space***, as distinct from ***nondirectional space***. The plan of the German Pavilion at Barcelona effectively illustrates nondirectional space, for there is no one obvious compelling path through the building but, rather, a variety from which to choose [19.21]. In contrast, in a Gothic cathedral, the emphatic axis directs movement toward the single focus—the altar at the end [1.12, see p. 8]. This gravitational pull seems especially strong in English cathedrals, such as the cathedral at Salisbury, with its superimposed and emphasized horizontal lines creating a strong visual focus on the altar in the distance.

We can speak, too, of ***positive*** and ***negative space***. A positive space is one that is conceived as a void, then wrapped in a built shell specifically erected to define and contain it. One example would be the plaster interior shell of the pilgrimage church of Vierzehnheiligen (Fourteen Saints), in the countryside of Franconia, southern Germany, 1742–1772, by Johann Balthasar Neumann [16.45, p. 414]. There is nothing structurally substantial about this suspended plaster shell; it is there solely as an envelope to define a particular space and shape a particular architectural and religious experience. In contrast, we can speak of negative space, created by hollowing out a solid that already exists. The earliest ready-made habitations of the human species may have been naturally hollowed-out caves, memories of which linger in such rock-cut caves as those at Ajunta and Karli, India, carved out from 2000 BCE through 650 CE [1.13].[5] In these cave temples, the space was created by laboriously cutting away the existing solid rock to create the desired void, often leaving columns and vaults that resemble buildings built of wood.

The concepts of positive and negative space can be applied in a somewhat analogous way to urban space as well. In this context, negative space might be defined as open space that is simply left over after the construction of surrounding buildings, but positive urban space would then be defined as deliberately and abstractly conceived and constructed in accordance with a preconceived plan. These two differing ideas can be seen in the city of Florence, Italy. The major public space, the Piazza della Signoria, is in front of the principal municipal building, the medieval Palazzo Vecchio, 1298–1310, which juts out into the irregularly shaped open space [1.14]. The irregular Piazza della Signoria, given shape as disparate buildings were erected over several centuries, could be described as a resultant negative space. However, as the Renaissance developed in Florence during the following century, an entirely new attitude toward space and its definition arose there—a notion of space closely related to the invention of mathematical perspective in painting and to the grid concept being used in contemporaneous mapmaking. In 1419, when Filippo Brunelleschi



1.11. Charles A. Platt, William F. Fahnestock House, Katonah, New York, 1909–1924 (demolished). In this residence the spaces are clearly compartmentalized for separation of activities and for acoustical privacy. Drawing: L. M. Roth.

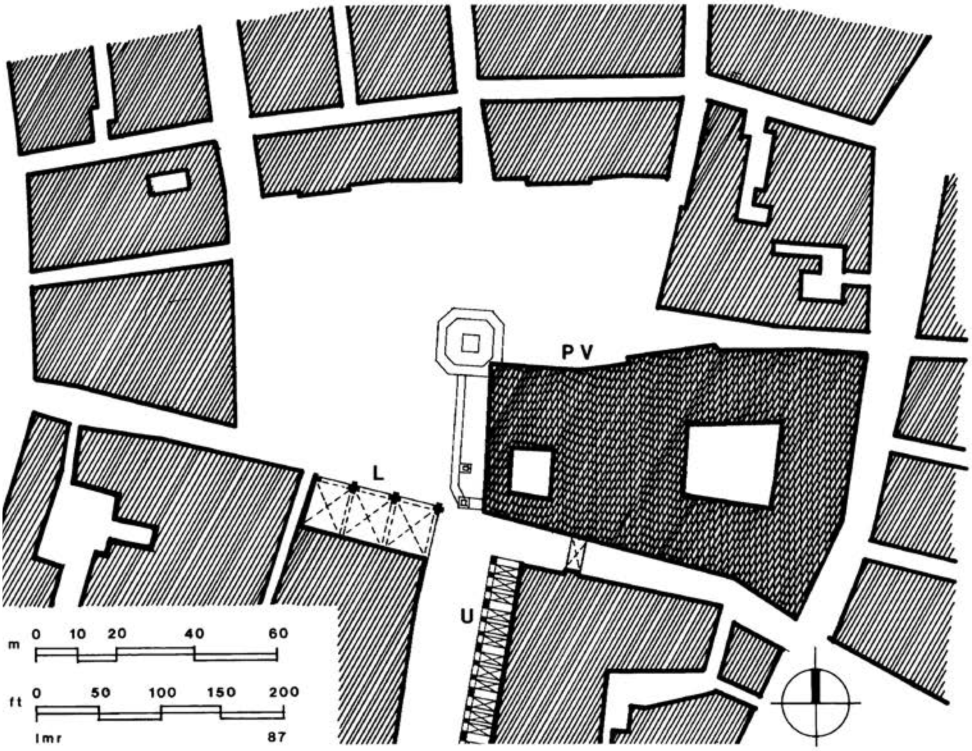


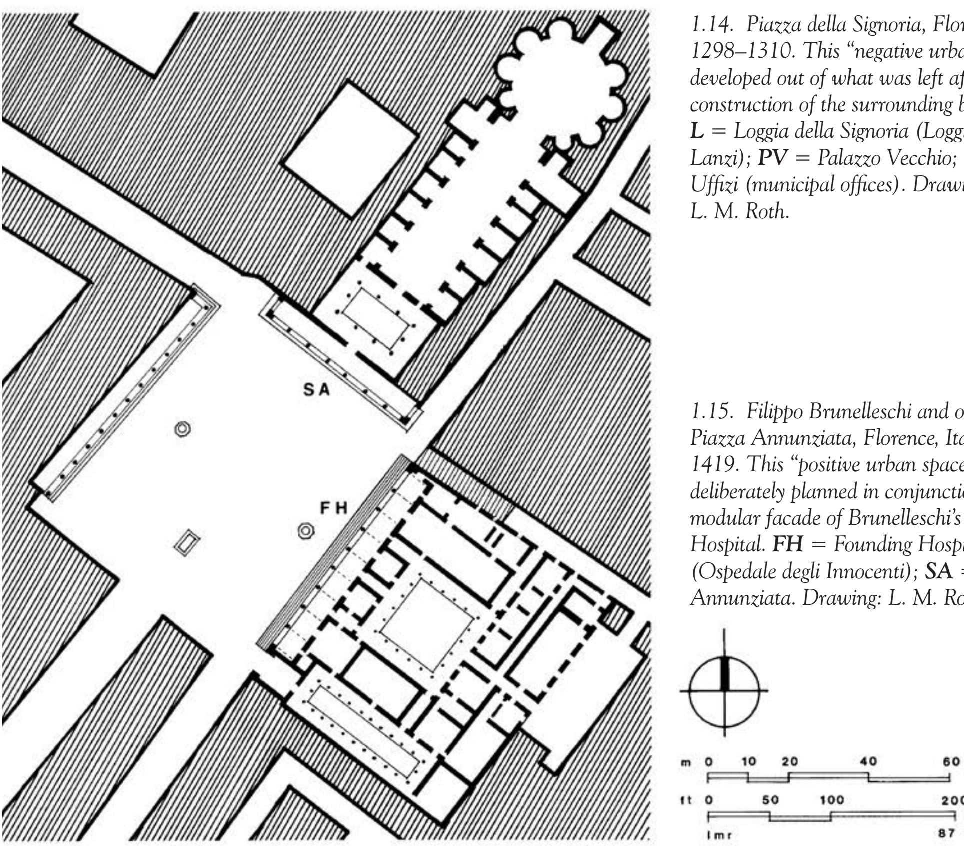
1.13. Cave temple, Karli, India, c. 100 CE. Plan and section. This example of "negative space" was created by hollowing out the solid rock of the cliff, leaving columns and a vaulted chamber inspired by traditional wooden architecture. Drawing: L. M. Roth, after Susan and John Huntington, The Art of Ancient India *(New York, 1985).*

designed his Ospedale degli Innocenti (Foundling or Orphans Hospital) about half a mile north of the Piazza della Signoria, he divided the facade into a row of identical square arcade modules. The space in front of the hospital was then opened up into an urban square, the Piazza Annunziata, and the architects of all the surrounding subsequent buildings based their facades on the Brunelleschian arcade module. The result was that the piazza became an orderly rectangle governed by an implied mathematical grid that seems to determine the placement of every part of its defining walls [1.15 and 15.7]. The Piazza Annunziata could be described as a positive space, defined in accordance with preconceived geometric ideas.

There is still another social way of defining space, and although it might not be thought of as strictly architectural, the architect nevertheless is well advised to take it into account. This is ***personal space***, the distance that members of a particular species naturally and automatically put between themselves. This is illustrated by the way birds space themselves along the ridgeline of a building or on a telephone wire, or by the way humans space themselves when resting on a bench in a shopping mall [1.16].[6] For most animals, this zone of comfort is genetically programmed. On rocky coastal outcroppings, seals and walruses heap themselves on top of each other in apparent bliss, while swans and hummingbirds generally take great care to avoid contact with or close proximity to others of their kind. Experiments in which animals are forced to exist in crowded conditions, in conflict with their internal genetically programmed code, can produce seriously aberrant behavior.

Humans, however, have proven themselves to be extremely flexible in their determination of personal space; they seem not to have any particular programmed genetic spatial code; or perhaps humans train themselves to ignore biological alarms. Instead, among humans, personal space is culturally determined and is largely fixed in childhood,





1.14. Piazza della Signoria, Florence, Italy, 1298–1310. This "negative urban space" developed out of what was left after the construction of the surrounding buildings. **L** *= Loggia della Signoria (Loggia dei Lanzi);* **PV** *= Palazzo Vecchio;* **U** *= Uffizi (municipal offices). Drawing: L. M. Roth.*

1.15. Filippo Brunelleschi and others, Piazza Annunziata, Florence, Italy, begun 1419. This "positive urban space" was deliberately planned in conjunction with the modular facade of Brunelleschi's Foundling Hospital. **FH** *= Founding Hospital (Ospedale degli Innocenti);* **SA** *= Santa Annunziata. Drawing: L. M. Roth.*

1.16. An example of personal space. This photo taken in Toronto (at the Eaton Centre shopping mall) clearly indicates the degree of acquaintance between individuals. While the young couple snuggle together closely, the other disparate adults keep as much distance between each other as is possible on this crowded bench. Photo courtesy of photographer John Ferri, from his 2011 photo series "Bench."

so that later in life, enforced changes in personal distance may produce severe anxiety. Typically Italians and the French prefer much more densely packed social arrangements, as in the seating in outdoor cafés, than do northern Europeans, Americans, or the English. Asians, however, customarily place themselves in extremely dense congregations. Even within the same culture, however, different sets of rules are adopted by males and females. Two unacquainted men will maintain a greater distance than will two unacquainted women, particularly in the United States. If an architect should happen to violate these unstated dimensions of personal space—for example, by placing workers in an office arrangement too close together, even if every other architectural variable is optimized—the result may be an environment that is resisted by the users and hence detrimental to the entire business operation.

Failure to understand these nuances of personal space and similar cultural factors creates a particular risk when an architect is designing for users belonging to a culture or social group to which he or she does not belong. This problem was vividly demonstrated by the design of the Pruitt-Igoe public housing of Saint Louis, Missouri, 1952–1955. This housing had been designed by well-intended, well-trained middle-class architects for very low-income residents but was done in such a way that its inhabitants could not visually supervise either the public spaces or the hallways in their long apartment blocks. The designers had little or no idea of how the intended residents might use (or misuse) the buildings. As a result, muggings steadily increased once the complex was occupied. In growing numbers, prospective residents simply began refusing to live there. Eventually, the housing proved so hazardous to inhabit that the city destroyed it in 1972 [19.56].[7]

In short, architects must think in terms of space: the space around and outside of a building, the space that people walk through when moving inside a building, the "borrowed perceptual space" that they can see but perhaps not directly access, the behavioral impact of that space, and the personal spatial interval that people desire to have between each other. The shaping of usable space is the primary function of architecture.

2.5. Adler & Sullivan, Wainwright Building, Saint Louis, Missouri, 1890–1891. The arrangement of the parts of this office building clearly expressed the differing functions of the parts of the building, effectively demonstrating what Sullivan meant when he wrote later that "form ever follows function." Photo by Hedrich Blessing. Chicago History Museum, negative HB-19240-C.

"Commoditie"

Building Functions

Haec autem ita fieri debent, ut habeatur ratio firmitatis, utilitatis, venustatis. (Now these [aspects of building] should be so carried out that account is taken of strength, utility, grace.)

—*Marcus Vitruvius,* De Architectura, *c. 25 BCE*

In architecture as in all other operative arts, the end must direct the operation. The end is to build well. Well-building hath three conditions: Commoditie, Firmeness, and Delight.

—*Sir Henry Wotten,* The Elements of Architecture, *1624*

The basic definition of architecture framed by the ancient Roman architect Marcus Vitruvius Pollio (c. 90–c. 20 BCE), in about 25 BCE, has never been improved upon. However, Vitruvius noted that architecture had been the subject of critical writing long before his time. Several Greek architects compiled books on their profession during the centuries before the Common Era, leading up to the text written by Vitruvius. He listed sixty-three Greek and Roman books on architecture that he consulted, some dating back to the fourth century BCE.[1] Sadly, with time and periodic upheavals, both natural and human-caused, all but the treatise by Vitruvius himself have been lost. Consequently, his sole surviving book has carried extraordinary importance for Western architecture.

The basic elements of architectural design described by Vitruvius have remained essentially unchanged since the time that humans first began to shape their environment. Architecture, Vitruvius wrote, must provide utility, firmness, and beauty or, as Sir Henry Wotten later paraphrased it in the seventeenth century, commodity, firmness, and delight. By utility, Vitruvius meant the functional arrangement of rooms and spaces so that there is no hindrance to use and so that a building is perfectly adjusted to its site. Firmness referred to foundations that were solid and to building materials being used wisely to do their required work. Beauty meant that "the appearance of the work is pleasing and in good taste, and [that] its members are in due proportion according to correct principles of symmetry."[2] No matter how this notion of beauty, or *venustas,* may have been construed in the intervening centuries, the Vitruvian triad still remains a valid primary summary of the elements of good architecture. The ultimate tests of architecture are these: First, does a building work by supporting and reinforcing its functional use; does it enhance its setting? Second, is it built well enough to stand up; will its materials weather well? But third and equally important, does the building appeal to the visual senses; does it provide a full measure of satisfaction *and* enjoyment—does it provide delight?

In the creation of architecture, there is another fundamental triad, however, that Vitruvius does not discuss directly. First is the person or group who calls the building into being, the ***client*** who provides the commission. The client is the source of funding—and of all the arts (except the performance of large-scale musical and dance works, and making motion pictures), architectural building is the most expensive to produce. And in terms of all aspects of building, it is the client who ultimately calls the shots. Second is the ***architect*** or designer who gives the client's wishes physical form, whether on clay tablets, papyrus, parchment, or paper or in bits of binary memory. To this should be added the assistant architects, the scores of drafts-people, cost estimators, materials specialists, and many other employees in a large architectural office. Third is the even larger army of ***builders*** who carry out the construction process following the architect's instructions: those who excavate and build the foundations, fabricate the structural frame and walls, apply the external and internal surface finishes, install the complex plumbing and mechanical systems (which today can easily account for half the cost of a building), and construct the furnishing called for by the architect. Architecture, in contrast to all the other durable arts, requires the services and contributions of many hundreds of participants, especially in large structures. Because of this commitment of energies and resources, building is no trivial or impulsive endeavor; it is a "bottom-line" activity, involving the expenditure of significant amounts of money. William A. Starrett, the general contractor of the Empire State Building, wrote in 1928 that "building skyscrapers is the nearest peace-time equivalent of war," so complex are the intertwined logistics of such construction. Architecture is arguably the most accurate, the most truly revealing, human cultural artifact.[3]

Function

The Vitruvian three-part definition of architecture, incorporating utility, firmness, and beauty, begins with the element that, on the surface, would appear most straightforward but that, since the mid-twentieth century, has proved extremely complex and multifaceted. This element is ***function***. Function, or the pragmatic utility of an object—its being fitted to a particular use—was a criterion analyzed by such Greek philosophers as Plato, Aristotle, and Xenophon.[4] Part of the difficulty we face is that there is only one word in English for function, whereas we need variations to describe different kinds of function. Our alternative has been to make compound words such as *circulatory function* or *acoustical function.*

Making the problem worse, in about 1920 the definition of function became restricted to a narrowly utilitarian or mechanical sense with the rise of what became called International Modern architecture—the "International Style," as it was christened in 1932 by Henry-Russell Hitchcock and Philip Johnson. Two models of this type of building are the AEG turbine factory, Berlin, 1908–1909, by Peter Behrens, and the Fagus factory, Alfeld, Germany, 1911, by Walter Gropius [2.1, 2.2]. In both of these buildings, the form was almost totally determined by a linear analysis of the internal industrial processes. In 1926, Gropius designed the new building for the Dessau (Germany) Bauhaus school, whose workshop wing exemplified the same industrial determinism [19.18]. At the same time, Gropius wrote of the new architecture: "A thing is determined by its nature and if it is to be fashioned so as to work properly, its essence must be investigated and fully grasped. A thing must answer its purpose in every way, that is fulfill its function in a practical sense, and must thus be serviceable, reliable, and cheap."[5] The Swiss-French architect Charles-Édouard Jeanneret (who wrote under the pen name Le Corbusier) described the functional inadequacy of the contemporary house, saying that, for the twentieth century and the new architecture demanded by it, "the house is a machine for living in."[6] The architect Bruno Taut summarized the intent of International Modern architecture in 1929: "The aim of architecture is the creation of the perfect, and therefore most beautiful, efficiency."[7] In short, beauty would result *automatically* from the expression of the leanest, strictest utility.

The problem that became increasingly manifest from the mid-twentieth century onward, however, was that few buildings (other than factories or other similar industrial structures) have the kind of internal process that can determine building form in such a direct, linear, and utilitarian way. Most human activities cannot be reduced to a kind of mechanical formula. And if the internal functional use is changed, does beauty shift? Stanley Abercrombie made an interesting observation regarding functional accommodation equating to beauty. He noted that Brunelleschi's Foundling Hospital in Florence, Italy, was essentially built by 1427 but was not completely finished until January 1445 and, further, that it was not put into operation for the care of orphans until February 5 [15.7]. When did it become beautiful—in 1427 or 1445, in January or February?[8] Furthermore, simply accommodating all the utilitarian functional requirements ignores much. The American architect Louis I. Kahn believed that "when you make a building, you make a life. It comes out of life, and you really make a life. It talks to you. When you have *only* the comprehension of the function of a building, it would not become an environment of a life."[9]

Another problem we have had to face in the last two centuries is that few buildings have continued to accommodate the function for which they were originally designed. This has necessitated enlargements, modifications, or the construction of wholly new buildings, with the original building being converted to a new use. The temptation would be to say that an old building was never functional because it cannot easily accommodate the *new* use we want it to serve. It may, in fact, have accommodated its original use very well.

An alternative is to design a building so that any possible future activity can be accommodated. This approach was taken in the mid-twentieth century

2.1. Peter Behrens, AEG Turbine Factory, Berlin, Germany, 1908. Behrens hoped in such factory buildings to create a more noble architecture, to raise the design of the factory to a higher aesthetic plane as a type to inspire all architecture. Photo: Foto Marburg/Art Resource, NY.

2.2. Walter Gropius and Adolf Meyer, Fagus Factory administrative wing, Alfeld-an-der-Leine, Germany, 1911–1912. Gropius followed the direction of his teacher Behrens in using an industrial expression for the administrative office wing of the factory. Photo: Vanni Archive/Art Resource, NY. © Artists Rights Society (ARS), New York/ VG Bild-Kunst, Bonn.

by Ludwig Mies van der Rohe, who devised what he called the *Vielzweckraum,* the "all-purpose space" or "universal space." Indeed, Mies said that he and his associates did not fit form to function: "We reverse this, and make a practical and satisfying shape, and then fit the functions into it. Today this is the only practical way to build, because the functions of most buildings are continually changing, but economically the building cannot change."[10] This multifunctional approach is demonstrated in the huge single room of Crown Hall, the school of architecture of the Illinois Institute of Technology, Chicago, 1952–1956 [2.3]. While such a vast single room can indeed hold any variety of future activities, it does not function at all well acoustically, for a sound generated in any part of the room ripples and reverberates through the entire space. Mies van der Rohe put into built form what a number of International Modernist architects had believed since the 1920s: that there was a universality of human needs and function. Le Corbusier even claimed it was possible to design "one single building for all nations and climates."[11] Unfortunately, this notion, so appealing in the mid-twentieth century because of its apparent simplicity, ignores the idea that function is socially and culturally determined and that a building's form is, in addition, a response to its psychological character, its physical setting, and the climate. As will be noted in Chapter 20, the impact of social convention and of regional and ethnic factors was rediscovered late in the twentieth century.

Function, therefore, has many components, the most basic of which is ***utilitarian*** or ***pragmatic utility***, or the accommodation of a specific use or activity in a specific room or space. A room might be used to contain a single bed for sleeping, it might be an office cell containing a desk, or it might be a large orchestral hall or some other public space.

Most buildings, of course, are composed of numerous rooms with interrelated functions. People therefore need to move from one room to another, so that almost as important as the utilitarian function is the ***circulatory function***, the making of appropriate spaces to accommodate, direct, and facilitate movement from area to area. When Charles Garnier designed the Paris Opéra, 1861–1875, he

2.3. Ludwig Mies van der Rohe, Crown Hall, Illinois Institute of Technology, Chicago, Illinois, 1952–1956. The interior consists of one vast room designed to house a variety of differing utilitarian functions. Photo: Rosenthal Collection, Department of Art History, Northwestern University.

2.4. Charles Garnier, Paris Opéra, Paris, France, 1861–1875. Stair Hall. For the Paris Opéra, social interaction, observing and greeting one another in the circulation spaces, was perhaps the primary function. Painting in the Musée Carnavalet, Paris; photo: Scala/Art Resource, NY.

analyzed just what the true function of the opera was. Certainly, he realized, Parisians went to hear the latest opera, but as Garnier also correctly understood, there was perhaps an even more important social reason for going to the opera—people went there to see and be seen. Its social function was as important as, or even more important than, its musical function. In fact, Garnier spent time at existing facilities around Paris examining how people moved, the numbers of people strolling in small groups, and how much distance the groups maintained between themselves as they moved about. These became his modules of measurement in designing the new Opéra. Further, as he quickly realized, the circulatory areas were every bit as important as the stage house and the auditorium, and as his plan clearly reveals, the grand stair, the foyer, and the vestibules make up a significant portion of the total floor area [2.4, Plate 2].

Similarly, when, toward the end of the nineteenth century, Louis Sullivan set out to design some of the first metal-framed commercial skyscrapers, he first examined just what this new type of building enclosed.[12] He discovered that there were five distinct utilitarian zones. The bottom-most was the basement, which contained machinery, storage, and other strictly utilitarian uses [2.5, p. 20]. Above that were four distinctly different functional uses: (1) the ground floor (containing the entrances, the elevator lobby, and shops at the perimeter facing the street); (2) a mezzanine level that might house support rooms for the shops below or offices opening onto an internal court; (3) the central section (floor upon floor of identical office cells arranged around the elevator); and (4) the terminating upper floor or floors (with elevator machinery, water tanks, storage, and other miscellaneous uses). For simplicity's sake, Sullivan himself often described this as being like a Classical column with a base, a mid-section shaft, and a capital or top. Since the new, tall office block was decidedly vertical in form, Sullivan argued that it was the architect's responsibility to emphasize this verticality and to express clearly the three functional zones, as he did in the Wainwright office building, Saint Louis, Missouri, 1890–1891.

Another architect who exploited the potential for expressive form by celebrating different functional activities was the Finnish architect Alvar Aalto. Among his best examples is one of the two buildings he designed in the United States: the library for the Benedictine monastery at St. Benedict near Mount Angel, Oregon, 1967–1971 [2.6]. Its principal pragmatic function is simply to contain books, which are arranged in bookcases that fan out northward from the central reading and circulation core. But its other support activities require different spaces, so on the north side are closely fitted rectangular offices and workrooms for the staff and to the south is a wedge-shaped auditorium. Each of the spaces is placed where it needs to be, is shaped in the best way to accommodate its use, and joins with the other spaces to form a harmonious whole.

A building often also has a symbolic function and makes a visible statement about its use. We usually expect some correspondence between what the building's use *appears to be* and what the use *actually is.* From the time of the Egyptians, Greeks, and Romans, up through Renaissance and Baroque architecture (that is, until about 1750), there were general guidelines regarding the form and appearance of buildings for ceremonial uses, but now there is much greater latitude. Since roughly 1920, therefore, architects have had to do two things simulta-

2.6. Alvar Aalto, Mount Angel Abbey Library, Mount Angel, Oregon, 1967–1971. The plan arrangement illustrates the differing functional activities: public entry, staff work areas, the auditorium, and reading/book storage. Drawing: L. M. Roth.

2.7. Mies van der Rohe, Boiler House, Illinois Institute of Technology, Chicago, Illinois, 1940. Heating plant building. With its tower-like chimney and high clerestory windows, this building has the physical attributes of early churches. Photo by Hedrich Blessing. Chicago History Museum, negative HB-12979B.

neously: invent original forms using new building technologies and, *at the same time*, devise appropriate new symbolic representations for the functions that their structures are housing. Often, the exploitation of new technologies has taken precedence over symbolic representation, and many mid-twentieth-century buildings truly tell us almost nothing about what goes on inside them. As an example, compare two buildings designed by Mies van der Rohe for the campus of the Illinois Institute of Technology (IIT) during 1940–1950 [2.7, 19.39]. One is the boiler house, perhaps the most utilitarian building of the ensemble; the other is the chapel. Yet nothing in either the form or the material of the chapel tells us how its function differs from that of the boiler house. In fact, using Early Christian buildings as prototypes, since one of the IIT buildings has high clerestory windows with a tower set to the side, we might mistakenly take the power plant for a church. Perhaps Mies van der Rohe was viewing the chapel as an all-purpose space and shunned the creation of a fixed image, allowing a new use to be accommodated later (in fact, by 1998, the IIT chapel had been converted to storage space). One might contrast the all-purpose IIT chapel with the interior of the Zion Lutheran Church, Portland, Oregon, 1950, by Pietro Belluschi [2.8], which to most observers suggests the character of a church without attempting to literally re-create Gothic vaults, crockets, or finials.

In the United States, the national Capitol Building in Washington established an image of governmental architecture, and since 1800, that image was recalled many times in successive new state capitols. One example is the Minnesota State Capitol, Saint Paul, 1895–1905, by Cass Gilbert [2.9]. Like the national capitol, this has two chambers on either side of a central circulation chamber that is capped by a tall dome. The Minnesota dome is specifically patterned after that of the Basilica of

2.8. Pietro Belluschi, Zion Lutheran Church, Portland, Oregon, 1950. Through the simple use of colored glass and laminated arches in wood, the traditional image of a church is suggested. Photo: © Wayne Andrews/Esto. All rights reserved.

Saint Peter in Rome, but the image conveyed is of a building in which the legislature does its business; the high dome of glistening white marble proclaims that function across the landscape of Saint Paul. In another more abstract example, when Eero Saarinen was engaged in 1956 to design a terminal building for Trans World Airlines at Idlewild (now Kennedy) Airport, New York, he set out to shape a building that, in architectural terms alone, would convey symbolically the mystery and magic of flight [2.10]. He and his associates conceived a building with great concrete shells cantilevering out from the center like giant wings, and interior surfaces that sweep, curve, and rise without sharp angles or corners. The fluid, sculptural architectural form psychologically prepared travelers for the miracle of flight as they passed through to board a plane.

Seldom is a building devoted wholly to one kind of function. Most buildings contain a mixture of purely utilitarian function and symbolic function. For any given building type, the mix of utilitarian and symbolic elements shifts over time. In the mid-twentieth century, a public library or a city hall might have been more purely utilitarian, but by the end of the twentieth century, just as in the nineteenth century, these buildings favored symbolic function much more. With the general spread of the various Postmodernism alternatives at the end of the twentieth century, such buildings have been given a greater component of symbolic functional expression.

Architecture also has important psychological and physiological functions to fulfill. For example, a hospital emergency waiting room is a place where most people experience great apprehension and distress. The architect might determine that creating a restful, domestic atmosphere like that of a home living room—perhaps with a view out to an enclosed garden, rather than an antiseptic, clinical space—would help reduce those anxieties. To mention just one example among many, the Riverbend Sacred Heart Medical Center in Eugene-Springfield,

2.9. Cass Gilbert, Minnesota State Capitol, Saint Paul, Minnesota, 1895–1905. Based on the Capitol in Washington, DC, this building clearly evokes the image of an American government building. Photo: L. M. Roth.

2.10. Eero Saarinen, Trans World Airlines Terminal, John F. Kennedy Airport, New York, NY, 1956–1962. With its soaring cantilevered concrete wings, Saarinen endeavored to shape in the TWA Terminal a symbolic representation of the magic of flight. Photo: L. M. Roth.

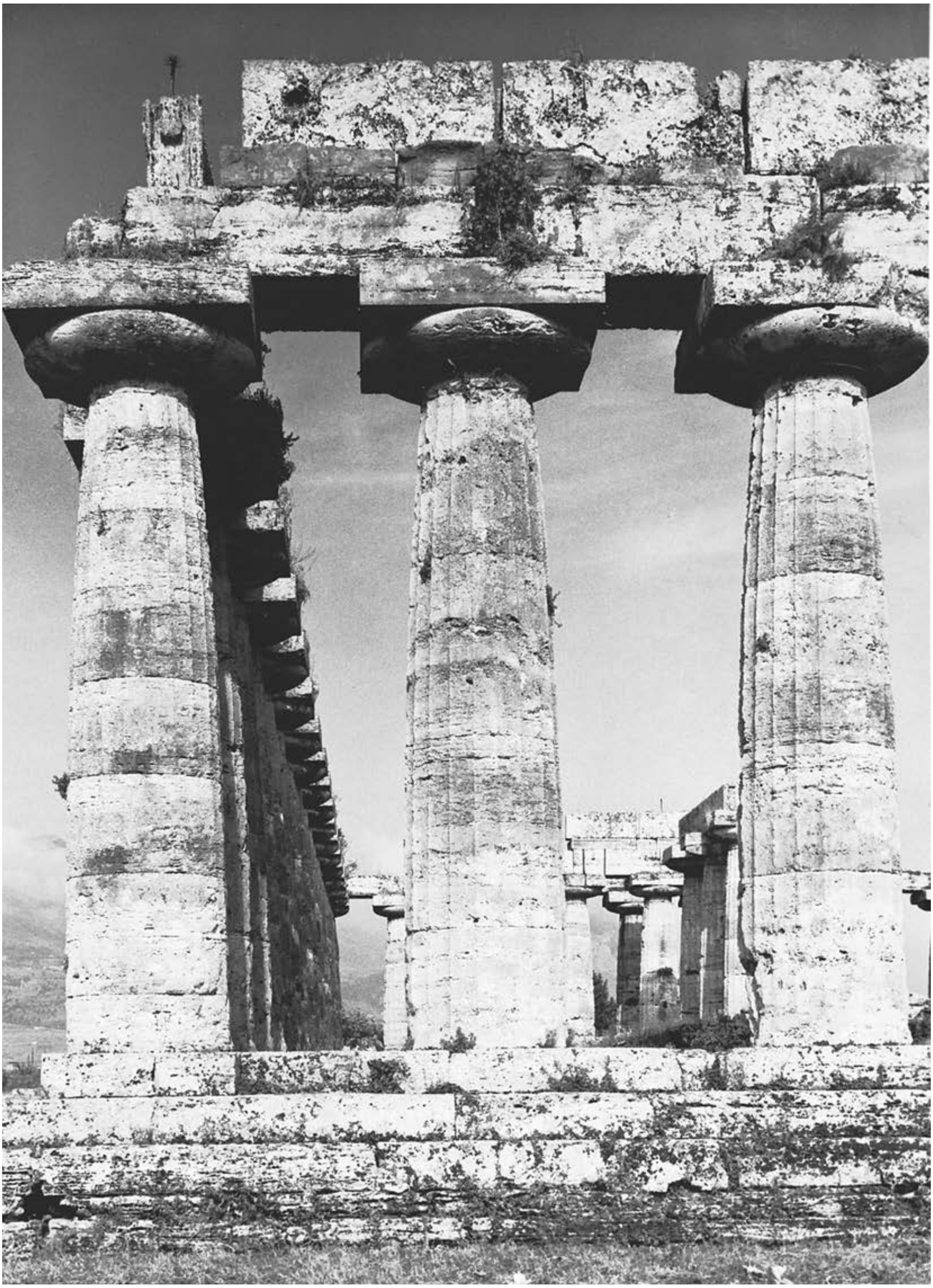
Oregon, 2002–2008, by Todd Tierney and Bill Lee of Anshen + Allen Architects, was conceived from the outset as a place not just for physical healing but for mental healing as well. Accordingly, the site selected is adjacent to the McKenzie River in a mature grove of towering Douglas firs, allowing for a paved path to weave among the trees where family members can stroll and reconnect with the natural environment. The exterior of red brick with massive wood beams and trusses opens to a two-story visitors' entry lobby with wood paneling and a stone fireplace that suggests more the lobby of a ski lodge than that of a sterile clinic. Small lounges on the upper floors, strategically located near intensive care and cancer wards, have broad windows that open onto roof gardens arnd use rain water to form "green roofs" [2.11]. In each patient's room is a built-in window seat/daybed so that, for example, a parent can sleep overnight to comfort an ill child. Clearly, in the design of this building, the needs of distressed family members were as carefully considered as those of the injured and seriously ill patients.

Besides what was achieved in this hospital there is a special psychological function that we might define as the optimum satisfaction of all the types of function just described. One modern architect who strikingly achieved psychological function on an abstract level was the American architect Louis I. Kahn, whose work is represented in the Jonas Salk Institute for Biological Studies, La Jolla, California, 1959–1965 [19.55]. Just as Garnier did for the Paris Opéra, Kahn penetratingly analyzed what the range of functions was to be in the laboratory, and he saw that satisfying the purely utilitarian and highly specialized function of providing space for conducting experiments was only part of his task. He was fortunate, too, that his client, the scientist Jonas Salk, likewise perceived the need for something more than the utilitarian. As Kahn said, Salk recognized that "the scientist . . . needed more than anything the presence of the unmeasurable, which is the realm of the artist."[13] Accordingly, the laboratory spaces were separated into two parts: large antiseptic spaces for work and small, private humane spaces for reflection. The large, universal spaces for setting up the experiments are on the outside of the U-shaped plan, while budding from their inward faces are the private studies. The work

2.11. Todd Tierney and Bill Lee, with landscape architect. RiverBend Sacred Heart Medical Center, Eugene-Springfield, Oregon, 2002–2008. In various internal locations, and on various rooftops, where the most at-risk patients would be located, healing gardens are provided either as visible respite or as quiet places to withdraw, places to promote spiritual and psychological healing. Photo: L. M. Roth, 2013.

spaces are expansive and functionally efficient, whereas the studies are small, intimate, and private, paneled in teak, with windows angled so that the researchers look out westward toward the open expanse of the Pacific Ocean. The work spaces are focused on empirical research; the private studies are designed to encourage a community of minds and private contemplation of the meaning of the research at hand. As Kahn and Salk wished to make clear, science is more than simply the raw accumulation of data. Although medical science grows out of the inextinguishable human desire to know, such knowledge inevitably influences the quality of human life and hence calls for the most penetrating, sober reflection.

Architecture is more than functional utility or structural display—it is the vessel that silently, perpetually, and inescapably shapes human life.



3.1. Temple of Poseidon, Paestum, Italy, c. 550 BCE. This stone column, larger than structurally necessary, conveys a clear impression of its strength. Photo: G. E. Kidder-Smith.

Chapter 3

"Firmeness"

Structure, or How Does the Building Stand Up?

Architecture . . . is the crystallization of its inner structure, the slow unfolding of form. That is the reason why technology and architecture are so closely related.

—Ludwig Mies van der Rohe, speech to Illinois Institute of Technology students, 1950

The most apparent part of a building is its structure, or what makes it stand up. This has been more obvious since the mid-twentieth century, when architects and engineers took particular delight in making structures do more work with less material, seemingly in defiance of gravity, while showing the structure more clearly. The tension we may feel when looking at a modern structure so delicate as to seem in danger of imminent collapse illustrates the difference between the ***physical structure***, that is, the "bones" of the building that do the work, and the ***perceptual structure***, or what we see. They are not the same, for a column may be much larger than structurally necessary in an engineering sense simply to reassure us that it is indeed big enough for its job. Such is the case with the extraordinarily thick columns of the Temple of Poseidon at Paestum, Italy [3.1, p. 32].

In a comparison between Lever House, New York, by Skidmore, Owings and Merrill, 1951–1952 [3.2], and the neighboring New York Racquet and Tennis Club, by the office of McKim, Mead & White, 1916–1919, we see a contrast between a wall of glass that hides the structure and a traditional massive masonry wall. The wall of the Racquet and Tennis Club looks stronger than it needs to be and reassures us through its structural excess, whereas the actual physical columns of Lever House are covered by a suspended skin of green glass, and there is no readily perceptible clue as to what holds the building up. Since we sense from experience that sheets of glass by themselves cannot hold up a building of that size, we must therefore visually hunt for the actual structure (the architects force us into a kind of game) until we finally see the columns emerge at the base of the building. This play between what we know to be a heavy building and its apparent weightlessness is part of the visual tease of these glass-skinned skyscrapers. Some modern viewers take delight in the idea that gravity has been cheated (although observers of earlier periods might have considered the structure of the building poorly expressed).

The emphasis in the preceding paragraphs on visible structure ignores perhaps the most important structural element in a building, the nonvisible portion—how it is supported on the ground itself (that is, on its foundation). There is a balancing act between the weight of the finished building and what the soil beneath it can bear. In mid-town New York City it is typically the case that the Manhattan Schist bedrock is just below the surface (and above the surface in parts of Central Park), so that excavating a basement means drilling and blasting the bedrock to create a hole. Buildings erected directly on this bedrock sit solidly and immovably. In Chicago the conditions below the sidewalk level are altogether different. During the Ice Ages the glaciers that repeatedly pushed through this area left behind layer upon layer of material—soft clay, hard-packed clay, gravel, sand—multiple layers in no particular order. Solid Joliet Limestone bedrock can lie anywhere from 100 to 200 feet below the many layers of softer materials [3.3]. The earliest commercial buildings built there in the 1850s through the 1870s had spread footings below their supporting masonry walls, but as the buildings got taller and taller in the 1880s, problems began to emerge in connection with uneven settling of the larger, heavier buildings. By the 1880s, Chicago architects and engineers had

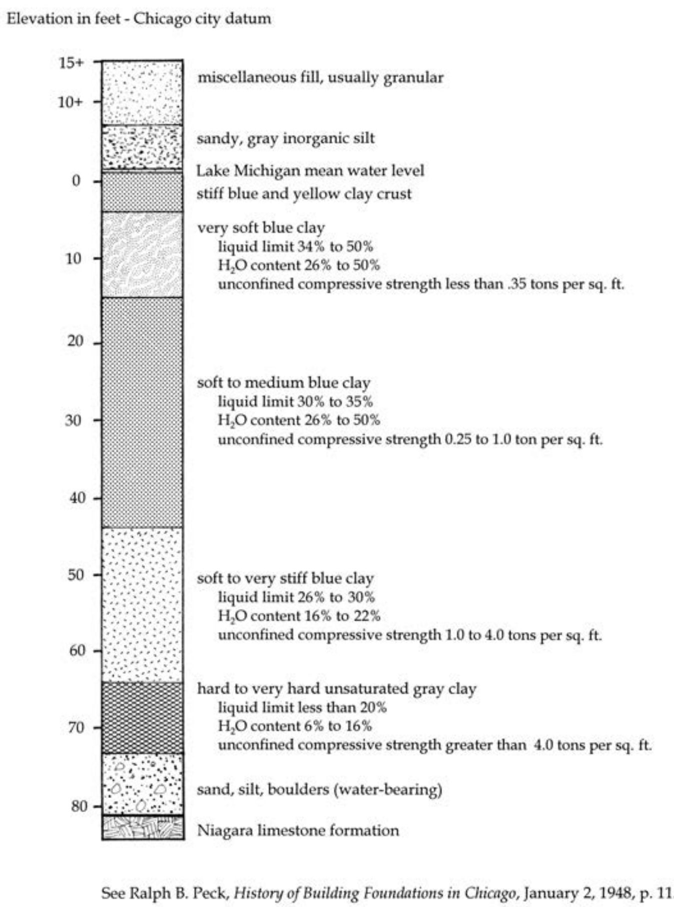
3.2. Skidmore, Owings & Merrill, Lever House, New York, 1951–1952. With its glass envelope suspended from the inner skeleton, Lever House visually hides its structure, whereas the adjacent New York Racquet and Tennis Club (by McKim, Mead & White, 1916–1919) has a boldly expressed wall structure. Photo: L. M. Roth.

developed ways of measuring the bearing capacity of the soil underneath the various parts of a projected building and then proportioning the size of each footing pad under a wall or column to match the bearing capacity at that point; the buildings settled into the soft soil as anticipated, but they did so evenly. Architects who did not adopt this practice started to notice that parts of their buildings, particularly high towers, began to settle more and cause cracks to open up in their just-finished buildings.

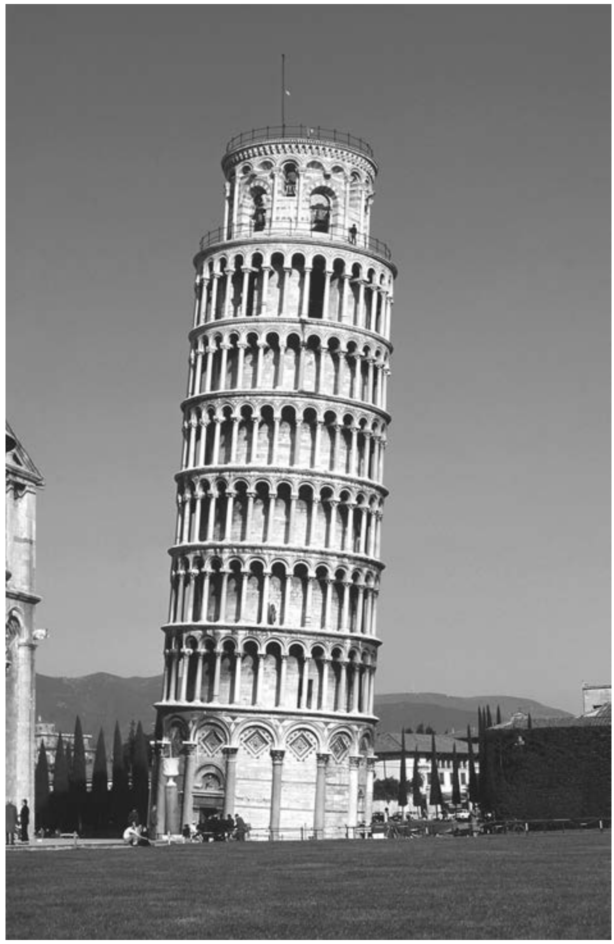
The same foundation problems seen in Chicago had been observed centuries earlier in the city of Pisa, Tuscany, Italy, in the twelfth century [3.4]. Begun in 1173, when the foundations for the free-standing bell tower were laid, the tower soon began to lean to the side when construction had reached only the second-floor level in 1178. Foundations only 9 feet deep rested on soil that had less bearing capacity on one side. Construction was stopped (since, in any case, Pisa was involved in political and military contests with surrounding cities) but resumed in 1272 when the architect at that time decided to build the new floors with one side higher than the other, making the tower look straighter but giving it a curve. The final seventh floor was built in 1319, continuing this countercurve. The tower continued its slow leaning, year after year. In 1964 the Italian government requested aid from engineers worldwide to prevent the tower from toppling (though there was no thought of trying to undo the sideways lean altogether, due to its appeal for tourism). Considerable study was focused on the problem, and the tower closed to the public while it was stabilized with cables attached to anchors several hundred meters away. The solution involved the removal of around 100 cubic meters of soil under the higher side of the tower base, allowing it to slowly lean back and straighten up slightly—pulling back roughly 45 cm (15 in) to re-achieve its angle as of 1838. In 2008, engineers declared that, due to the remedial measures taken, the tower had stopped its slow leaning motion for the first time in its history; it is now open to the public once again.

Through our childhood play we grow up developing a good intuitive sense of gravity and how it affects objects around us, for from the first moment we try to move our limbs (once removed from the comparative weightless state of the womb), we experience the unceasing pull of gravity. As infants, we must figure out how to raise our bodies erect and maintain a state of equilibrium, or stasis, while standing, and then how to move on two legs. Accordingly, long before we can articulate the concept in scientific terms, as infants we have a clear idea that objects that are not supported will fall straight down, or, to be exact, toward the center of the earth. And that is the essence of architectural structure—making sure that objects will not fall to the earth, despite the incessant pull of gravity.

We develop early a way of understanding objects around us through ***empathy***, of imagining ourselves inside the object and feeling how gravity works on it. So, for example, when we see the pyramids in Egypt, we sense that they are inherently stable objects, whereas when we see something like the inverted pyramid of Shapero Hall of Pharmacy at Wayne State University, Detroit [3.5], we feel a sense of instability and perhaps marvel at the work of the architect and the engineer who placed such a structure on its head. In the case of Lever House, the architect played with our differing perceptions of solid stone and transparent glass, knowing that we would sense one building (the Racquet and Tennis Club) as solid and heavy, and Lever House as



3.3. Diagram illustrating varying subsoil conditions in Chicago. Because of repeated glacial scrapping and deposit of differing soils over many millennia, the subsoil of Chicago is made up of numerous layers of sand, gravel, and clay, all varying in bearing capacity. Drawing: L. M. Roth.



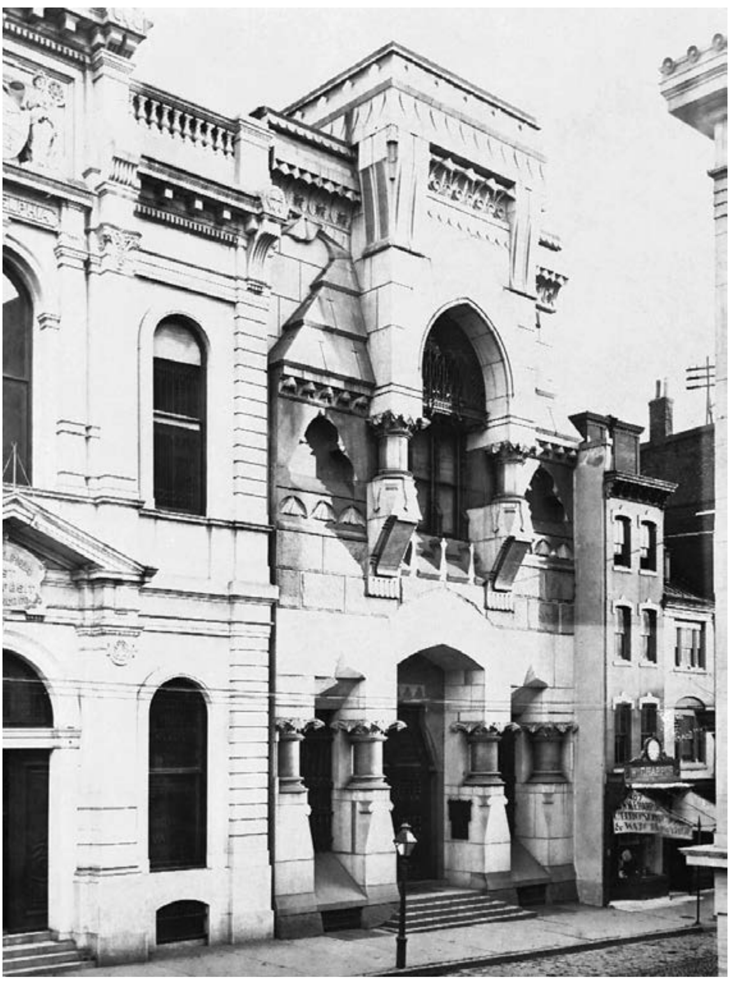
3.4. Guglielmo, Giovanni di Simone, and Tommaso di Andrea Pisano, Campanile Tower of Pisa, 1173–1350. The alluvial soil beneath Pisa is made up of varying layers, with the bearing capacity per square inch on one side of the tower being less than on the other side, resulting in the tower's settling more into the softer side. Photo: Art Resource, NY.

light. Some architects, in fact, have taken pains to accentuate the sense of weight, as did Frank Furness, a nineteenth-century architect from Philadelphia. His Provident Life and Trust Company, Philadelphia, 1876–1879 [3.6], a building regrettably now demolished, projected a sense of immense weight, so that the parts of the building seemed to be compressed, sliding downward and telescoping into one another under the pull of gravity.

Part of our perception of architecture has to do with this empathetic analysis of how forces are handled in buildings. Hence, what we perceive at Paestum and in the Parthenon in Athens [11.28] is a careful balance of vertical and horizontal elements, neither of which dominates, suggesting a delicate equilibrium of forces and thus exemplifying the classical Greek philosophical ideal. In contrast, Gothic architecture, as represented by the east end of the cathedral of Beauvais, France, is characterized by soaring, thin, vertical supports and a multiplicity of vertical lines [3.7]. All of this suggests ascent, lift, weightlessness, aspiration, and a visual denial of the tremendous forces being generated by the roof and inner stone vaults 140 feet (42.7 m) in the air, both vertically and laterally or spreading outward, all insistent on being conducted safely down to the ground and to the invisible foundations below.

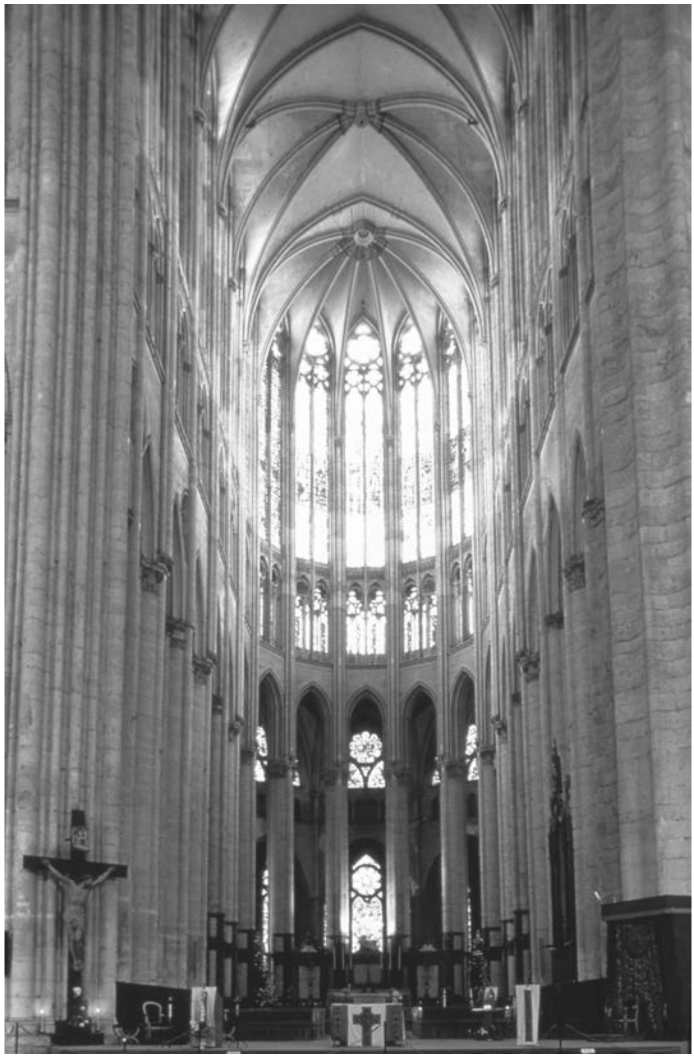
Elements of the Oldest Architecture

We will likely never be certain just when humans began to fabricate structures to protect themselves, because once out from under the shelter of the primeval cave, the earliest structures humans put together used tree saplings, thatch, grass, animal skins, and other organic materials that all quickly returned to the earth. Most such shelters probably lasted no more than 10 or 20 years. In at least one instance (discovered so far), such organic dwelling



3.5. Paulsen and Gardner, Shapero Hall of Pharmacy, Wayne State University, Detroit, Michigan, 1965. This unusual building, seeming to rest on its smallest point, makes the viewer wonder how it is held up. Photo: University Archives, Wayne State University.

3.6. Frank Furness, Provident Life and Trust Company, Philadelphia, Pennsylvania, 1876–1879 (demolished 1959). The architect deliberately exploited strong contrasts in form, scale, and texture to create an image that was bold and unique. Photo: Penrose Collection, Historical Society of Pennsylvania.



3.7. Choir of Saint-Pierre Beauvais, France 1225–1569. In this building, devoted to the aspiration to heaven, the vertical line dominates everywhere. Photo: Anthony Scibilia/ Art Resource, NY.

building materials did survive for more than 13,000 years, to be uncovered in the 1970s. These were the wood timbers and hides of shelters found at a site called Monte Verde, Chile, discussed in Chapter 9 [9.4, p. 171]. Far older, however, are the indications of branches being used to enclose a shelter some 400,000 years ago, at a location called Terra Amata off the Mediterranean coast of southern France. The branches themselves long ago disappeared, though their indentations remained in the ancient soil when it was uncovered in the 1960s.

When European settlers first arrived on the Atlantic coast, dwellings similar in construction to those found at Monte Verde, Chile, were being lived in by the Powhatan and Wampanogue Native Americans (to name just the tribes encountered by the first English settlers in Virginia and New England). Rounded wigwams, and also somewhat elongated rectangular round-topped houses, were built of saplings pushed into the ground and bent over in a series of parallel U-shaped hoops, the frame then being covered with sheets of elm or birch bark, layers of sewn reed mats, or animal skins [3.8]. In analogous ways—also exploiting local materials such as thin saplings, wood lattice covered with adobe (wattle and daub), palm, grass thatch, or even adobe bricks—various African tribes continue to use ancestral building techniques to construct dwellings.

Another ancient building material is adobe, used to great advantage around the world where earth

3.8. Algonquian longhouse and wigwam dwelling types. An Algonquin Indian village traditionally was made of bark-covered dwellings such as wigwams and longhouses in the Northeast woodlands. Photo: Copyright Marilyn Angel Wynn. Courtesy of The Institute for American Indian Studies, Washington, CT.

with a clay content can be mixed with water (with perhaps an admixture of grass or straw to serve as an additional binder) to form building blocks or bricks. Typically these building units are dried and "baked" in the sun. Adobe's density and mass make it a good thermal insulator (or heat storage mass); these aspects of adobe are discussed in Chapter 6. Adobe is highly serviceable in dry desert-like environments where rain is light and infrequent. So long as a sacrificial outer coat of adobe plaster is continually maintained through periodic replastering, the protective plaster keeps the inner structural adobe building blocks from dissolving. That this easily crumbled and rain-vulnerable material can be used for long-term durable buildings is illustrated well by the Taos Pueblo structures built in northern New Mexico during 1000 to 1450 CE (and replastered every autumn) [3.9], as well as the Great Mosque at Djenné, Mali, Africa, built initially in the thirteenth century and rebuilt in 1906–1907. The projecting bundles of rodier palm provide scaffolding for annual maintenance [AF-4, p. 552].

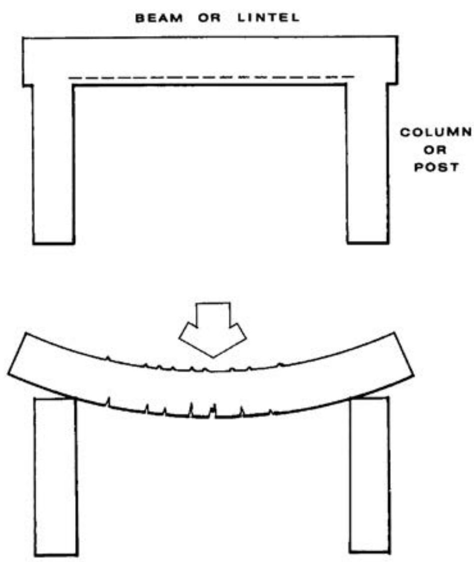
The Elements of Lithic (Stone) Structure: The Post and Lintel

The beginning of a more durable structure is the stone wall, but a room enclosed with walls has no light or view, so the wall must be opened up. The blocks or bricks over that opening must be supported against the pull of gravity, and this is done either by means of a beam (of wood or, after 1750, metal) or by means of an arch. Such a beam inserted in a wall to support the wall above is called a ***lintel***. The wall could also be cut away, so to speak, and replaced with slender stacks of blocks to form piers, or rounded shafts forming columns, with lintels spanning the spaces between them. The architect Louis Kahn spoke of "the momentous event when the wall parted and the column became."[1] The column and beam—or post and lintel—system is as old as human construction [3.10]. Archaeological and anthropological evidence suggests that post and lintel systems of wood or bound papyrus reeds were used long before they were translated into more

3.9. Taos Pueblo, Taos, New Mexico, c. 1450. Photo: © Wayne Andrews/Esto. All rights reserved.

durable stone. Such a post and beam system is called a ***trabeated*** system (from the Latin *trabs,* "beam"). One of the most straightforward examples of post and lintel construction is the Valley Temple east of the pyramid of Khafre, in Giza, Egypt, built between 2570 BCE and 2500 BCE [3.11]. Here, finely polished square lintel beams of red granite rest on square piers of the same material, contrasting with the alabaster floor. All beams, whether of stone, wood, or any other material, are acted on by gravity. Since all materials are flexible to varying degrees, beams tend to sag or deflect in the middle of their span as a result of their own weight, and even more as loads are applied. This means that the upper part of a beam between two supports is squeezed together and is in compression along the top surface, while the lower part is stretched and is said to be in tension.

Extending the beam over the end of the column results in a ***cantilever*** [3.12]. In a cantilever, the situation is exactly reversed over the supporting post, for as the extended projecting beam sags due to the pull of gravity, the *upper* part is stretched

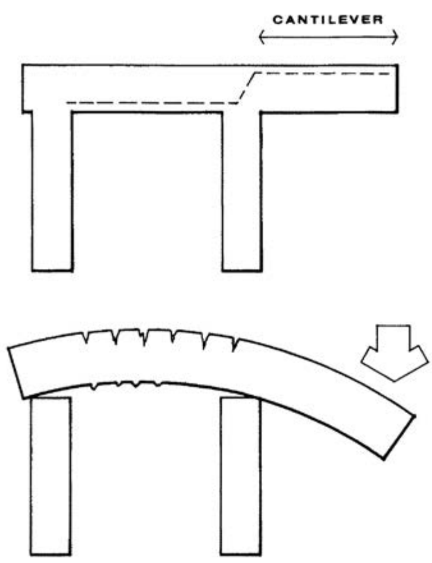


3.10. Diagram of the post and lintel system. Drawing: L. M. Roth.

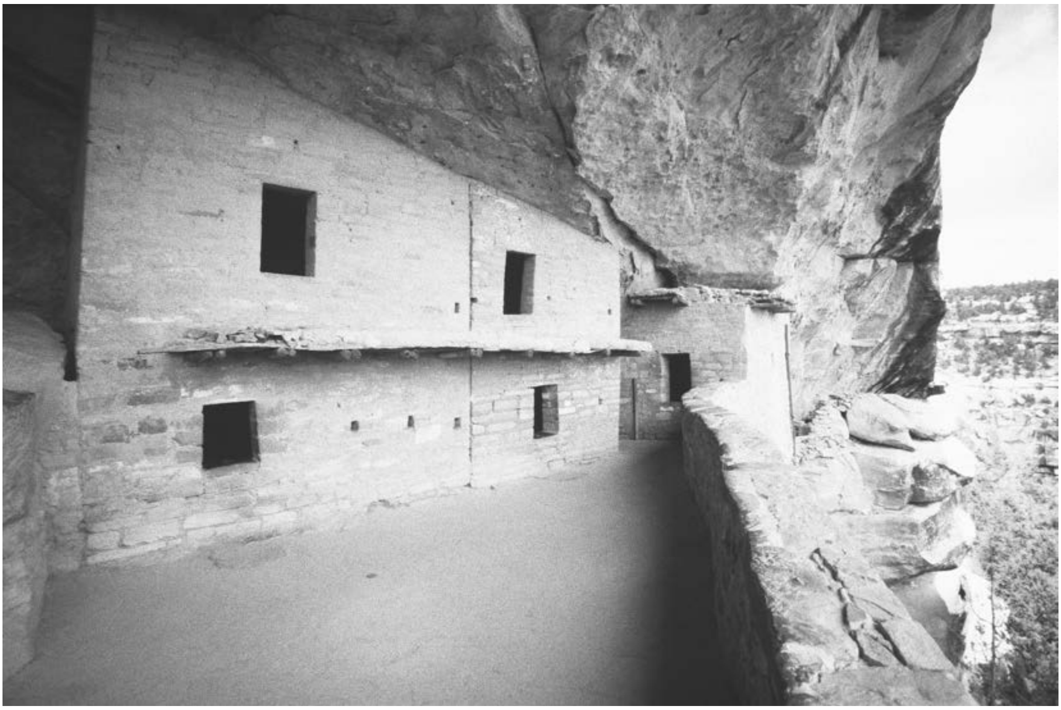
3.11. Valley Temple, Pyramid of Khafre, Giza, Egypt, c. 2570–2500 BCE. This is one of the purest and most direct expressions of stone post and lintel construction. Photo: Hirmer Verlag, Munich.

(put in tension) and the *lower* portion experiences squeezing compressive stresses. In the cantilever, these forces are strongest just over the support. In fact, it is the continuity of the material of the beam over the support that makes the cantilever possible. The perception of weightlessness that the cantilever suggests (together with the strong emphasis on the horizontal line) were characteristics greatly favored by Frank Lloyd Wright, perhaps nowhere more so than in the dramatic cantilevers he incorporated in his famous weekend house for Edgar Kaufmann called Fallingwater [4.24].

Wood, being a fibrous material, resists tensile stresses relatively well, as do wrought iron and rolled modern steel; beams of steel can span significant distances. The tensile forces along the bottom of a beam (or along the top of a cantilever) are determined by the length of the span and the load placed on the beam, so that eventually, given a sufficiently great span and high load, the tensile strength of the material will be exceeded; the beam will crack at the bottom (or along the top in a cantilever) and will eventually collapse. Stone and solid plain concrete have far less tensile strength than do fibrous wood or metal, so that a wooden beam over a given span might carry a load that would crack a stone beam [3.13]. Of course, the stone beam starts out being far heavier by itself, creating a significant load from the outset. In beams of concrete, which has great strength in areas of compression, the solution is to place something within the concrete that will take or resist the tensile forces. The solution to this problem, used by early Romans and modern-day builders alike, is to place iron (and now steel) rods in the formwork into which the liquid concrete is then poured. The result is reinforced concrete. As the dotted lines in 3.10 and 3.12 indicate, the steel is placed where the tensile forces accumulate—on the bottoms of concrete beams and at the top of concrete cantilevers.



3.12. Diagram of a cantilever. Drawing: L. M. Roth.



3.13. Balcony House, Mesa Verde, Colorado, c. 1250–1280. Photo: L. M. Roth.

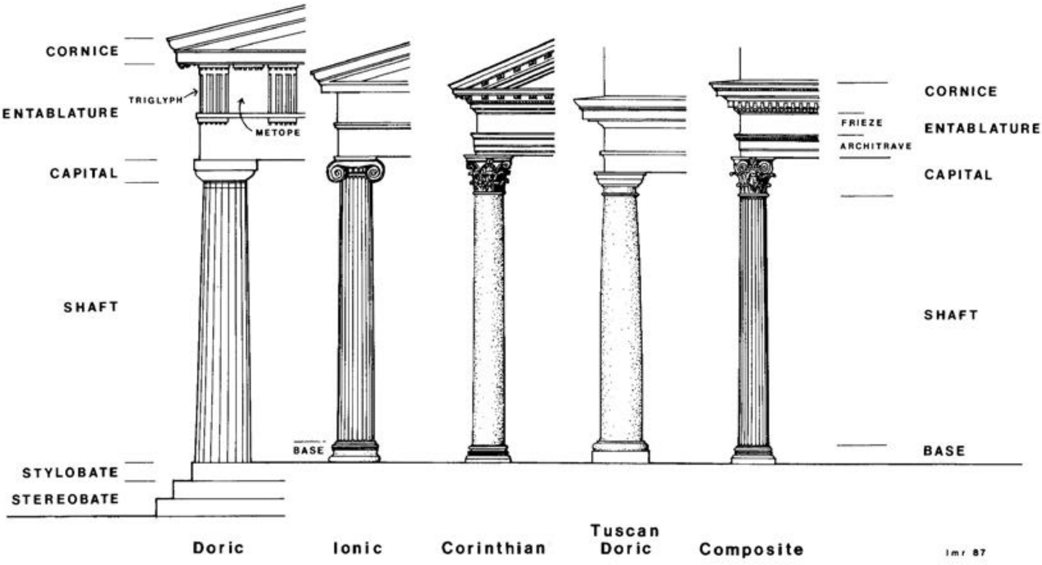
The ancient Greeks also faced this problem. The central opening of the gateway to the Akropolis in Athens, the Propylaia, built in 437–432 BCE [11.21], had to accommodate the passage of pairs of sacrificial oxen with their handlers. The gateway had to have a broad span of 18 feet (5.5 m), far too great for a solid block of marble that also had to carry the roof load. The solution adopted by the architect Mnesikles was to hollow out the beam to reduce its own weight (it still weighed eleven tons) and to place iron bars along the top of the beam, apparently to carry the weight of the marble blocks above. In this unique instance, the iron bars are at the top of the beam, not the bottom, where they would be expected today. Even so, over the centuries, cracks developed in the marble lintel beam.

The Classical Orders

The columns of the Propylaia are splendid examples of one of the three column types the Greeks developed for their civic and religious architecture: Doric, Ionic, and Corinthian [3.14]. These three columnar types, or orders, were adapted by the Romans, who added more ornate variations of their own (Tuscan and Composite), and the orders later became part of the basic architectural vocabulary from the Renaissance in the fifteenth century down to our own times. The columns of each Greek order consist of three basic parts—base, shaft, and capital—and, in Greek usage, rise from the three-stepped temple base composed of the top ***stylobate*** (from the Greek *stulos,* "column," plus *bates*, "base"), with a two-step ***stereobate*** below. In all the Greek orders, the height of the column and the relative size of all the related component parts, as well as of the ***entablature***, are proportional derivatives based on the diameter of the column.

Aside from each of the orders rising from some sort of base platform, each carries a stylized beam and cross-beam ends, all capped with a cornice. This assembly of beams atop the column is called the *entablature* and consists of three basic layers, varying slightly between the different orders. The entablature of the Doric order is made up of (1) the lower ***architrave*** (from *arch,* "main," plus *trabs,* "beam"), (2) the middle range made up of alternated ***triglyphs*** (stylized beam ends) and ***metopes*** (sculpted infill panels), and (3) the uppermost ***cornice***, formed of several progressively projecting moldings.

Doric columns [3.15], the most massive of the three Greek orders, are four to six and a half times as tall as the diameter, and the Doric *entablature* (the stylized system of beams and beam ends resting

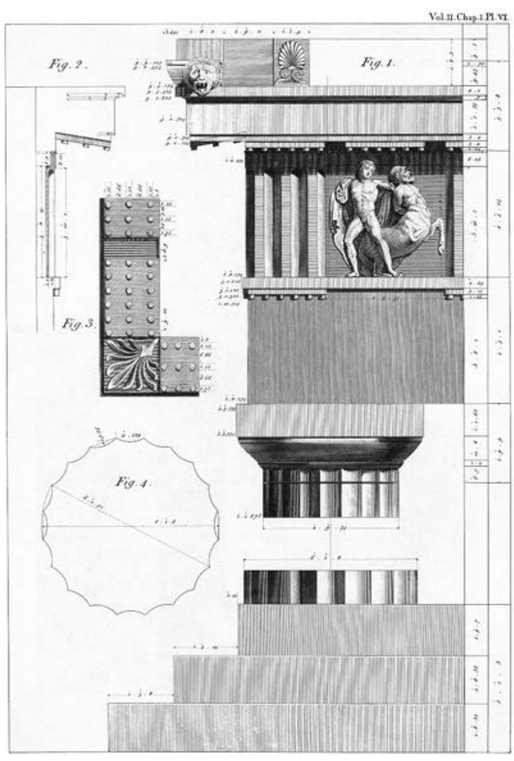


3.14. Comparison of the five Classical orders. The Greek orders consisted of the Doric, Ionic, and Corinthian. To these the Romans added the Composite (a combination of the Ionic and Corinthian) and the simpler and thicker Tuscan Doric. Drawing: L. M. Roth.

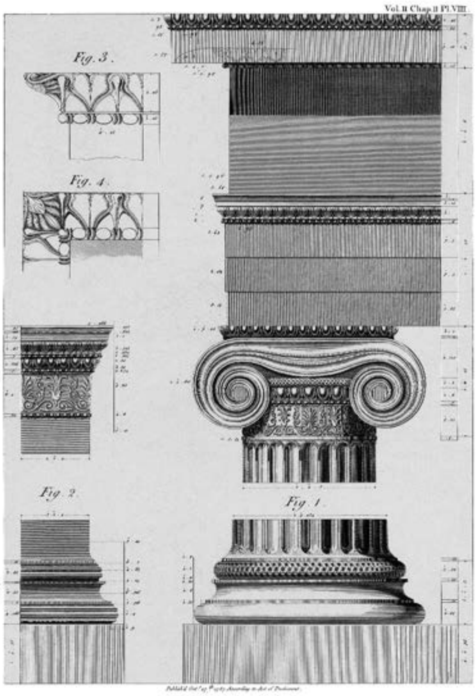
on the column) is roughly one-fourth the height of the column. The shaft of the Doric order rises directly from the stylobate platform; it has no base. The shaft itself has twenty broad scalloped indentions, or *flutes,* with sharp outer edges. Atop the shaft, the ***capital*** of the Doric column consists simply of a banded necking, a gently outward-swelling ***echinus***, and a final square ***abacus*** slab.

The more slender ***Ionic*** order [3.16] has an ornamental base, from which the shaft rises. The column itself is roughly nine times as high as its diameter, and the shaft has twenty-four flutes with flattened edges. The capital has unique curled ***volutes*** resting on an egg-and-dart molding; over the egg-and-dart molding is a swelling *pulvinus* (Latin for "pillow"), connecting the curling volutes. The Ionic entablature is roughly one-fifth the height of the column and is made up of an architrave of two or three vertical flat surfaces or faces, with a middle ***frieze***, most often filled with a continuous narrative band of relief sculpture. Atop this is the cornice.

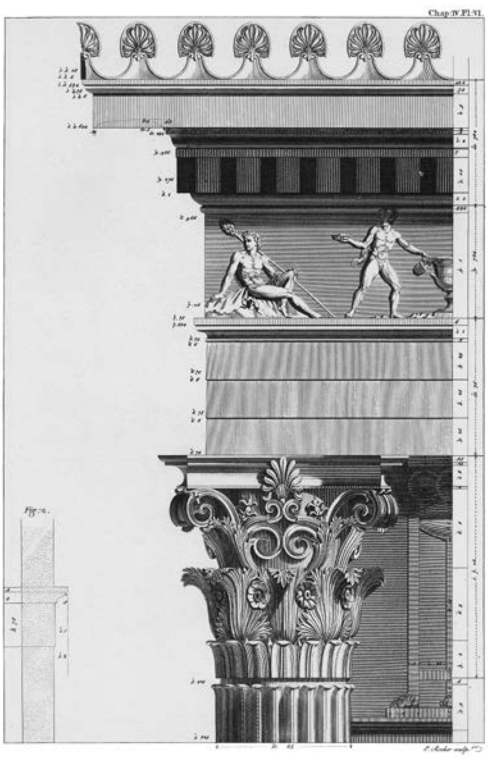
Slightly more slender still is the ***Corinthian*** order [3.17], whose column is ten times the height of its diameter. It rises from a base similar to that of the Ionic order and, like it, normally has twenty-four flutes. The Corinthian capital is the tallest of the three, with two or three concentric bands of lush outward-curling acanthus leaves. The entablature is similar to that of the Ionic order.[2]



3.15. Doric capital (Parthenon, Athens). From: Stuart & Revett, Antiquities of Athens *(London, 1762).*



3.16. Ionic capital (Erechtheion, north porch, Athens). From: Stuart & Revett, Antiquities of Athens *(London, 1762).*

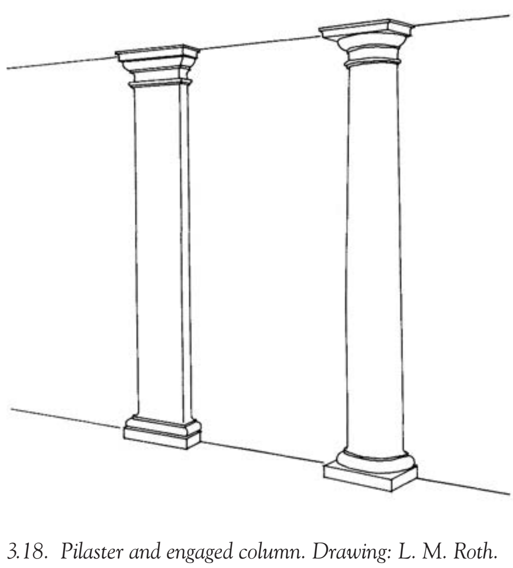


3.17. Corinthian capital (adapted from Choragic Monument of Lysiscrates). From: Stuart & Revett, Antiquities of Athens *(London, 1762).*

The Greek orders were subsequently adopted by the Romans, who used them largely as decorative elements; one of the principal changes introduced by the Romans was making the Doric order into the more slender Tuscan Doric, with the addition of a base and usually a smooth, unfluted shaft [3.14]. The other major addition was the ***Composite*** order, formed by placing the volutes of the Ionic capital atop the curled acanthus leaves of the Corinthian. The Romans also introduced a decorative adaptation of columns, merging the column with the wall, so that a half-column, or ***engaged*** column, seems to emerge from the wall [3.18]. The Romans also developed a flat, pier-like projection on the wall, the ***pilaster***, complete with base and capital corresponding to those of a column of the same order. Both these devices allow the rhythm of a colonnade to be continued along an expanse of an otherwise flat wall.

Structural Frames

If the two-dimensional planar structural system of posts and lintels is extended into three dimensions, the result is a frame. This can be a frame like that of the stone columns and beams of the Valley Temple, or of large, square, wood timbers fitted together with mortise and tenon joints. Today frames are more typically of nailed wood lumber [3.19], as in the conventional ***balloon frame*** used for home construction in North America since the mid-nineteenth century, or made of riveted or welded steel members [3.20], as in much commercial construction. (The differing nature of iron and steel as building materials is discussed in Chapter 19.)



3.18. Pilaster and engaged column. Drawing: L. M. Roth.

3.19. Balloon frame. Photo: L. M. Roth.

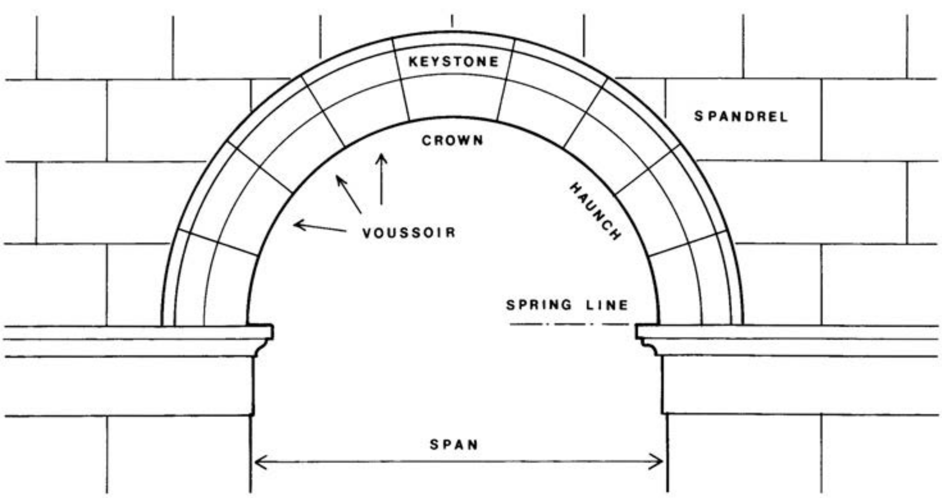
3.20. Steel frame of the Lake Shore Drive Apartment towers under construction, designed by Ludwig Mies van der Rohe, 1948–1951. Photo by Hedrich Blessing. Chicago History Museum, negative HB-1380914.

The Arch

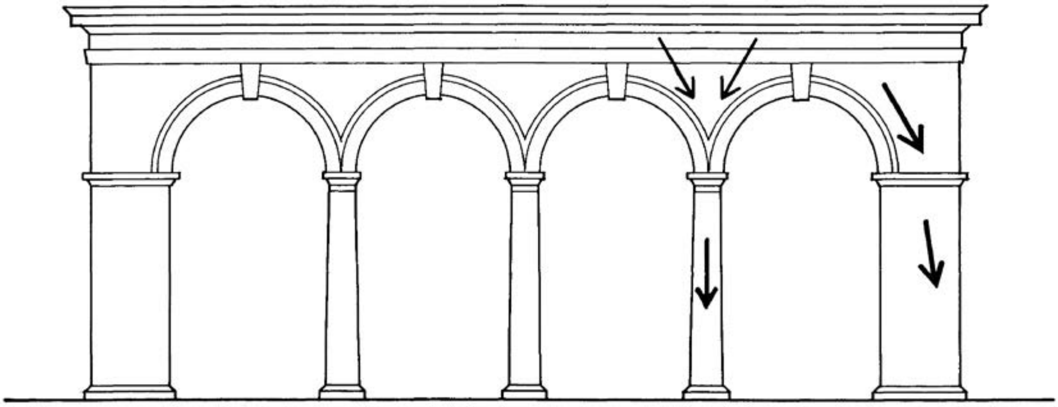
In masonry construction, the alternative for spanning an opening is the arch [3.21]. Like the lintel, the arch can be made of stone, but the arch has two great advantages. First, the masonry arch is made up of many smaller parts, the wedge-shaped ***voussoirs,*** so the necessity of finding a large stone lintel block free of cracks or flaws is eliminated, as are the delicate logistics of handling large blocks of stone for lintels. Second, because of the physics involved, the arch can span much greater distances than can a stone lintel, and within certain constraints can span long distances. The gravitational forces generated by the wall above the arch are distributed over the arch and converted in the voussoirs to diagonal forces roughly perpendicular to the lower face of each voussoir. Each voussoir is subjected to compressive forces. One of the drawbacks of arch construction, however, is that during construction, all the voussoirs must be supported by a wooden framework, called ***centering,*** until the uppermost voussoir, called the ***keystone,*** is inserted, locking the arch in place. At that precise instant, the arch becomes self-supporting and the centering can be removed to be used to build the next arch.

Traditionally, centering was semicircular in form, as this shape was the easiest to lay out with pegs and rope on the job site. Unfortunately, the semicircular arch is not a truly perfect structural form for the arch, because the forces at the base of an arch of this shape are not going straight down. In many structural forms that span an opening, there are lateral (sideways) forces generated in addition to vertical forces (those generated by gravity and going straight down). This is especially true in the semicircular arch, and the problem increases in direct proportion to the vertical forces the arch carries. These lateral forces would cause the base of the arch to spread unless suitably restrained, as in a large arched bridge in which the feet of the arch push against the bedrock on either side of a gorge. In an arch that has no superimposed wall bearing down on it, there is another problem—the arch's own weight. A single point load focused at the apex, or crown, of the arch will cause the arch to rupture or bulge upward on its upper surface at roughly 40° up from the horizontal, but this problem quickly diminishes as an additional uniform load (such as a superimposed wall) is spread over an arch and also pushes down against the arch.

Several arches placed end to end form an ***arcade***. In an arcade, the lateral forces of one arch are exactly counteracted by the opposed lateral forces of the adjacent arch, with the resulting force over the column being purely vertical [3.22]. With this arrangement, the arches can be placed on slender piers or columns, for the lateral forces are canceled out—except, that is, at the very ends, where there must be buttressing. The Romans used this structural action to excellent advantage in their arcades and aqueducts, as for example in the Pont du Gard, a combination bridge and aqueduct over the Gard River near Nîmes, in the south of France, built in the late first century BCE [3.23]. The total length of the bridge is 900 feet (274.3 m), with arch spans of 64 feet (19.5 m), except for the center span, which is roughly 80 feet, 5 inches (24.5 m).



3.21. Diagram of an arch system. Drawing: L. M. Roth.

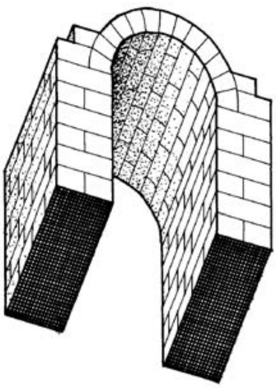


3.22. Diagram of an arcade. Drawing: L. M. Roth.

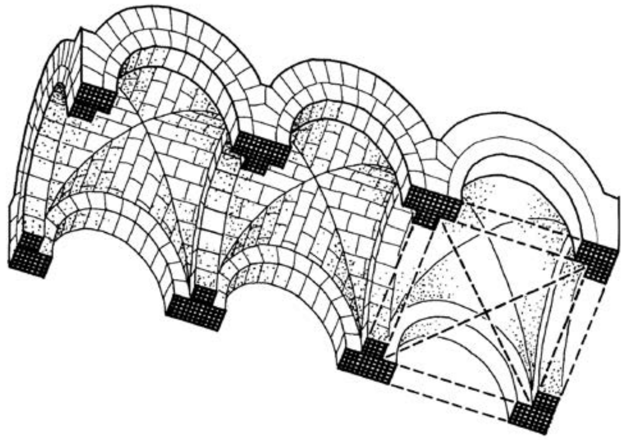
Vaults

In an ***arcuated*** structure, one built up of arches, the arch acts structurally along a flat plane, but if the arch is imagined pushed through space, the form that results is a semicircular vault. In the case of a semicircular arch, the resulting vault is called a ***tunnel*** or ***barrel vault*** [3.24]. Usually, such masonry vaults were placed on thick walls. Since the solid barrel vault is heavy, this causes the walls to spread out at the top. These lateral forces can be resisted by substantial buttresses along the walls or by thickening the wall. An example of a barrel vault raised to great height is the nave of Saint-Sernin, Toulouse, France, built in 1077–1096 [14.25]. But, as Saint-Sernin also shows, solid barrel vaults result in dark interiors. A solution devised earlier by the Romans was to run additional barrel vaults at right angles to the main vault so that they intersected, resulting in a ***groin vault***, opened up by wide, semicircular lunettes at each end and along the sides [3.25]. With this arrangement, the forces are channeled down along the groins, where the vaults intersect and are concentrated at points at the foot of the vaults. A three-section, or three-bay, groin vault was used by the Romans in many of their large public buildings, such as baths and basilicas. An excellent example is the immense Basilica of Maxentius, Rome, c. 307–c. 312 CE [3.26,

3.23. Pont du Gard Nîmes, France, 25 BCE. A combination bridge and aqueduct with superimposed arches. Photo: Touring Club de France, Paris.



3.24. Diagram of a tunnel or barrel vault. Drawing: L. M. Roth.

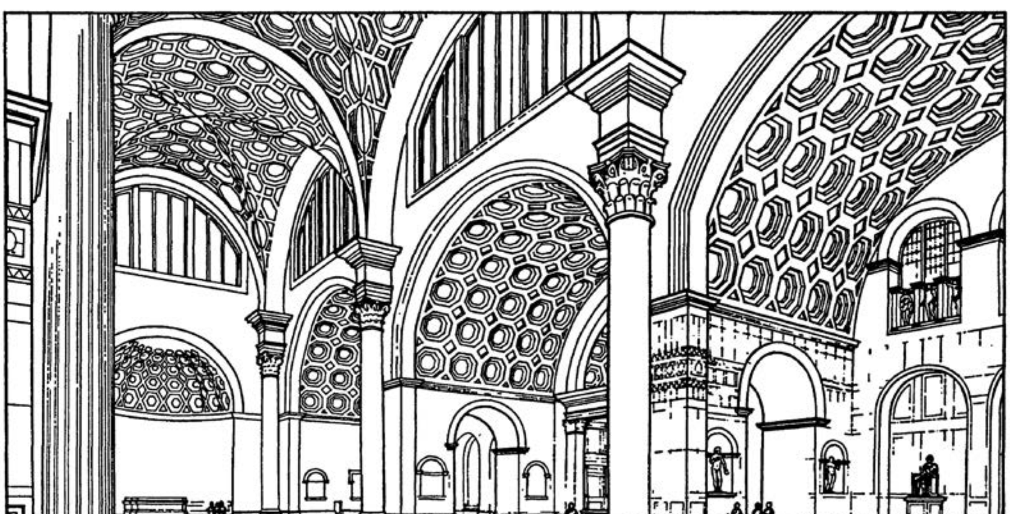


3.25. Diagram of a groin vault. Drawing: L. M. Roth.

12.11]. Built with a form of concrete developed by the Romans, this had three center bays measuring 88 by 83 feet (26.8 by 25.3 m) each, for a total length of 265 feet (80.8 m). The lateral forces of the groin vaults, lifted nearly 80 feet (27.8 m) into the air, were carried to the foundations by walls of adjoining chambers on each side, each chamber measuring 76 by 56 feet (23.2 by 17.1 m). Three of these side chambers, themselves barrel-vaulted, are the only portions that survive today.

Domes

An arch rotated about its center vertical axis generates a dome; a semicircular arch thus makes a hemispherical dome. Domes, too, were much used by the Romans, both for structural reasons and also because domes symbolically suggested the overarching heavens. The largest, clearest, and most impressive of all was the immense dome of the Pantheon, Rome, c. 118–c. 128 CE [3.27, 12.13].



3.26. Basilica of Maxentius, Rome, Italy, 307–315 CE. This legal hall (that is, court house), now largely destroyed, demonstrated how the Romans could cover vast public spaces with concrete vaults. From: Boëthius and Ward-Perkins, Etruscan and Roman Architecture *(Harmondsworth, England, 1970).*

3.27. Giovanni Paolo Panini, Interior of the Pantheon, c. 1750. This painting conveys better than any modern photograph the effect of the space inside the Pantheon. Photo: Samuel H. Kress Collection Image © 2005 Board of Trustees, National Gallery of Art, Washington, c. 1734, oil on canvas, 128 x 99 cm ($50\frac{1}{2}$ x 39 inches); framed: 144.1 x 143 cm ($56\frac{3}{4}$ x 56 inches).

Here, the clear span is 142 feet, 6 inches (43.4 m). The dome is a massive shell of concrete, 4 feet (1.2 m) thick at the top, where there is the broad, single opening of the eye, or oculus, 30 feet (9.1 m) across. The thickness of the dome is greatly increased at the point where rupture would tend to occur (at about 40°), and continues to increase in thickness down to its base, where it is 21 feet (6.4 m) thick. The total weight of the dome is reduced by deep recesses, or coffers. In fact, as a result, the Pantheon dome functions structurally as twenty-eight radial quarter-arches run from the oculus to the wall of the supporting drum below. The wall of the lower supporting drum is equal in height to the hemispherical dome; it is 21 feet (6.4 m) in depth but is structurally made up of eight pairs of double-wall piers (acting like radial buttresses) connected at their tops by radial barrel vaults. Moreover, both the dome and the drum wall are interlaced by numerous brick relieving arches and stubby barrel vaults set in the concrete to help direct the forces to the supporting piers.[3]

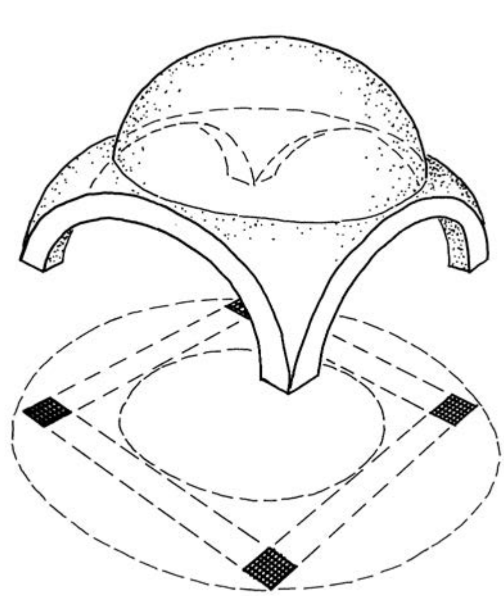
Concrete (commonly and incorrectly called cement) was a material developed and exploited by Roman builders. Their remarkable structures probably could not have been built without the use of concrete. Concrete is in essence an artificial stone that begins as a viscous mixture of water and assorted aggregate pieces of broken rock (*caementa* in Latin), combined with a binding material, or cement, derived from lime that will bond everything together. By changing the type of *caementa* used in the concrete, the weight per cubic foot of concrete used in the Pantheon could be varied by the Roman architects and engineers. At the top of the dome, where the weight to be carried was the least, the *caementa* aggregate was light volcanic pumice filled with gas bubbles; at the foundation ring at the base of the drum, where the weight carried is greatest, the aggregate is the very densest and heaviest basalt.

It might be well to clarify the difference between Roman concrete and what is commonly used today. In both materials, the basic composition is similar, but the binding agent in Roman concrete was *pozzuolana,* a volcanic ash that undergoes a chemical action when ground and mixed with water, forming an artificial stone. In modern concrete, developed in 1824 in England by Joseph Aspdin, the binding cement is made of chalk and clay, carefully roasted or fired, with the resulting nodules ground to a fine powder. When this cement powder is mixed with water, sand, and gravel aggregate, the resulting artificial stone closely resembles the fine-grain natural limestone found in the region of Portland, England, as Aspdin observed. As a result, this artificially produced cement is still called Portland cement to this day. For both the Romans and us, the cement or binding material itself is far too costly for people to make entire buildings, sidewalks, or other constructions out of it alone. Even the mortar used between bricks and stone is stretched by the addition of sand aggregate, and in making concrete, gravel and sand are mixed in as the aggregate. Another major difference in Roman concrete is that the Romans incorporated large volumes of fired tile and brick, formed as in the relieving arches, and this also served as a kind of large-scale aggregate. In all likelihood, newly mixed Roman concrete was thick with a consistency like dense oatmeal, whereas modern concrete is a more liquid slurry.

Like stone, concrete is immensely resistant to compressive, or squeezing, forces, but relatively weak resisting tensile, or stretching, forces. Realizing this, the Romans added iron bars to concrete in some instances, but they preferred to use integrated relieving arches of brick and tile. Since the mid-nineteenth century, iron or steel rods have been placed in the formwork for modern concrete wherever tensile forces will occur, resulting (as described earlier) in reinforced concrete.

While the new viscous concrete is curing or hardening in its first days and weeks, it must be held in place by formwork, which constitutes one of the cost disadvantages of using concrete. The formwork (called *shuttering* in England) is like the centering used for arch construction. Unlike arch construction, however, which becomes instantly structurally self-supporting the moment the keystone is dropped into place (so that the centering can be moved elsewhere and reused), the formwork around and under concrete must remain in place during the early curing process. As a common saying reveals, to make a concrete structure you construct two buildings—the first one in wood and the second one in concrete, and then you throw the wooden one away. In large structures, both in Roman times and now, the construction of substantial and expensive formwork is time-consuming and expensive, and then the formwork must often be destroyed to reveal the concrete structure. In the last two centuries, builders have partly surmounted this disadvantage by using reusable, standardized forms to make building parts of precast concrete.

Domes, particularly those the size of the Pantheon in Rome, are powerfully evocative spaces, but they require circular plans, making it somewhat difficult to add adjacent spaces. This problem became acute by the fourth century CE, but the solution devised by Byzantine architects was to place a dome over a square plan. What made this possible was the curved-triangle-shaped, spherical segment called a ***pendentive*** [3.28]. Imagine a square over which you wish to place a dome. First, cover the square with a larger hemisphere, which just touches the corners of the square; then slice straight down along the sides of the square so that looking down on the cut hemisphere, you see a square. Then, just at the top of the semicircles now forming the sides, slice off the top parallel to the square below. The resulting form has a circular shape at the top while, at the bottom, it is a square. The four curved segments that remain are the pendentives, making the transition from the square plan below to the circular plan above. An excellent example of the use of pendentives is found in the church of Hagia Sophia (Holy Wisdom), Istanbul, 532–537, designed by



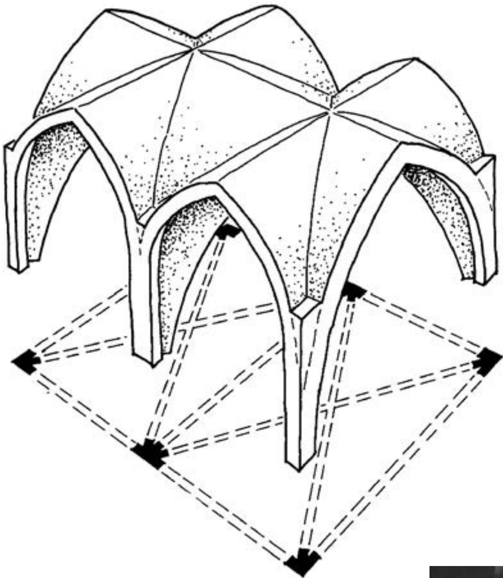
3.28. Diagram of pendentives. Drawing: L. M. Roth.

3.29. Hagia Sophia, Istanbul, Turkey, 532–537. Interior view. Photo: Erich Lessing/Art Resource, NY.

Isidoros of Miletos and Anthemios of Tralles [Plate 3, 3.29]. As with the Pantheon in Rome, the space enclosed is huge; here the dome is 107 feet (32.6 m) across, but with the extended half-domes below and the barrel-vaulted spaces beyond, the total clear distance from one end of the church to the other is more than 250 feet (76.2 m).

The base of the dome of Hagia Sophia is raised nearly 132 feet (40.2 m) above the floor, and the considerable weight of the brick dome gradually caused the side walls to spread. After two earthquakes, in 553 and 557, the dome collapsed; although rebuilt, it collapsed again after another quake in 989. To prevent further spreading, enormous buttresses were then built against the pendentives on the northeast and southwest sides; along the main axis, the dome was already well buttressed on the remaining sides by the two half-domes, which in turn were buttressed by smaller half-domes and stubby barrel vaults resting on columns and piers. The result was that along the main axis, the forces exerted outward and downward by the dome were conducted by this cascade of half-domes and vaults to the broad expanse of the lower part of the church and to the foundations [13.18]. But on the shorter cross axis, on the other two sides, the original piers proved inadequate to resist the stresses accentuated by earthquakes; it was here that the later external buttress towers were added [13.19].

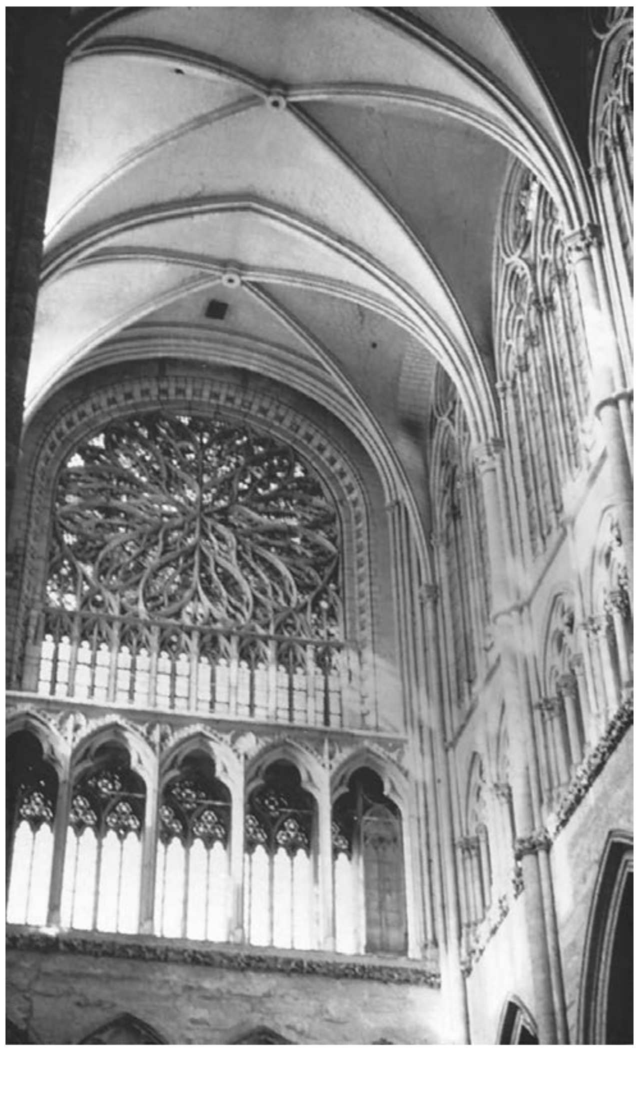
Once the hemispherical Roman dome was placed on pendentives, it became possible to put a dome over a square or rectangular room, and to add additional spaces to the sides, each perhaps with its own lesser dome, as in the arrangement of



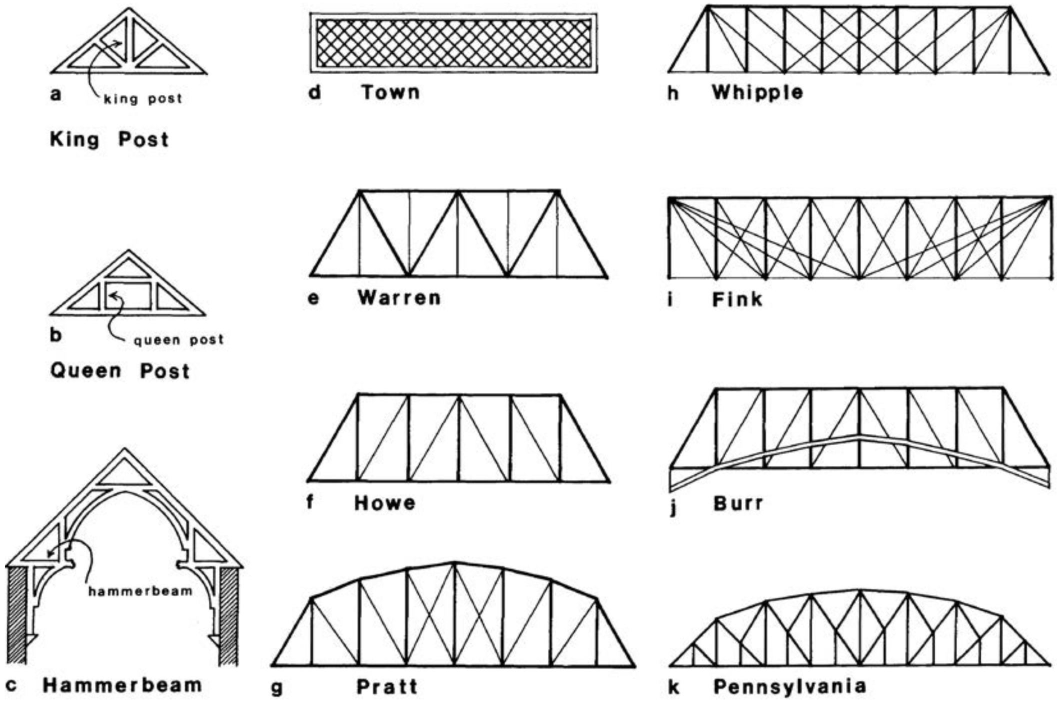
3.30. *Diagram of rib vaulting. Drawing: L. M. Roth.*

the cross-shaped church of San Marco, Venice, with five domes [13.26, 13.27, 13.28].

As serviceable as the Roman groin vault was, its disadvantage was that it worked well only over square bays; when the bays became rectangular or especially trapezoidal, the lines of the groins (where two vaults intersect) became curved and the vault lost structural strength. Besides, such vaults were difficult to cut in stone. The solution to this problem was the *rib vault*, which was developed in about 1100 at Durham, England, and at Saint-Denis, France, in 1135–1144. Construction of the rib vault entailed first building the ribs, or free-standing diagonal arches, along the lines of intersection of the groin vault, as well as along the outer edges of the vaults [3.30, 3.31]. The remaining webs of the vaults could be filled in afterward. One advantage of the rib vault was the great reduction



3.31. *Robert de Luzarches, Notre-Dame de Amiens, Amiens, France, 1221–1269. The vaults of Notre-Dame in Amiens are quadripartite, having four diagonal curved webs crossing in each bay section of the choir and nave. Photo: L. M. Roth.*



3.32. Comparison of truss types. The trusses include medieval types (queen post, king post, and hammerbeam) and patented nineteenth-century forms (Howe, Pratt, Whipple, Warren, Fink). Drawing: L. M. Roth.

in the amount of centering needed; in a structure with repeated bays, only one set of centering supports was needed. Once the ribs and webs were up in one bay, the centering could be moved to the next bay. Even better, in addition to the rib vault, medieval masons soon substituted ribs of pointed or "broken" arches, made up of two segments of circles. By shifting the centers of the two arcs making up the arches, masons could create arches on all sides of a trapezoid or any irregular square or rectangle, all of roughly equal height, some arches sharply pointed, others less so. The result was Gothic rib vaulting as used in most French, English, and German Gothic cathedrals, such as Notre-Dame of Amiens, France, begun in 1221.

Trusses

In timber construction, the Romans also used another structural type that has proved basic to large constructions since the nineteenth and twentieth centuries—the ***truss***. A truss is made up of straight wood timbers (or, nowadays, steel members) arranged in triangular shapes or cells [3.32]. By virtue of its built-in geometry, the triangle cannot be changed in shape without distorting, bending, or breaking one of its sides. Hence, through the process of adding triangle to triangle, it is possible to construct extended figures that are quite strong despite being relatively light. Wooden trusses were used in a wide variety of forms for roof construction in Roman buildings and continued to be used during the Middle Ages, especially in the roofs of the large tithe barns. One superb example of medieval wooden truss construction is the hammerbeam truss roof of Westminster Hall, London, built in 1394–1399 by Henry Yevele and Hugh Herland and spanning 68 feet (20.7 m). This building has the broadest wooden span of medieval times in the West [14.46]. The great Gothic cathedrals such as Amiens were covered by such wooden roofs built over and protecting the masonry of the rib vaults below [14.38].

During the nineteenth century, many new forms of trusses were devised, often identified by the name of the engineer who first used or patented them (some of these are shown in 3.32). The truss, particularly when built up of steel members, proved capable of great spans and hence was used to enclose vast spaces. An example is the Palais des Machines, the

3.33. C. F. Murphy and Associates, McCormick Place, Chicago, Illinois, 1970–1971. Designed by Gene Summers, this space frame has spans of 150 feet (45.7 m) in both directions and covers a total area of 19 acres. Photo: Courtesy, Murphy-Jahn.

largest of the buildings in the international exhibition held in Paris, in 1889 [18.23]. The building had a series of curved steel arch trusses that spanned 377 feet (114.9 m). Here, as with any arch, there were considerable outward-pushing lateral forces at the base, but massive buttresses were made unnecessary because the bottom ends of the arched trusses were connected by steel rods just beneath the floor.

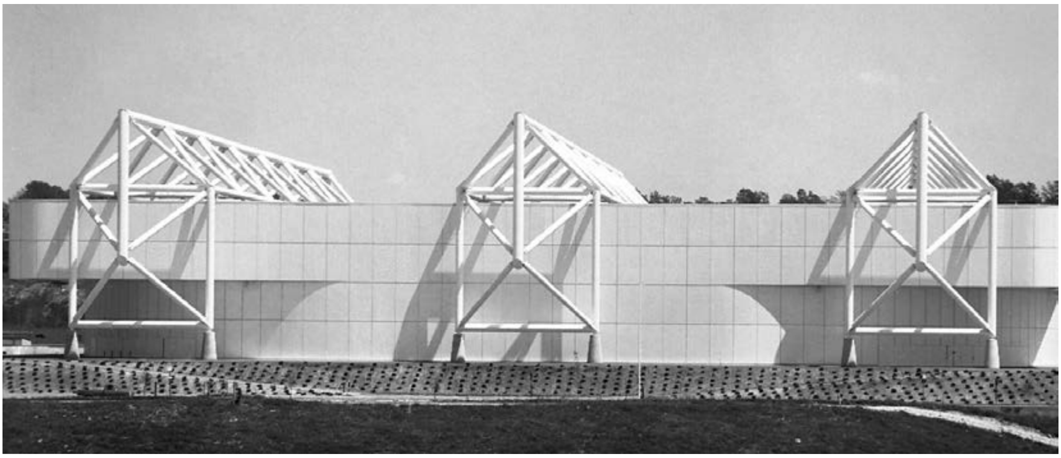
Space Frames and Geodesic Domes

Like the post and lintel or the arch, the truss can be extended in three dimensions, forming a new type of structure. The truss extended in three dimensions becomes a space frame, a relatively new structure in widespread use only since about 1945. Like the planar, or flat, truss, the space frame can span considerable distances. Properly designed, it can be supported at virtually any of the junctures of its members, permitting large cantilevers, as in McCormick Place, Chicago, 1970–1971, by C. F. Murphy and Associates [3.33]. An intriguing variation is the R. Kemper Crosby Memorial Arena, Kansas City, Missouri, 1975, also by C. F. Murphy and Associates [3.34]. In the arena, substantial three-dimensional trusses, built up of tubes of steel and having a clear span of 342 feet (104.2 m), carry the roof slung from their underside.

Just as the arch can be rotated to form a dome, so a truss can be curved in three dimensions to form what R. Buckminster Fuller christened the "geodesic dome." Like the truss, the geodesic dome is built up of small, light, easily handled steel members. Fuller began designing and building these domes after 1945, and in 1967 he was asked to design the US Pavilion for the international exhibition held in Montreal, Canada [3.35].

Shells

Another innovative structural type developed during the twentieth century is curved shells. Typically constructed of concrete, shells can be very thick and heavy or extremely thin and light. The American architect Eero Saarinen was particularly interested in shell forms and used a portion of a sphere cut to a triangular plan in his Kresge Auditorium at Massachusetts Institute of Technology, Cambridge, in 1954. He then devised sweeping, reinforced-concrete cantilevered shells for the Trans World Airline Terminal at Idlewild (Kennedy) Airport, New York, 1956–1962 [19.46]. The total covered space is 212 by 291 feet (64.6 by 88.7 m), with enormous



3.34. C. F. Murphy and Associates, Kemper Crosby Memorial Arena, Kansas City, Missouri, 1975. Designed by a young Helmut Jahn, this has three lateral trusses, each 27 feet high and spanning 324 feet (8.2 by 98.8 m), from which the roof is suspended. Photo: Courtesy Murphy-Jahn.

cantilevers at the ends of 82 feet (24.9 m). Typically, the edges of such shells are subject to significant internal stresses and deformation, so large curved beams run along the edges of such shells to stiffen them. As can be imagined, the massive, foot-shaped piers that support the cantilevered shells are packed with reinforcing rods to take up the enormous tensile stresses generated by the 82-foot overhangs.

One can, however, build shells with much less material, as the Mexican architect Félix Candela demonstrated in a number of buildings in the 1950s and 1960s. A good example is his restaurant at Xochimilco, Mexico, 1958 [3.36]. The concrete, applied by hand over steel wire mesh, is only about 4 inches (10 cm) thick, but what gives the structure its strength is not the mass of the material itself but

3.35. R. Buckminster Fuller. United States Pavilion, 1967 World's Fair, Montreal, Quebec, Canada, 1967 (destroyed by fire, 1976). In this structure a space frame is curved to enclose a sphere. Photo: Ilse Friesmen, courtesy of R. Buckminster Fuller.

3.36. Fèlix Candela, restaurant, Xochimilco, Mexico, 1958. The building shell is built of concrete applied over a mesh of steel wire, with a total thickness of about 4 inches. Photo: George Andrews, courtesy of the Visual Resources Collection, Architecture & Allied Arts Library, University of Oregon.

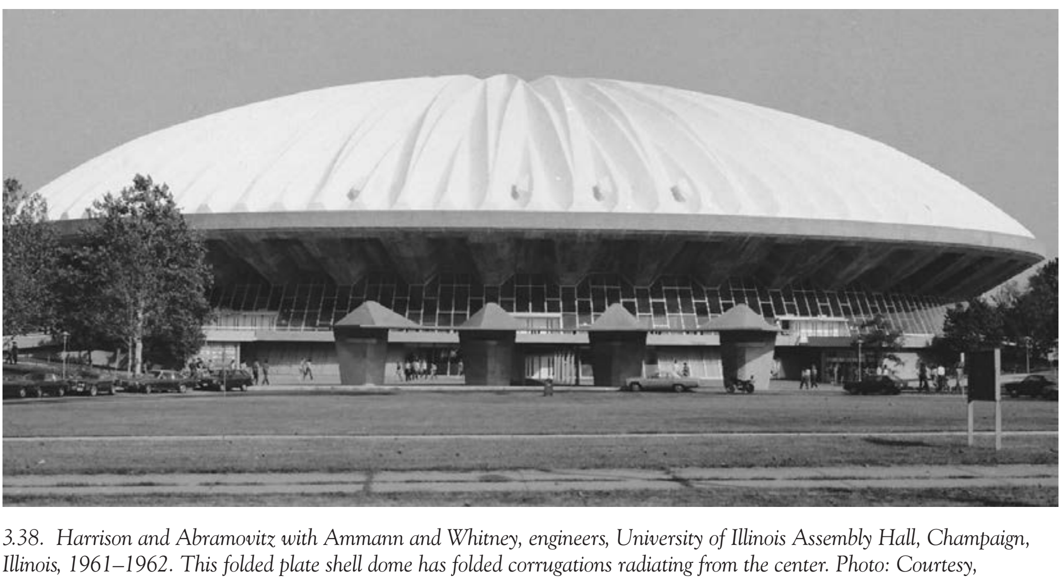
the geometric curves of the shell. The rigidity of the structure is, in a truly mathematical sense, a function of its double curvature, for it is curved radially as well as circumferentially. This was the structural technique used by the Spanish architect Antoni Gaudí in Barcelona at the end of the nineteenth century, although his shells were built of thin tile laid in a very tenacious cement mortar [19.3].

A shell may also be curved or folded in only one direction—for instance, an accordion-fold shell, as in the Minneapolis International Airport terminal building, 1962–1963, by Cerny Associates [3.37]. A particularly interesting use of a folded shell is in the Assembly Hall at the University of Illinois, Urbana-Champaign, 1961–1962, by Harrison and Abramovitz, and engineers Ammann and Whitney [3.38]. This dome consists of an enormous radially folded plate, 394 feet (120 m) in diameter, which rests on a series of radial supports reaching upward from a footing ring at the base. The enormous lateral forces exerted at the outer edge of the dome are taken up by a girdle belt of almost 622 miles (1,000 km) of steel wire wound under tension around the base of the folded-plate dome. Even more visually dramatic are the protective awnings of the Hippodrome in Zazuela, Madrid, 1935–1936, by engineer Eduardo Torroja, working with architects Arniches and Dominguez. Here, one sees a combination of slightly curved concrete shells held out over the seating by cantilevered concrete beams [3.39].

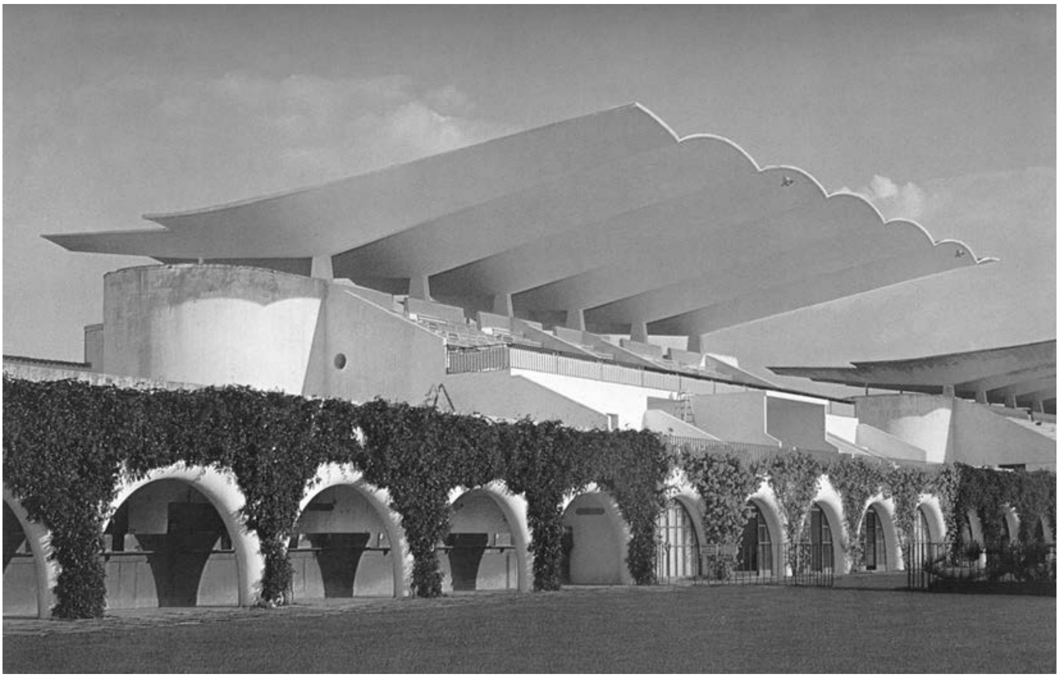
Suspension Structures

Technologically emerging peoples have used vines and ropes for suspension bridges since time immemorial; good examples are the rope suspension bridges built by the Incas in Peru. Among many still being built is the Qeswachaka bridge about 62 miles outside Cuzco, Peru [3.40]. Spanning 120 feet over the Apurimac River, the bridge cables must be rewoven every year by a group of roughly one hundred Incan descendants who weave together many strands of the local Qoya herb to form the rope. How long the bridge has been in existence is not clear, but the fact that it was destroyed by the Inca

3.37. Cerny Associates, Minneapolis International Airport Terminal, Minneapolis, Minnesota, 1962–1963. The roof has the form of a folded plate similar to a simple accordion-fold fan. Photo: Ron Tadsen.

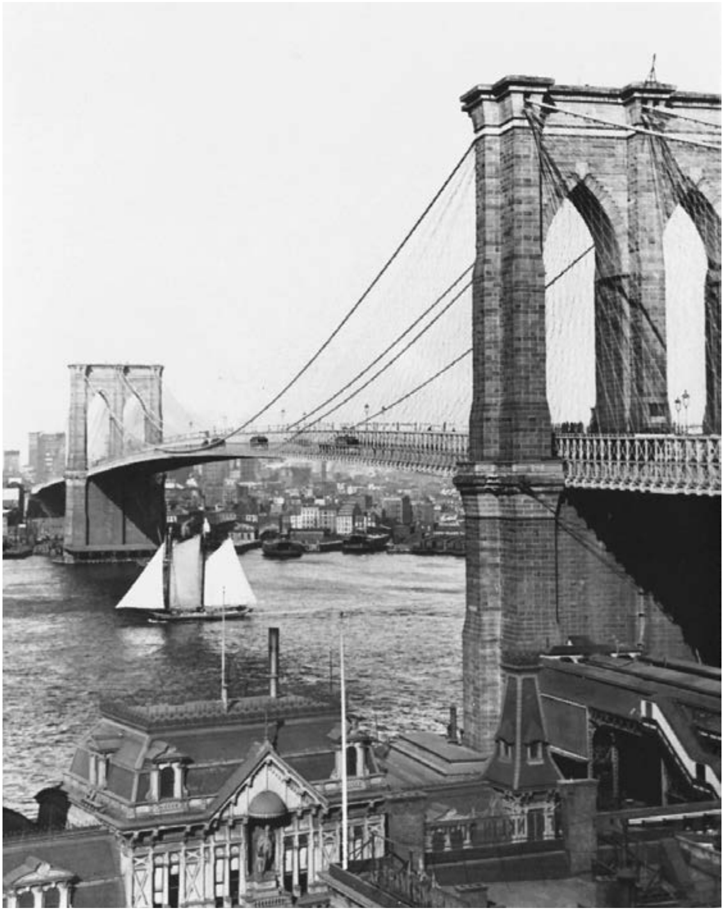


3.38. Harrison and Abramovitz with Ammann and Whitney, engineers, University of Illinois Assembly Hall, Champaign, Illinois, 1961–1962. This folded plate shell dome has folded corrugations radiating from the center. Photo: Courtesy, University of Illinois.



3.39. Eduardo Torroja, Hippodrome, Zarzuela Horse Racetrack, Madrid, Spain, 1935–1936. In an elegant combination of efficient structural forms, Torroja used cantilevered thin curved concrete shells to create an awning over the hippodrome seating. Photo: From W. Hoffmann and U. Kultermann, Modern Architecture in Color *(New York, 1970).*

3.40. Qeswachaka suspension bridge, over the Apurimac River, 62 miles from Cuzco, Peru, first built well before 1533. Photo: Isaiah Brookshire.



3.41. John Augustus Roebling, Brooklyn Bridge, New York, NY, 1867–1883. This bridge established the structural basis for all modern suspension bridges; its wrapped steel wire cables were among the first instances of steel being used in an American structure. Photo: Courtesy, The Long Island Historical Society.

in 1533 to prevent the troops of Francisco Pizarro from reaching Cuzco gives some idea of its antiquity. (The maneuver failed to stop the advance, and the bridge was rebuilt several years later and has been annually rebuilt ever since by the present-day Inca as a ceremony of respect for their ancestors.)

Beginning in the early nineteenth century, suspension bridges began to be built of iron chains and then bundled iron or steel wire cables. The classic example of the modern suspension bridge is the Brooklyn Bridge, begun by John Augustus Roebling in 1867 and finished by his son, George Washington Roebling (with construction supervised by George's wife, Emily), in 1883 [3.41]. In this bridge, steel wire was used in the cables for the first time. The Brooklyn Bridge has remained the model for iron (later steel) cable suspension bridges since its construction.

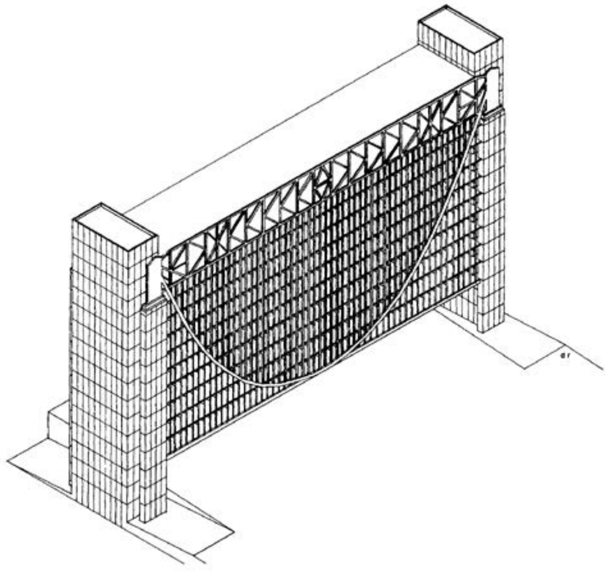
A tension structure is especially efficient in structural terms, since the entire cable is in tension, whereas most other structural forms have mixed stresses (as was noted in connection with the simple beam, which is in compression along the top and in tension along the bottom). A suspended cable assumes a curve described mathematically as a catenary (very close to a parabola) and is an ideal structural form, for it is entirely in tension. In fact, if it were possible to freeze that form and invert it, the result would be a catenary curve virtually entirely in compression. Gaudí used such arches, and the vault forms derived from them, at the start of the twentieth century in Barcelona [19.3].

Only since 1955 has the principle of cables in tension been used extensively for buildings other than bridges. Eero Saarinen, so interested in powerfully expressive shell forms, also used suspension in a number of buildings. In his Ingalls Hockey Rink, Yale University, New Haven, Connecticut, 1955–1956, Saarinen built a reinforced-concrete parabolic arch rising like a spine and running the length of the rink. From it, suspended cables sweep down to curved ground-level walls on either side of the rink. A wooden roof deck was then laid on the cables. Saarinen enlarged on this idea in his Dulles

3.42. Eero Saarinen, Dulles International Airport Terminal, Washington, DC, 1958–1962. The roof is suspended on cables anchored in the beams running along each side of the building. Photo: © Wayne Andrews/Esto. All rights reserved.

Airport Terminal, outside Washington, DC, 1958–1962 [3.42]. Here he created two opposing rows of outward-leaning column arms, curving over at the top to carry beams running the length of the terminal. Between these two elevated parallel beams, cables were suspended. Concrete slabs were placed on the cables to create the roof deck. This was not a lightweight structure, since fairly heavy concrete roof panels had to be used to keep the roof from lifting and fluttering in the wind.

Another building using the same principle is the Federal Reserve Bank in Minneapolis, 1968–1973, by Gunnar Birkerts. The written requirements for this building stipulated that there be a large, column-free area below the ground-level paving, so that within this open subterranean area armored vans could move about to deliver and pick up shipments of currency. This meant that there could be no supporting columns coming down from any structure above. Birkerts's solution to this dilemma was to concentrate the support structure for the entire building into two towers and then to support all the upper floors on cables suspended from the tops of two towers, much like a suspension bridge [3.43]. The side walls are rigid grids attached to the cables, and all floor beams are fastened to these



3.43. Gunnar Birkerts, Federal Reserve Bank, Minneapolis, Minnesota, 1972–1973. Diagram of the structural parts, showing the principal structural cables and the restraining truss at the top. Drawing: David Rabbitt.

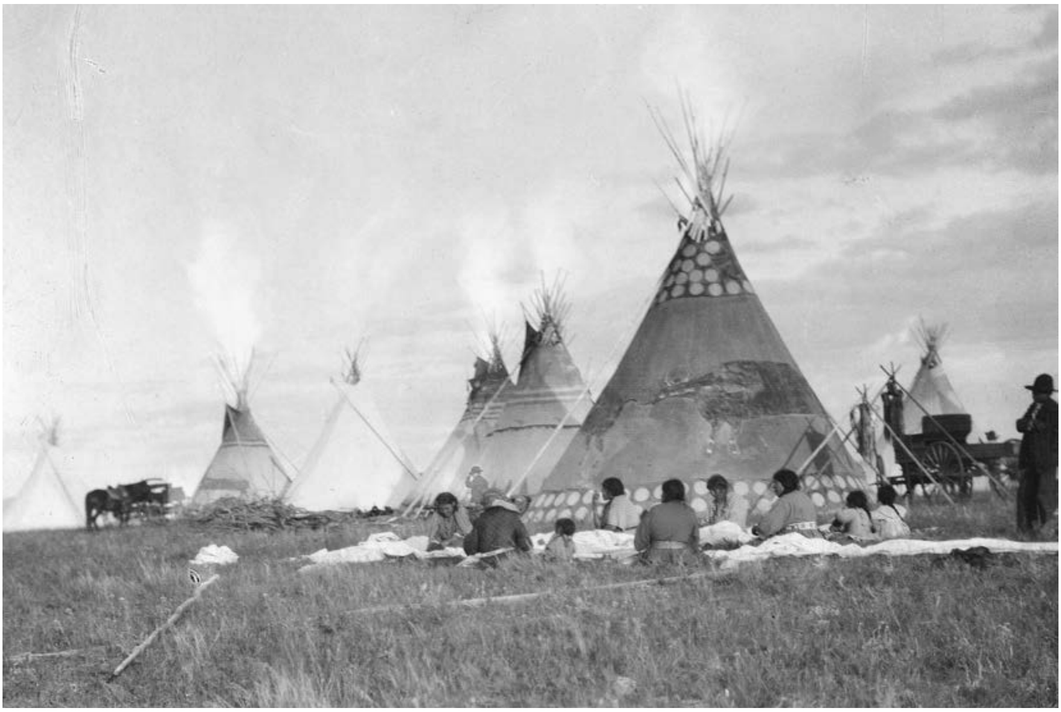
3.44. Rhone and Iredale, with Bogue and Babicki, engineers, Westcoast Transmission Building, Vancouver, British Columbia, Canada, 1968–1969. The floors are carried on beams and columns attached to exterior cables that angle back to the central structural mast. Photo: Jack Lindsay, Vancouver, Canada.

cable-supported wall grids; hence all floor and wall loads are carried by the cables back up to the tops of the towers and from there down to the foundations. However, with the tops of the towers being constantly pulled in, they would be drawn together; to counter this, spanning the top of the building is a truss serving to keep the towers apart. Birkerts also provided for the construction of two arches atop the towers from which additional floors could be hung if the building needs to be enlarged vertically. If that is ever done, the outward-directed lateral forces created by the arch carrying the added upper floors will counteract some of the inward-directed lateral forces created by the lower floors hanging from the cables.

Buildings and bridges can also be suspended by cables from a single support or from multiple mast supports. In fact, most large buildings are constructed nowadays using such a suspension-based device: the cranes that lift construction materials. These cranes have cables or steel rods from a central mast supporting the ends of the boom of the crane. A striking early example of this cable-stay technique employed as the principal structure of a building is the Westcoast Transmission Building, Vancouver, British Columbia, Canada, 1968–1969 [3.44], by Rhone and Iredale, architects, and Bogue and Babicki, engineers. In this building, the floors are suspended by cables coming out from the central core that rises above the topmost floor. More recently, since the mid-1980s, Spanish-born and Zurich-based architect and engineer Santiago Calatrava has used striking mast and cable-stay designs for several successive bridges.

Membrane (Tent) and Inflated Structures

The use of tents for human shelter is likely a tradition thousands of years old, and tent structures are still constructed around the globe, such as by Berber groups in the Moroccan desert. Another tent



3.45. Blackfeet Yellow Buffalo tipi with a group of women preparing a new tipi cover. Although constructed in the traditional way, the tipi cover here was canvas since the buffalo had already been severely depleted. Photo: Photographed by Walter McClintock in western Montana in the later 1890s. Courtesy of the Yale Collection of Western Americana, Beinecke Library, Yale University.

dwelling overly familiar to Americans and people around the globe who have watched cowboy and Indian movies is the tipi of the American high plains. Used originally by the central plains natives, it may seem a simple and perhaps crude enclosure, but the Native American tipi ("dwelling place" as it was called by the Sioux) was a highly sophisticated structure incorporating many aerodynamic refinements [3.45]. Beyond the rich symbolism associated with living within the protection of the bison (for the covering was made by sewing together ten to twelve bison hides), the tipi was traditionally positioned facing east, meaning that the door was on the eastern downwind low-pressure side. The hide cover was attached to the last of many lodgepole pine poles, which in turn was placed centered on the west side. The hide cover could then be pulled around to the east side, where the two edges were fastened together by willow pins. The tent poles were positioned not in a true circle but in the oval shape of an egg, with the wider side just west of the center (meaning that the tipi was larger west to east but had a narrower width north to south—the dimension that faced the prevailing winds). The poles were arranged so that they leaned slightly west into the wind. The upper ends of the cover, the wind flaps pushed out by two individual poles, opened up just above the center of the tipi so that the dense mass where all the poles converged was just behind the wind flap opening. Depending on the weather, the wind flaps could be either adjusted to the wind direction or closed during beating rain storms. Like the door opening next to the ground, the wind flap opening at the top was in a low-pressure area so that, in accordance with the Bernoulli Principle (see Chapter 6), smoke from the central fire would automatically be drawn outside. Inside, an inner dew lining facilitated better ventilation, and during winter months the space between outer cover and inner liner was often stuffed with dry grass to provide insulation.

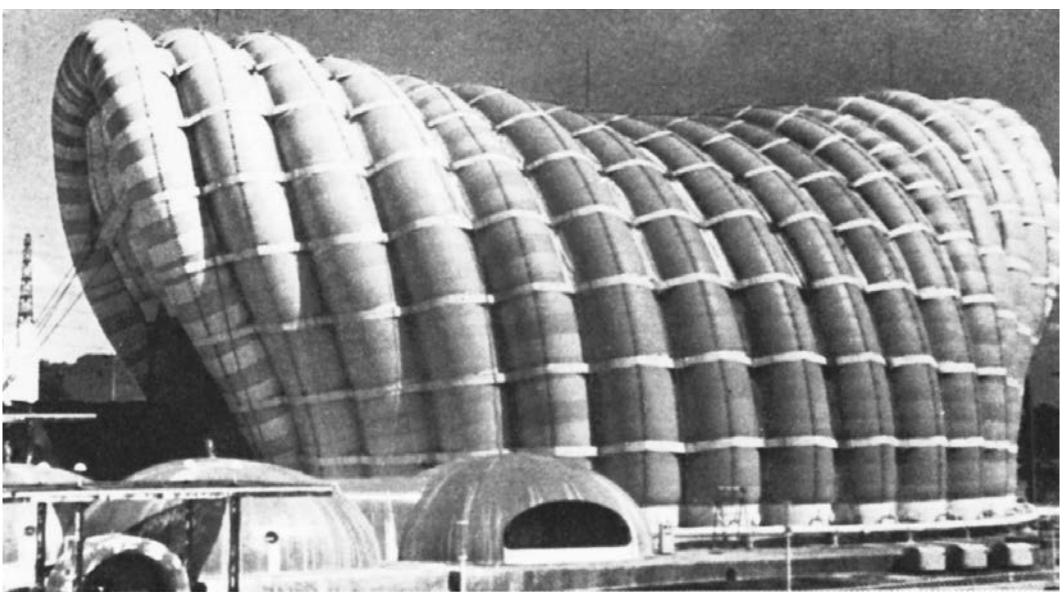
Since the mid-twentieth century, a number of manufactured materials including fiberglass and various plastics have permitted exotic construction techniques. Eventually, these may become just as commonplace as metal framing. Remember that in 1851, when masses of identical precast iron members were used to build the Crystal Palace in London, cast iron was a novel building material. Today, iron-based steel is one of the most common framing materials. In the 1960s, the German architect and

3.46. Frei Otto, German Pavilion, 1967 World's Fair Montreal, Quebec, Canada, 1967. In this building the protective enclosure is provided by a membrane held taut by cables stretched from masts to the ground. Photo: From W. Hoffmann and U. Kultermann, Modern Architecture in Color *(New York, 1970).*

engineer Frei Otto focused his energies on developing membrane structures in which the tent is supported by masts carrying a net of interwoven cables stretched to tie-downs anchored in the earth (this prevents the membrane from fluttering in the wind). Over this net, the membrane itself is attached. A good example was his German Pavilion for the international exhibition in Montreal, Canada, 1967 [3.46]. Similar to this is the tent-like roof of Teflon-coated fiberglass fabric enclosing the entry pavilion of the Denver International Airport, 1991–1995, by C. W. Fentress, J. H. Bradburn and Associates [3.47].

Another new membrane building type is the inflated structure, also made possible by new advances in textile fibers, weaving, and plastic impregnation. One application is for temporary covers over swimming pools and other such seasonal facilities. Often, a pneumatic structure has a single membrane sealed to the ground or floor deck, and the atmosphere within the structure is pressurized by fans, inflating the structure. An alternative is the double-wall inflatable (a sort of enlarged version of the inflated tubular child's swimming pool), in which tubes are fastened together so that the inflated tubes have structural integrity and the atmosphere inside the building need not be pressurized. A good example of this type was the Fuji Pavilion at the international exhibition at Osaka, Japan, 1970, designed by Yutaka Murata [3.48]. This structure was made up of sixteen tubes, each 12 feet (3.7 m) in diameter, positioned in a circular plan measuring 150 feet across; the tubes rose to 75 feet (22.9 m). Far larger is the Pontiac Stadium, Pontiac, Michigan, built in 1980, its roof designed by David Geiger. This has a cable-reinforced fiberglass Teflon skin attached to the upper rim of the octagonal building wall. Supported by an internal air pressure of 3.5 pounds per square foot, the skin covers an area of 10 acres. The disadvantage of inflated structures is that they require a nearly constant input of energy to power the fans to maintain the pressure, and they are susceptible to holes and rips in the fabric. (The Pontiac Stadium roof fabric was damaged by a heavy snowstorm on March 4, 1985, and was subsequently replaced by a new roof supported by steel girders.) Membrane and inflated structures are increasingly being used to cover sports areas and other structures needing broad covered spans, but it remains to be seen how well these materials will stand up to decades of exposure to the elements so successfully resisted by the Pantheon in Rome and medieval Gothic churches.

3.47. Fentress Bradburn Architects, Denver International Airport arrival terminal, Denver, Colorado, 1991–1995. Fiberglass-reinforced fabric is stretched from several masts to create this multi-peaked tent-like pavilion. Photo courtesy of Fentress Bradburn Architects.



3.48. Yutaka Murata Fuji Pavilion, 1970 World's Fair, Osaka, Japan, 1970. In this building the protective enclosure is provided by a membrane held taut by cables stretched from masts to the ground. Photo: From D. Sharp, A Visual History of Twentieth-Century Architecture *(Greenwich, CT, 1972).*

Building Technology and Risk

It seems that part of the expression of human aspiration in recent times, at least in modern Western cultures, has been to push the limits and immediately exploit new technologies and building methods. Humans have an apparently irrepressible desire to "push the edge of the envelope." And, as is often sadly the case, the risks and disadvantages of a new procedure or material are discovered only *after* a structure is in use. Perhaps Greek architects learned by bitter experience just how big a stone lintel could be lifted into place before cracking and collapse occurred, and French Gothic architects realized they had reached the limits of their technology when the vaults of the Beauvais cathedral repeatedly collapsed (see Chapter 14). The compulsion toward extreme structural leanness and novelty became particularly evident in modern architecture after 1920, when the goal was the visual dematerialization of architecture (as in the transparent glass wall of Lever House). The objective was to get the maximum structural performance from the minimum amount of material, with joints and connections made as small and invisible as possible, so that the building seemed immune to the pull of gravity.

The result has been that some designs have proved deadly, as in the case of the suspended "skywalks" of the lobby of the Hyatt Regency Hotel, Kansas City, Missouri, built in 1978–1980. The U-shaped building was wrapped around a large atrium court, with the upper floors connected by skywalks suspended by the slenderest of steel rods to steel trusses overhead. Designed only for periodic use by occasional guests who needed to walk from one side of the building to the other, the skywalks nevertheless became highly popular among the hundreds of people who came to the hotel on weekend afternoons for refreshments and big-band dancing. The skywalks offered excellent elevated vantage points from which to watch the dancing below. The manner in which the walks were fastened to the slender rods, however, proved too weak to withstand the pulsing, rhythmic loads generated by the crowds of dancing people—a use totally unimagined and unanticipated when the skywalks were designed. On the afternoon of Friday, July 17, 1981, the aerial walkways, one placed above the other, were filled with stomping crowds. Suddenly, the minimal connections of the suspension rods gave way, with everything crashing to the floor in a matter of seconds, instantly crushing 113 people and permanently maiming 180 more [3.49].[4]

3.49. Hyatt Regency Hotel, Kansas City, Missouri, built 1978–1980; the skybridges collapsed July 17, 1981. Photo: From The Kansas City Star, *July 18, 1981 © 1981 McClatchy. All rights reserved. Used by permission and protected by the Copyright Laws of the United States. The printing, copying, redistribution, or retransmission of this Content without express written permission is prohibited.*

The collapse of the Hyatt Regency skywalks, due to unanticipated intensive dynamic loads, was one of the worst building disasters up to that time, the result of minimal and defective support for the skywalks subjected to loads never dreamed of by the designer and engineers.

Yet that death toll, bad as it was, paled in the shadow of the thousands of deaths caused by the 2001 terrorist attack directed at the twin World Trade Center Towers, built in 1962–1973. As American office towers soared from 90 to 100 stories and beyond in the 1960s and 1970s, the logistical problems of construction resulted in the taking of calculated risks to reduce the amount of material in the ever-taller towers. Moreover, there was a push to devise construction methods streamlining construction and the building process, since delays had significant financial implications. Every pound lifted up 110 stories was money spent. Such was the case with the design and construction of the World Trade Center Towers. The 110-story towers were designed to be just adequate in strength to meet anticipated worst-case hurricane wind loads; the designers even factored in the improbable possibility of an accidental collision by an errant Boeing 707, the largest commercial aircraft at the time the building was designed. In an effort to reduce costs and maximize rentable floor space, the designers made the interiors column-free by moving some of the structural steel columns to the exterior, spacing them close together, and placing the rest around an inner core. The structural columns around the perimeter and the core were connected by the long, lightweight, open-web steel trusses supporting the floors. Then, the steel columns and the open-web floor joists were given the required legal minimum of fireproofing in the form of a lightweight sprayed-on concrete mixture. As a means of further reducing total building weight (and building time), the emergency-exit stair towers in the core were enclosed in standard gypsum board instead of being encased in their own protective concrete walls. Structurally, the towers met the letter of the law (in 1962) and were adequate to the task of standing up—but only just barely. There was no margin for any extreme imposed conditions.[5]

The towers were targeted by radical Islamic terrorists who, on September 11, 2001, shortly after takeoff, hijacked several large commercial passenger aircraft scheduled for nonstop transcontinental flights (and hence fully loaded with jet fuel). Using the planes as aerial missiles, the terrorists flew two of them at full speed into both towers, one after the other. The built-in safety measures were totally overwhelmed. The impact sheared off numerous structural columns, although the towers initially remained standing.[6] It was the enormous and long-sustained heat of the subsequent fires that caused the ultimate disaster. The impact explosions not only blew off the insulating sprayed-on concrete, exposing the thin steel rods of the open-web floor joists to extreme heat, but also destroyed the fire-control sprinkler systems. In addition, they blew away the gypsum board enclosing all the exit stairs, so all of the people working above the impact zones became trapped. Soon the exposed open-web floor joists began to soften and collapse, leaving the structural columns without lateral support. In time, even the enormously thick steel structural columns softened in the heat and started to buckle. The weight of the intact upper floors started causing the structural columns below to buckle. The stored kinetic energy invested by raising the steel to 110 stories could not be stayed; the upper sections of the towers dropped to the floors below, causing the columns below to collapse in turn under the unanticipated dynamic vertical load surge. The towers pancaked down, one floor after another. Once started, the total collapse took only a matter of seconds.

Because the towers had been the target of a previous unsuccessful terrorist attack in 1993, and regular exit drills had been implemented, workers inside below the impact levels of 2001 were able to quickly exit the buildings, even as rescue workers poured into the towers behind them in an effort to assist the people on the upper floors. Although the towers did indeed stand for many minutes, as mortally wounded as they were, the ensuing collapse took the lives of hundreds of firefighters and police as well as those trapped on the upper floors. It was the single worst building disaster ever recorded, resulting in nearly three thousand deaths. The question remains whether the economies taken in design and construction in the 1960s and '70s exacerbated the collapse. But as strong as the twin towers seemed to be, clearly no buildings are destruction-proof when targeted by persons intent on mass annihilation.[7]

Structure As Cultural Expression

Structure is more than just a simple matter of creating a frame or an envelope. The materials that are selected and the way they are assembled, suggesting either massiveness or dematerialization, are part of a culture's view of itself and its relationship to history. Thus, as will been seen in Part II, the massiveness of the Egyptian pyramids was an expression of the unchanging nature of the universe held by the ancient Egyptians, the balance in Greek temples a representation of the ideal of equilibrium in Greek philosophy, the upward reach of the Gothic cathedrals an expression of the hope of heaven, and the slender supports of the Hyatt Regency skywalks a demonstration of cockiness in the modern desire to defeat gravity. The proud, free-standing, soaring slender towers of the World Trade Center, at least in the minds of their attackers, were interpreted as the preeminent symbol of American economic hegemony and arrogant cultural dominance over the rest of the world. In the attackers' view, the towers had to be destroyed, taking with them as many people as possible. *What* we build says as much as *how* we build.

4.5. Notre-Dame de Chartres, Chartres, France, 1134–1507. The simpler south tower, built 1134–1155 in the Early Gothic Period, contrasts sharply with the more ornate north tower, begun in 1507 in the Late Gothic Period. Photo: Clive Hicks, London.

Chapter 4

"Delight"

Seeing Architecture

Our eyes are made to see forms in light.

—*Le Corbusier,* Towards a New Architecture, *1927*

Life is not life at all without delight.

—*C.V.D. Patmore,* The Victories of Love, *1863*

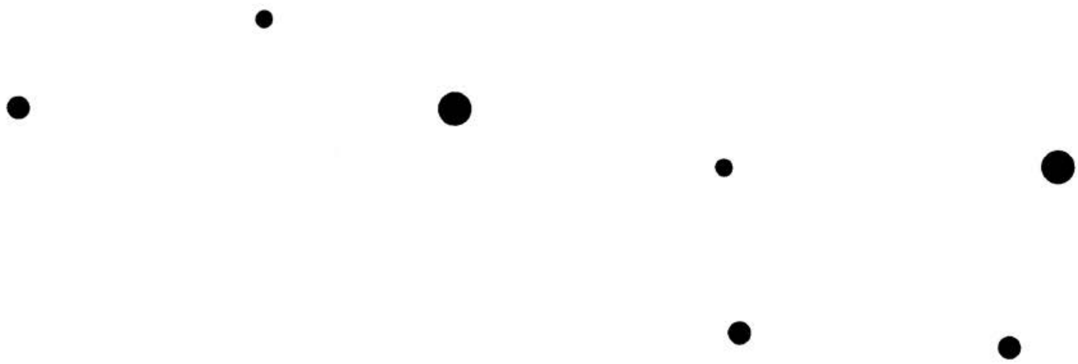
As Sir Henry Wotten put it, the third element in Vitruvius's description of architecture, following utility and sound structure, is delight. This is the most complex and diverse of all the components of architecture, for it involves how architecture engages all our senses, how it shapes our perception and enjoyment of (or discomfort with) our built environment. It is perhaps the area with which most people, architects and users alike, have difficulty. This is partly because delight involves, at every turn, subjective responses that differ from individual to individual, culture to culture. But perhaps even more important, for over half a century, from 1910 to 1965, Western architects and others around the world whom they influenced chose to believe that delight in architecture had no independent existence, that beauty resulted automatically through maximizing functionality and the clear expression of structure. Advocates of what came to be called International Modernism argued that the Vitruvian formula had been forever dispelled, so that commodity *plus* firmness equaled delight, or, as Bruno Taut wrote, architecture was the creation of "the perfect, and therefore most beautiful, efficiency."[1] Since about 1965, however, architects, critics, and historians have reversed this position, arguing again that there can be an independent quality of delight in architecture and that the most esteemed architecture endeavors to produce the greatest pleasure for the price, with function and durability being satisfied as well.

Visual Perception

Because our visual pleasure in architecture arises from our perception of it, we must start by considering how the human eye and mind receive and interpret the visual data of architectural experience. How does the psychology of vision and sensory stimulation affect our perception of architecture?

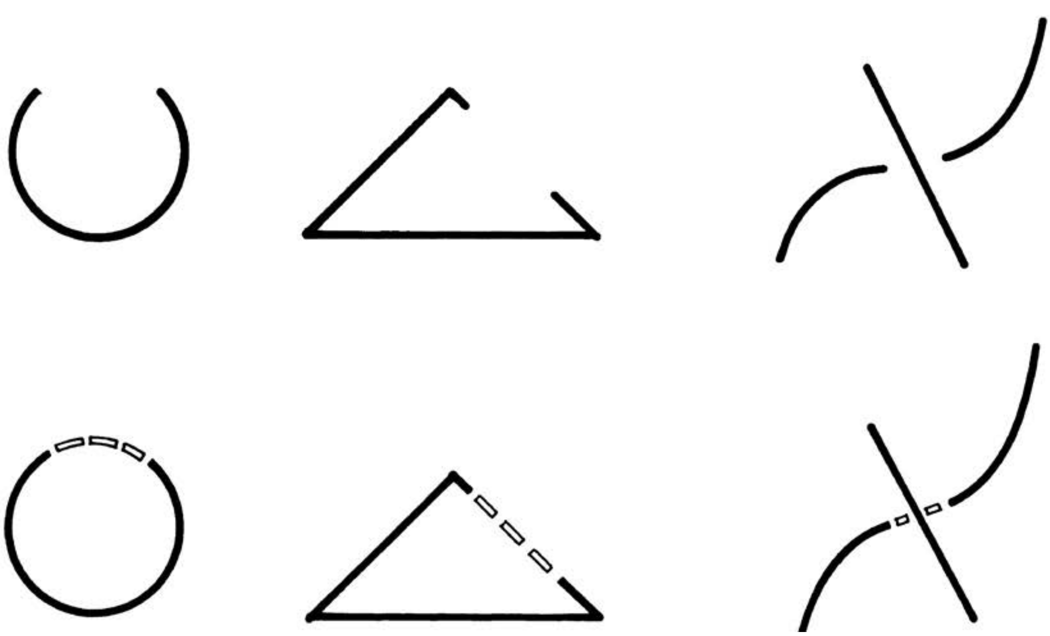
Perhaps the most fundamental concept is that the mind, particularly the human mind, is programmed to seek meaning and significance in all sensory information sent to it. This, no doubt, is linked with the instinct for survival, for eons ago, the eye, the ear, and the mind learned to interpret a change in color in the grass or the snap of a twig as indications of an approaching predator. The result, as far removed from our primeval origins as we believe ourselves to be, is that the mind seeks to place all information fed into it into a meaningful pattern. The mind does not interpret incoming data as signifying nothing. Even purely random visual or aural phenomena are given a preliminary interpretation by the mind on the basis of what evaluative information it has already stored away. Hence, what we perceive is based on what we already know. How the mind interprets forms and patterns presented to it is the subject of Gestalt psychology (from the German *Gestalt,* "form" or "shape").[2] Faced with random or unknown visual information, the mind organizes the data according to certain built-in preferences. These preferences are for proximity, repetition, simplest and largest figure, continuity and closure, and figure-to-ground relationship.

Proximity: Objects close to one another are seen to represent a pattern, and points in space are interpreted as lying on a single plane, even if one is distant and another is closer. The ancient interpretation of star constellations as the figures of the Zodiac and as gods and goddesses is a classic example [4.1]. Although the seven stars making up the



4.1. Diagram of seven dots illustrating the concept of proximity. The dots are close enough to be interpreted as a unified figure, commonly called the Big Dipper. Drawing: L. M. Roth.

4.2. Row of dots illustrating the concept of repetition. The slight irregularities in the spacing are largely ignored by the eye/mind in favor of seeing an even row. Drawing: L. M. Roth.



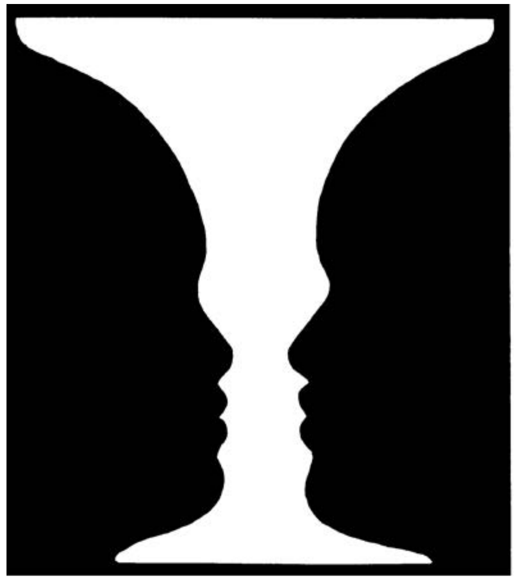
4.3. Diagrams illustrating the concept of continuity and closure. The mind attempts to complete each form on the basis of known forms in the simplest way possible (the principle of simplest and largest form). Drawing: L. M. Roth.

Big Dipper are in fact at various distances from the earth, we cannot see those astronomical differences in distance and so we interpret the stars as being on a single plane and forming the outline of a dipper with a long handle (or a bear with a long tail, or a caribou with extended antlers).

Repetition: Equalities of spacing or distance are seen even where none exist, so that a row of lines or dots will be seen as being equidistant and two parallel lines, slightly different in length, will be seen as equal in length [4.2]. This is one reason why the corner columns of Greek temples are of interest, for they were purposely made a little thicker than the others and were positioned a little closer to each other, so that what we *want* to see as a series of equal objects arranged in space is, in actuality, a carefully calculated sequence of subtle inequalities [11.29].

Simplest and largest figure: When presented with elements that suggest an image it can recognize, the mind fills in any missing pieces to form the simplest and largest meaningful figure. The related mental operation that makes this possible is the impulse toward *continuity and closure* [4.3]. What appears to be a fragment of a circle will be completed as a circle rather than as a crescent or some other shape, and the curved line will be seen as being solid where the short line "crosses" it.

Figure-to-ground relationship: A shape seen in the context of an enclosing shape will be interpreted as a form against a background, with the mind deliberately choosing which is which [4.4]. In the standard illustration of this phenomenon, we can choose to see either a turned white vase against a dark background or two faces in silhouette against a white background. This principle, too, seems to have been employed in the Greek temple colonnade. The corner columns were thickened, since they alone of all the columns were seen silhouetted against the sky; these corner columns would have been seen as a dark mass against a light sky, whereas the other columns would have been seen as light masses against the shaded *naos* wall behind them. (The *naos* chamber is discussed in more detail below.)



4.4. Figure/ground illustration. Depending on what the mind chooses to interpret as the background, one sees either a turned white vase in front of a dark background or the profiles of two faces against a light background. Drawing: L. M. Roth.

The mind seeks to find order, regularity, and uniformity. It craves information, constantly *varying* information, and when that input is cut off—when sight, hearing, smell, and touch sensors are completely unstimulated, as in an isolation flotation tank—the mind will eventually invent its own stimuli, and hallucination will result. Alternatively, when information becomes purely repetitive, the mind tunes it out and focuses instead on the deviations from the anticipated pattern. This happens automatically, or it can be made to happen as the result of a conscious mental decision; we choose not to hear street traffic at night so that we can sleep, but the slightest cry of an infant rouses parents from sleep as a distress signal—it is the information that deviates from the accustomed accepted norm. Again, the Greek temple illustrates this point [11.28]. One reason the Parthenon in Athens has been considered intriguing for so long may be because there is not a single straight or regular line in it. What appears at first glance to be repetitively uniform is in fact, as will be shown in Part II, a subtle and mathematically precise arrangement of inequalities and curves. So, too, many observers prefer the facades of the Gothic cathedrals of Chartres and Amiens [4.5, p. 68] because their facades are *not* bilaterally symmetrical. In fact, the towers of the west end of Chartres were built four centuries apart (1134 and 1507) and represent two different stages of architectural development in France. Or, to take more contemporary examples of similar function, we might contrast the repetitive facades of the Federal Center buildings in Chicago, by Mies van der Rohe, 1959–1964 [4.6], which exploit the industrial production of building parts, with the variation of window shapes and sizes in Boston City Hall, by Kallmann, McKinnel & Knowles, 1961–1968 [4.7].

There is also a kinesthetic, empathic bodily response to forms and lines. Thus, the horizontal line

4.6. Mies van der Rohe, Federal Center Chicago, Illinois, 1959–1964. In this design, Mies van der Rohe pulled the glass curtain wall outside the columns, resulting in absolutely uniform window bay units, and suggesting that activities within were all similar. Photo by Hedrich Blessing. Chicago History Museum, negative HB-27043d3.

is sensed empathetically as being at rest, just as the human body is at rest when horizontal. Frank Lloyd Wright exploited this response in his Prairie Houses around Chicago [18.34], stressing and emphasizing the horizontal lines and planes of his houses—not only to relate their form to the flat Midwestern prairie but also to convey the image of domestic tranquility. In contrast, the vertical line is sensed as one of aspiration, reaching, assertiveness [4.5]. There is a sense of dynamic equilibrium as a result of forces at work in the vertical line (just as our bodies are maintained erect by a multitude of constant, dynamic muscle actions). But the line that most strongly conveys dynamic action and movement is the diagonal. This phenomenon was exploited in numerous compositions in Baroque and Romantic paintings from 1600 through 1900, but it has also been used for dramatic effect in such architecture as Walter Gropius's *Memorial to the March Victims* at Weimar, Germany, 1920 [4.8]. It can be seen, too, in the well-known *Marine Corps War Memorial* in Washington, DC, 1945–1954, by

4.7. Kallmann, McKinnel and Knowles, Boston City Hall, Boston, Massachusetts, 1961–1968. Although housing functional activities similar to the Chicago Federal Center, this building has considerable variations in external window forms. Photo: © Wayne Andrews/Esto. All rights reserved.

4.8. Walter Gropius, Memorial to the March Victims, Weimar, Germany, 1920. A series of sharp diagonals is used for dramatic effect in this memorial to victims shot in a street uprising; the pointed angularity can also be described as being "hard." Photo: © Wayne Andrews/Esto. All rights reserved.

the sculptor Felix W. de Weldon, based on the gripping Pulitzer Prize–winning photograph by Joe Rosenthal taken on Iwo Jima, February 23, 1945.

The crystalline angularity of Gropius's memorial also enhances its visual effect. Such faceted objects can be described as hard, in contrast to the rounded Einstein observatory tower in Potsdam, Germany, 1919–1921, by Erich Mendelsohn, which, in contrast, could be said to be soft [19.13]. In literal fact, both are hard, for the Einstein observatory is built of brick covered with stucco.

Proportion

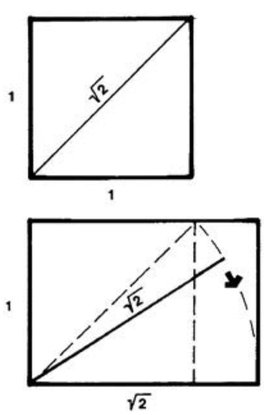
The mind also seeks out mathematical and geometrical relationships—or proportions—in patterns. The ancient Greeks believed that all nature was governed by abstract universal laws. The philosopher Pythagoras demonstrated that two taut strings, having a ratio in their lengths of 2 to 3, would produce what is called a fifth when plucked together. And a string twice as long as another (having a ratio of 2 to 1) would produce the same tone an octave lower. Moreover, since the ancients also believed that human form was based on that of the gods, universal and divine geometric and proportional relationships could be observed in the proportions of the human body. Vitruvius described how, by taking the navel as the center, the extremities of the human body lie on the edges of both a square and a circle, the most elemental and ideal of geometric figures [15.4].

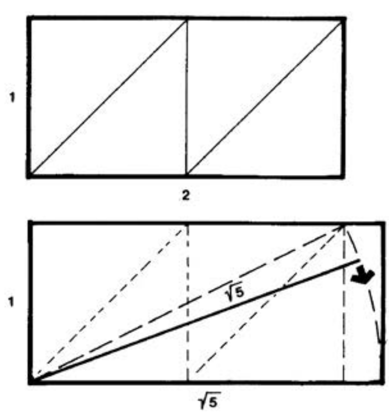
Vitruvius also described how to generate geometric figures with irrational numbers (that is, numbers that cannot be expressed as the ratio of two whole numbers). His demonstrations all begin with a square. The particular advantage of this system, and the basis of many Greek proportional systems before Vitruvius, was that such geometric figures could be laid out on the flat earth of the construction site with only wooded pegs and lengths of rope. Whole building plans, therefore, could be scratched out on the ground with utmost regularity of part to part. By measuring off the diagonal of a square, and then rotating it down along one side of the square, one creates what is described as a $\sqrt{2}$ rectangle [4.9] in which the sides have the proportional relationship of 1 to 1.414 (or $1{:}\sqrt{2}$). Or, one might lay out two squares, end to end, measure off the diagonal of this rectangle, and then rotate it down to the long side to form a $\sqrt{5}$ rectangle [4.10], in which the sides have the proportional relationship of 1 to 2.2361 (or $1{:}\sqrt{5}$). Many medieval churches show these proportional systems in the arrangement of their plans. Another proportional system followed by the Greeks was the relationship of x to $(2x + 1)$, so that Greek temples normally had six columns across the ends and thirteen along the sides (6 to $2\times 6 + 1$) or, less often, eight columns by seventeen (8 to $2\times 8 + 1$).

Perhaps the proportional system most associated with Greek architecture and design, and with Classical architecture as a whole, is what is called the Golden Section, or Golden Mean. Just as gold is the most imperishable and thus the most perfect of metals, so too was this proportional relationship believed to be perfect. It can be described as the relationship of two unequal parts such that the smaller part is to the larger as the larger is to both parts combined. Today, we can write this algebraically, with a being the smaller unit and b the larger:

$$\frac{a}{b} = \frac{b}{a+b}$$

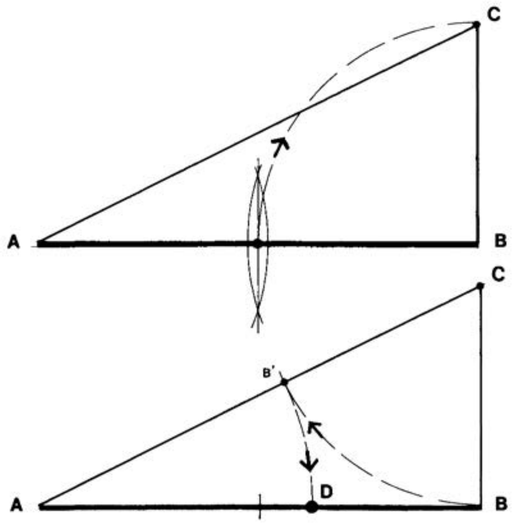
This can be rewritten as an equation: $b^2 = a^2 + ab$. If a is assigned a value of 1, and the equation is solved for b, the result is that b equals 1.61804. Or,





4.9. Diagram of a square root of 2 rectangle. Drawing: L. M. Roth.

4.10. Diagram of a square root of 5 rectangle. Drawing: L. M. Roth.



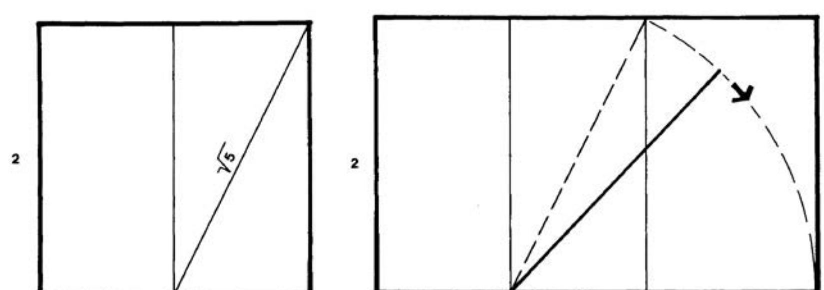
4.11. Diagram showing how a line can be divided with drafting tools, or rope and pegs on the ground, so that the portions have the proportion of the Golden Section; that is, the ratio of the short to the long part is the same as that between the long portion and the entire line: 1 to 1.618. Drawing: L. M. Roth.

if *b* is given the value of 1, the result is that *a* is 0.61804; the proportional relationship between 1 and 1.618 and between 0.618 and 1 is the same.

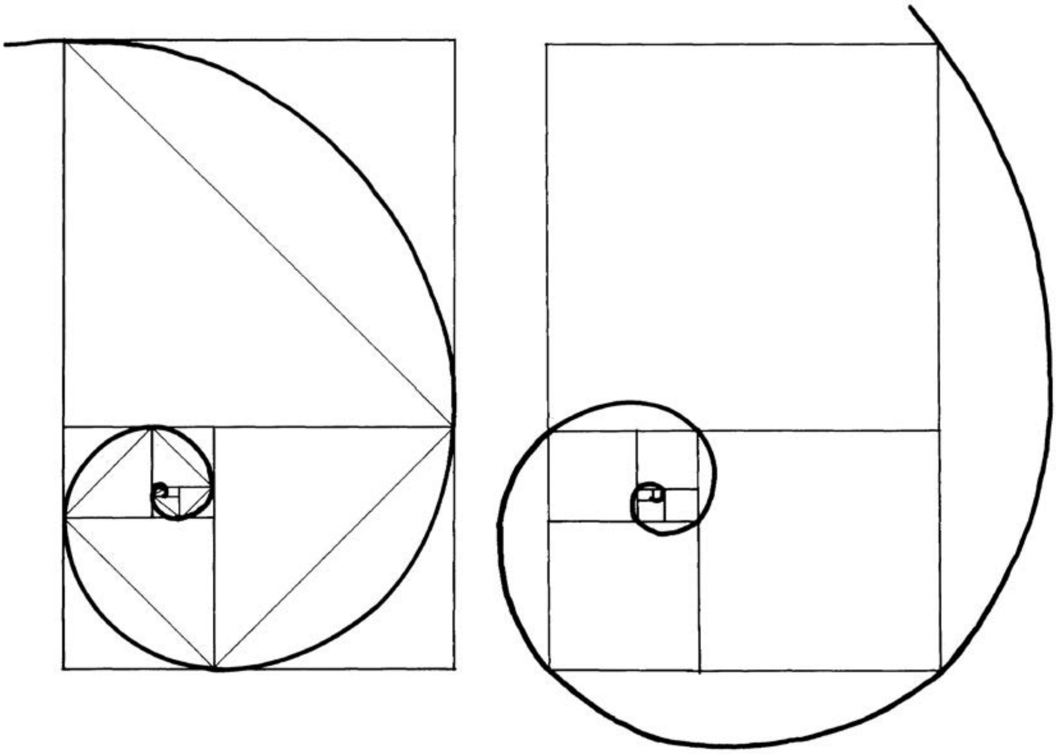
The Greeks demonstrated this theory geometrically in two alternative ways, with ropes and pegs in the field or with drafting instruments on a sheet of vellum (sheepskin). The problem is to divide a line *A–B* into two parts so that the short part is to the long part as the long part is to the entire original line [4.11]. First, the line *A–B* is bisected; then half of the line is swung up to the perpendicular to form the triangle *A–B–C*. Using C as the center point, the line *B–C* is swung up to strike the hypotenuse A–C to locate the point B'. Then, using A as the center, the line *A–B'* is swung back down to the original line, *A–B,* to locate the desired point of division, *D.* The ratio of the two lengths of the divided *A–B* is mathematically the same as in the algebraic equation; the length of *D–B* is to *A–D* as *A–D* is to *A–B*.

Even more simply, a Golden Section rectangle may be generated from a given square. The objective is to create a rectangle in which the short side and the long side represent the Golden Mean. First, the square is divided in half, so that each half measures one unit by two units [4.12]. Then, the diagonal of one of these rectangles is rotated down along the side of the original square. From the end of the rotated diagonal, the desired Golden Section rectangle is constructed. The proportions of the finished rectangle are 2 to $(1 + \sqrt{5})$, which is 2 to 3.236, or 1 to 1.618.

A further derivative from the Golden Section rectangle results in a most interesting curve [4.13]. In a Golden Section rectangle, the square is marked off at one end; a smaller square is drawn in the end



4.12. Golden Section rectangle. The short side is to the long side as the long side is to the two sides added. Drawing: L. M. Roth.



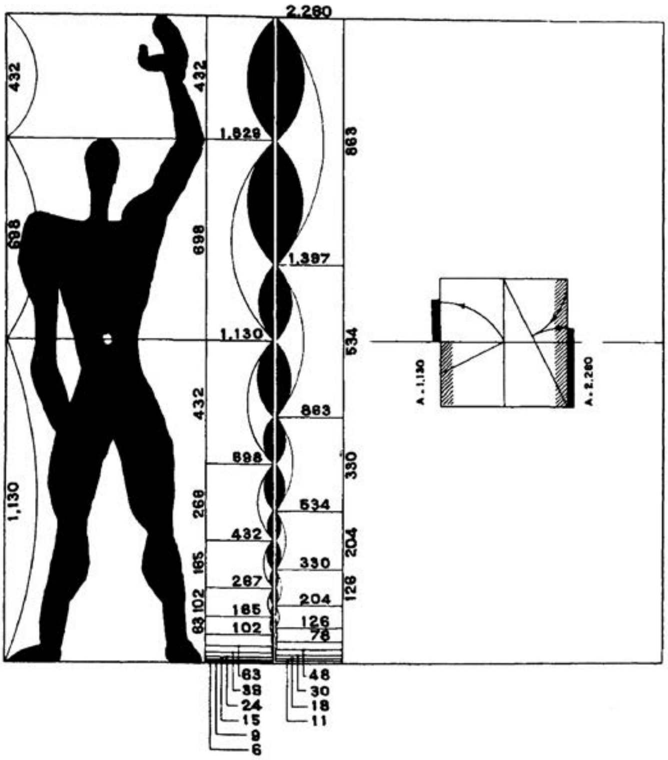
4.13. Logarithmic spirals based on the Golden Section. Drawing: L. M. Roth.

of the remaining rectangle, and another square is then drawn in the leftover rectangle, and so on, until no more squares can be drawn. If the corners of these nested rectangles are then connected by a curved line, the result is a logarithmic spiral, or ***volute***, very much like that found in the patterns of seeds in a sunflower or in the section of a chambered nautilus. It was also such a curve that the Greeks used in the volute of the capital of the Ionic order [see 3.16].[3]

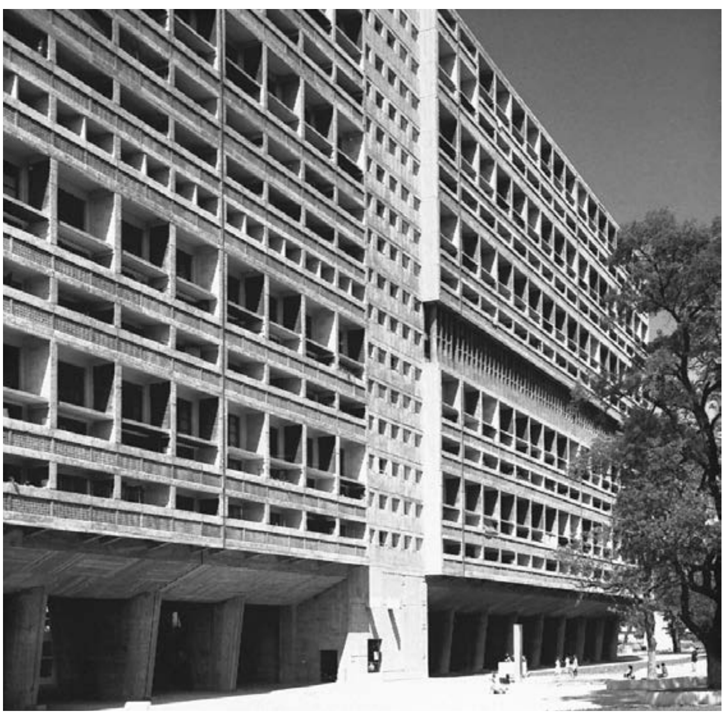
There is yet another intriguing correspondence to a proportional system based on a numerical series, first described by the medieval mathematician Leonardo Fibonacci (c. 1170–c. 1240). The numerical sequence is generated by starting with the number one, adding that to itself, and then generating the next in the series by adding the last number to the number preceding it, thus: 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, and so on. The larger these numbers become, the closer the last two approach the Golden Section; for example, 21 to 34 equals 1 to 1.61905, and 34 to 55 equals 1.61765, and 55 to 89 equals 1:61818. On the basis of the Fibonacci series, the architect Le Corbusier developed in the late 1930s a proportional system he called the Modulor [4.14]. He used this as the basis of design for a large apartment block, the Unité d'Habitation in Marseilles, France, 1946–1952, casting the image of the Modulor man with upraised arm in the concrete of its elevator tower. In fact, among twentieth-century architects, Le Corbusier was the most frequent user of proportional systems, both in arranging the placement of walls and structural supports and in the sizing and placement of windows and doors in exterior walls [4.15].

Scale

Architecture and landscape architecture are the largest and most encompassing of the visual arts. One of the challenges faced by the user is to determine just how big a building is, and the yardstick against which we measure the size of a building is our own human size. How big a building is, relative to the size of the average human being, is said to be its scale.[4] In the Unité d'Habitation, Le Corbusier conveniently cast into its side a clear ruler by which we can see just how big the building is. Frank Lloyd



4.14. Le Corbusier, diagram of the Modulor man, 1947. Photo from Peter Blake, The Master Builders *(New York, 1960)*



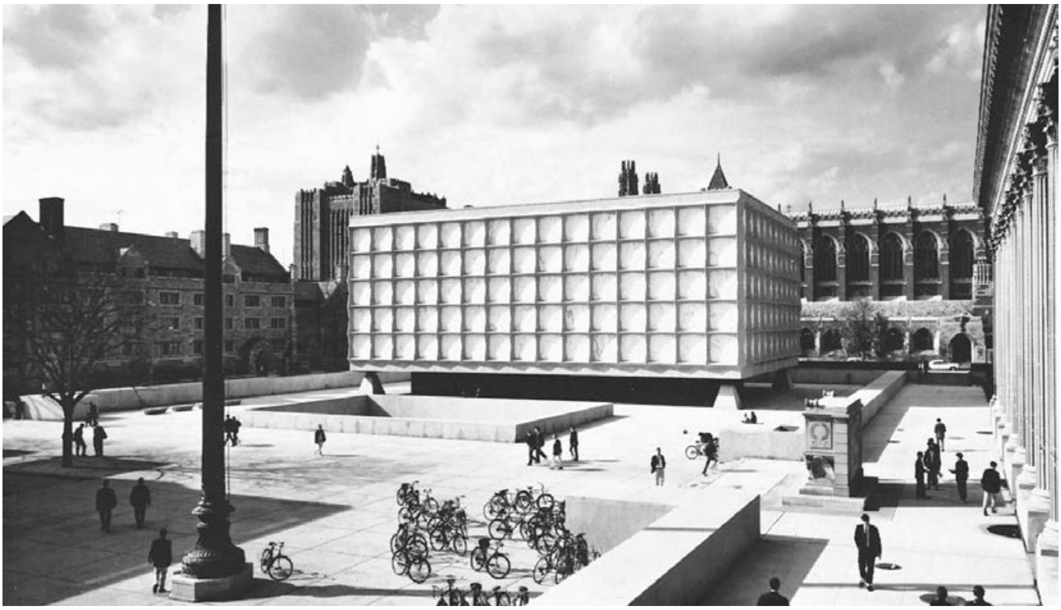
4.15. Le Corbusier, Unité d'Habitation, Marseilles, France, 1946–1952. The entire building, in all its parts, was proportioned using the Modulor and its numerical relationships based on the Fibonacci series (1:2:3:5:8, etc.). Photo: © Wayne Andrews/Esto. All rights reserved.

4.16. Michelangelo, Basilica of Saint Peter, Rome, Italy, 1549–1564. East end. In an effort to give visual unity to this huge building, Michelangelo deliberately used overscaled elements to reduce the number of parts, but the result also makes it difficult to judge the true scale of this building relative to human size. Photo: Leonard von Matt.

Wright designed his houses for what he considered the ideal height, 5 feet 8½ inches (which, of course, just happened to be his own height). As he himself wrote, had he stood 6 feet 2 inches tall, his architecture might have been significantly different.

For the most part, there are many clues in a building as to its size—windows, doors, steps—but even all these may be enlarged so that our sense of scale is distorted. Such is the case with the east exterior wall of the Basilica of Saint Peter in Rome, built under the direction of Michelangelo, for the windows and pilasters are two and three times larger than what we would expect [4.16].

One of the problems inherent in the austere and industrially inspired architecture of the International Modernism of the mid-twentieth century was that it lacked such scale clues. Architects, in fact, were quite proud of the way they stripped away details that for centuries had provided visual clues. The dilemma is well illustrated in the Beinecke Rare



4.17. Skidmore, Owings & Merrill, Beinecke Rare Book Library, Yale University, New Haven, Connecticut, 1960–1963. The scale-less forms of the Beinecke Library contrast sharply to the much finer and more easily interpreted scale elements of the Yale Law School, 1931, in the distance. Photo: Courtesy, Skidmore, Owings & Merrill.

Book Library at Yale University, New Haven, Connecticut, 1960–1963, by Skidmore, Owings and Merrill [4.17], especially when the building is viewed in the context of the surrounding buildings dating from the 1920s. The older buildings provide many clues as to their size relative to human beings, but the library provides few. Only when the students and bicycles in the foreground are viewed in relation to the library does its size begin to be revealed. Although in some situations the game of trying to guess the scale can be amusing—and this is the basis of the whimsy in the sculpture of Claes Oldenburg—ordinarily, the task of trying to determine scale, when it occurs again and again in the modern urban cityscape, becomes unsettling.

Rhythm

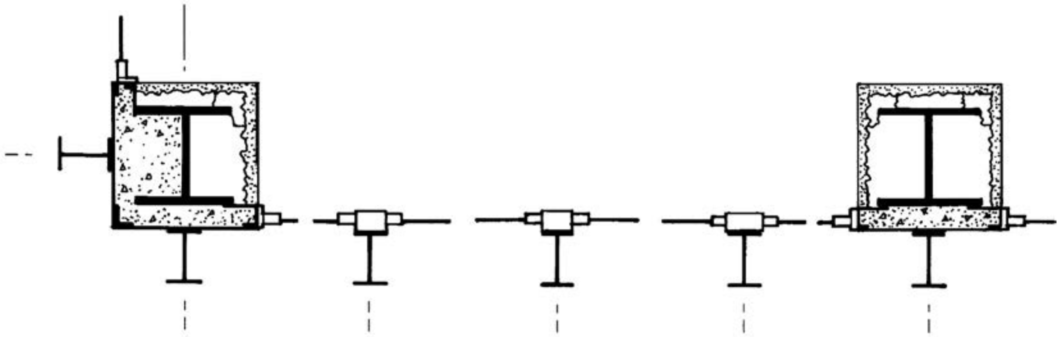
There are a number of ways by which ordered variety can be given to buildings. One is the use of rhythm, or what can be called the alternation between incident and interval, between solids and voids. Rhythm in architecture is the pattern created in windows spaced in a wall, or columns in a colonnade, or piers in an arcade. This architectural rhythm is read by visually scanning the surface, much as one might scan, say, a musical score, reading the patterns the notes make through time. This is one way that architecture is like music, for both must be experienced in time. So, too, one can experience the rhythm of a colonnade or an arcade by walking along it, sensing the passage of the piers. We can also speak of the continuous, unvarying rhythm of Mies van der Rohe's federal buildings in Chicago, for the pattern of the windows does not change at all, whether one reads from top to bottom or from left to right. We can see a similar, even rhythm in the arcade that runs across the facade of the Foundling Hospital in Florence, 1419–1424, by Brunelleschi [15.7]. There are slight differences in the end bays, added later, where the Corinthian columns of the arcade are framed by taller Corinthian pilasters. If we take the center line of the columns or piers as marking the edge of each bay, and we scan the facade from left to right, we find that the first bay differs slightly from the next to the right, and that it in turn differs slightly from the next, but after that, the bays are identical until we approach the other end. So, we can assign symbols to this reading, saying that the facade has this rhythm: a-b-c-c-c-c-c-c-c-b-a.

Such order and clarity of form are characteristic of the Renaissance in Italy and began with the Foundling Hospital. But we might compare that arcade to the garden facade of the Palazzo del Te in Mantua, Italy, 1527–1534, by Giulio Romano [4.18].

4.18. Giulio Romano, Palazzo del Te, Mantua, Italy, 1527–1534. Garden facade. What appears at first glance to be a simple repetition of arcade units turns out, after closer examination, to be a complex series of variations on a theme. Photo: Scala/Art Resource, NY.

At a first casual glance, there appears to be an equally even rhythm in the arcade, except, of course, that the center arches are slightly larger. But closer observation reveals that no two adjacent bays are the same.[5] Reading the rhythm from left to right, we find that the end bay is butted up against the wall of the garden enclosure and framed with doubled pilasters on the other side. The next bay is framed with doubled pilasters and a wall with a niche on the left and doubled pilasters and an opening to the right. The next bay is framed with a single column and a pilaster; the next one is a flip-flop inversion, but with its pilaster lying behind the large pilaster of the larger central unit. The next bay is the outer bay of the enlarged central pavilion and is framed with a pilaster and a column on the left and a pair of columns on the right. Finally, the centermost bay is framed with doubled columns (actually, it is a cluster of four, two in front of two others). Assigning symbols to this reading, we would get a-b-c-d-E-F-E-d-c-b-a. It is a bilaterally symmetrical composition, with every element to the left of the center mirrored by what is on the right, but each part of that rhythm varies slightly from the part next to it—an excellent example of ordered variety.

As in music, we can find two rhythms played against each other simultaneously. This occurs in many of the arcades and colonnades of the Renaissance and Baroque periods, as well as in more recent times. Consider the facades of Mies van der Rohe's apartment towers at 860–880 Lake Shore Drive, Chicago, 1948–1951 [4.19, 19.28]. Mies devised a structural frame of square bays, so that each tower measures three by five bays. The structural steel columns, in accordance with Chicago building codes, had to be insulated in protective concrete fireproofing, which Mies encased in steel skins. Mies then divided the interval from the center lines of the structural columns into four equal parts, using these secondary dividing lines for the centers of the mullions supporting four windows. The windows were made flush with the edge of the structural column, so that the thickly insulated structural column used up some of the width of the adjoining window, making the outer windows in each structural bay slightly narrower than those in the middle. The result is two overlaid rhythms. The larger structural rhythm is absolutely even, A-A-A, but the window rhythm within the structural bay is a-b-b-a. As will be shown in Part II, the rhythms in Italian Renais-



4.19. Mies van der Rohe, 860–880 Lake Shore Drive (Lakeshore Drive Apartments), Chicago, Illinois, 1948–1951. Plan of one wall bay showing windows and structural columns. What seems at first a simple repeated window module is in fact varied by the thickness of the supporting columns. Drawing: L. M. Roth.

sance buildings were normally governed by deliberate mathematical Vitruvian relationships, but the rhythms in Mies van der Rohe's Lake Shore Drive apartments were the result of the application of mass-production techniques to window frames. In his later buildings, such as the Seagram Building, New York, 1954–1958 [see 6.13], and the federal buildings in Chicago [see 4.6], Mies pulled the plane of glass in front of the structural columns, causing the structural rhythm to disappear behind an absolutely even window rhythm.

In architecture, rhythm also can be created by the alternation of solid and void. In his later architecture, Le Corbusier excelled in this. One particularly interesting example is the elongated Secretariat Building he designed for the new capital of Punjab State in India, Chandigarh, 1951–1958 [4.20]. This office building required a number of identical office cells, expressed externally by the repetitive rhythm, whereas at the center, the rhythm changes dramatically in favor of larger, asymmetrical patterns corresponding to larger chambers and differing internal functions.

It is also possible to speak of rhythm in architecture in reference to undulating or curving walls. Buildings with frame construction, whether of wood or steel, tend to have rectilinear forms; hence their facades tend to be flat planes. Curved forms, however, have more dramatic impact. During the Baroque period, curved walls were exploited extensively, for they suggested not only that they bound space but that space pushed back on them. A good

4.20. Le Corbusier, Secretariat Building, Chandigarh, India, 1951–1958. In this elongated building, Le Corbusier varied the rhythm of the shape and sizes of the sun screens, breaking up the long facade, and indicating office cells contrasted to committee rooms. Photo: John E. Tomkins, courtesy of the Visual Resource Collection, Architecture & Allied Arts Library, University of Oregon.

4.21. Alvar Aalto, Baker House, Massachusetts Institute of Technology, Cambridge, Massachusetts. Viewed at close range, the randomly placed and protruding rough bricks create a visual and tactile texture in the wall. Photo: C. Condit Collection, Department of Art History, Northwestern University.

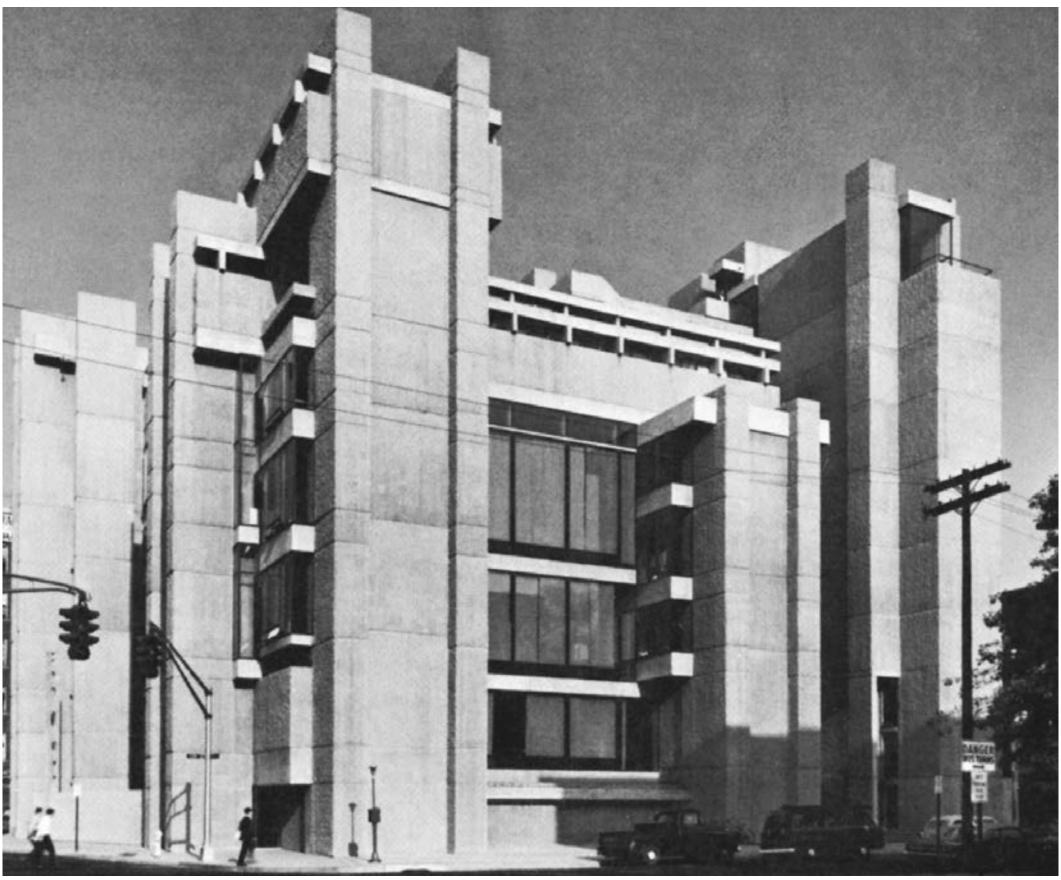
example is the facade by Francesco Borromini of the Church of San Carlo alle Quattro Fontane in Rome, 1662–1667 [see 16.15]. The facade is a series of curves and countercurves that establishes a play of rhythms. Such curved buildings have been rare in the twentieth century, particularly before 1960, but a notable exception is Baker House at the Massachusetts Institute of Technology, Cambridge, 1946–1948, by the Finnish architect Alvar Aalto [4.21]. Here, the undulating form was not only a way of fitting what needed to be a long building into a restricted site but also a response to the oblique views across the Charles River that Aalto discovered the students preferred.

Texture

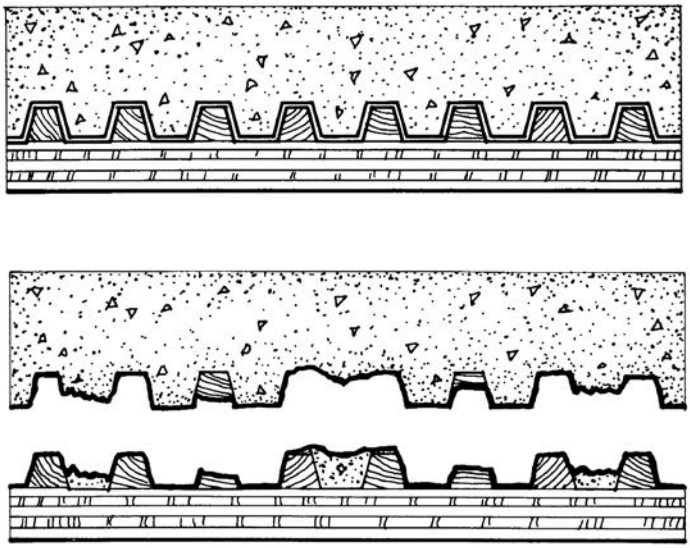
Another of the many devices used to add variety to architecture is texture, a term that has various meanings. The visual, or optical, texture of a building refers to its visual pattern at the large scale, whereas its haptic, or tactile, texture refers to what can be physically felt with the human hand. So, for example, the Secretariat at Chandigarh, seen from a distance [4.20], has a rich optical texture in the variation between the uniform office cells and the more irregular "texture" of the larger meeting rooms. Another of Le Corbusier's buildings, the Unité d'Habitation apartment block in Marseilles [see 4.15], has a similar bold texture pattern when viewed from a distance. But we can also speak of the tactile texture, for the roughness of surface can be felt. When one gets close to the Unité apartments, one can see that the concrete was poured in forms specially made of rough lumber so that when the forms were removed, a bold pattern was left imprinted in the concrete. Moreover, Le Corbusier had the workers rotate alternate panels of the formwork, creating a basketwork checkerboard pattern in the concrete that adds to the textural richness at both the optical and the tactile levels. In addition to the visual rhythm of his Baker House, Aalto had the wall laid up with rough clinker bricks—those that had become twisted and darkly burned during firing and normally would have been rejected. The bricks were placed randomly to add a visual and tactile texture to the walls [see 4.21]. At certain times of the day, when the sun rakes along the surfaces, the protruding, misshapen bricks cast irregular shadows along the wall.

Concrete, in particular, lends itself to the creation of texture, for it must be poured into a form of some kind. It is virtually impossible to make the joint invisible between successive pours of concrete, for even slight variations in the composition of the cement will cause color variations. An architect can take care to design the details where the panels of the formwork come together, accentuating that line and thereby creating a texture in the finished concrete that is a record of the act of construction. Louis I. Kahn did this with great care, especially in the concrete for the Salk Institute at La Jolla. In another attempt to create a special texture in concrete, there resulted an even rougher texture than originally planned. When erecting the Art and Architecture Building for Yale University, 1958–1964 [4.22], the architect Paul Rudolph used forms made of plywood panels to which chamfered strips of wood had been screwed [4.23]. The forms were oiled in the expectation that the concrete would not stick to the forms, so they could be pulled off easily for reuse. Nonetheless, the concrete bonded to the formwork. When the forms were pried off, either the wooden battens pulled away from the plywood, sticking fast in the concrete, or the corners of the concrete stuck fast to the wood and chipped off the building. Rudolph then had all the edges of the concrete ridges hammered off, exposing the sharp crushed-rock aggregate and creating minute variations in color as well as a brutally abrasive surface.

Architects may create strong contrasts between different textures, as did Michelozzo di Bartolomeo in the Palazzo de' Medici in Florence, 1444–1460 [15.27]. He began with aggressively rough stone masonry (called ***quarry-faced ashlar masonry***) at the lower level, changing to ***rusticated*** masonry in the middle level (the individual blocks have their edges cut back to emphasize the joints), and then to completely smooth ashlar masonry in the uppermost level, where the joints between the stone blocks are almost impossible to see from the street. Frank Lloyd Wright created an equally dramatic contrast in Fallingwater, near Mill Run, Pennsylvania, 1936–1938 [4.24]. The house was built in a ravine about 51 miles (82 km) from Pittsburgh, where the client,



4.22. Paul Rudolph, Art and Architecture Building, Yale University, New Haven, Connecticut, 1958–1964. Rudolph used cast-in-place concrete, placed in forms to create a bold texture of vertical ridges in the concrete walls. Photo: Ezra Stoller © Esto.



4.23. *Art and Architecture Building, Yale University. Section diagrams of the wooden forms for the concrete in the Yale Art and Architecture Building, illustrating the results of a failure of a clean release when the forms were removed. Drawing: L. M. Roth.*

4.24. *Frank Lloyd Wright, Edgar Kaufmann residence, Fallingwater, near Mill Run, Pennsylvania, 1936–1938. Wright created strong contrasts between the rough vertical masonry piers (with stone slabs laid to imitate natural rock strata) and the smooth horizontal concrete floor slab upstands. Photo by Hedrich Blessing. Chicago History Museum, negative HB-04414-5d.*

4.25. André Le Nôtre, Château de Versailles, Versailles, France, 1661–c. 1750. The gardens, designed by Le Nôtre, exhibit a variety of textures in plant materials, paving, architectural embellishments, and the use of water. Photo: © Eye Ubiquitous/ Alamy.

Edgar Kaufmann Sr., liked to get away from the city. Wright learned from Kaufmann that he most enjoyed sitting on a large rock ledge over the stream. Wright then built the house over that very spot, leveling part of the rock outcropping for the floor of the house. Stone from the site was used to build up the major structural piers of the house, laid in a rough and random pattern emulating the texture of the adjacent rock outcroppings themselves. But the concrete used for the cantilevered balconies was made especially smooth, so that the greatest possible contrast was created between the rough, dark vertical piers and the smooth, light-colored horizontals.

Variation of texture is also a large part of landscape architecture and garden design, in which plants with different foliage patterns, colors, and heights are played against one another. To this can be added the textures of gravel, rock, and water. In the sprawling gardens of Versailles, first laid out in the seventeenth century, nearly all these variations can be found, from the geometrically laid-out and close-clipped parterres near the château itself, with their hedge-framed flower beds, gravel walks, splashing fountains, and quiet reflecting basins, to the large masses of trees and more rustic woodlands farther out [4.25].

Modern architects have had to rediscover tactile texture, for it was suppressed by International Modernism from 1920 to 1960. Curiously, since humans first began to make objects, roughness of surface was equated with unskilled handwork, whereas smoothness of surface was achieved by careful and painstaking craftsmanship. With the rise of industrialization, however, smoothness became easier to achieve in factory-made products. Smoothness then became equated with mechanized production and eventually with cheap mass production. Roughness and irregularity then became equated with handwork. The great irony was that much International Modern architecture, in its early phase, which was made to appear machine-made with smooth, textureless surfaces, was very often achieved through the most painstaking handwork, as in the sleek, chromium-plated columns in the work of Mies van der Rohe in the 1920s. By 1930, avant-garde architecture had no tactile texture. Rudolph's Art and Architecture Building at Yale is important, therefore, as one of the first to deliberately and dramatically exploit texture once again.

Perhaps the most sensitive and subtle interplay of textures is to be found in the traditional Japanese

4.26. Imperial Villa of Katsura near Kyoto, Japan, 1620–1658. The gate combines a wide variety of textures in architectural and landscape materials. Photo: From Akira Naito, Katsura: A Princely Retreat *(Tokyo and New York, 1977).*

house and its surrounding garden. In this fusion of building and landscape, the architect uses plant materials, rocks, gravel, water, and architectural materials to create a full range of textures, from rough to smooth. This exploitation of texture is summarized in the most elegant and understated way in the pavilions and gardens of the imperial villa of Katsura, about 3.5 miles (6 km) southwest of central Kyoto.[6] The villa was built in three stages, on a site of about 16.5 acres (66,000 square meters), from 1620 to 1658. Included were a main house surrounded by five tea pavilions overlooking a series of ponds fed by the Katsura River. As one approaches the complex, a hedge, or screen, of living bamboo trees is seen first. The screen leads to a fence of cut bamboo; this in turn leads to a hedge that frames the Imperial Gate, which is protected by a gable roof of thick thatch. One then proceeds along a broad path paved with carefully fitted flat pebbles. The entrance to the main house is through the Central Gate [4.26]. The view through that gate is a study in the play of textures: gravel and pebble walkways, a fieldstone threshold, and a bamboo fence and gate with a thatch roof contrast and complement the house beyond, which has smooth plaster surfaces and dark-stained wood frame members.

Within the villa buildings themselves, one finds on the floor thick, grassmat-covered tatami mats contrasted with the grain of the wood in the verandas at the house's edge. The walls are defined by paper-covered and silk-brocade-covered sliding screens. The ceilings in the main house are a carefully finished wooden lattice, whereas in the garden teahouses, one looks up to the bamboo rafters and bamboo mat beneath the thatch. As viewed from the various openings in the house and tea pavilions [see Plate 1], every square inch in the gardens is a study of the interplay of plants, rock, and water—an interplay that changes throughout the course of the day as well as the cycle of the seasons.

Light

Perhaps the most powerful element in our perception of architecture is light. Louis I. Kahn insisted that there was no true architecture without natural light. Our eyes are receptors for sensing the environment, and the light illuminating that environment is critical for the information we receive. The perception of textures is dependent upon the quality of light falling on the building. Moreover, light creates psychological responses and has a strong physiological effect.

In 1647, in designing the chapel for Cardinal Federico Cornaro for the left transept arm of the Church of Santa Maria della Vittoria in Rome, the sculptor and architect Gian Lorenzo Bernini designed what is in effect a miniature theater. He included portrait figures of the cardinal and members of the cardinal's family in "boxes" to the sides observing the *Ecstasy of Saint Teresa* depicted on a "stage" at the center [16.6].[7] The action is lit by a window hidden behind the architectural frame of the stage, and the image of the flood of heavenly light down on the miraculous event is accentuated by the golden rays that radiate from that hidden light source. Everything else in the chapel is dimly lit, so that one's eye is automatically drawn to that brightest spot in the entire composition.

Light is a most effective element in creating a sense of mystery and awe, and the manipulation of light is a principal agent in the creation of shrines and religious buildings. In his later architecture, Le Corbusier proved himself extremely sensitive to the atmospheric role of light, beginning with Notre-Dame-du-Haut at Ronchamp, France, 1950–1955 [19.42, 19.45]. A pilgrimage church on a promontory in the Jura foothills near the Alps of the French-Swiss border, it was reconstructed after being severely damaged during World War II. Le Corbusier covered the church in white stucco, so that from afar, its gleaming whiteness, seen over the surrounding green landscape, acts as a beacon. As one approaches the hill, only the swelling gray concrete roof of the chapel is visible, but as one ascends the hill, the white southern wall comes increasingly into view. When the pilgrim reaches the top of the hill, especially at midday, the full brunt of the sunlight is reflected back into his or her face. Proceeding through the southern door into the chapel, the visitor is then plunged into near-total darkness, as if going into a cave. Through this device, Le Corbusier suggests the separateness of the world outside and the mystical world created inside, at first shrouded in darkness. Then, as if in revelation, the details of the interior space gradually become clear as one's eyes adjust to the dim light, and the silo-like towers first seen from outside are discovered to be giant scoops capturing and filtering light down onto devotional altars below. It is an architecture that, from the inside, is almost entirely shaped and defined by the accomplished manipulation of light.

Color

The term *light* has been used so far to mean the entire visible solar spectrum, with its mixture of various wavelengths. But sunlight is composed of many colors, and color, too, is a powerful evoker of moods and physiological response.[8] During the nineteenth century, much was written about the effects of color on humans. Johann Wolfgang von Goethe discussed optics and the physiological effects of colors in 1810; in 1877, Niels Finsen began color therapy for patients. As with all stimuli, the human organism adjusts to and compensates for continuous, unvarying stimuli, but even so, it is possible to measure distinct physiological responses to colors in the spectrum. Exposed to red, for example, the body experiences an increase in muscular tension, the release of adrenaline, an increase in heartbeat, and a stepping-up of gastric activity. In other words, one might say the human organism prepares for flight or for digestion at the sight of blood.[9] It is for this reason that restaurants often employ red or red-checked table linens. The atmosphere in such places often includes dark, so-called warm colors (oranges and browns, for example) and candles with low light output that is rich in the red and orange portion of the spectrum, augmented with directed beams of concentrated low-level artificial light to enhance the physiological effect of red while also creating an intimate psychological environment—all directed to enhancing the dining experience.

On the other hand, when exposed to green or blue (so-called cool colors), the body experiences a release of muscular tension, a slowing of the heartbeat, and a slight lowering of body temperature. This is why summer clothing is often in pale blues and lime greens. This is also why fast-food eateries, at least until recently, tended to make the eating experience less genial by using high light levels, achieved by using fluorescent tubes rich in blue light, and color schemes avoiding reds and oranges, thus encouraging a rapid turnover of customers and thereby increasing the volume of food sold and profits made.

A standard color wheel shows the spectrum with the two groups of principal hues arranged around the wheel [Plate 4]. The red, red-orange, orange, and yellow-orange group is said to consist of warm colors, while the yellow-green, green, blue-green, blue, and blue-violet group is said to consist of cool colors. The so-called primary colors (when mixing pigments for paint, for example) are red, yellow, and blue, and all other colors can be created by mixing these together in appropriate proportions; when all three are mixed together, the result is a deep gray approaching black. When mixing light itself, however, the three primary colors are different (reddish blue, or magenta; yellow; and bluish green, or cyan), and a mix of these three produces white light; this is the principle of color television. We say a color, or chroma, is saturated when it cannot be made any more intensified than it is, that a red or a blue cannot be made any redder or bluer. If gray or black is added to a color pigment, darkening it, the result is a shade. If white is added to a color, the result is a tint, commonly called a pastel.

Various theorists suggest an optical phenomenon in which the mind interprets warm colors as being closer to the eye than they physically are, while cool colors are interpreted as being slightly farther away. The same is true for dark shades and light tints, the darker shades being sensed as closer and the lighter tints as slightly farther away. So, in selecting paint for a room, if the room is small, the color of choice to make it seem larger would be a tint of green or blue. If a room is extremely large and barn-like and the desire is to make it seem smaller, a shade in the warm part of the spectrum might be the color of choice. Even when one selects an off-white, the choice of the pigment to be mixed in will have perceivable if subliminal results; a subtle, warm pigment makes the room more intimate, and a cool pigment makes the room more expansive. Thus, without affecting the physical space at all, the psychological perception of that space can be changed.

Color has been used effectively in architecture since Paleolithic times, as the paintings in caves suggest. Fragments of plaster used to cover the wooden Neolithic houses at Hăbăşeşti, Romania, built about 3130 BCE, are covered with decorative painted patterns. Dwellings built on Crete during the Minoan period in the Mediterranean (c. 2000–1300 BCE) had brilliant red columns, while ceremonial and living chambers were vividly painted with murals and decorative bands, as seen in the restored palace at Knossos, built around 1600 BCE [4.27 and Plate 5]. Later, the Greeks similarly painted their white marble temples—a fact that long went unnoticed, since the exposed ruins had been bleached by centuries of exposure to the sun and rain. Only in the mid-nineteenth century did the French architect Jacques-Ignace Hittorf discover in the protected recesses of the ornament of

4.27. Palace at Knossos, Crete, c. 1700–1380 BCE. The columns, tapering inward toward the bottom, were found to be painted deep red when excavated after 1900. Photo: © Walter Bibikow/JAI/Corbis.

4.28. Sainte-Chapelle, Paris, France. This view of the lower chapel (for lesser members of the medieval French court) has a deep blue painted ceiling with red borders and silver stars. Restored under E.-E. Viollet-le-Duc in the 1840s. Photo: Scala/Art Resource, NY.

Greek temples in Sicily the traces of intense red, blue, and other saturated colors that had been used to pick out and accentuate parts of the orders. In the Doric order, for example, the flat background of the sculpted metope panel was painted a deep saturated red, to point up the raised relief figures [Plate 6]. The publication of Hittorf's theories caused an uproar among some Neoclassicists who were convinced that Greek buildings has always been pure white. Egyptian temples, particularly the engraved hieroglyphic inscriptions, were also brilliantly painted, but since these too have been bleached out by thousands of years of exposure, the nearest approximation of the rich colors of the temples can now be seen in Egyptian tomb walls, whose murals were never exposed to the blast of the sun.

Early Christian churches, built after the end of the Roman Empire, were exceedingly plain externally, but inside, the walls and vaults were covered with vivid mosaics made of tiny bits of stone and glass, forming images of biblical figures and Christian symbols. The dazzling brilliance of such murals, combined with veined marble columns and inlaid floor patterns, is evident in the decoration of the apse of San Apollinare, a church built circa 532–549 in Classe, then a suburb of Ravenna, Italy [Plate 7], and in the Church of San Vitale, built in 532–548 in Ravenna by the Byzantine Emperor Justinian. The two mosaics of the sanctuary area in San Vitale show the emperor and his court presenting the bread and wine used in the Eucharist service.

Gothic churches also were alive with color, although much of their painting (unlike the earlier mosaics) has also faded and disappeared. The stained-glass windows, however, and the patterns created by the light that passes through those color filters as it strikes the internal walls, have endured. In the mid-nineteenth century, Eugène-Emmanual Viollet-le-Duc restored the small royal chapel in Paris, the Sainte-Chapelle, 1242–1448, repainting the deep-blue vaults with twinkling golden stars [4.28 and Plate 8].

Perhaps the most colorful buildings of all were those built by Muslims in what is now Iran and in Spain. The practice originated in the ancient Near East in the Tigris-Euphrates valley, where buildings were made of soft brick. Since the structural brick was soft-fired (to save wood used for brick firing), it was susceptible to damage by rain. Hence, the soft-brick buildings were covered with a protective outer skin of hard-fired glazed ceramic tiles, so that the outer surfaces of the buildings were ablaze with brilliant colors. This practice is well illustrated in the mosques of Isfahan, Persia (now Iran), especially the Masjid-i-Shah Mosque, 1611–1638, in which the tile is used to convey passages from the Koran in stylized calligraphy [Plate 9]. This practice of using ceramic tile as covering and embellishment was carried to Spain, where, as part of Moorish architecture, it eventually became part of traditional Spanish vernacular architecture; from Spain this tradition of using highly colored tile was carried to Mexico and the Spanish colonies in the New World.

Renaissance architects were comparatively far more interested in clearly delineating the component volumes of a building than in exciting the eye, but they did use dark stone for the pilasters and entablatures of their interiors to draw the mathematical edges of their geometrical designs [15.14, 15.33]. Otherwise, the walls of their interiors were of plain white plaster. Andrea Palladio restricted the color schemes of his mid-sixteenth-century churches even more, creating interiors that are essentially studies of creams, whites, and light grays. By contrast, in the Baroque period that followed, architects deliberately set out to captivate the eye of the beholder, so that once again color became a major element of design and embellishment. This reached its culmination in the Late Baroque-Rococo architecture of the early eighteenth century, and perhaps nowhere better than in the carved and gilded stuccowork of the artisans Johann Michael Feichtmayr and Johann Übelhör in the Church of Vierzehnheiligen (Pilgrimage Church of the Fourteen Saints) in Franconia, Germany, designed by Johann Balthasar Neumann and built in 1742–1772 [Plate 10]. The colors and patterns evident in such south German Rococo interiors, however, were largely the result of highly skillful painting on polished plaster, so that what appears to be marble usually is not.

Color continued to be an important element in nineteenth-century European and American architecture, but in accordance with the then-held view that architecture ought to be real and truthful, building materials were used to exploit their inherent color. Thus, the red of brick contrasted with polished marbles, white and cream limestone, and the wide spectrum of slate from gray, green, and red to beige [Plate 11]. Color of this kind, employing the rich effects achieved in building materials, was severely restricted with the rise of International Modernism. One exception, however, was Mies van der Rohe's elegant German Pavilion in Barcelona, 1929, with its polished marble and onyx panels [see Plate 30]. That pavilion, however, was a demonstration piece, representing the best of German industry. In large measure, the color scheme of International Modernist architecture—as it was crystallized in the 1920s by the designers associated with the Bauhaus in Dessau, Germany—was inspired by the architects of the Dutch De Stijl movement. De Stijl architects proposed an objective and systematic use of saturated primary colors applied as paint to the planes shaping space, with black being reserved for structural members. In their fifth manifesto, which was published in 1923, De Stijl theorists asserted, "We have given color its rightful place in architecture" [Plate 12].[10]

How effective primary colors can be, especially when used in conjunction with carefully controlled lighting, is demonstrated in the chapel design by Le Corbusier for the priory of La Tourette near Lyons, France, 1956–1959. The chapel was a large, rectangular box of reinforced concrete with only a few narrow slits for windows. At the bottom of the box and extending to the sides were lateral chapels containing the numerous altars at which the friars said Mass once a day. The light coming into the side chapels is admitted through tubular light monitors overhead; sunlight is caught and splashed across the walls behind the side altars, where it rakes the rough-cast surfaces painted in deep saturated reds, blues, and yellows. Thus, using concentrated strong light and pure color to direct the eye, Le Corbusier focused attention on the most important functional part of the monastic chapel, the altars used by the friars.

In recent years, with the rise of Postmodernism, architects have turned with renewed vigor to exploiting a rich complexity of ornament, color, and texture in an effort to entice and stimulate the eye of the observer. One architect who did this with particular gusto was the American Charles Moore, as is dramatically evident in his design for the Piazza d'Italia in New Orleans, 1975–1980 [Plate 13]. In most instances, however, as with Late Baroque and Rococo architecture, the colors arise not so much from the natural weathering of materials as from applied paint that must periodically be renewed. Nonetheless, such environments have reinstituted a measure of vivacity and energy, which was suppressed by the austerity of International Modernism in the mid-twentieth century.

Ugliness

Among the major contributions of philosophy in the late eighteenth century were the notions of the "picturesque" and the "sublime," extolling the virtues of irregular and rough forms, and the delight in the thrill of implied physical danger. Out of the sensibility of the picturesque came an awareness of the aesthetic power of ugliness.[11] Certain nineteenth-century architects, such as William Butterfield in England and Frank Furness in the United States, took pleasure in devising compositions that reveled in dramatic juxtapositions of forms and collisions of colors.

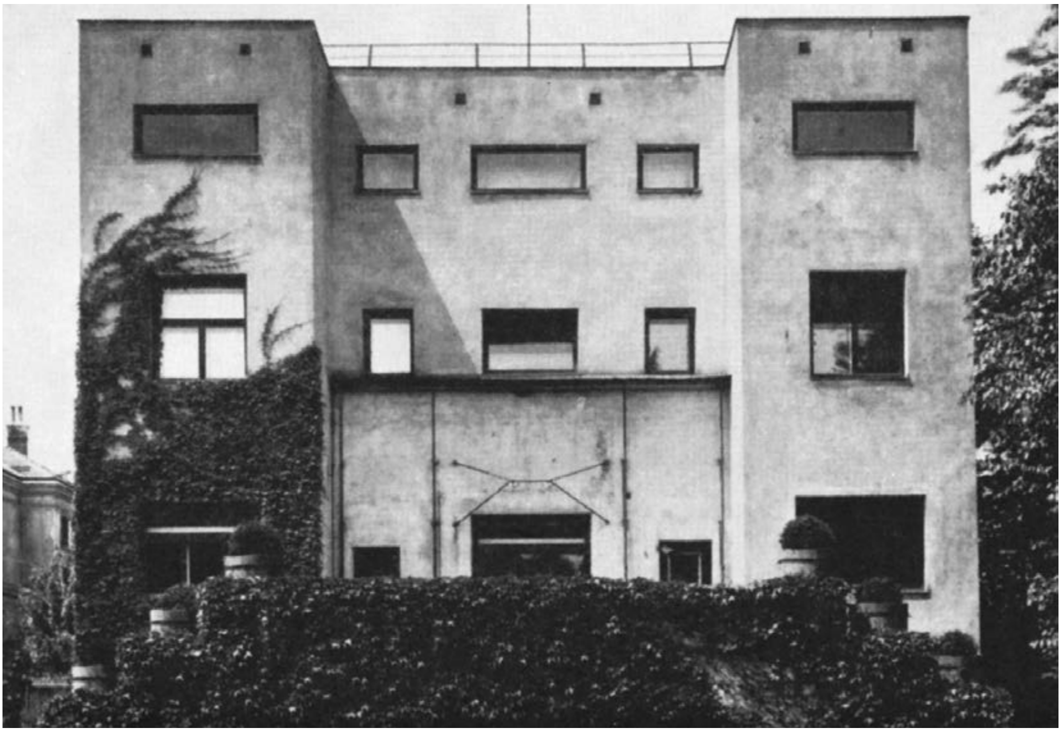
Ugliness can be defined in a number of ways: as a quality that is confusing because it is ambiguous or displays an absence of a perceivable pattern of relationships, as a quality that is monstrous because it does not conform to accepted norms, or as artistic willfulness and capriciousness. For example, Frank Furness's Provident Life and Trust Company Building, Philadelphia, 1876–1879 [see 3.6], now destroyed, had a facade that displayed a clear, bilaterally symmetrical pattern, but it deviated emphatically from accepted norms of its own period (and, even more so, those of the mid-twentieth century), suggesting a certain artistic willfulness. Moreover, this stylistic idiosyncrasy was exacerbated by the most dramatic contrasts of building material color.

The late twentieth century and early twenty-first century are an age of pluralism in which various conflicting artistic values and standards, present and past, are mutually acceptable or at least tolerated. But this is a recent development. Most periods have denigrated the art and architecture of the period immediately preceding. During the Renaissance, for example, the architecture of the Middle Ages was despised, since it seemed without logic in its form in comparison to the newly rediscovered Classical humanist architecture. Medieval architecture was said to be the work of barbaric Goths (hence Gothic). Similarly, in the eyes of the rationalists of the late-eighteenth-century Enlightenment, the exuberantly embellished and curved architecture of the preceding century and a half was said to be misshapen and formless. The critics of the Enlightenment even applied to it the pejorative term (for them) of *baroque,* for to them the wildly curved architecture of the seventeenth century was as much a freak of nature as twisted and misshapen "baroque" pearls, called *barroco* by the Portuguese. During the 1970s, the angular forms of Art Deco of the 1930s, as well as the pseudo-streamlined forms of the early 1950s, were nostalgically appreciated, but the structurally determined architecture of Mies van der Rohe of the late 1950s and 1960s was ridiculed. But then in the late 1990s, the precision and clarity of Mies van der Rohe's architecture began to elicit renewed acclaim among academics, culminating in major dual exhibitions focused on his life and work in the summer of 2001.

Each generation thus rejects its parents and embraces its grandparents; it tends to think of the work of the previous generation as barbaric, since it does not conform to contemporary standards or values. In the same way, during the 1950s, the work of Furness in Philadelphia was considered irredeemably ugly, and much of it was wantonly demolished before a new sensitivity to Furness's deliberate and individualistic "ugliness" arose during the 1960s with the birth of Postmodernism. In part, the prejudice against Furness may have arisen as much because of the accumulation of three-quarters of a century of atmospheric pollution on the rough surfaces of his buildings as because of the bold and very personal ornament that Furness invented. In the mid-twentieth-century International Modernist propagandists tried to convince us that ornament was a crime against nature and society.[12] And yet, as Furness's deliberate flouting of the rules of taste of his time shows, the value of ugliness is that it forces us to examine our accepted conventions. We may find that our preconceptions do not have much substance.

Ornament

In the past century and a half, the value attached to architectural ornament has swung from one extreme to another. In the mid-nineteenth century, the English critic John Ruskin could readily persuade his readers that "ornament is the chief part of architecture."[13] And yet, in 1908, the Viennese architect Adolf Loos laid the groundwork for International Modernism with his article "Ornament and Crime," asserting that "the evolution of culture is synonymous with the removal of ornament from utilitarian objects."[14] He equated the use of ornament in modern architecture to degeneracy and the smearing of erotic graffiti on lavatory walls. It is a risky proposition, however, to use this equation to evaluate architecture while ignoring other information. For example, using Loos's criteria literally, what are we to make of a comparison between his Steiner House in Vienna, 1910 [4.29], in which he exemplified



4.29. Adolf Loos, Steiner House, Vienna, Austria, 1910. This house is a good example of the elimination of ornament that Loos advocated in his article "Ornament and Crime," published in 1908. Photo: From N. Ponente, The Structures of the Modern World, 1850–1900 *(New York, 1965).*

his austere principles, and the William M. Carson House in Eureka, California, 1884–1885 [4.30]? The temptation would be to say that the first was the work of a virtuous person and the second the work of someone deranged. If, however, we look into historical circumstances, a very different picture emerges. Loos was working in Vienna in an avant-garde cultural environment in the early twentieth century—an environment that was intent on creating a new and scientifically objective architecture suited to the new century. The Carson House, designed by Samuel and Joseph Newsom, was built much earlier by a prominent developer of the California redwood lumber industry. The year 1884 was marked by a severe though short-lived nationwide business recession. As there was, temporarily, greatly reduced demand for redwood, it is likely that Carson had this house built as a kind of local public works project to keep his mill-hands busy and also as a demonstration of what could be done with redwood. Small wonder that so much attention was lavished on this showpiece while Carson and his employees waited for the economy to recover.

The ornament of the Carson House, then, served specific economic and social purposes for its time. Ornament may serve many other purposes as well. There is nothing wrong with saying, at the very outset, that ornament can be used solely for the reason given by Vitruvius and Wotten—for pure visual delight. This would be the case for the remarkable interior of the church sacristy of the Cartuja Carthusian monastery, Granada, Spain, built in 1730 and decorated in 1742–1747 [16.5]. Underlying all the carved plaster flourishes is a straightforward Classical pilaster and entablature system, but the intent here was to add element upon element, layer upon layer, for the sheer delight of the eye. The same is true of the mirrored interior of the small Amalienburg pavilion in the grounds of the Nymphenburg Palace outside Munich, Germany, 1734–1739, designed by François Cuvilliés and decorated by J. B. Zimmermann and Joachim Dietrich [Plate 22]. Every surface is covered either with glass or with small-scale gilded ornament, and the whole is a treat for the eyes. It is all there solely for visual delight.

4.30. Samuel and Joseph Newsom, William M. Carson House, Eureka, California, 1884–1885. This elaborate house was built of redwood to illustrate the extreme versatility of this durable soft wood and also to keep Carson's lumber mill workers busy during a recession period. Photo: Library of Congress, HABS CAL 12-EUR 6-2.

Ornament can also have a strictly utilitarian purpose, such as enhancing the longevity of a building. For example, the demon-like gargoyles stretching out from Gothic cathedrals, from a purely functional point of view, are water spouts to throw the water collected from the upper roofs away from the building [4.31]. The same purpose is served by the many projected moldings that serve as horizontal ridges on Gothic buildings, forcing rainwater to drip away from the wall surface. When these details are reused on later buildings, under similar climatic conditions, the same beneficial weathering effect is achieved. Even though the Gothic Revival limestone veneer of the Chicago Tribune Tower of 1922–1925 was once ridiculed—because this medieval shell was said to be inappropriate for the twentieth century—the Gothic detailing has meant that the building has stood up to weathering much better than adjacent Modernist (and detail-less) skyscrapers built three decades later.

Ornament also can serve an acoustical function. An excellent case study is Philharmonic Hall,

4.31. Notre-Dame de Amiens, Amiens, France, 1221–1269. The gargoyles on the buttresses of the choir serve the very practical purpose of throwing rainwater away from the building. Photo: Sandak, University of Georgia.

designed by Harrison and Abramovitz in 1960–1962 as part of the prestigious Lincoln Center, New York, which became the official home of the New York Philharmonic Orchestra. The original unusual design was quickly christened the "Coke bottle" plan. From the ceiling, elongated hexagons were suspended as "acoustical clouds," to disperse the sound to the audience below [4.32]. As quickly became clear, however, the room did not function well acoustically. Among several problems, the sound was unevenly dispersed throughout the hall. Eventually, a number of celebrated soloists and orchestras flatly refused to perform there. In 1971, with the donation of funds by Avery Fisher, it was decided that the interior of the hall would be rebuilt. The revised plan, devised by the architect Philip Johnson with the acoustical consultant Cyril M. Harris, was a more traditional rectangular-box room, and among the important changes was the incorporation of large, massive ornamental reflecting panels [4.33].[15] Today, the rebuilt concert house, renamed Avery Fisher Hall, is considered among the foremost symphony halls in the world, but the mistakes took $4.5 million to correct!

Articulation (clear expression) of the parts of a building is another function of ornament. A good example is Adler & Sullivan's Wainwright Building in Saint Louis, 1890 [2.5], in which each of the distinct functional zones, as analyzed by Sullivan, is expressed by a change in the stone or terra cotta blocks enclosing and protecting the steel skeletal frame. The separate functional activities are directly indicated in the skin of the building.

Ornament can serve an expressive utilitarian purpose as well. One example might be to accentuate a functional aspect of a building. Looking at the west front of the Gothic cathedral of Reims, France, we see the doors announced unmistakably by broad, recessed archways [4.34]. At close range, the carvings of individual figures from the Bible, showing the life of Christ and episodes from the Old Testament, are evident. But from somewhat farther back, these merge in a series of concentric arches to form hoods over the doors, showing clearly where to enter.

4.32. Harrison and Abramovitz, Philharmonic Hall, New York, NY, 1960–1962.The original interior shows the suspended "acoustical clouds" intended to disperse sound. Photo: ©1976 Lincoln Center for the Performing Arts, New York, by Norman McGrath.

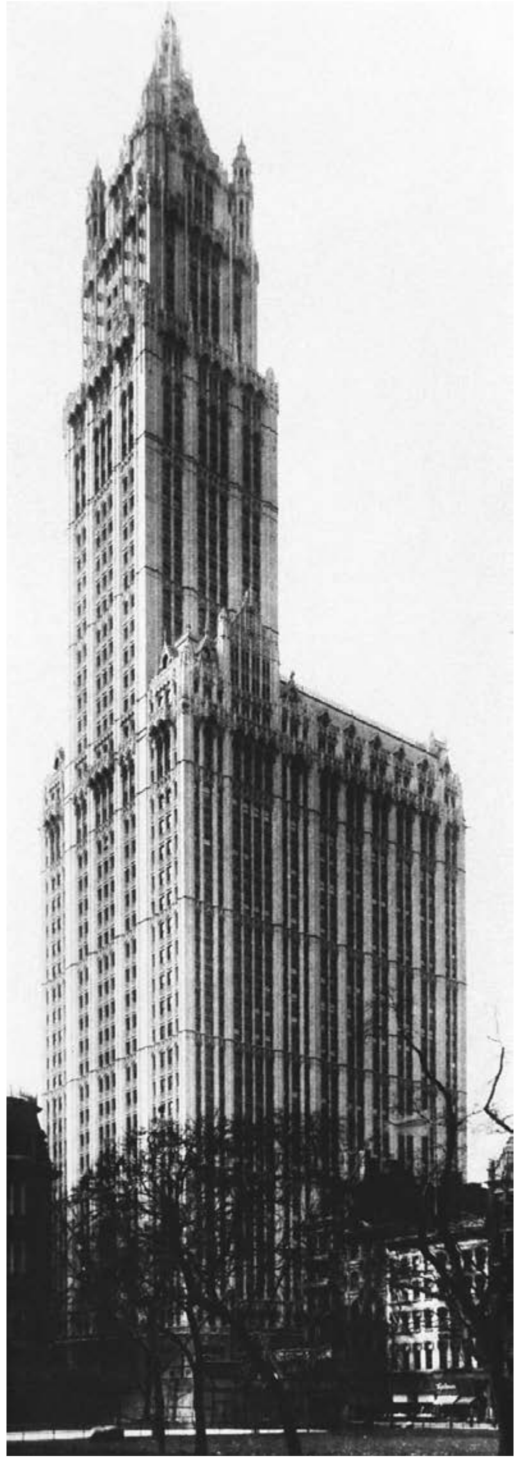
4.33. Cyril M. Harris with Philip Johnson, Avery Fisher Hall (formerly Philharmonic Hall), New York, NY, 1971–1974 (1973, during renovation). Gutted, redesigned, and rebuilt, Avery Fisher Hall bears little resemblance to its original state; the acoustical results, however, are far superior. Photo: Lincoln Center for the Performing Arts, New York, by Sam Spirito.

4.34. Notre-Dame de Reims, Reims, France. Where the entrances are located is immediately evident to the observer. Photo: Scala/Art Resource, NY.

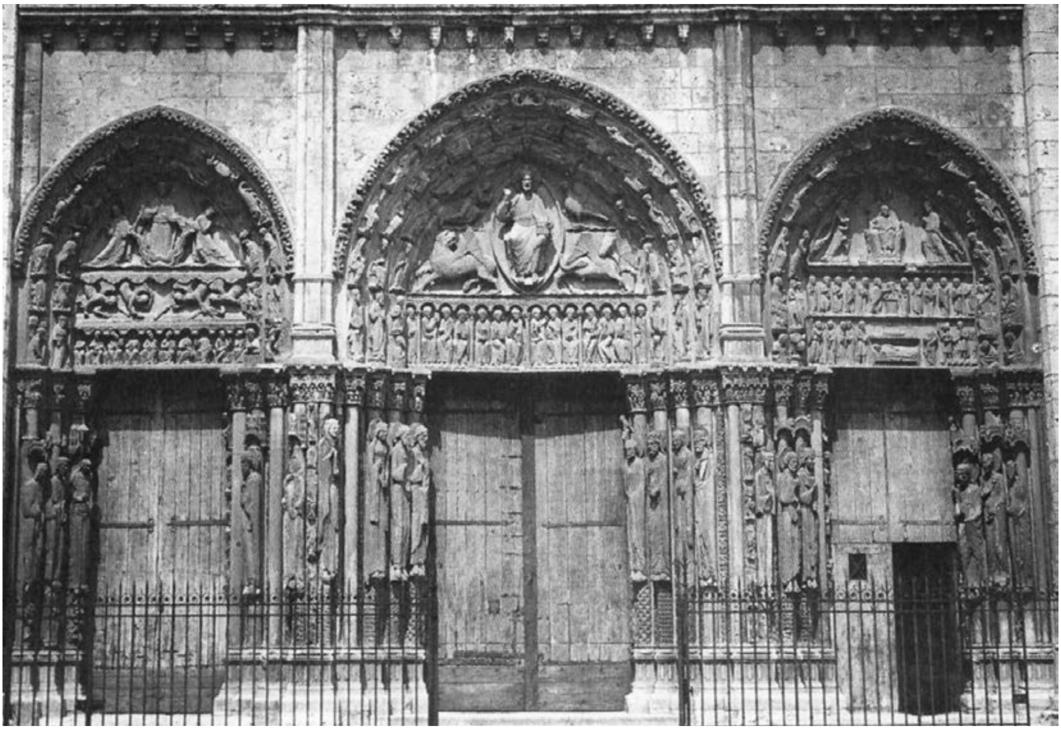
At the beginning of the twentieth century, when the modern metal-framed skyscraper was developed, Gothic ornamental devices were used for a different expressive purpose. Some architects employed Gothic details in these early skyscrapers to emphasize and accentuate their vertical character. Such is the case with the Gothic detailing of the Chicago Tribune Tower, as well as with the earlier and taller Woolworth Building, New York, 1911–1913, by Cass Gilbert, which inspired the Chicago skyscraper [4.35].

Up until the early years of the twentieth century, one of the major purposes of figural ornament was to be didactic, to tell a story through images of men, women, and animals related to the building's function. This storytelling is most self-evident, perhaps, in Gothic cathedrals, in the portals where the sculpture (as in the west front of the Reims cathedral) related the life and work of Christ and the Last Judgment. The general disposition of figures and narrative had been established in the portals of Notre-Dame at Chartres, carved between 1145 and 1170 (the rest of that church was destroyed by fire, but it was immediately rebuilt, 1194–1220) [4.36].[16] On the right (south) side, in the tympanum panel over the door itself, are three depictions of Christ's birth. The tympanum panel on the left (north) portal shows Christ's ascension into heaven. The center and largest tympanum depicts Christ in judgment, framed by symbolic representations of the four Evangelists. By means of such coherently organized storytelling images, arranged across the breadth of the church, the message of the Bible is presented for the illiterate, the building itself becoming a Bible in stone.

Such a fusion of pictorial imagery and building function also occurred in Greek temples, but the mythological stories are not so generally known today. The correspondence of ornament and function is clearest perhaps in the sculpture carved to fit into the low, triangular pediments at the ends of the roof of the Temple of Zeus at Olympia.[17] The site had been sacred since about 3000 BCE, and, as with most sites in Greece, various myths gradually evolved that locally related to the gods and demigods associated with this region. By the eighth century BCE, the importance of the site had spread and it was held sacred by Greeks of all the various interminably quarreling city-states. Yet at four-year intervals, a general truce was declared, so that athletes from city-states all across the Peloponnese (the peninsula of Greece) could travel safely to Olympia to participate in the celebrated contests. Gradually, the site was divided into two sections [4.37, 11.17]. To the west was a sacred precinct,



4.35. Cass Gilbert, Woolworth Building, New York, NY, 1911–1913. In order to express the height of this building as dramatically as possible, Gilbert used vertically soaring Gothic details. Photo: C. Condit Collection, Department of Art History, Northwestern University.



4.36. Notre-Dame de Chartres, Chartres, France, 1194–1220. Portal in west front. The sculptural embellishment of the entrance portals is carefully organized to illustrate the life and teaching of Christ, the Last Judgment, and the foretelling of Christ's life in the Old Testament. Photo: H. Roger-Viollet.

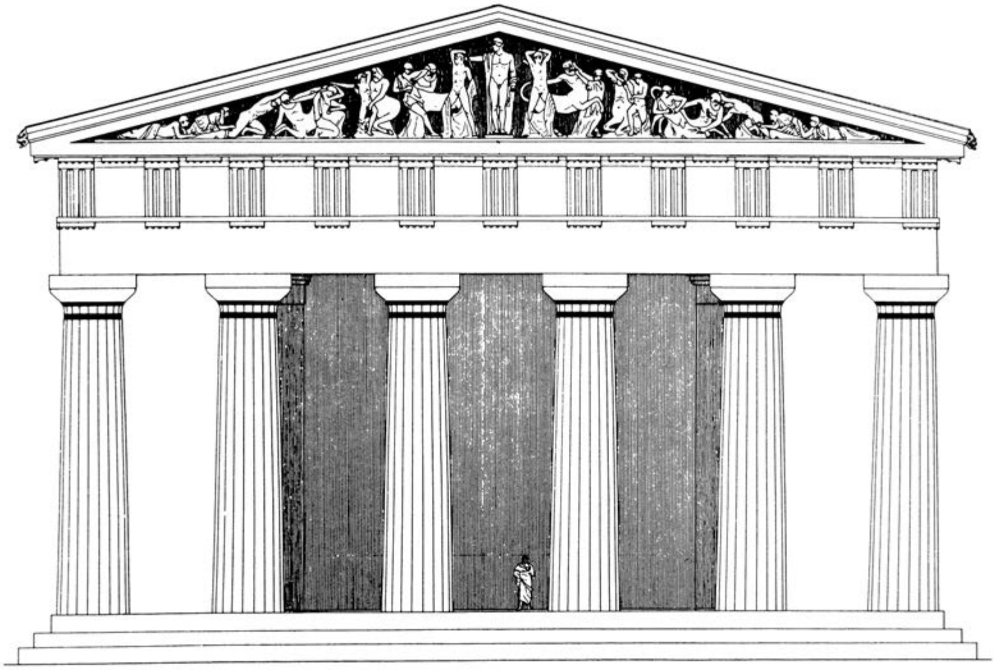
with temples, altars, and treasury buildings along the north edge; to the east was a stadium for the games and the chariot races. During 470–456 BCE, a large, new marble Doric temple to Zeus was built after designs by the local architect Libon. Placed inside was a colossal seated figure of Zeus, impressive not only for its commanding visage but also because it was fashioned of gold and ivory by the Athenian sculptor Pheidias.

The temple to Zeus had six columns across the ends and thirteen along the sides, in accordance with the standard Greek design formula. As was customary in Greek temples, within the encircling outer Doric colonnade was the *naos,* the enclosed chamber for the image of the god; the *naos* chamber had porches at each end with two Doric columns framed between projections of the *naos* walls. In the inner Doric entablature at either end of the *naos* were two sculptural metope panels above each columnar support, meaning that there were six sculptural panels at each end of the *naos*. These twelve panels were sculpted to portray the twelve Labors of Herakles since, through his fabled endurance and strength, he was associated with the games.

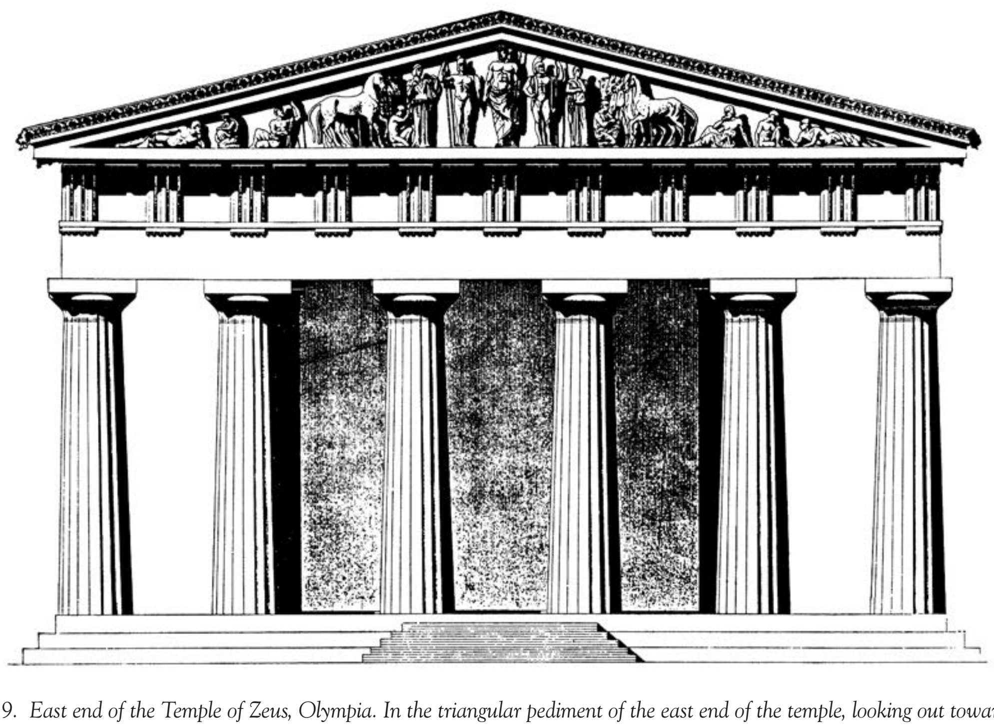
Zeus's temple was oriented roughly on an east-west axis, and in the pediment on the west side (facing away from the playing fields) was a depiction of the story of the Lapiths and the centaurs who had once lived in this region [4.38]. In the traditional story, the centaurs, half man and half beast, were invited by the Lapiths to a royal wedding. It was well known that when the centaurs consumed too much wine, for which they had virtually no resistance, their uncontrolled animal nature took over. Nonetheless, hospitality dictated that wine be served at the wedding, and soon the drunken, lust-driven centaurs began to carry off the Lapith women. A brawl ensued from which the Lapiths emerged victorious, their wives and daughters saved. Thus, the fighting portrayed in the west pediment was a representation of right being victorious over wrong, of the triumph of human reason over unthinking, brutish barbarism. Everywhere in the figures, there was the strongest contrast between the snarling, grimacing faces of the violent centaurs and the composed faces of the Lapith women, who, even when confronted by physical danger, controlled their emotions.

Depicted in the east pediment (facing the stadium), however, was a story that had special connection to this site and the games [4.39]. It concerned the chariot race between local mythical King Oinomaos and Pelops, a young suitor who hoped to gain the right to marry the king's daughter, Hippodameia. Oinomaos deeply loved his beautiful daughter and had publicly pledged to give her up only to the suitor who could beat him in a chariot race. Now, since Oinomaos had been given special horses by the god Ares, all previous suitors had lost, forfeiting their lives. When Pelops arrived, however, Hippodameia fell in love with him and conspired with her father's charioteer, Myrtilos, to replace the metal linchpin in her father's chariot with one made of wax. Thus, during the subsequent race Oinomaos's chariot would disintegrate and he would lose the race. What Hippodameia could not know beforehand was that the planned accident would kill her father. The east pediment shows us the moment just before that fabled race, as the contestants pledge an oath before a statue of Zeus. One lone figure in the pediment, a seer crouched far to the right, suddenly reels back in horror—he has seen into the future, is aware of the impending death, and yet is powerless to avert the disaster [4.40]. When the temple was first built, this pediment could be seen from the starting blocks in the stadium, so that as the athletes gathered for the games, they could look back over their shoulders to see this image of the mythic chariot race. They would be reminded of the oath they themselves had just taken before a similar statue of Zeus; there, together with their brothers, fathers, and trainers, they had vowed to do no wrong to the games. As they put themselves on the mark, the athletes would be reminded by Zeus to reflect on the treachery of Hippodameia and Myrtilos. The athletes vowed not to do likewise in their games; they were commanded not to cheat.[18]

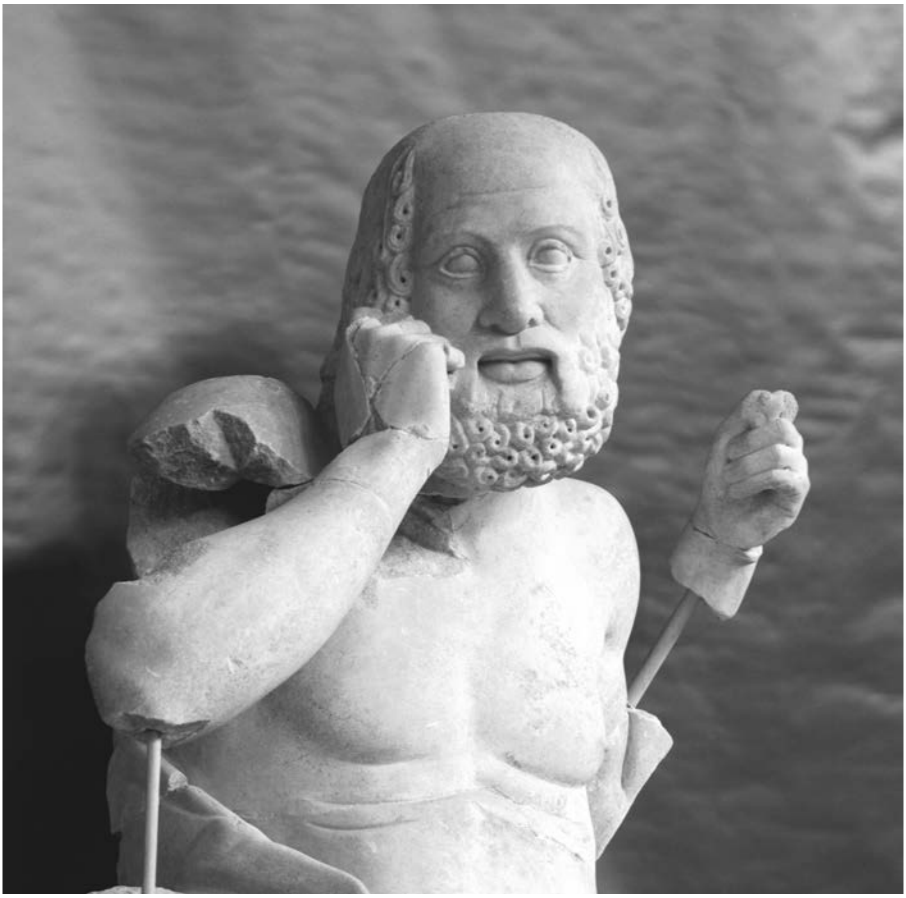
4.37. Aerial view of the sacred precinct, Olympia, Greece, showing the Temple of Zeus, fifth century BCE. To the east of the sacred precinct (the temenos, shown here) was the stadium where the Olympic Games were played. From A. E. Lawrence, Greek Architecture *(Harmondsworth, England, 1967).*



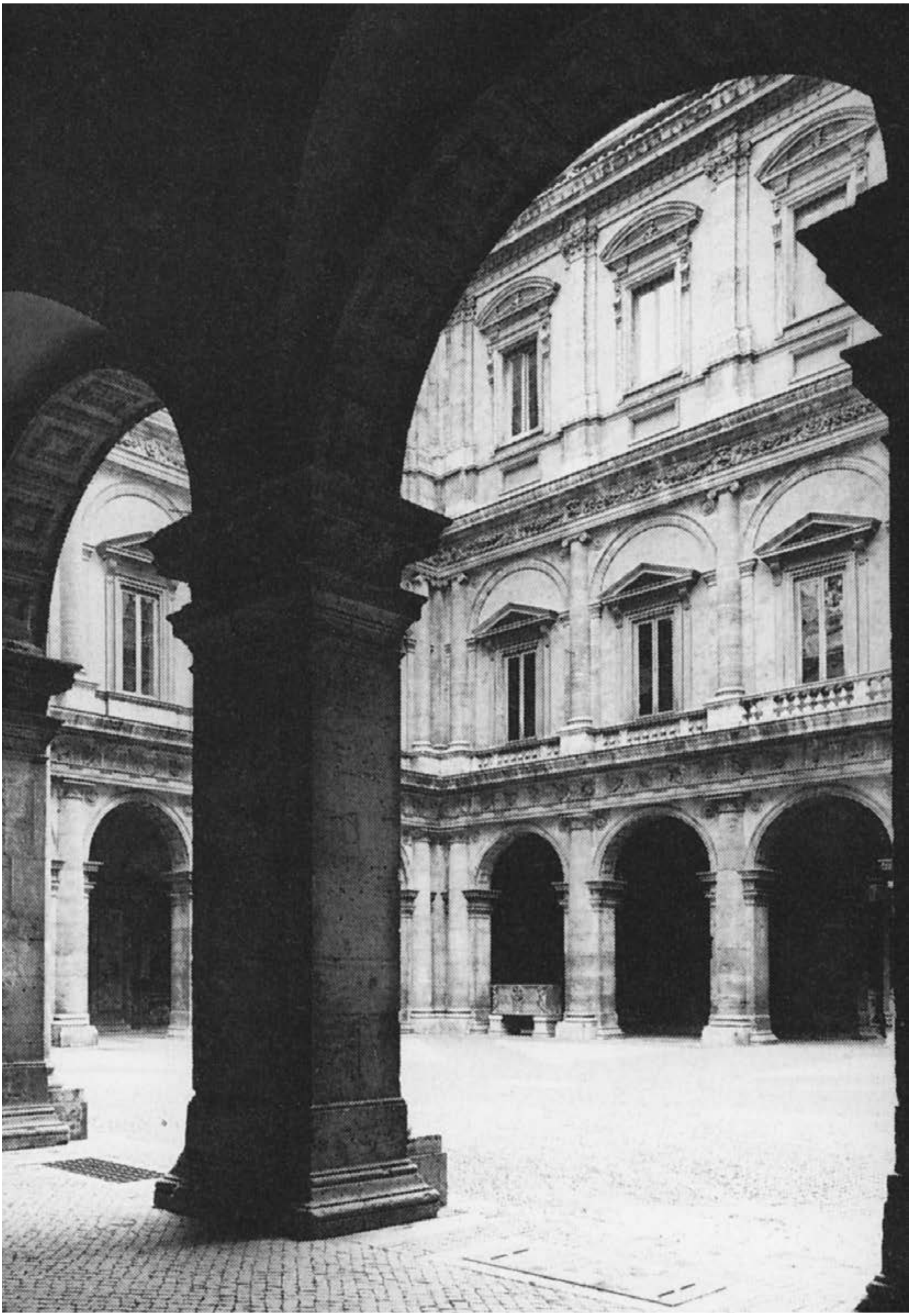
4.38. *Libon (architect), west end of the Temple of Zeus, Olympia, Greece, 470–456 BCE. In the pediment triangle were sculptural figures depicting the story of the battle between the human Lapiths and the part-beast Centaurs. From J. Hurwit. "Narrative Resonance . . . at Olympia,"* Art Bulletin 69 *(March 1987).*



4.39. *East end of the Temple of Zeus, Olympia. In the triangular pediment of the east end of the temple, looking out toward the Olympic stadium, were figures depicting the race between King Oinomaos and Pelops, who won through deception and murder. From Berve and Gruben,* Greek Temples, Theaters and Shrines *(New York 1963).*



4.40. Figure of Seer. On the right of the pediment, a seer or prophet sees into the future, perceives the imminent patricide, and recoils in horror. Photo: Alison Frantz.



5.1. Antonio da Sangallo the Younger, courtyard of the Palazzo Farnese, Rome, Italy, begun 1535. The massive piers of the palazzo are large enough to echo the sounds of footsteps, enabling a person to hear the architecture as one walks past. Photo: Leonard von Matt.

Chapter 5

Architecture and Sound

Architecture is frozen music.

—*Friedrich von Schilling,* Philosophy of Art*, 1805*

. . . but music is not melted architecture.

—*Susanne K. Langer,* Problems of Art*, 1957*

In a multitude of ways, architecture shapes human behavior, for as Winston Churchill observed, "We shape our buildings, and afterwards our buildings shape us." In a similar way, first we shape our buildings and afterward our buildings shape our music, for architecture shapes acoustical space, which has its own unique properties and influence.

Hearing Buildings

We could speak about "hearing" architecture, although for sighted people the aural perception of architecture is nearly completely overpowered by the visual perception of architecture. Yet, if a sighted person loses that visual ability, then hearing gradually becomes more sensitized, so that it becomes possible to navigate by listening to the echoes bounced off buildings, and one can sense whether a space is large or small. This is how flying bats locate their prey, by emitting high-pitched sounds that are reflected by objects and insects, and this is partly how blind people navigate, by listening to the reflected sounds of the tapped cane or the reflections of their own footsteps. It is a good exercise for one who is sighted to walk through an arcade or a colonnade that has large massive piers, to close one's eyes, and to listen as one passes the piers; in this way, one can *hear* the architecture [5.1].

Sound is air in motion; it is a succession of rapid pressure waves in the air. The actual movement of the atoms in the air is quite small; for a tone at 256 cycles per second (cps), middle C on the piano, the atoms in the air are vibrating back and forth over a distance of only about one-tenth of a millimeter. But given the huge number of atoms, each with its own minute mass, there is kinetic energy in sound. If sound is to be stopped, that energy must be absorbed either by a large mass capable of absorbing the kinetic energy without itself moving much or by a resilient, acoustically spongy material, such as a mat of loose fiberglass, which can absorb the energy.

In acoustical terms, we speak of live spaces as those that have hard, nonporous, highly sound-reflective surfaces, such as dense, polished marble; ceramic tile; mosaic on massive walls; or other hard, rigid surfaces. Glazed tile securely attached to massive walls reflects nearly all the sound coming toward it, roughly 98 percent. Eventually, as the sound bounces around such a room, it loses its energy to the surfaces it bounces from, and gradually the sound will die away. The time required for that to happen is called reverberation time. In large spaces with hard surfaces, the reverberation time may be six to eight seconds or even much more.

Conversely, dead spaces are those that have an abundance of sound-absorbing surfaces, such as heavy draperies, thick rugs, upholstered furniture, and other soft, resilient surfaces. A typical home living room, with wall-to-wall carpeting, upholstered furniture, draperies, filled bookcases, and other resilient materials may have almost no reverberation time at all, generally far less than half a second.

Studying low-level sounds involves taking scientific acoustical measurements in special rooms isolated from the outside environment with multiple massive layered walls, floors, and ceilings. The surfaces of the innermost walls of these *anechoic chambers* are lined with deep pyramidal wedges of foam rubber or fiberglass. The operational floor of such a room is a sound-transparent web of taut steel cables suspended above additional absorbing pyramids. In anechoic chambers, all sound generated is immediately absorbed; reverberation time is considered absolutely zero. If one stands in such a chamber for a short time, the total absence of sound is almost alarming; soon one can hear the heart beating and the pulse pounding in the head. In such a chamber, the blind could not navigate by sound reverberation alone. Experiencing such an anechoic space suggests that even the sighted may use their hearing in a subliminal way to perceive architectural space.

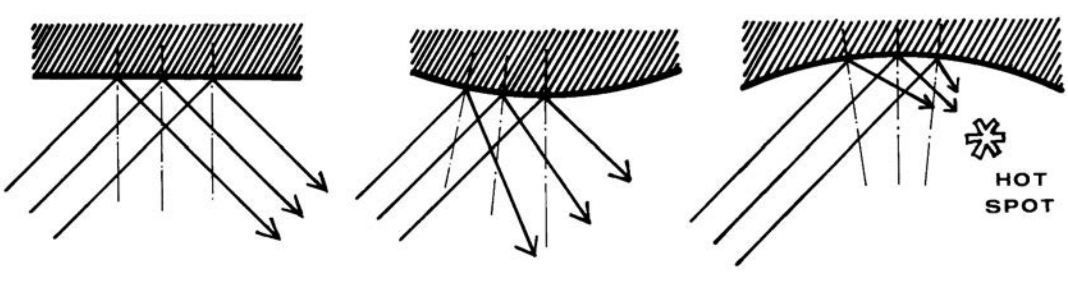
Sound: Focusing and Dispersing

Except for such special anechoic chambers, all spaces reflect sound to some extent. Out of doors, tree trunks and cliff faces reflect sound. The problem the architect and the acoustical engineer face is designing a space in such a way that sounds are absorbed or reflected in the optimally desired ways. To an extent, reflected sound behaves somewhat like reflected light, so that the angle at which a sound approaches a hard surface is equal to the angle at which it bounces off; in other words, the angle of incidence is equal to the angle of reflection [5.2]. But this rule of thumb applies only to the higher tones with frequencies over 1,000 cps. Furthermore, the surface reflecting a sound must be roughly three times larger than the wavelength to be reflected. The length of the wave of a given tone is directly proportional to the speed of sound in the transmitting medium and inversely proportional to the frequency.

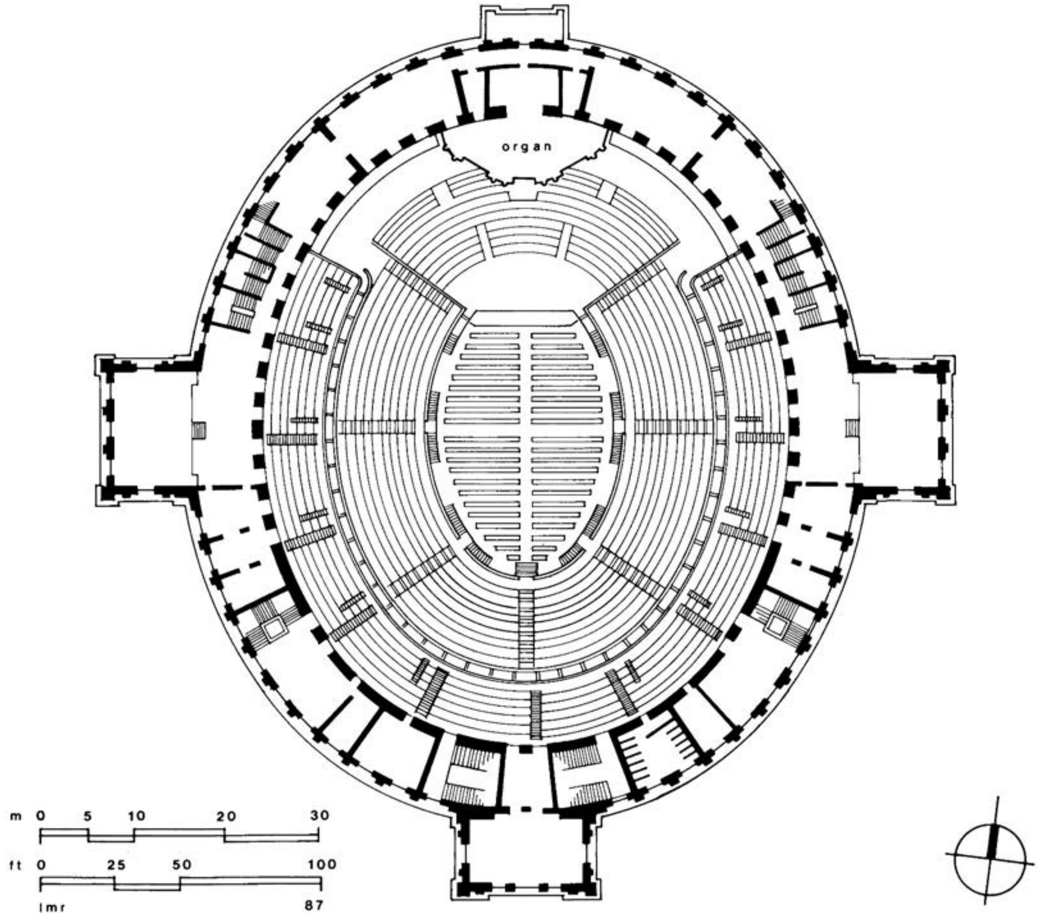
For middle C, at 256 cps, the wavelength is approximately 4 feet 5 inches (1.3 m), so the reflecting surface would need to be roughly 13 feet (4.0 m) across at the minimum. For C an octave below, the reflecting surface would need to be 26 feet (7.9 m) across, and for C at the bottom of the piano keyboard, 32 cps, the surface would need to be 105 feet (32.0 m) across. The tone C two octaves above middle C, at 1,024 cps, has a wavelength of nearly 12.75 inches (0.34 m), and surfaces to reflect this frequency need only be 3.5 feet across (almost exactly 1.0 m).

As a consequence, optical models that use light to study how sound is reflected work only for sounds higher than two octaves above middle C, a very high range occupied mainly by flutes, violins, the piccolo, and metallic percussion instruments. Such models can be constructed with miniature wall segments made of mirrors, with a narrow beam of light simulating the source of sound. One technique for studying the reflections of sounds lower than 1,000 cps is to bounce radio signals off models; another is to play the sounds electronically in a model at a speed raised in proportion to the size of the model. It is a costly exercise, but making such a model may prove far less expensive in the long run than rebuilding a concert hall, as demonstrated by the case of Avery Fisher Hall in New York.

Echoes are a form of reflection. The human ear and brain may not be as receptive to sounds as those of a dog or a bat, but humans can still make extremely minute discriminations in the arrival times of different sounds. When a sound is produced, an echo or a distinct reflected image of that sound will be heard if it arrives at the ear only 30 to 45 milliseconds after the original sound, or, in other words, if the reflecting surface is more than 35 to 40 feet (10 to 12 m) away. However, a particular form of echo, a ***flutter echo***, can occur in a small room having parallel walls with hard surfaces, for conversation bounces back and forth from side to side, causing a buzzing sound. Aside from paneling one wall with absorptive acoustical tile, another solution is to simply avoid parallel walls. In the small lecture room/auditorium at the Mount



5.2. Diagram showing reflection of sound waves and how curved surfaces can disperse or focus reflected sound. Drawing: L. M. Roth.

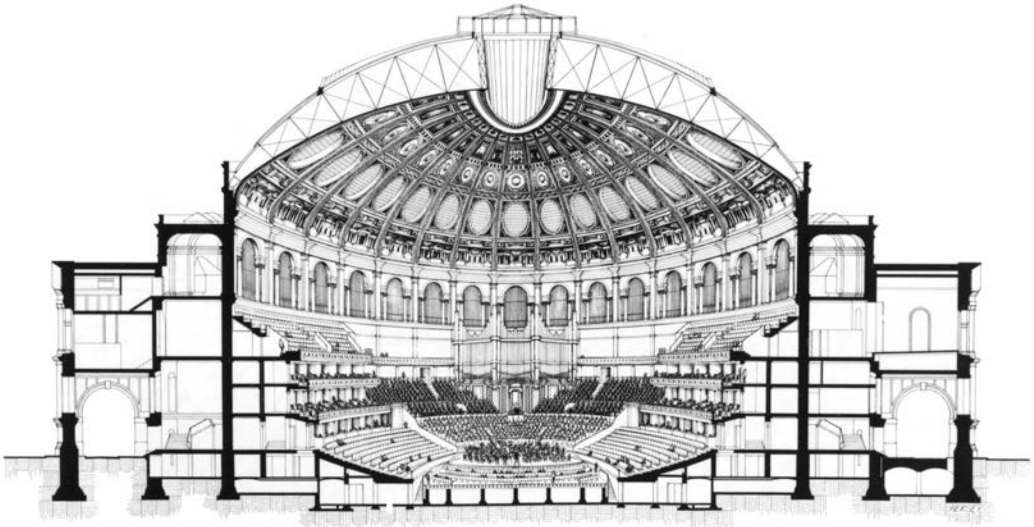


5.3. Captain Francis Fowke with George Gilbert Scott, Royal Albert Hall, London, England, 1867–1871. Plan. Because of its size and its curved walls and ceiling, this building was initially an acoustical disaster. Drawing: L. M. Roth, after G. C. Izenour.

Angel Abbey Library, St. Benedict, just outside Mt. Angel, Oregon [19.36], Alvar Aalto used both these solutions, with the addition of sound-absorbing material at the back of the room to prevent reflections from returning to the stage, and with the walls placed at a splayed angle.

Sound: Lingering and Echoing

Since the Italian Renaissance, with the complete enclosure of theaters and auditoriums, architects have been fond of designing auditoriums with domed ceilings. Curved shapes are not particularly unsatisfactory acoustically *so long as they are high enough from the source of sound,* but all too often the focus of the curve of the dome is near the floor, so that sound is concentrated there in what are called acoustical hot spots. Hence, dome vaults are particularly troublesome, since they have a distinct sound focus and do not disperse sound evenly. A similar problem occurs if the rear wall of an auditorium is curved, for sound from the stage is focused back toward the front of the audience to a particular spot. A classic example of a building in which almost everything was done wrong in acoustical terms is the vast Royal Albert Hall, London, 1867–1871, designed by Captain Francis Fowke with the architect George Gilbert Scott [5.3, 5.4]. The building, a huge oval in plan, is covered by an ellipsoidal dome, 185 by 219 feet (56.4 by 66.8 m), so there are curved surfaces both in the plan and in the dome. Because of the combination of curves and size, the result was that in portions of the hall, the audience received clear reflected images one-fifth



5.4. Royal Albert Hall. Section. From G. C. Izenour, Theater Design *(New York, 1977).*

of a second late, well over the limit for echoes. One sarcastic critic said the audience ought not to complain since they heard two concerts for the price of one. The solution adopted was to hang heavy fabric drapery overhead to absorb the bulk of the sound formerly reflected from the dome.[1]

In designing an auditorium, an architect must optimally meet several requirements. There should be good sight lines to the performance area or stage; good "presence," or strong, even dispersion of initial reflections; good reflection of all frequencies in the sound spectrum; and an even decay of sound during the reverberation time. It is this reverberation time that bears special consideration, for the optimum time depends on the activity in the room. For a lecture hall or a theater, in which it is vitally important to hear speech clearly, the reflections of words need to die away very rapidly, and one second is considered the optimal reverberation time. Slightly more reverberation time is desired for the music of small ensembles, such as modern jazz groups or chamber orchestras in which each note produced by each instrument must be clearly heard—perhaps 1½ seconds. For choral church music, symphonic music of the nineteenth century, or Romantic music for large orchestra, 2 to 2½ seconds is most desirable. Thus opera, where both music and speech are intertwined, requires a reverberation time somewhere in the area of 1¾ seconds.

The problem before 1900 was that there was no way to predict what the reverberation time of a particular space would be, except to say that small rooms had shorter reverberation times and large rooms had longer reverberation times. Of course, reverberation time had not been a problem until the Renaissance, for theaters in antiquity were open to the sky. The semicircular concentric rings of seats in ancient theaters, such as that at Epidauros, Greece, built about 350–300 BCE by Polykleitos the Younger [11.15, 11.16], which could seat 17,000 people, did reflect sound directly back to the center of the orchestra circle. But because the seats were so steeply sloped on the hillside, the reflections went upward into the air. In any case, the many clothed theatergoers would have provided good sound absorption. The Romans modified the Greek theater form by using a strict semicircle of seats (the Greek theater was about 200° around) and constructed large, multistory permanent backdrops, or ***scenes*** (from the Greek *skēnē*) [12.20]. Since hillsides were not always conveniently available, the Romans often ramped the seats on tiers of inclined barrel vaults carried by heavy arcades. The well-preserved theater at Aspendos, Turkey, built about 155 CE by Zeno of Theodorus, is placed on a hillside; it seats 7,000 [12.21]. A Roman theater—and the larger amphitheater formed by placing two theaters face to face (minus the *scene*)—was often covered by a ***velarium***, a huge awning supported by a web of ropes.

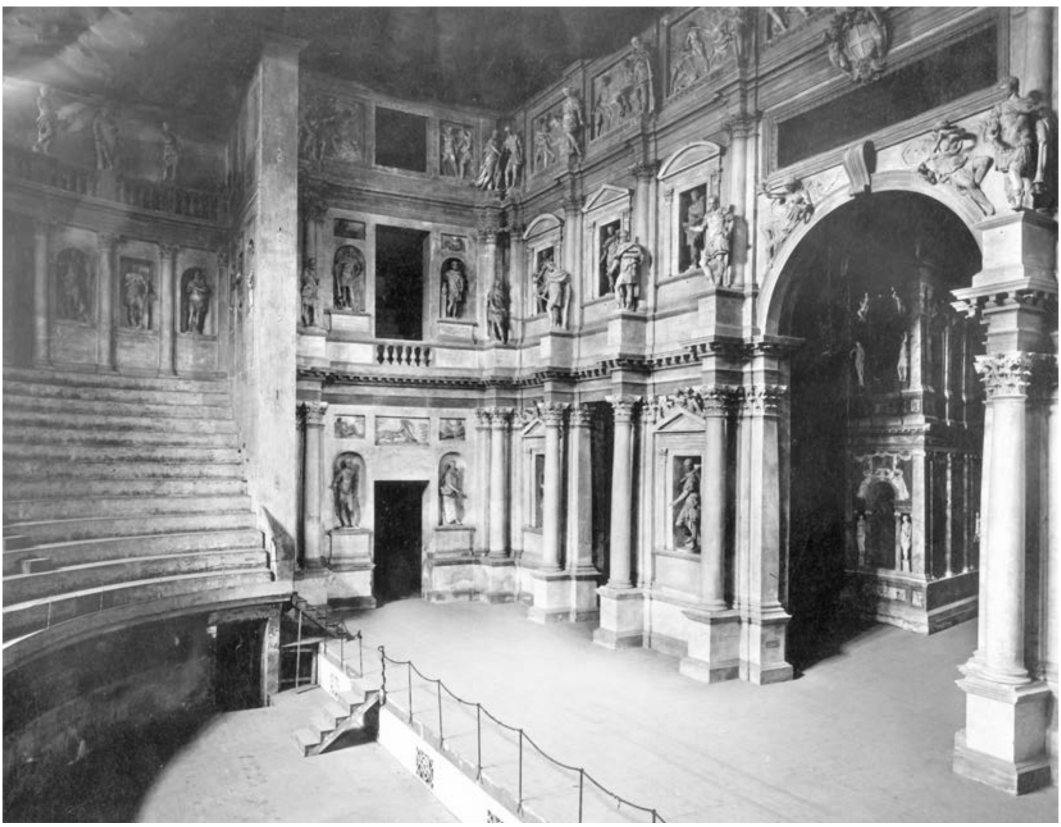
With the suppression of secular theatrical productions by the medieval church, the construction of theaters stopped, but with the rise of interest in

Classical literature in the Renaissance, the need for this building type emerged once more. Humanists in the area around Venice were especially keen on mounting productions of Greek drama, and they wanted a building that they believed was appropriately shaped for such an undertaking. In Vicenza, near Venice, in 1580, a group of enthusiasts engaged Andrea Palladio to design the Teatro Olimpico as a reproduction of a Classical theater [5.5, 5.6, 5.7]. It was far smaller than a Greek theater, seating only 750, and in fact it was more Roman than Greek, but it provided a suitable atmosphere. Because of the smaller size, Palladio was able to put a trussed roof on his theater and in that way make a closed volume. Suddenly, reverberation time became a consideration.

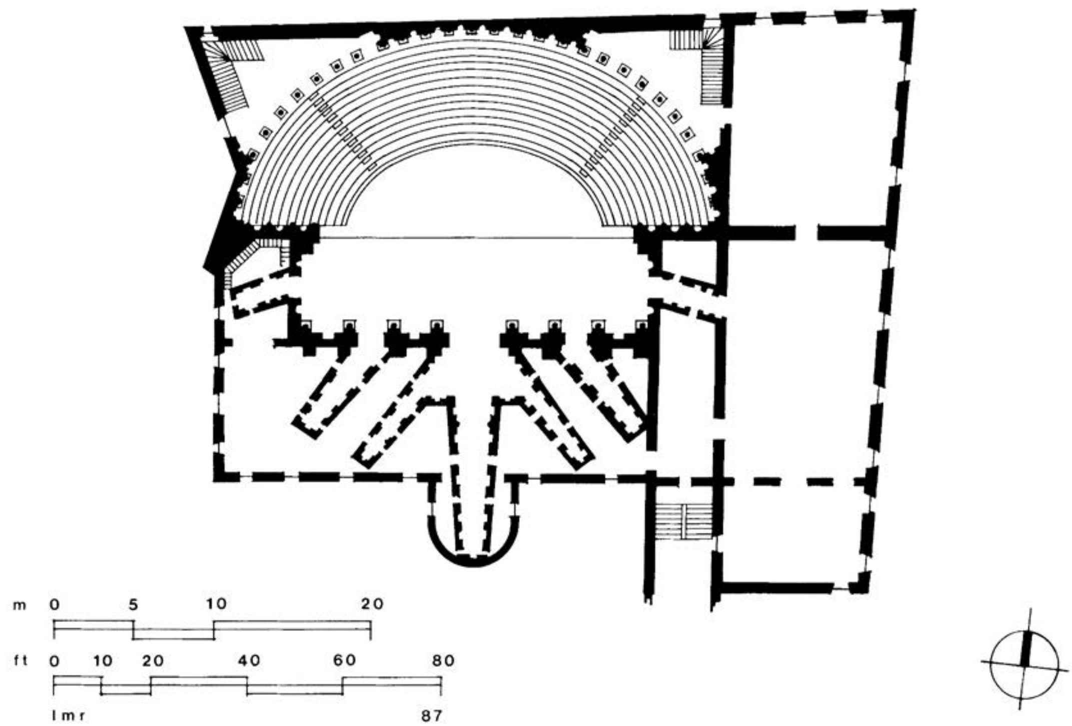
Shaping Early Church Music

Since the end of the Roman Empire, reverberation time literally had been shaping the development of Western church music, including the ways it was composed and performed. When early Christians adopted the form of the Roman basilica meeting hall for their churches, they adjusted themselves to buildings with large volumes, hard stone surfaces, and long reverberation times. It was not possible simply to verbally preach the good news in such halls, for the words resounded for about six to eight seconds after being uttered, and the multiple overlays made normal speech unintelligible.

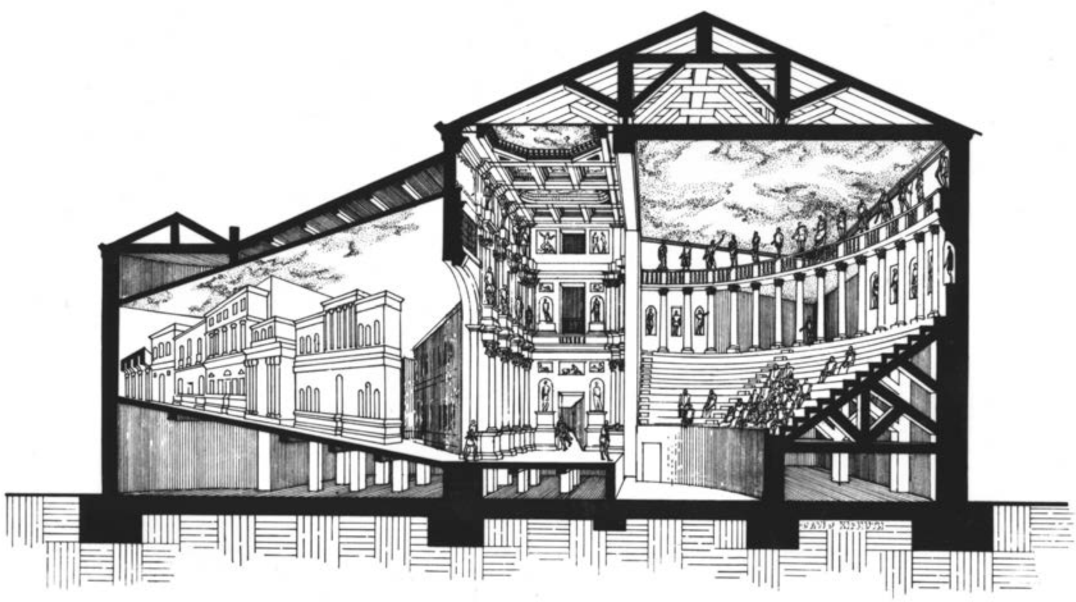
The solution was to chant the liturgy, and by a process of trial and error, no doubt, a basic acoustical principle was discovered. Virtually every enclosed volume has a resonant frequency. In the case of a long, closed, tubular organ pipe, the resonant frequency is twice the length of the pipe; hence, for middle C—with a wavelength of nearly 53 inches (1.3 m)—the length of the pipe is half that, or 26.4 inches (0.7 m). Long, narrow basilicas can be argued to function much like organ pipes [5.8].[2] So, San Apollinare in Classe, Ravenna, Italy, built in



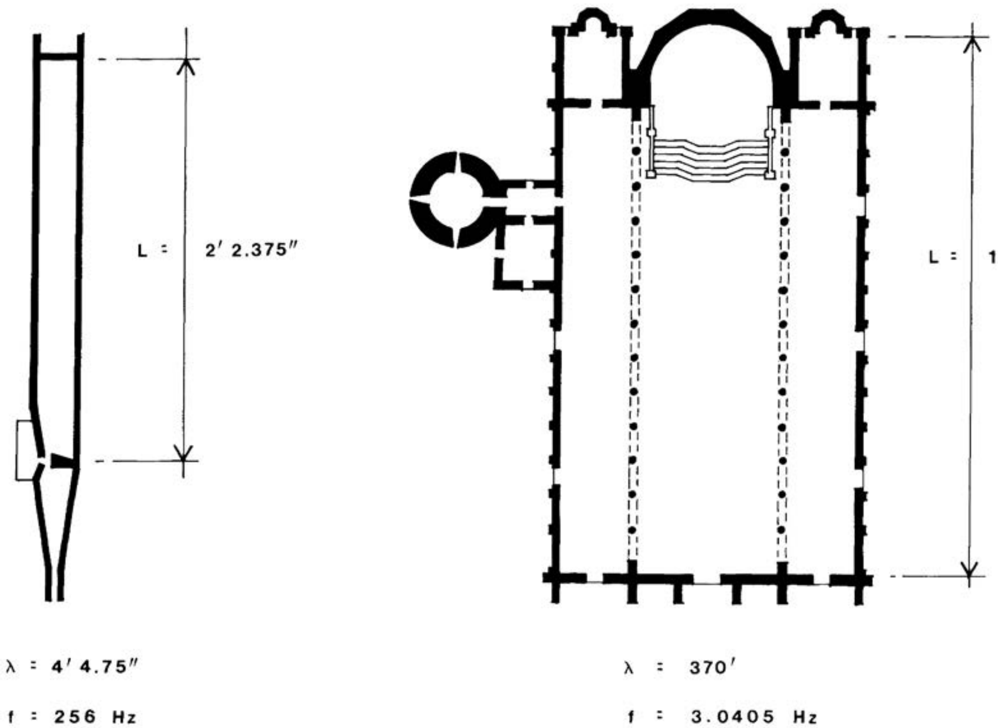
5.5. Andrea Palladio, Teatro Olimpico, Vicenza, Italy, 1580–1584. Interior. Palladio's theater was built to house revivals of Classical Greek drama and, hence, was loosely patterned after Classical models; it is like a very small Roman theater, but covered with a permanent roof. Photo: Alinari/Art Resource, NY.



5.6. Teatro Olimpico, Vicenza, Italy. Plan. Drawing: L. M. Roth, after G. C. Izenour.



5.7. Teatro Olimpico, Vicenza, Italy. Section. From G. C. Izenour, Theater Design *(New York, 1977).*

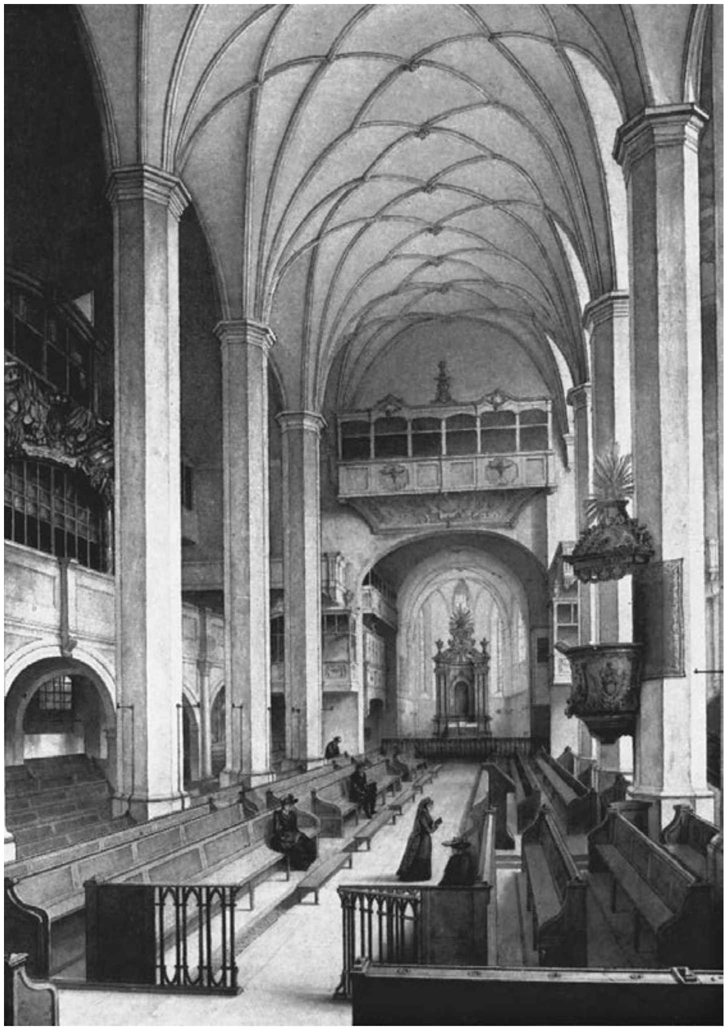


5.8. San Apollinare in Classe, outside Ravenna, Italy, 530–549. Diagram comparing the shape of a closed organ pipe and the long basilica church plan of San Apollinare in Classe. Drawing: L. M. Roth.

530–549, with a length of 185 feet (56.4 m), has a resonant frequency of about 3.0405 cps. Now, all musical tones consist not only of the basic note but also of a series of ascending harmonics, and one of the high upper harmonics of this extremely low frequency is near F below middle C. The triad up from F is A. Hence, theoretically, if the priest chanted the liturgy using harmonic intervals around A, the air in the vast volume of such basilicas would soon vibrate on its inherent upper resonant frequencies, and the air vibrating throughout the building would carry the message to the worshipers. Thus the plainsong, or Gregorian chant, was born.

A particular musical development of the later Renaissance merits special attention, for it represents a clear case of a singular building shaping music. The palace church of the doges, or dukes, of Venice, San Marco's, was built not in the traditional form of the Latin cross (with a T-shaped plan) but in the form of a Greek cross with four equal arms, each arm and the center bay capped by a dome. Moreover, the interior surfaces were covered with gold-backed glass mosaic, a very hard, reflective surface [13.26, 13.27, 13.28]. In each of the arms of the plan, there are upper-gallery choir lofts. During the sixteenth century, the choirmasters at San Marco's, especially Giovanni Gabrieli, developed a technique of using multiple dispersed choirs and multiple instrumental ensembles in the separated lofts. The choirs would perform antiphonally, singing against one another and tossing the melodic line back and forth across the space of the church. As many as four groups would perform simultaneously. This technique was then adopted by German composers as well, including Heinrich Schutz in Munich and Johann Sebastian Bach in Leipzig. The volume of San Marco's is considerable, and the reverberation time today is about six to seven seconds, although tapestries then hanging in the church probably shortened this reverberation somewhat in Gabrieli's time. Gabrieli's melodic lines move comparatively slowly, avoiding passages of extremely rapid notes that would pile up acoustically in the long-reverberant space of St. Mark's.[3]

During the same period, the princely Renaissance families of the Italian city-states assembled



5.9. Thomaskirche, Leipzig, Germany. Interior. This engraving by O. Kutchera shows the church as it was when Johann Sebastian Bach was organist and choir-director there. Photo: Berlin, Archiv für Kunst and Geschichte.

private chamber groups to perform secular music in their households. Because such secular and dance music was performed in much smaller rooms, or even outdoors, where there is negligible reverberation, it involved much faster rhythms and more rapid passages of notes. Such was also the background of the court music of Versailles, written by Louis XIV's master of music, Jean Baptiste Lully.

Church music underwent a change in the north of Europe after 1500, partly as the result of adaptation to smaller churches and partly as the result of changes introduced by Martin Luther when he embarked on reforming the church and thereby touched off the Protestant Reformation. Another change in the music for the new Lutheran church was the development of more responsive organs. The result was a body of church and organ music, most notably the music of J. S. Bach from the early eighteenth century. Bach, too, adapted his music to the acoustical conditions in the places where he worked. His well-known *Toccata and Fugue in D Minor* was written in about 1708 for the small palace chapel of his master and employer, the Duke of Saxe-Weimar at Weimar. But later, when Bach was employed by Prince Leopold of Cöthen, he wrote the rapid arpeggios of the Brandenburg Concertos to be played in the small music room in the palace there. When Bach subsequently moved to Leipzig and the larger Lutheran church of Saint Thomas [5.9], he began his program of cantatas written for the calendar of the church year, including such large works as the *St. Matthew Passion* oratorio.[4]

The Synchronous Development of Orchestras and Orchestral Halls

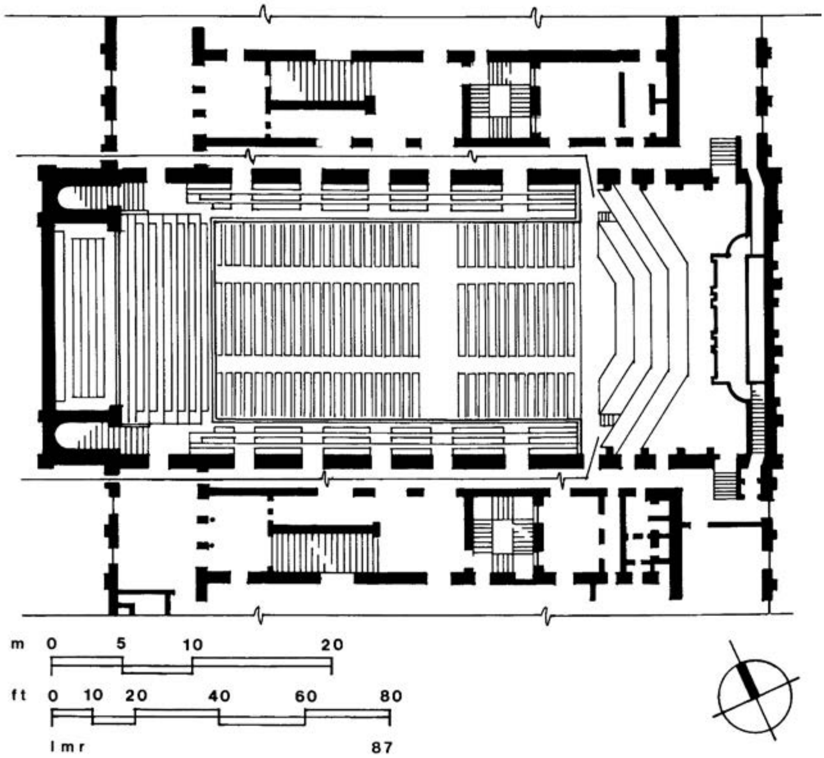
By the time Bach died, in 1750, there had already been established in Leipzig an orchestral ensemble that began playing public concerts in a large room in the Gewandhaus (Garment Merchants Hall). By the early nineteenth century, under the direction of Felix Mendelssohn, this ensemble had become a major symphony orchestra. But in Vienna, where Ludwig van Beethoven was writing his dynamic piano concertos and symphonies, there was neither an orchestra to perform them properly nor a hall to perform them in. When such large orchestral pieces were performed in Vienna, theaters were pressed into service, as was the large, rectangular ballroom called the Redoutensaal, in the Austrian imperial residence. Not until the mid-nineteenth century was the Vienna Philharmonic Orchestra formally organized and, finally, a special building erected for its use in 1867–1870 [5.10, 5.11, Plate 14]. This hall, the Musikvereinsgebaude, was designed by Theophil von Hansen and patterned on the older rectangular Redoutensaal. The Musikvereinsgebaude worked so well that its proportions served, in turn, as the model for the new building for the Leipzig Gewandhaus orchestra, built in 1882–1884 from designs by Martin Gropius and Heinrich Schmeiden. What happened during the nineteenth century is that musical performances were no longer reserved for the nobility and their friends in royal palaces but, rather, began to be public performances attended by the growing numbers of the expanding middle class—and large new buildings were needed for this new use.

During the nineteenth century, opera houses also expanded greatly in size, based on models provided by eighteenth-century theaters. In this instance, too, the expanding buildings were created to serve the new middle-class audiences. Often, however, the sight lines were not good, the acoustics were less than ideal, and the facilities on the stage were extremely cramped. During the 1840s, in the course of conducting his early operas across Europe, Richard Wagner discovered that none of the existing opera houses could provide the facilities he required for the opera cycle he was then composing, the expansive four-part *Ring of the Nibelungen.* His only alternative was to design a new kind of opera house to accommodate the music he was writing. He obtained the patronage of Ludwig II, the king of Bavaria, who provided him with a site and the funds to construct his new opera house, the Festspielhaus (Festival Hall) at Bayreuth, built in 1872–1876 from sketch designs by Wagner himself and developed by architects Otto Brückwald and Carl Brandt [5.12, 5.13]. The Bayreuth theater, in turn, served as the inspiration for the even larger Auditorium Theater in Chicago, 1887–1889, by Adler & Sullivan, in which excellent acoustics were developed by the engineer and architect Dankmar Adler.

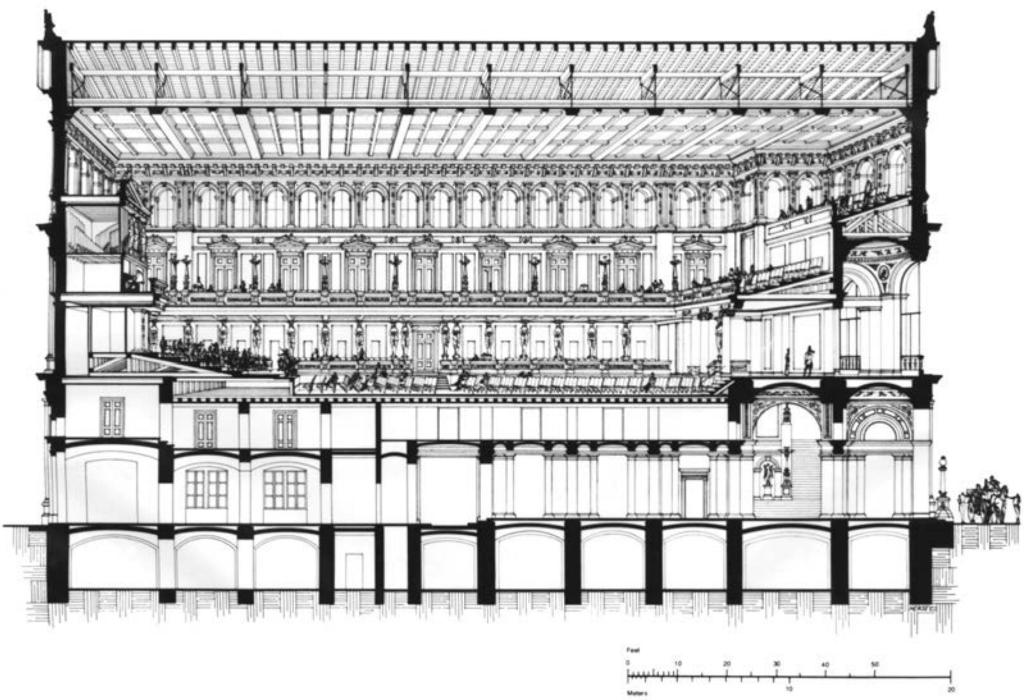
Wagner's success, and that of Adler in the auditorium, were largely the result of careful observation and informed intuition. The first building in which the acoustical performance was scientifically and mathematically calculated beforehand was Boston Symphony Hall. The first steps to build a new performance hall for the Boston Symphony Orchestra were taken in 1892–1894, supported by businessman Henry Lee Higginson (the principal patron of the orchestra) and his architects, McKim, Mead & White. But then a business depression delayed the project.

This hiatus proved most fortuitous, for in 1898, quite independently, Wallace Sabine, a young physicist at Harvard, was asked to investigate severe acoustical problems in some of Harvard's lecture halls. Sabine developed several mathematical formulas to define acoustical performance and devised experiments to test the troublesome rooms. The most problematic formula to devise was one to account for reverberation time. It seemed clear to Sabine that reverberation time was directly proportional to the volume enclosed by a room, but then it occurred to him that it was also inversely proportional to the capacity of the room to absorb the sound. That absorptive capacity was determined by the combined effects of all the materials used in the surfaces of the room, so he set up more experiments to determine empirically the absorptive capacities of various materials and finishes. He had just concluded his investigations when the firm of McKim, Mead & White was asked to prepare final designs for Boston Symphony Hall in 1899.

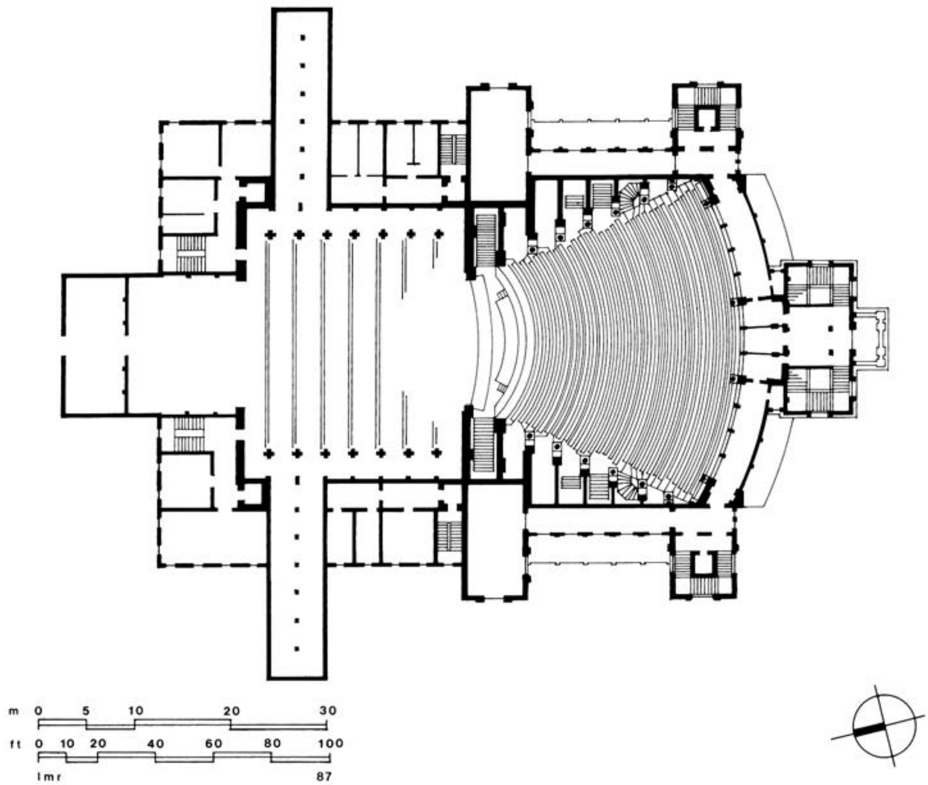
Following instructions that the orchestra members had relayed to McKim, Mead & White via Higginson, the architects used as their model the new Leipzig Gewandhaus, enlarging it by nearly 50 percent [5.14, 5.15]. McKim, Mead & White then had the drawings for the building examined by Sabine, who suggested modifications in the surface materials. If these changes were made in the materials, he predicted, then the reverberation time would be precisely 2.51 seconds, only one-hundredth of a second longer than in the orchestra's old hall in Boston. Given the acoustical failures of some prestigious, recently built venues in Europe, Sabine's guaranty was unheralded. But when the first concert was given in 1900, Sabine was proven correct and a new scientific basis had been given to acoustical design.[5]



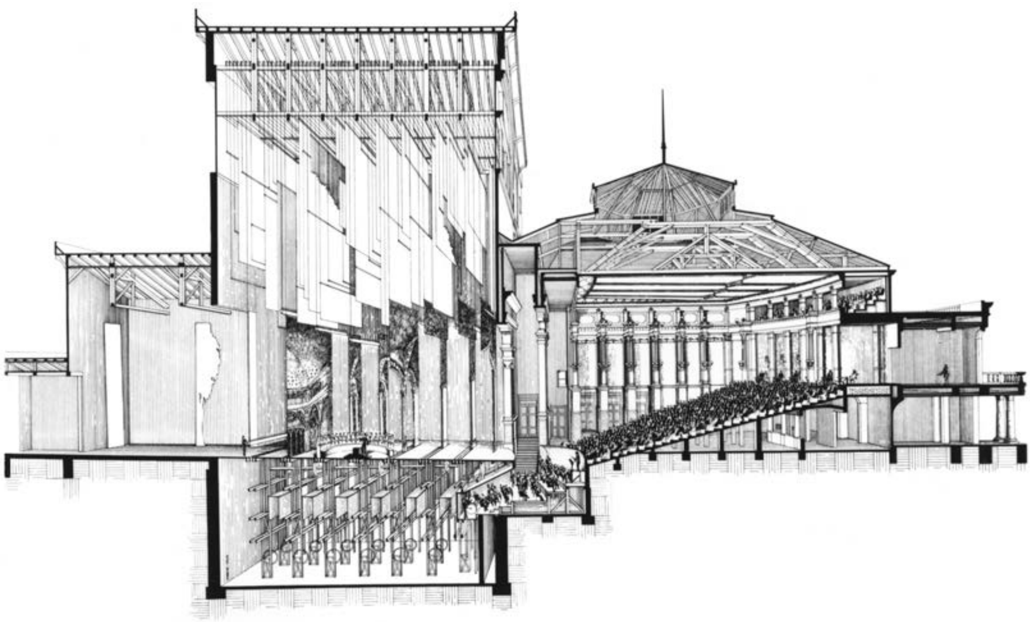
5.10. Theophil von Hansen, Musikvereinsgebaude, Vienna, Austria, 1867–1870. Plan. Designed especially for use by the Vienna Philharmonic Orchestra, this rectangular orchestral hall set the pattern for many subsequent halls. Drawing: L. M. Roth, after Izenour.



5.11. Musikvereinsgebaude, Vienna. Section. From G. C. Izenour, Theater Design *(New York, 1977).*

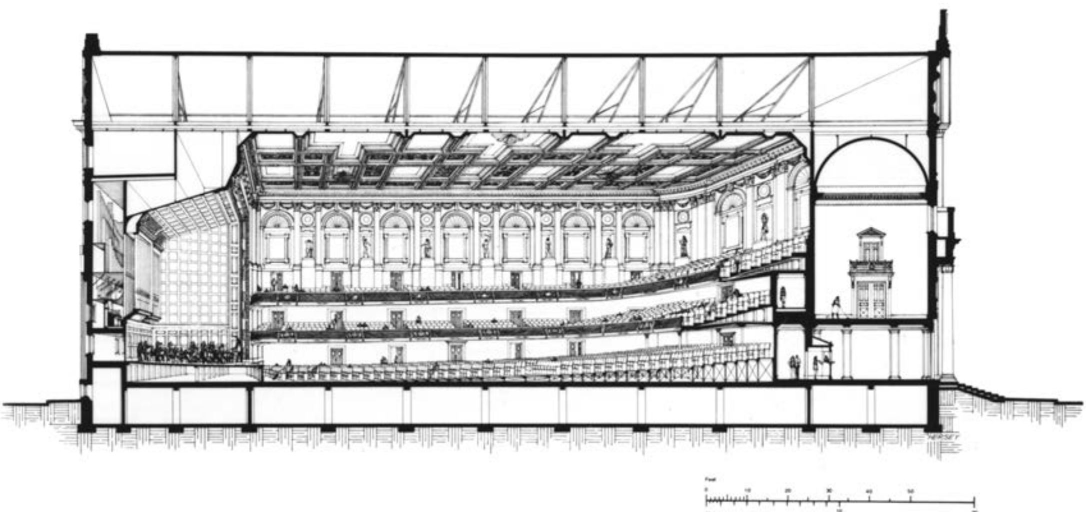


5.12. Otto Brückwald and Carl Brandt, Festspielhaus, Bayreuth, Germany, 1872–1876. Plan. Designed on the basis of instructions from the composer Richard Wagner, this opera house was built specifically to enhance the experience of the opera. Drawing: L. M. Roth, after Izenour.



5.13. Festspielhaus, Bayreuth, Germany. Section. From G. C. Izenour, Theater Design *(New York, 1977).*

5.14. McKim, Mead & White, Boston Symphony Hall, Boston, Massachusetts, 1892–1900. Exterior. Although patterned after the Musikvereinsgebaude in Vienna and the Gewandhaus in Leipzig, this design was modified in accordance with acoustical calculations made by the engineer Wallace Sabine, making this the first building acoustically and scientifically planned to be a symphonic hall. Photo: L. M. Roth.



5.15. Boston Symphony Hall, Boston, Massachusetts. Section. From G. C. Izenour, Theater Design *(New York, 1977).*

Nevertheless, acoustical engineering, particularly in the design of opera houses and symphony halls, has not always been so exact a science, as is evident in the costly errors made in the design of Philharmonic Hall in New York, 1960–1962, by Harrison & Abramovitz, with the acoustical consulting firm Bolt, Beranek & Newman (this hall is discussed in Chapter 4 in connection with ornament). Fortunately, given sufficient funds provided by Avery Fisher, Philip Johnson and Cyril M. Harris were able to correct those mistakes and create a superior acoustical space [see 4.33]. It is no coincidence that Avery Fisher Hall (as Philharmonic Hall was renamed) is extremely close in volume and form to Boston Symphony Hall and to the new Gewandhaus in Leipzig.

The most successful orchestra halls of recent years have been those viewed by their architects as forming the largest of the instruments of the orchestral ensemble. In describing his proposed auditorium for the Fort Wayne Arts Center in Indiana, planned in 1965, Louis I. Kahn said, "Being in the chamber is like living in the violin. The chamber itself is an instrument."[6] This is also how Hans Scharoun conceived of the new hall for the Berlin Philharmonic Orchestra, the Philharmonie, 1957–1965 [19.49, 19.50, 19.51]. In the Philharmonie, the audience surrounds the players; the listeners are part of a community united in a musical experience, for as Scharoun wrote, "Music in the center, that is the simple idea which determined the new concert hall."[7] The angled balconies reflect and disperse the sound, as do the convex curves of the ceiling, creating the intimate feeling of participation with the orchestra.

Architecture affects all our senses, not just the eyes. The perception of architecture, then, is an activity in which the whole realm of the body's senses is involved—basking in the warmth of a sun-filled court or feeling the cool shadows of its encircling arcade, scanning the rhythm and scale of a facade, tuning our ears to the volume of a room, feeling the roughness of stone or the cool smoothness of glazed tile under our fingers, smelling the bite of a sun-baked boxwood hedge along a garden's edge, tasting the cool water of a fountain.

6.1. Le Corbusier, High Court Building, Chandigarh, Punjab, India, 1951–1956. Detail. Drawing from the idea of a parasol carried to protect dignitaries from the sun, Le Corbusier used an elevated roof over a roof to protect the rooms within from direct exposure to the sun, with broad openings for moving air to carry away built-up heat. Photo: Fernando Stankuns.

Chapter 6

Architecture

Part of the Natural Environment

An effective relationship of building to earth is fundamental to architecture.

—*Stanley Abercrombie,* Architecture As Art, *1984*

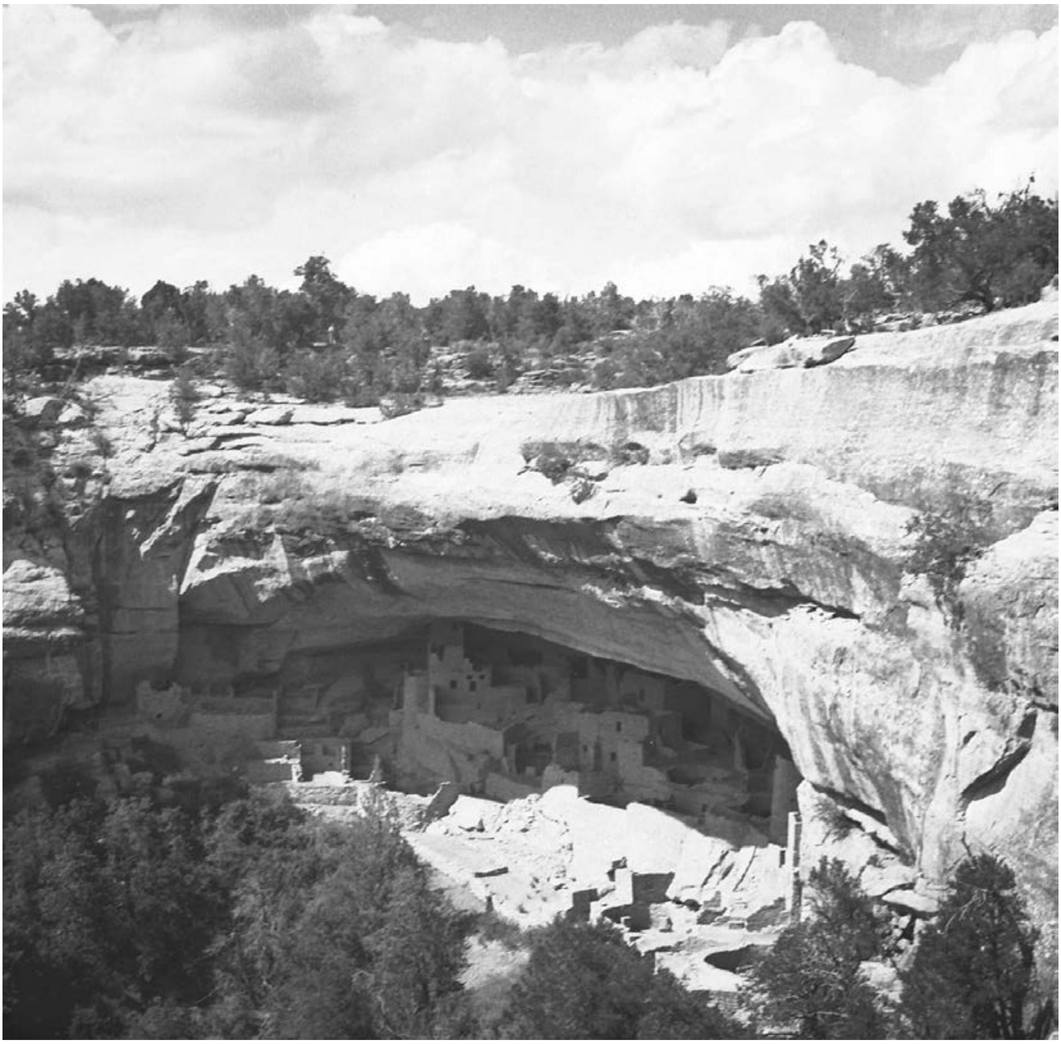
As was evident in the discussion of how architecture and sounds interact, there are immutable laws of physics that must be dealt with. We cannot wish them away. Nor can we forget that a building, like any other object in the world, becomes a part of the world. In the West, one of the legacies of the Renaissance is the tendency to think of buildings primarily or initially as objects of artistic or social significance, but not as objects operating within the environment. Landscape architects escape this myopia from the outset, since they deal with living objects, and their success as designers depends on whether they know that the soil and the climate in a particular area will support the plant materials they propose to use. Especially in the twentieth century, after the development of effective heating, ventilation, and air-conditioning equipment, architects in the industrialized West largely stopped thinking about such concerns as sun exposure, wind patterns, and prevailing local temperatures, because they felt confident that, given enough equipment, they could overcome any difficulty. More technology seemed to be the solution to all problems and impediments. There was a price to be paid, of course, but that was a challenge to be borne by the client and the user in the long years after the completion of the building. Architects did not then worry much about that.

Once a building is built, it becomes as much a part of the environment as a tree or a rock. This fact has double importance. First, it means that the architect needs to consider, at all steps of the design process, how the proposed building will affect its setting, regardless of whether the setting is an urban context or a natural landscape. Does the proposed building enhance the existing context, or does it stand in distinct and deliberate contrast to the context? Does it seem out of place? Second, once completed, the building is subject to the same incessant impact of sun and rain as well as the inevitable interaction of various building materials, time, and the never-ending pull of gravity. Sometimes, the patron and the architect wish to make a deliberate statement, as in the case of temporary exhibition buildings, and thus place their lowest priority on how a building responds to environmental concerns. But for other seemingly permanent buildings, it would make better sense to consider the impact that environmental forces have on a building, as well as the effect the building has on its immediate environment.

Buildings, Sun, and Heat

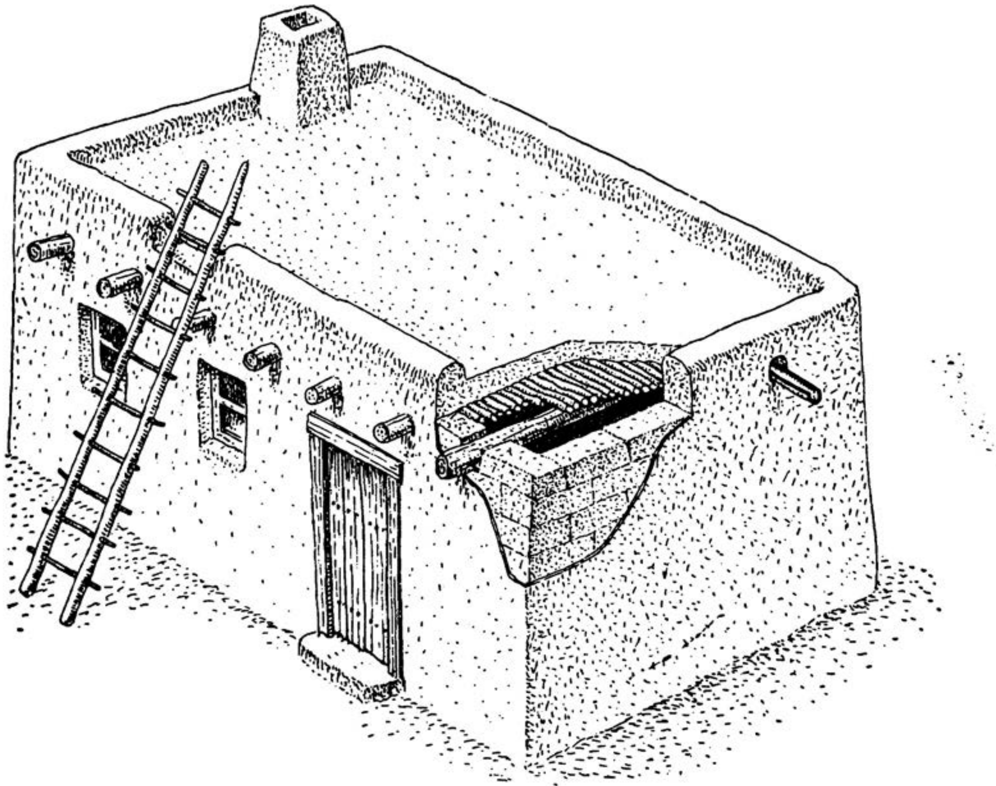
Buildings by so-called primitive peoples almost invariably reveal subtle and sophisticated responses to the environment. Consider, for example, the thick adobe construction of the typical house in the American Southwest. The material and construction techniques are similar to those used north of the Sahara, from Morocco to Egypt and in other places with comparable climate. The problem is the constant exposure to the sun, which in late June radiates 2,750 British thermal units (Btu) of energy per day on just one square foot.[1] Translated into more manageable figures, this means that a roof in Albuquerque, New Mexico, at 35° latitude N, measuring 10 feet to a side (100 square feet, or 9.3 square meters), receives enough energy each day to raise the temperature of 4 tons of water (8,000 pounds, or 3,629 kg) from 90° F to 124° F. This is clearly a significant amount of heat.

One way of dramatically cutting down that heat gain is to prevent the sun from ever touching the

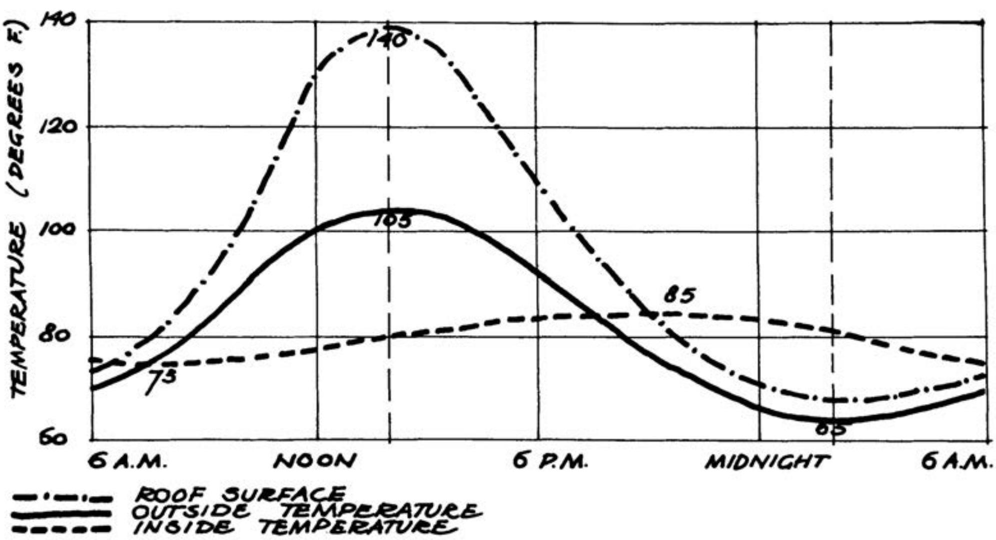


6.2. Cliff Palace (Anasazi village), Mesa Verde, Colorado, c. 1200–c. 1300. These closely clustered houses were pushed just far enough back so that the overhang of the cliff provided shade at midday during the hot summer months. Photo: Lindsay Hall, courtesy of the Visual Resources Collection, Architecture and Allied Arts Library, University of Oregon.

roof directly, as the Anasazi people did nine hundred years ago in building their villages up in the recesses of caves, as at Mesa Verde in southwestern Colorado [6.2]. The houses are positioned just far enough back into the alcove that, in late June, the overhang of the cliff prevents the sun from reaching the roof surfaces until quite late in the afternoon. In the winter, however, the low-slanting sun reaches to the back of the cave. But if no cliff overhangs are conveniently nearby, one simple solution in the arid American Southwest has been to use a large mass of material between the interior space and the sun so that the mass slows down the absorption and transfer of heat, as do thick mud-brick walls and roofs of adobe construction [6.3]. Even when the afternoon temperature reaches 140° F on the surface of the roof, the internal temperature of the room is 80° F, rising gradually to 85° F at 9:00 p.m., and when the outside temperature plummets to 60° F at 2:00 a.m., the internal temperature of the room will begin easing down from 80° F to a low of 75° F by 8:00 a.m. the next morning [6.4].[2] In traditional adobe construction, the windows and doors were intentionally kept small to prevent hot drafts from entering and disturbing the relatively cool temperatures inside. And, of course, if a number of



6.3. Drawing of a typical adobe dwelling in the American Southwest, showing the thick walls and roof structure that serve to retard solar heat buildup. From J. M. Fitch, American Building: The Environmental Forces That Shape It *(Boston, 1972).*

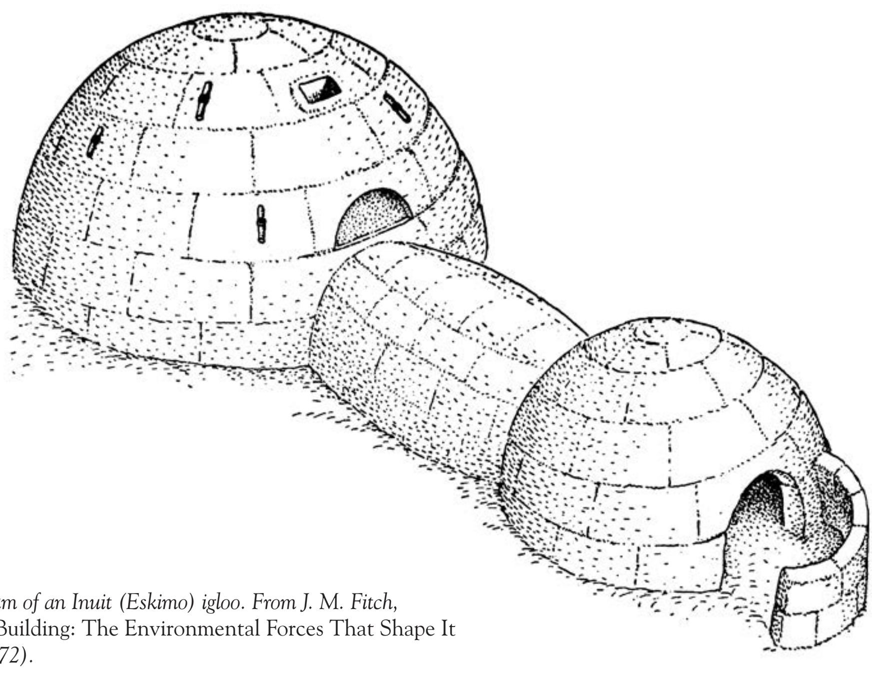


6.4. Time-temperature chart for an adobe dwelling, showing properties of thermal insulation and heat flow retardation provided by thick adobe masses. From J. M. Fitch, American Building: The Environmental Forces That Shape It *(Boston, 1972).*

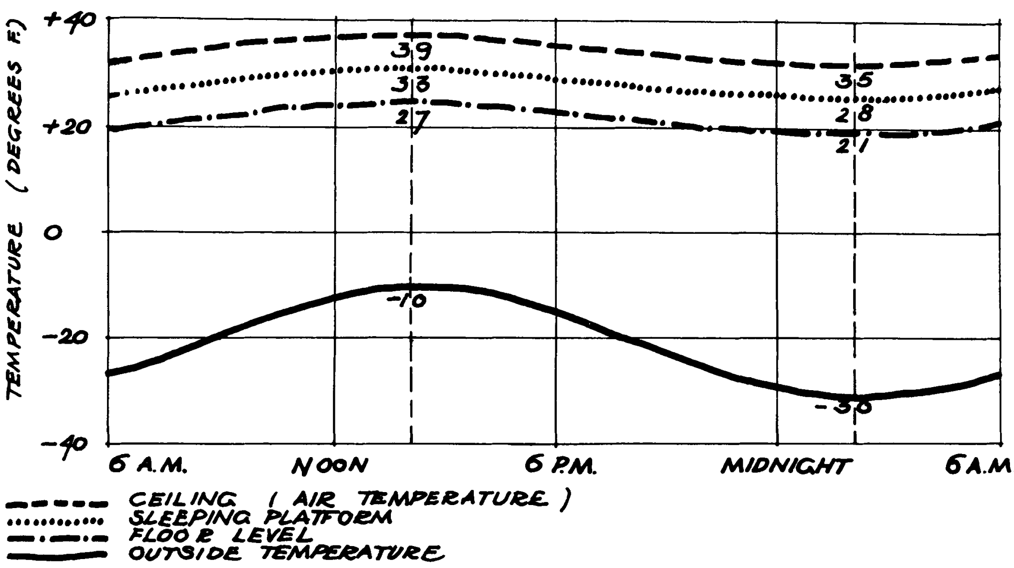
such rooms are piled atop one another, those at the core of the pile will remain quite cool, as is the case in such pueblos as Taos, New Mexico [3.9].

As the Inuit (Eskimos) of the Arctic and the Mandan Indians of the upper Missouri River discovered, building mass will work just as well for cold temperatures. The Mandan, who lived along the upper Missouri River before the arrival of Europeans, built large, round houses with a heavy internal wooden frame, on which earth was heaped to a thickness of 1 foot at the top and several feet around the base. This thick insulation prevented the searing heat of late summer from penetrating to the interior and just as effectively kept frigid winds from lowering the internal temperature in winter (the low, round form also presented the least resistance to the wind). In Arctic regions with severe snowy winters, there is neither wood nor exposed earth, so the winter dwelling of the traditional Inuit was built of packed snow cut into blocks and laid in a closing spiral to form a dome—the igloo [6.5]. The construction process begins by hard-packing a level circle in the snow surface, then cutting half the circle down into the snow in front of what will become a seating platform. An even lower cut at the edge of the lower half-circle is made to form the inside end of the entry tunnel. Construction of the dome starts with a series of low snow blocks at the edge of the circle, rising in an inward-curving circular spiral until the last keystone block closes the topmost opening. Air holes are created through the dome. The entry tunnel is covered by a snow-block barrel vault protected by an outside deflector wall. The occupants enter through the sublevel tunnel and then rise to sit and work on the raised floor encapsulated by the dome. Any heat generated (that of the people themselves and from their traditional seal blubber lamps) is captured and held inside. The trapped air in the thick, packed snow blocks is an excellent insulator, so while the outside temperature may fluctuate from –10 F to –30° F or lower, the internal temperature in the upper half of the snow igloo will be a chilly but survivable 35° F to 39° F [6.6].

The igloo is effective because it captures not only the small amount of heat generated by lamps but also the heat that living beings generate simply by being alive, which is itself significant. All living beings are in a constant state of slow oxidation, or combustion, but since humans use only about 20 percent of the heat they generate, the rest is thrown off. Even motionless, the human body creates heat; but if it is moving or working, that amount can easily double or triple.[3] If applied with 100 percent efficiency, the heat created by a person doing heavy physical labor could raise 4 pounds (1.8 kg) of room-temperature water almost to the boiling point. In the igloo, this radiated heat is urgently needed, but in buildings in moderate or hot climates, it simply adds to the internal heat load



6.5. Diagram of an Inuit (Eskimo) igloo. From J. M. Fitch, American Building: The Environmental Forces That Shape It *(Boston, 1972).*

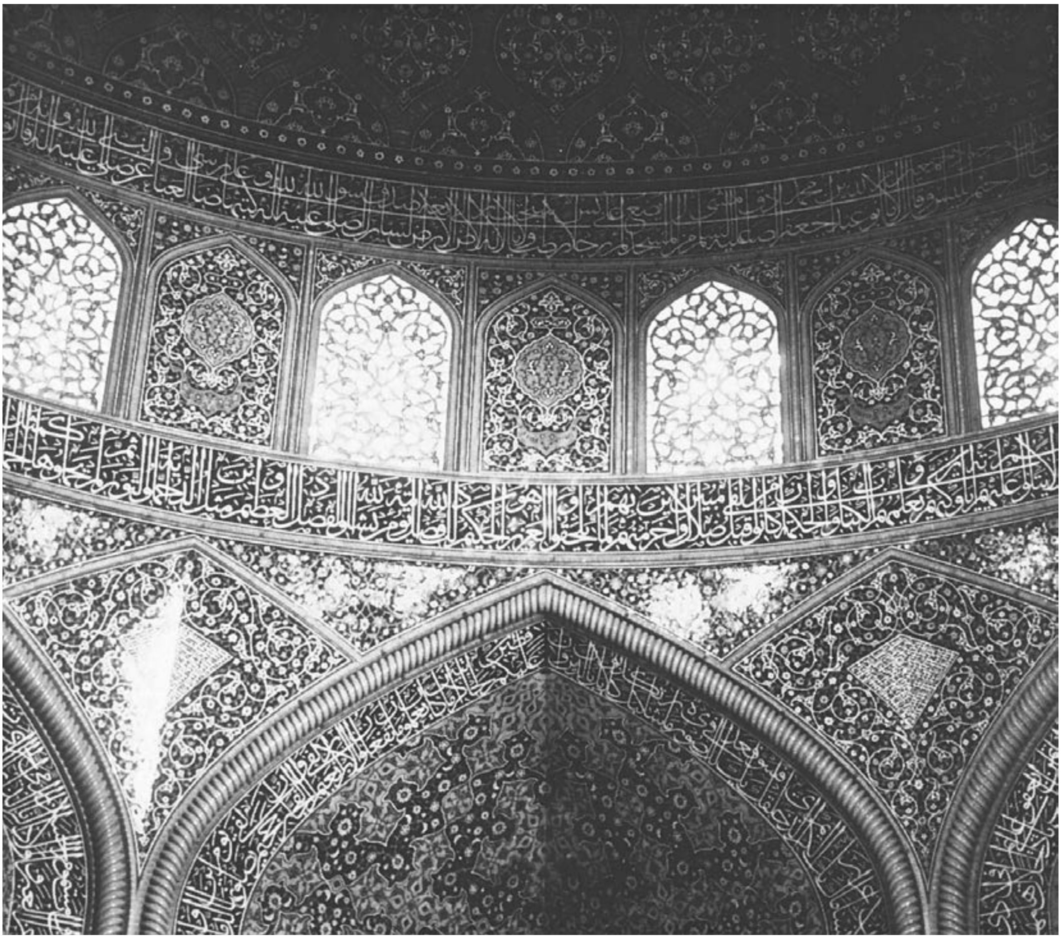


6.6. *Time-temperature chart for an igloo, showing properties of thermal insulation of packed snow. From J. M. Fitch,* American Building: The Environmental Forces That Shape It *(Boston, 1972).*

that must be dissipated. By comparison, in southern Florida, Seminole Indians built their Chickee dwellings without any side walls so that air could freely move through and remove any heat generated within.

Since about 1970, architects and engineers have adapted many of the principles demonstrated in these ancient Native building methods, devising "new" ways of heating buildings. For residences, it is often possible to use a ***passive solar heating system***, in which sunlight falls on thermal masses, such as brick floors or masonry walls; these soak up the heat and then radiate it back into the building at night. For more precise control, an ***active solar heating system*** may be installed. In such a system, exterior collector panels absorb solar radiation, and a fluid circulating in pipes through the panels picks up this heat. Pumps move the heated fluid to another area where a thermal mass (a water reservoir or a mass of rock) stores the transferred heat. Finally, an additional secondary system of air ducts or water pipes carries the heat from the storage mass to the rooms where it is needed. In addition, two electrical sensing systems are needed to turn both the collecting and the secondary systems on and off as required. As this brief description suggests, an active solar heating system is a complex network of interconnected subsystems that may fail if any one of its components breaks down.

The best solution for keeping a building cool, as the ancient Anasazi realized, is to keep the sun off a building in the first place. But the development of air-conditioning during 1902–1906 by Wallis Haviland Carrier (1876–1950) kept architects (American architects in particular) from exploiting passive means of preventing solar heat gain until economic pressures and awakening ecological sensibilities caused widespread changes after 1973. It is also possible to keep internal temperatures in a building comfortable by increasing the flow of air through the building, thus removing heat, and encouraging the sensation of being cooled by evaporation of perspiration on the skin—in other words, by keeping the light out while letting the air in. This was done with delicate grace in the Islamic architecture of Iran (ancient Persia) and northern India [6.7]. In these hot locations, windows were covered not with glass but with perforated screens of carved marble, cutting down significantly on the intrusion of light while creating a dappled pattern within the building and facilitating the flow of air. The screens simultaneously provided opportunities for complex decorative patterns [Plate 9]. Such devices were used throughout the mosques in Isfahan and can be seen clearly in the royal tombs at Agra, India. In designing the US embassy in New Delhi, India, 1958, the architect Edward Durell Stone similarly used precast concrete block to prevent



6.7. Shaykh Baha' al-Din (attrib.) and Ustad Abdul Qasim, Masjid-i-Shah Mosque, Isfahan, Persia (Iran), 1611–1638. The pierced stone screen is used to cut down on sunlight penetrating the interior while also permitting easy ventilation. Photo: Wallace Baldinger, courtesy of Visual Resources Collection, Architecture & Allied Arts Library, University of Oregon.

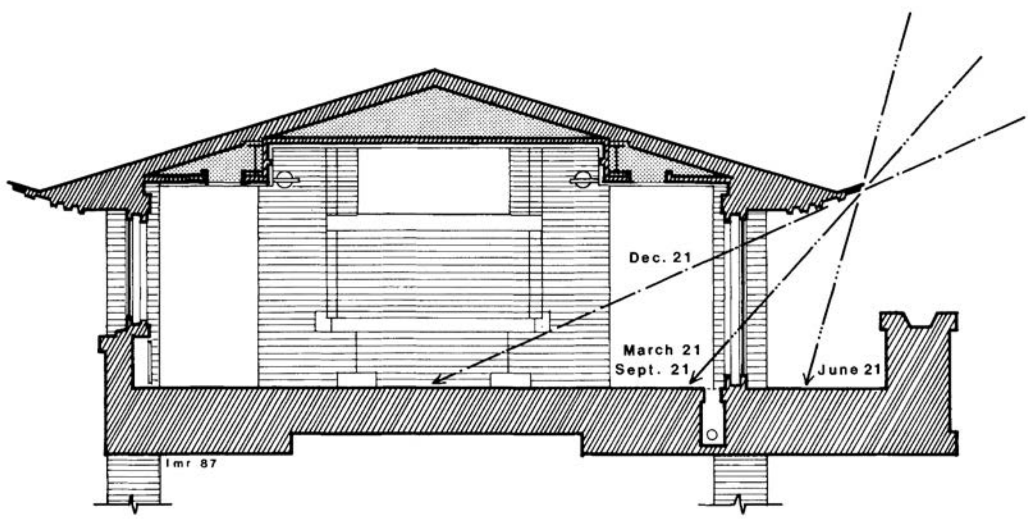
direct sunlight from reaching the inner glass envelope; he also used a cantilevered roof to keep much of the sunlight off the wall altogether.

For all the transparency and visual lightness that glass has made possible in architecture, it has also caused problems associated with extensive heat gain in modern buildings. Sunlight easily passes through glass, but once it strikes a surface in a room, the heat of the warmed surface results in long-wavelength infrared energy, which cannot pass through glass and is thus trapped inside. The result is a gradual heat gain, commonly called the greenhouse effect—as was discovered long ago and used to good effect in orangeries and similar glass-enclosed buildings designed to house tropical plants in the winter. But the greenhouse effect occurs in all glass-enclosed buildings, whether intended as greenhouses or not. Again, the solution is to keep the sun off the glass while retaining the view, by using projections outside the wall, either above the window or to the side, depending on the orientation of the window. In addition, these projections need to be proportioned to the latitude of the building and the angle of the sun.

Frank Lloyd Wright exploited such devices in many of his Prairie Houses from 1900 to 1910, though he seldom mentioned them in his writing. In his Robie House, Chicago, Illinois,1908–1909, he had no alternative but to orient his building running east and west on a narrow Chicago lot. The main facade would face south and was to have a continuous bank of glazed French doors from floor to ceiling [18.34, 18.35]. He proportioned the roof overhang on the south facade so that, in the summer, the sun is prevented from penetrating the glass [6.8], and by greatly extending the roof to the west, he could keep the lower afternoon sun off the west-facing windows as well.[4] In winter, the noon sun extends through the windows halfway into the living and dining rooms. George Fred Keck and William Keck, two brother architects of Chicago, pursued this strategy in a series of houses from the mid-1930s through the 1970s, using southerly orientations and carefully calculated roof overhangs to keep sunlight off the window-wall until the cooler months of the year. The Keck brothers were inspired to develop their passively heated buildings as a result of an all-glass house that George Fred Keck designed for the Century of Progress exhibition held in Chicago in 1933. During construction, in the dead of winter of 1932, Keck observed that the workmen inside had stripped down to shirt-sleeves because the glass box acted as a greenhouse. For the next forty years the brothers carefully calculated building orientation to the south, together with equally carefully proportioned roof overhangs, to provide a significant measure of passive winter solar heating [6.9].

At almost the same time, the French architect Le Corbusier had a similar experience. In 1929–1933, he was building a long, multistory block with a southern exposure for the Salvation Army in Paris [6.10]. The structure was conceived by the architect as an example of fully rational and scientific architecture, its functions analyzed and its form purified; Le Corbusier even spoke of it as an *usine du bien,* or "a factory of goodwill." Its dormitory block was planned to be a hermetically sealed glass box.[5] Unfortunately, the double glazing and the cooling equipment specified by Le Corbusier were deleted due to cost. The building was opened for use in the winter of 1933, but the following summer it became a hothouse. The lesson was not lost on Le Corbusier, for in 1936, when he designed the Ministry of Education in the tropics of Rio de Janeiro, he added vertical louvers in front of the glass wall of that building, calling the panels *brise-soleils,* or "sun breakers."

If the sun could be kept off the glass to reduce heat gain, so too could prevailing winds be used to cool a building. When Le Corbusier designed the Unité d'Habitation for the city of Marseilles in 1946, he incorporated exterior balconies to create horizontal and vertical *brise-soleils,* and by extending the apartment units through the entire width of the building, he enabled the residents to open windows at each end and let air flow through [see 4.15]. And in 1950, when he began work on the new capitol buildings for the Punjab state in northern India, on a sun-drenched plain in a hot, arid climate, he responded to the nature of the environment. For the High Court at Chandigarh, he used deep *brise-soleils* both vertically and horizontally, and a double-roof system, with the upper parasol-like roof carried aloft on spaced piers and cooled by winds that pass underneath it [6.11].



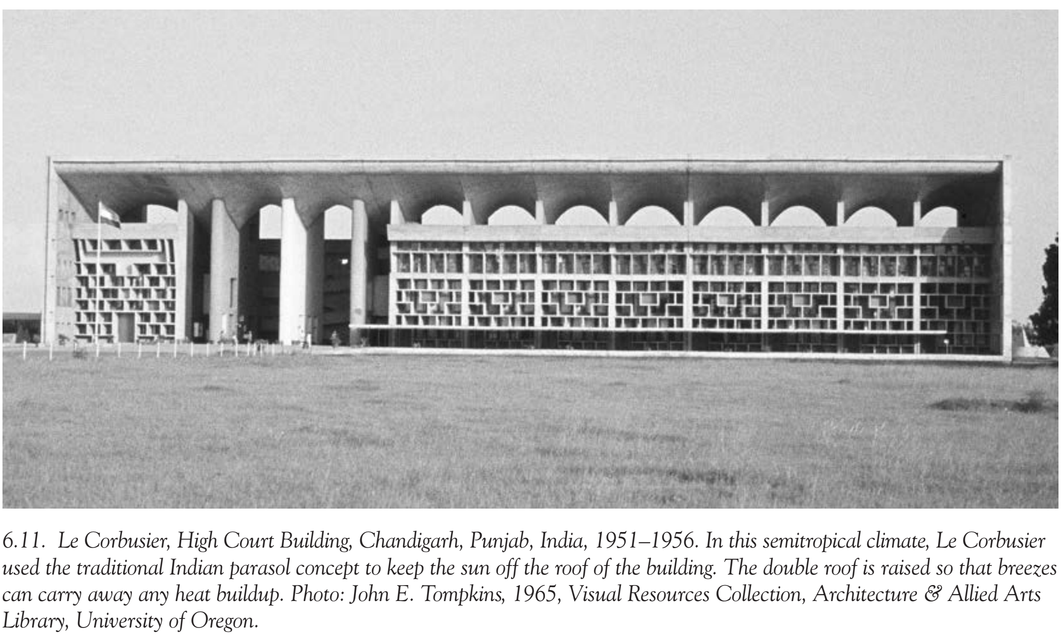
6.8. Frank Lloyd Wright, Frederick C. Robie House, Chicago, Illinois, 1908–1909. Section of the living room showing roof overhang and angle of the sun at noon at midsummer, at the equinox, and at midwinter. Drawing: L. M. Roth, after Mary Banham.

6.9. George Fred Keck and William Keck, Hugh D. Duncan house, Flossmoor, Illinois, 1941. In the mid-afternoon, since the house faces south, the roof overhang prevents the sun from penetrating very far into the room to keep the heat load down. Photo: C. Condit Collection, Department of Art History, Northwestern University.

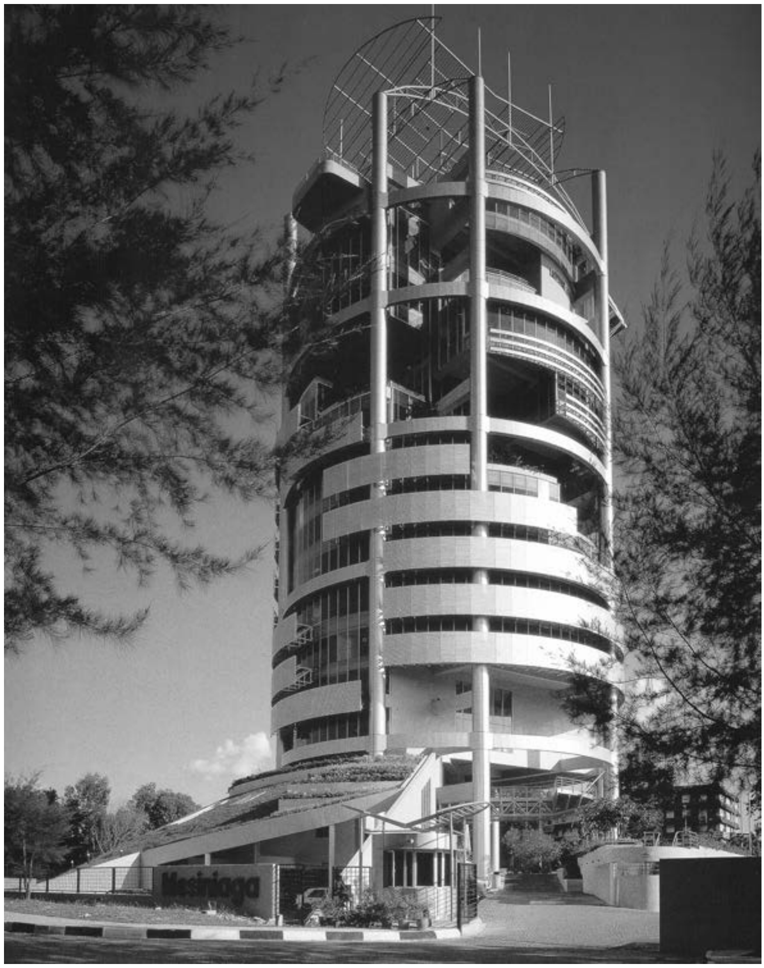
Some of the most sophisticated and elegant passive solar heat design is being done by architect Ken Yeang and his associates, based in Kuala Lumpur, Malaysia. Born and raised in a tropical climate and then educated in England, Yeang is particularly sensitive to heat loads near the equator, expanding on the work of Le Corbusier—giving special attention to the orientation of his buildings and their geographical latitude and devising a variety of louvers, both vertical and horizontal, as well as openings passing through his buildings so that wind can carry off excess heat. An early skyscraper design by Yeang is the Menara Mesiniaga (IBM) tower near Kuala Lumpur, Malaysia, 1992 [6.12]. Here, the spaces between the upper floors are not left for infill later but are an integral part of the complete design, leaving space for air to move through the building. (Yeang's work is further discussed in Chapter 21.)

Le Corbusier, perhaps realizing the ongoing energy cost, and knowing that elaborate air-conditioning systems are not always reliable, had turned to more integral, passive architectural ways to control the environment in his last buildings. His contemporary, Mies van der Rohe, however—with the wealth of the American business community available to him in the 1950s and '60s—never felt so constrained, and extolled pure glazed forms despite their dependence on extensive mechanical systems. In 1948, when Mies van der Rohe designed the Lake Shore Apartments in Chicago, he was able to have the all-glass wall he had been dreaming of since 1919, but the air-conditioning equipment originally specified was omitted to reduce building costs. Small, operable panels in each window bay offered limited comfort from the summer heat—but they were placed at the *bottom* instead of the top of

6.10. Le Corbusier, Cité de Refuge (Salvation Army Hostel), Paris, France, 1929–1933. Like the Robie House, Le Corbusier's Salvation Army Hostel was orientated east-west, its broad southern glass front exposed to the sun. The heat buildup was to be countered by double glazing and an air-conditioning system, but these were not installed, necessitating the later retro-installation projecting sun screens. Photo: C. Condit Collection, Department of Art History, Northwestern University.



6.11. Le Corbusier, High Court Building, Chandigarh, Punjab, India, 1951–1956. In this semitropical climate, Le Corbusier used the traditional Indian parasol concept to keep the sun off the roof of the building. The double roof is raised so that breezes can carry away any heat buildup. Photo: John E. Tompkins, 1965, Visual Resources Collection, Architecture & Allied Arts Library, University of Oregon.



6.12. Ken Yeang, Menara Mesiniaga (IBM) Tower, Subang Jaya, near Kuala Lumpur, Malaysia, 1992. By introducing open levels between floors and separating the central circulation spine from the surrounding offices, Yeang facilitated natural ventilation. Photo: Courtesy of Ken Yeang.

the window-wall, thus restricting the effects of convection cooling. In 1954, with the aid of an elaborate cooling apparatus atop his Seagram Building [6.13], Mies van der Rohe achieved the sealed box that Le Corbusier had attempted in the Salvation Army Building. By the time the Seagram Building was designed, mechanical systems for vertical transportation, lighting, heating, and cooling were consuming more than half the budgets of new buildings. It was as if the building now *was* the mechanical system, simply wrapped in a membrane. A night view of the Seagram Building shows just how transparent to radiant energy the new architecture was [6.14]. Such buildings proved to be equally superb sponges of radiant energy on hot summer afternoons, just as they were excellent radiators of precious heat energy during long cold winter nights.

At the time he assisted Mies van der Rohe in designing the Seagram Building, Philip Johnson shared his mentor's purist views. In 1949, he finished building for himself a sealed glass-box weekend house in New Canaan, Connecticut. Like Mies, Johnson did not want to compromise the form with the addition of sun screens, but he discovered a "natural" way of moderating the sun's impact, having his transparent glass bubble without roasting in it. He placed the house immediately east and north of a group of mature deciduous oak trees; in the summer, their dense foliage shaded the house, and in the winter when the leaves dropped, the sun filtered through the bare branches, helping to warm the house [6.15].

Buildings and the Wind

Buildings are affected not only by exposure to the sun but also by exposure to the wind. Moreover, they have a reciprocal effect on wind patterns. As

6.13. Ludwig Mies van der Rohe with Philip Johnson, Seagram Building, New York, NY, 1954–1958. This building is totally sealed, relying on an extensive heating and cooling system to regulate the temperature. Photo: Ezra Stoller © Esto.

6.14. Seagram Building. This twilight view reveals how transparent the building is to radiant energy. Despite the darkly tinted glazing, during the day sunlight passes into the building, heating it up; but in the winter just as easily heat escapes at night. Photo: Ezra Stoller © Esto.

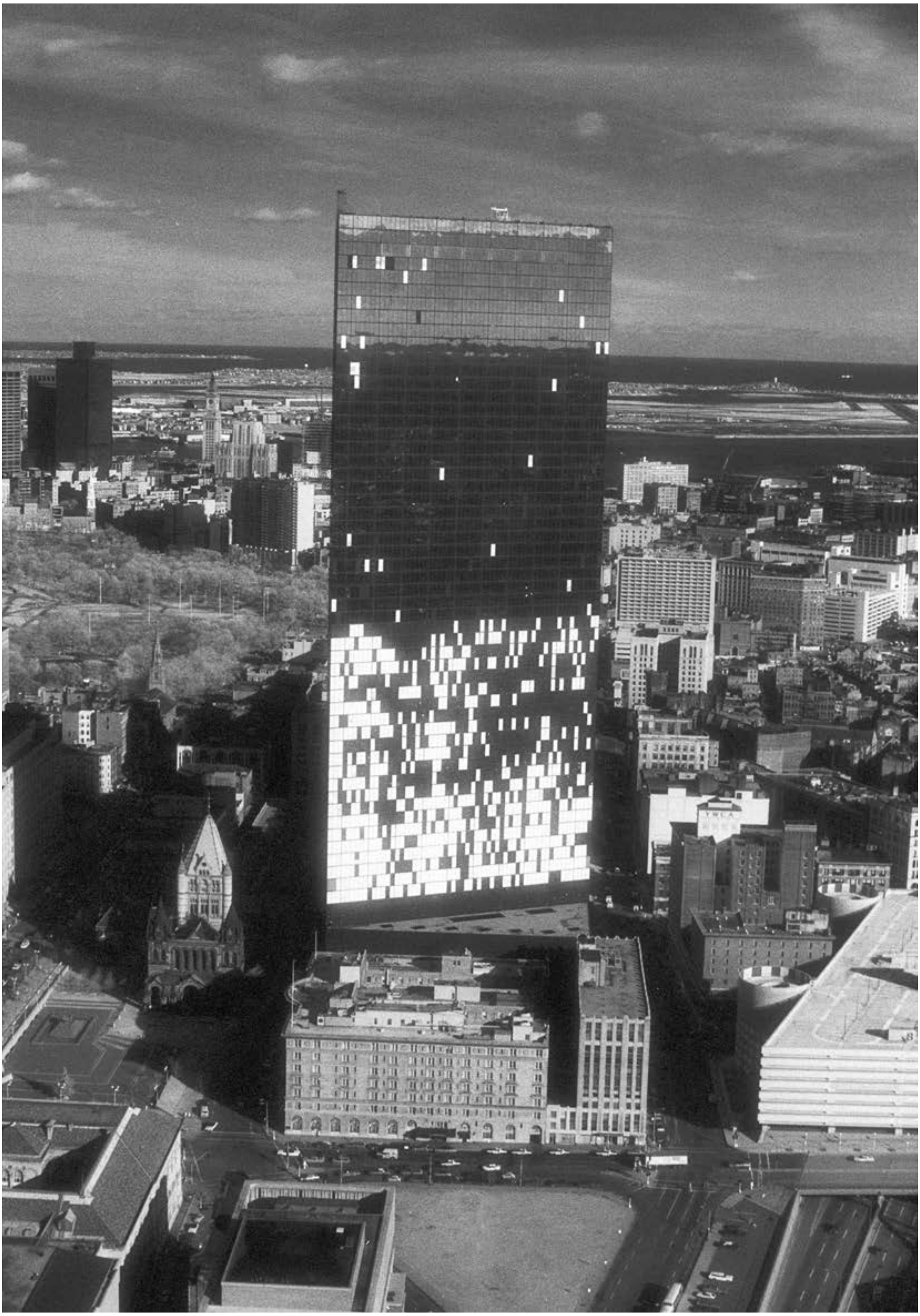
6.15. Philip Johnson, Johnson House, New Canaan, Connecticut, 1945–1949. Although the house that Philip Johnson built for himself has walls entirely of glass, it is shaded and cooled in the summer by trees to the west, but then warmed in the winter when sunlight filters through the bare branches. Photo: Alexandre Georges, courtesy of Philip Johnson.

moving air encounters an object, it moves over and around it along the path of least resistance. On the windward side (upwind), a high-pressure zone develops, and on the leeward (downwind) side, a low-pressure zone develops. As the wind rises to go over the dome of the Pantheon in Rome, the air speeds up and creates a negative pressure that pulls the air out of the oculus at the top. The decrease in pressure from the sped-up air is called the Bernoulli Principle, identified by the early Dutch-Swiss scientist Daniel Bernoulli and published in 1738. Bernoulli observed that when a fluid such as air moves past stationary objects, the pressure drops, and the faster the movement the lower the pressure—the action that causes heavier-than-air airplanes to fly. By anticipating prevailing winds and considering building form and orientation, the architect can use the outside movement of the air to ventilate and cool effectively. In Egypt, Iraq, and Pakistan, for example, traditional houses are built with air scoops on the roofs to catch prevailing winds and provide ventilation.

So long as buildings were relatively low and built with thick walls, their mass was enough to resist lateral forces exerted by the wind. In low masonry buildings, the lateral forces generated by wind pressure are less significant than the vertical forces generated by gravity. The effect of lateral forces remained generally minor until the design of buildings began to change in the mid-nineteenth century. As building volumes increased and the mass of material diminished, buildings such as the Crystal Palace and the great train sheds began to behave like bubbles in the wind.[6] Suddenly, the lateral forces caused by the wind began to surpass the downward forces generated by gravity. The lacy ironwork of Joseph Paxton's Crystal Palace in London, 1851, had to be stiffened by diagonal braces, making the building essentially a vast truss [18.20, 18.21]. When the skyscraper was first developed in Chicago in the 1880s, architects turned to Paxton's techniques and tied together the vertical and horizontal steel framing members with diagonals, creating a trussed spine through the center of the building. Then, in the mid-1960s, as a new generation of skyscrapers rose to heights of one hundred stories, or nearly 1,000 feet (304 m), architects and engineers began to view them as vertical cantilevers whose principal structural task was to resist lateral wind pressure. The resulting buildings were not the older braced frames but, rather, rigid tubes.[7] The tapered Hancock Center in Chicago, 1965–1970, is an example [6.16].

Large buildings, especially groups of modern skyscrapers, also have an effect on wind patterns. As the wind nears a tall building, some of the air rises over the building, creating an updraft on the windward side and a downdraft on the leeward side. Some of the wind goes down and, as it nears the ground, flows around the building. As a result, under the right conditions at sidewalk level, there may be hurricane-force winds that make walking nearly impossible. At times, the negative pressure may be great enough to suck windows out of their frames.

6.16. Skidmore, Owings & Merrill, John Hancock Center, Chicago, Illinois, 1965–1970. In buildings of great height, the lateral pressure of the wind becomes a more significant structural design factor than vertical gravity-generated forces; hence, as in the Hancock Center, large-scale externalized diagonal bracing stiffens each of the vertical columns. The shorter twin buildings just to the right, below the Hancock Center, and closer to the lake, are the Lake Shore Drive apartment buildings by Ludwig Mies van der Rohe, 1948–1951. Photo: L. M. Roth.



6.17. I. M. Pei, John Hancock Tower, Boston, Massachusetts, 1966–1975. The failure of modern architecture was graphically illustrated by the plywood sheets used to replace the windows of the Hancock Tower that had been sucked out by turbulent winds. Photo: Spencer Grant/Archive Photos/Getty Images.

A well-known example of material failure, compounded by the Bernoulli effect of wind, is the John Hancock Tower in Boston, designed in 1966–1967 by Henry N. Cobb of the office of I. M. Pei. Built during 1967–1975 on Boston's Copley Square near the clustered towers of the Prudential Center, it was designed to have double-glazed windows with a metallic reflective film on the inner pane of glass. Unfortunately, the windows failed to stay in place and were sucked out of their frames; during 1972 and 1973, the streets below the soaring tower were periodically and unpredictably showered with shards of glass [6.17]. Wooden covers had to be built over the sidewalks so pedestrians could walk safely. Some experts claimed that a heat buildup between the two panes of glass, due to the reflective film, caused the windows to crack, while others said that inadequate frames allowed the glass to be sucked out by the turbulent aerodynamics around the building. As successive legal suits were followed by countersuits, the double glass was replaced with single sheets of half-inch-thick, mirrored, tempered glass. The city of Boston approved the reglazed building for occupancy in 1975, but only in 1981 was the litigation settled out of court (with the terms of the settlement sealed).[8] Such recent and dramatic examples of the shortcomings of newly formulated materials and technologies are not unique to the last century, however. Even in ancient times, Vitruvius cautioned Roman architects not to use inappropriate materials in their buildings.

The Chemistry of Buildings

In a way, skyscrapers are human-made mountains, and like mountains, they are incessantly worn down by heat, frost, galvanic action, and all the other agents of nature that are forever building up and tearing down. Oxidation of building materials is relentless and some metals are especially susceptible, iron being one in particular. Iron ore occurs in a natural state in a number of different oxide compounds, with the chemical element iron (Fe) attached to oxygen atoms and perhaps a carbon atom. The iron can be isolated from oxygen through smelting (applying intense heat), but iron wants to reattach to oxygen as quickly as possible, once again forming iron oxide or rust. Coating the exposed iron with a

6.18. Hugh Stubbins, House of World Cultures (originally built as the West Berlin Congress Hall), Berlin, Germany, 1957; roof collapsed 1980; rebuilt. Constructed as a gift to Berlin from the US government. The roof collapsed in 1980 due to water infiltration, which caused corrosion of the steel cables supporting the concrete panels suspended between the arched edge beams. Photo: Vanni/Art Resource, NY.

film—perhaps oil or paint—prevents oxygen from reaching the iron, but the coating must be maintained in perfect condition, for the smallest crack will allow oxygen to recombine with the exposed iron and cause rust to form. Since the iron-oxide formation expands as it forms, it opens the crack wider, allowing more iron to be exposed, more rust to occur, and so on. The telltale orange streaks on painted iron buildings and bridges reveal where oxidation is occurring. This oxidation in the thousands of older bridges that exist throughout the world will eventually cause structural failure if the oxidation is not halted or the weakened pieces are not replaced.

Iron also reacts with other metals via galvanic action or electrolysis, in which the two metals act like a storage battery, generating a small electrical current between them and in the process destroying the metals. (This is also the process that occurs when one metal is electroplated onto another.) Metals can be arranged on a galvanic scale, with cathodic metals on one end and anodic metals at the other. The rate at which the corrosive action takes place depends on the degree of difference of the location of two metals on the scale. Silver is very near the cathodic end, while zinc and magnesium are at the opposite end; copper and iron are not quite as far apart in their positions, respectively, but are still far enough apart that in the presence of an electrolyte (such as salt water) the iron corrodes and is deposited on the copper. The only way to stop this action is to remove the electrolytic fluid connecting the metals or to block the electrical action by means of some insulating substance. Unfortunately, iron and its close galvanic neighbor aluminum are often found in buildings with copper elements as well—a most destructive combination.

One structural collapse in 1980 directly associated with corrosion was the failure of the steel suspension cables spanning between the arched concrete edge beams of Hugh Stubbins's Congress Hall, Berlin, Germany, built in 1955–1957 [6.18]. Water had infiltrated the roof, causing corrosion of the vital cables in tension. A dramatic demonstration of a building as sculpture, Congress Hall (now the House of World Cultures) was rebuilt and reopened in 1987.

Another well-known case where combined metals in salt air caused great damage involved the Statue of Liberty, which was designed and prefabricated in France in 1870–1884 and then shipped to and erected in New York Harbor in 1883–1886.[9] The huge statue is hollow, shaped of hammered sheets of copper riveted to an underlying wrought-iron frame that is anchored in the tall stone and concrete base. Knowing the galvanic risk associated with attaching the huge curved sheets of copper to the iron frame inside, sculptor Auguste Bartholdi and engineer Gustave Eiffel used special washers to isolate the copper from the iron. The torch that Liberty holds aloft was likewise originally shaped of joined copper segments; however, in 1916 the gilded torch flame was rebuilt in the same form but with 250 panels of glass and a strong lamp placed inside. Eventually the joints in the glazed flame separated, permitting water to drip down inside; small holes in the copper allowed for even more infiltration of water. Over time the insulating washers failed and, with water already present inside the statue, the inevitable electrolysis began, dissolving the iron and corroding the copper next to the internal iron frame. Even worse, as the thin iron bars rusted, the expanding rust pushed against the attachments, causing them to bend to the point of popping the copper rivets that held on the exterior copper skin. Through the tens of thousands of popped-rivet holes, yet more water seeped inside, exacerbating the damage. In 1982–1986, the French and American governments undertook a joint operation to restore the Statue of Liberty in preparation for the centennial of its dedication, replacing the worn and eroded copper sections, installing new special noncorrosive stainless-steel attachment bars, and using a special Teflon tape for the insulators. It will take another century before we know whether these measures have sufficiently protected the statue, but incessant stealthy and insidious galvanic action never rests.

In addition to natural corrosive actions such as rusting, for more than a century buildings have been assaulted by industrial chemicals wantonly dumped into the atmosphere. Smoke produced by sulfur-containing fuels results in acid rain that causes marble to be transformed into calcium carbonate and gypsum, and their chemically softened surfaces flake off. And in a matter of a few decades, hard marble turns into something analogous to wax under a heat lamp. The building, the sculpture, any carved detail—all simply melt away, as is happening to the ancient marble buildings in Athens, Greece. Political action could deal with these atmospheric problems, but it is the architect's task to select materials and to detail the ways they are joined so that buildings may endure such attacks for whatever period of time is desired. The Egyptians of the Fourth Dynasty thought it appropriate to build the Valley Temple for their Pharaoh Khafre using hard red granite so as to last him through eternity, and it has stood—yielding to nature only minimally—for over forty-five hundred years. Modern industrial civilization tends to adopt a far shorter view. First, we generally do not want buildings to last very long. Typically, clients are not willing to pay for materials that will last much longer than it takes to amortize their building's mortgage; they hope the building will continue looking passably good only until they can unload it. Second, we are increasingly using new manufactured materials and methods of assembly with adhesives and sealants whose long-term durability can only be guessed. How long will various caulking compounds, silicon sealants, and other plastics last under the incessant onslaught of ultraviolet light and cycles of freezing and thawing? Unfortunately, it is our children, and theirs, who will discover those answers.

7.1. Portrait sculpture of Anton Pilgrams (c. 1460–1516), sculptor of the pulpit of St. Stephen's Cathedral and architect of several churches in Swabia and Rottweil, in St. Stephen's, Vienna. Pilgrams shows himself holding the instruments symbolic of an architect: the dividers (in his right hand) and the mason's square (in his left hand). Photo: Gianni Dagli Orti/The Art Archive at Art Resource, NY.

Chapter 7

The Architect

From High Priest to Profession

The Architect . . . must be looked upon as something much more than a designer of buildings—lovely, elegant, charming, and efficient though they may be. His greater role is that of being the delineator, the definer, the engraver of the history of his time.

—*Eugene Raskin,* Architecture and People, *1974*

The roles and responsibilities of architects have changed greatly over the centuries, shifting from court official to independent designer. Without a client, however, a building does not happen. Unlike painting or poetry, which can be pursued by individual artists on their own, architecture results only when a client or patron has the desire and financial wherewithal to call it into being. Thus, the creation of architecture is also a history of the relationship between client and architect—who, in turn, work with the building contractor and the scores or even hundreds of workers with myriad skills who work at the contractor's direction. Of all the design and visual arts, except perhaps for movie-making with its many participants, the creation of buildings is the most complex process.

One early recorded architect is Imhotep, who was active in Egypt under the Pharaoh Zoser from about 2635 BCE to 2595 BCE. (Imhotep's accomplishments in creating the tomb complex for Pharaoh Zoser are presented in Chapter 10.) On the base of Imhotep's portrait statue, his many titles are listed as "Seal-bearer of the king of Lower Egypt, chamberlain, ruler of the great mansion, hereditary prince, greatest of seers, Imhotep, carpenter, sculptor."[1] Other portions of the inscription indicate that he was also a physician. Imhotep's important status is the result of his many achievements. He is credited with introducing stone construction in Egypt, inventing the pyramid, and, in many ways, laying the basis for all later architecture in the West. His importance was such that he was described as a demigod and, by the Twenty-Sixth Dynasty, was in fact considered a god.

Other Egyptian architects are known as well, particularly Senmut, who was described in contemporary carvings as the "confidant" of Queen Hatshepsut, who ruled as pharaoh in 1503–1482 BCE. Inscriptions describe Senmut as "the greatest of the great in the entire land."[2] Portrait figures of Senmut, showing him holding the royal princess in his lap or with coiled, knotted measuring ropes and other tools of his profession, were found in large numbers in the Queen Hatshepsut's Mortuary Temple at Deir el Bahri, a temple he designed [7.2]. As inscriptions on their portrait statues reveal, these architects held exalted positions in the priesthood, for indeed all education was provided by the temple priests. Working under these priest-architects were hosts of overseers and craftsmen. We have abundant evidence of such tomb craftsmen of the Middle Kingdom from the tombs they made for themselves near their workmen's village, now called Deir el-Medina, which is a short distance from the tombs of the pharaohs, in the Valley of the Kings.[3]

Loose sketch designs by Egyptian architects or work foremen, found on *ostraka,* or flat flakes of limestone chipped off larger building blocks, were likely done in the field during the work process. Because they were made on stone, they survived. But more formal drawings were prepared on papyrus sheets. A grid of squares was first drawn out, and then a flat elevation in black ink could be drawn over the grid, thus showing the correct proportions of all parts of the design. One of the few such surviving drawings, now in Turin, Italy, shows front and side elevations for a shrine chest [7.3].

In Mesopotamia, the land watered by the Tigris and Euphrates Rivers, plans of buildings were

7.2. Portrait of Senmut holding Nefurure, princess and daughter of Pharaoh Hatshepsut, c. 1470 BCE. © The Trustees of the British Museum/Art Resource, NY.

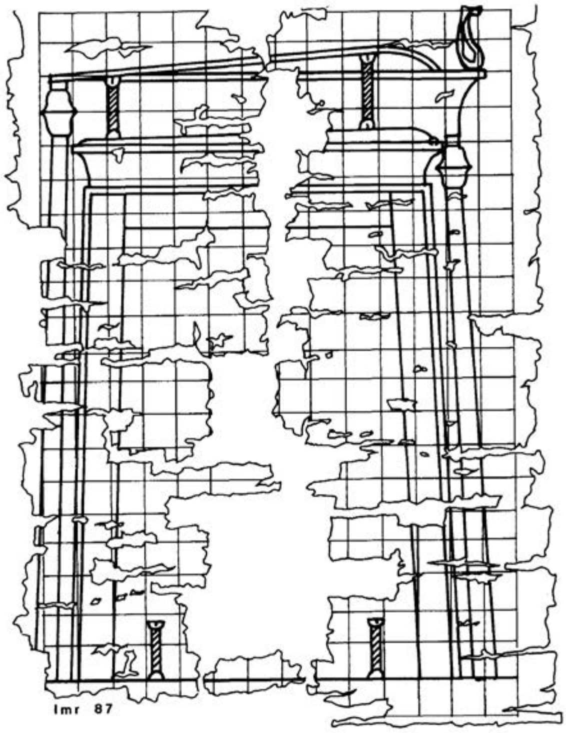
inscribed on clay tablets. One small tablet, about 2.3 by 3.5 inches (6 by 9 cm), made in about 2300 BCE, shows what appears to be a house plan, indicating the thickness of the walls and the placement of doors [7.4]. Official portrait statues of the Sumerian ruler Gudea of Lagash, about 2200 BCE, show him holding on his lap such a plaque engraved with the plan of a building [7.5]. As in Egypt, in Sumerian cities and later in the Babylonian Empire, buildings were designed and built by the rulers and the priests.

The word *architect* is Greek, and its components—*arkhi,* "chief," and *tekton,* "builder" or "craftsman"—indicate that to the Greeks, the architect or chief builder was far from being an elevated priest or "greatest of the great." As Plato wrote in *Politicus,* architects were not workmen but directors of workmen, and hence they possessed theoretical knowledge as well as practical skills. Nonetheless, they were artisans of lowly position, and not priests. Some of the first Greek architects, however, enjoy the mythical status of Imhotep. Daedalus, who is credited with designing the labyrinth where the Minotaur lived on Crete, was also a sculptor and inventor; he devised the apparatus that enabled Queen Pasiphae to mate with a bull, resulting in the Minotaur. The Greek word *daedalus* means "cunning worker" or "skillful one." When he fell into political disfavor, Daedalus fashioned wings so that he and his son, Icarus, might fly to Sicily. As the legend relates, elated with the hubris of his flying ability, Icarus flew too close to the sun, the wax holding his feathers melted, and he fell into the sea. Daedalus himself, however, made it to Sicily, where he is said to have built an underground steam bath for King Kokkalos.[4]

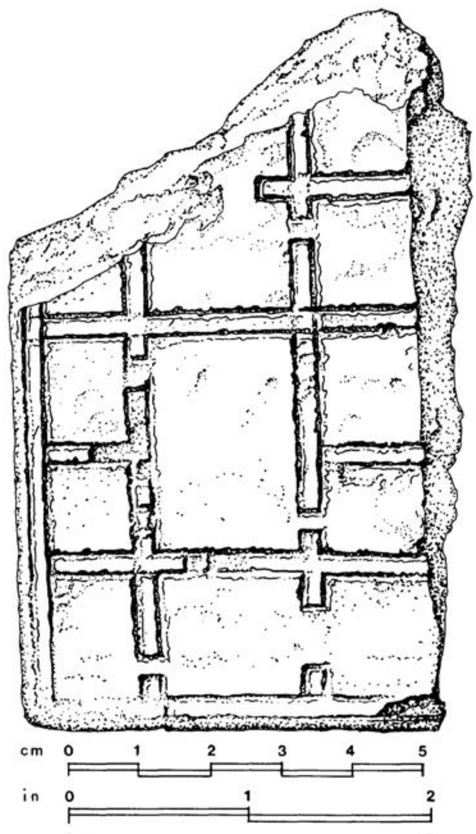
Real-life Greek architects lived far more prosaically, and although we know the names of more than a hundred of them, we can piece together almost nothing of their lives.[5] Official legal descriptions of buildings survive in some detailed inscriptions, but we have none of the Greek theoretical treatises that Vitruvius later said he consulted, nor do we have any Greek drawings. Some scholars have suggested that Greek architects made no drawings as we think of them, on vellum or parchment, suggesting instead that architects worked in the stone yard in close connection with the masons and had little need for abstract drawings.[6]

The position of the architect rose during the Roman Empire, as architecture symbolically became a particularly important political statement. Cicero classed the architect with the physician and the teacher (*De officiis,* 1.151) and Vitruvius spoke of "so great a profession as this" (*De architectura,* 1.1.11). Marcus Vitruvius Pollio (c. 90–c. 20 BCE), a practicing architect during the reign of Augustus Caesar, recognized that architecture requires both practical and theoretical knowledge, and he listed the disciplines he felt the aspiring architect should master: literature and writing, draftsmanship, mathematics, history, philosophy, music, medicine, law, and astronomy—a curriculum that still has much to recommend it. All of this study was necessary, he argued, because architects who have aimed at acquiring manual skill without scholarship have never been able to reach a position of authority to correspond to their plans, while those who have relied only upon theories and scholarship were obviously "hunting the shadow, not the substance."[7]

The practice of drawing, as described by Vitruvius, also sounds remarkably modern, for he writes of ground plans (*ichnographia*) being laid out with compass and ruler, of elevation drawings (*orthographia*)



7.3. Redrawing of an Egyptian papyrus drawing showing the side elevation of a shrine, c. Eighteenth Dynasty (Turin, Italy). The lighter lines (in black ink on the original) are a proportional grid; the thicker lines (originally in red ink) show the profile of the shrine. Drawing: L. M. Roth, after a XVIII Dynasty papyrus, Museo Egiziano, Turin.



7.4. Plan of a house inscribed on a clay tablet, c. 2300 BCE; found in Tell Asmar, Iraq. Drawing: L. M. Roth, after a tablet from Tell Asmar, Oriental Museum, Chicago.

7.5. Portrait figure of Gudea of Lagash. c. 2200 BCE. Resting on the lap of this ruler of Lagash is an inscribed plan of a building. Photo: The Louvre, Paris.

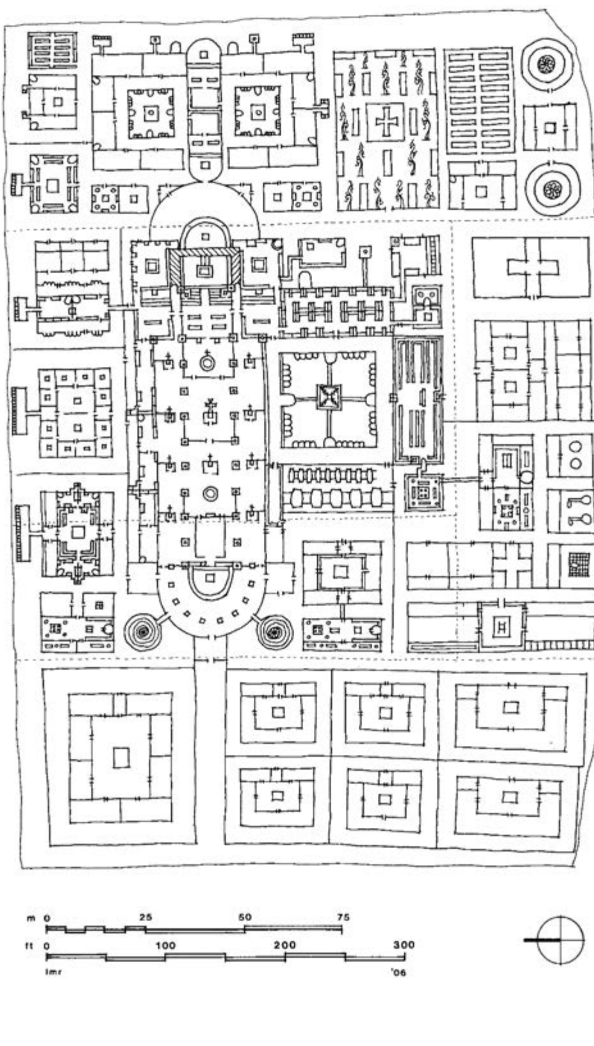
being "a vertical image of the front," and of perspectives (*scaenographia*) with shading and retreating lines converging at a vanishing point. Although none of these ancient architectural drawings themselves survive, splendid examples of wall paintings from Pompeii suggest the skill of Roman draftsmen [Plate 15]. In addition, there are a number of building plans engraved in stone, including one particularly interesting engraved plan of what may have been a funerary monument, dating from the middle of the first century CE.

During the later imperial period, the building trades in Roman cities became more highly organized and were increasingly subject to government control. Each building operation had its *collegium*, or trade organization—blacksmiths and iron workers, brick makers, carpenters, stone workers, general construction workers, and even demolition experts. Brick making was standardized, and for over a century bricks were stamped with the abbreviated names of the reigning consuls and the brick maker, making it possible to date Roman buildings with some precision. The process of construction and the deployment of the building trades were highly organized and were particularly important for the building of scaffolding, for centering, and for timing the laying and curing of concrete.

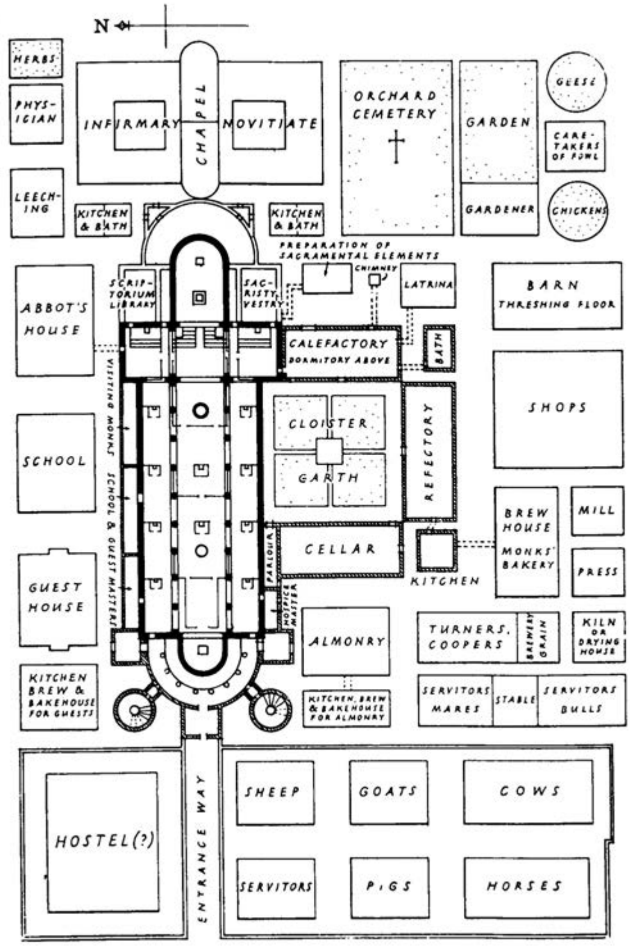
One of the last architects in the tradition described by Vitruvius was Anthemios of Tralles, who was born in western Asia Minor sometime before 500 CE and died about 540 CE; he was the designer of the church of Hagia Sophia in Constantinople, working closely with the architect-engineer Isidoros of Miletos.[8] Anthemios came from a distinguished family; his father was a well-known physician, as were two of his brothers, and another brother practiced law in Rome. Anthemios was an architect, an engineer, a geometrician, and a physicist. He wrote on mathematics and may have been the first to describe how to draw an ellipse by using a loop of string around two pins.

The conventional emphasis on the piety of the Middle Ages has fostered many misconceptions regarding the medieval architect. For example, it appears that the architect was assumed to be a self-less, uneducated master-mason who worked from no plans, using strictly traditional knowledge, and who gloried in his anonymity. There is some limited basis for these notions, but they are far from the truth.

Understandably, perhaps, the abbots of monasteries or their historians tended to downplay the contributions of their designing masons while emphasizing their own accomplishments. Moreover, state sponsorship of building had dropped rapidly in the western part of the Roman Empire after the fifth century. Only around 800, with the amalgamation of a new empire under Charlemagne, did building begin again on an ambitious scale. A particularly pressing need was the construction of new monastic communities. One of the most important documents of early medieval architecture is a parchment drawing done in about 814 that shows how an ideal monastery might be laid out [7.6, 7.7]. The parchment was specially prepared by Abbott Haito of the monastery Reichenau and was sent to his colleague Abbot Gozbertus at the monastery of San Gallen, or Saint Gall, Switzerland, since Gozbertus was planning on building a new monastic complex.[9] The ink drawing is on one large sheet of parchment (stretched calf or sheepskin), sewn together using five smaller sections to form one page roughly 44 by 30 inches (112 by 77 cm) in size. It is one of the oldest surviving medieval drawings. Such drawings on



7.6. Plan of ideal monastery, Saint Gall, Switzerland, c. 814. Facsimile drawing of the original parchment drawing. The light dotted line indicates where the parchment sheets were sewn together to form the larger sheet. Drawing: L. M. Roth, after the Saint Gall parchment in Horn, Born, and Adalard, The Plan of St. Gall . . . *(Berkeley, 1979).*



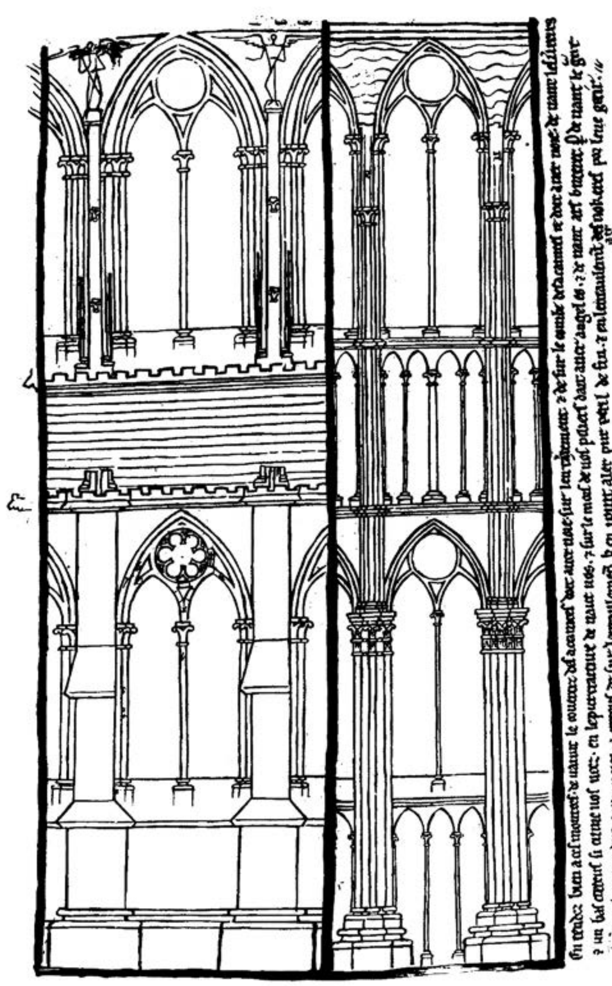
7.7. Schematic diagram of Saint Gall Monastery plan showing layout of the various buildings. Diagram by Kenneth J. Conant. From Kenneth J. Conant, Carolingian and Romanesque Architecture, 800 to 1200 *(Harmondsworth, England, 1966).*

sheepskin were used throughout the Middle Ages, but because parchment was valuable, it was often scraped clean and reused, or turned over and another document written on the back. Several drawings survive for this reason, having been filed away in monastic libraries under the heading of the second document written on the back. This is exactly how the Saint Gall plan survived, for in the late twelfth century, another monk inscribed *The Life of Saint Martin* on the other side of the parchment and then folded the parchment several times down to book size and stored it away.

The *collegia* of workmen survived the end of the Roman Empire, gradually becoming the guilds of the Middle Ages. These were vitally important organizations, providing not only training for youths but also a network for the transmission of ideas across Europe. Medieval masons traveled extensively from one guild lodge to another, viewing work under construction and jotting down personal observations. Designer and mason Villard de Honnecourt assembled just such a "scrapbook," originally with eighty-two pages, intending to make it available to other guild members.[10] He was born in northern France and trained as a stonemason. In about 1190, he became a journeyman while working on the cathedral at Vaucelles, which he sketched in his book. He traveled to Reims and Chartres and, around 1220, set out for Hungary to aid in the construction of a monastery there. On his return trip, he stopped in Reims, where he assisted in building the cathedral, making a number of drawings of the interior and the exterior of the choir [7.8]. Other drawings showed roof framing, pulpits, ornamental carving, and even a perpetual-motion machine; the sketches are accompanied by straightforward notes such as "this is good masonry" and "I drew it because I like it best."

One reason the position of the medieval architect may have become poorly understood is that many different titles were used for this occupation. In addition to *architectus* and *magister* (master, maestro, *Meister*) for master-mason, we find *ingeniator* (engineer), *artifex, operarius, mechanicus,* and words more directly connected with stonework, such as *lapicida, cementarius,* and *lathomus.* The inscription on the gravestone of Pierre de Montreuil, the designer of parts of the abbey church of Saint-Denis and of Notre-Dame in Paris who died in 1254, describes him as *doctor lathomorum,* or professor of freemasons. By the mid-thirteenth century, master-masons were accorded a position of privilege and were buried with honors, as is evident in the gravestone of Hugues Libergier, who was the architect of the cathedral in Reims and who died in 1263 [7.9].[11] He is shown framed in a trefoil (three-lobed) Gothic arch; in his left hand is a measuring rod, with a mason's square and dividers at his feet, and in his right hand is a model of a building.

What distinguished the medieval architect master-mason from those of the Renaissance, Baroque, and modern periods that followed was this: as apprentices, journeymen, and eventually masters trained in stonecutting or carpentry, they understood intimately, from the inside out, how a building was put together. When they undertook contracts to erect buildings, they functioned as both designer and contractor-builder. The nature of the medieval master craftsman-architect, as well as the established position of the construction guilds, must be understood if one is to appreciate the revolutionary change brought about by the Renaissance. In a list of the most important Renaissance architectural designers—such as Filippo Brunelleschi, Leon



7.8. Villard de Honnecourt, c. 1220. Exterior and interior elevation drawings of Notre-Dame de Reims, Reims, France. This page, from the travel sketchbook of this medieval mason, tells much about the travels of medieval builders, how knowledge was disseminated among brothers in the crafts guilds, and how medieval artists made abstracted symbolic images instead of literal images. From J.B.A. Lassus, Album de Villard de Honnecourt, architecte du XIIIe siècle; manuscript publié en facsimile *(Paris, 1858).*

7.9. Tombstone of Hugh Libergier, Notre-Dame de Reims, thirteenth century. The inscription running around the border reads: "Here lies Master Hugh Libergier, who began this church in the year 1229 and died in the year 1267." The architect is surrounded by instruments of his trade; he holds a measuring rod and a model of a church. Photo: Drawing Association, Cathedral of Our Lady of Reims, courtesy of Père Jean-Marie Guerlin, Curé de la Cathedrale de Reims.

Battista Alberti, Donato Bramante, Michelangelo Buonarroti, Giulio Romano, and Sebastiano Serlio—there is not one trained architect in the medieval sense of the word. In the fifteenth century, with the rise of Classical humanism and the study of ancient literature, the ideal individual was one who mastered all the liberal arts, and the master-craftsman-architect, with his technical and practical experience, was replaced by the humanist-artist-designer, with his theoretical knowledge. Nearly all major architects in Italy after 1400 were trained as painters, sculptors, or goldsmiths; like Leonardo da Vinci or Michelangelo, they worked in all the visual and design arts. During the Middle Ages intellectually trained scholars and teachers were considered to profess a learned discipline, whereas hands-on builders, painters, and goldsmiths were viewed as merely practicing a craft (comparable to the position that architects held in the Greek world). Renaissance architects sought to change

7.10. Raphael, School of Athens fresco, Stanza della Segnatura, Vatican Palace, Rome, Italy, 1509–1511. In this painting praising human intellect, Raphael depicted all the great Greek philosophers grouped around the central figures of Plato and Aristotle. Many of the faces are portraits of living Italian artists and architects, and the setting depicts the unfinished shell of Bramante's new Basilica of Saint Peter. Photo: Scala/Art Resource, NY.

this attitude and to elevate their position from artisan-technician to scholar-theoretician.

In 1505, Donato Bramante (1444–1514) began construction of the immense new Basilica of Saint Peter in Rome, proposing to replace the ancient church built by Constantine in 333.[12] The plan of the church was derived from the new theoretical and geometric ideals of the Renaissance, meant to symbolize God's omniscience and omnipresence as well as to celebrate the intelligence that God had given humankind—all represented in the pure geometry of neo-Platonism. The new basilica was to be a vast Greek cross within a square, centered on four huge piers carrying pendentives and a gigantic dome rivaling that of the Roman Pantheon.

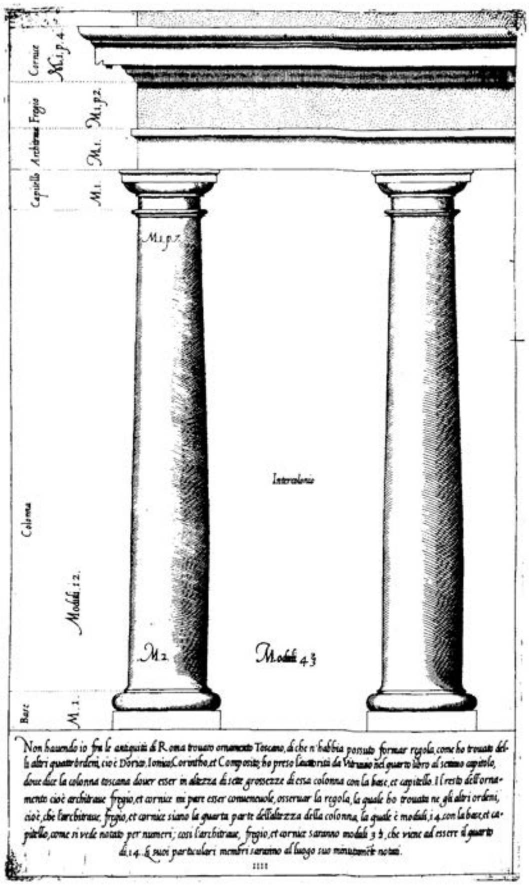
Bramante, then sixty-one years of age, started work on the piers, but he died leaving only the arches silhouetted against the sky [15.25]. At the same time, Bramante's patron, Pope Julius II, was having Bramante's nephew, Raphael Sanzio, paint four mural frescoes in the adjoining Vatican Palace. In one of the semicircular fresco panels, Raphael depicted the gathering together of all the great ancient Greek philosophers, who are arranged in two groups on either side of two central figures, Plato and Aristotle [7.10]. Those who pursued Platonic theoretical abstraction are arranged on the left (stage right), while those who favored the observation of natural phenomena are associated with Aristotle on the right (stage left). In addition, Plato points upward with his right hand, toward the higher plane of the mind and toward heaven, while Aristotle gestures toward the horizontal—that is, toward the natural world and observable phenomena. The figures descend stairs and terraces in an architectural setting of immense proportions, with Classical piers and vaults supporting pendentives carrying an open circular colonnade silhouetted against the sky. This hypothetical setting, exemplifying Greek ideals and Greek philosophy, is not actual Greek architecture of the ancient Classical period; rather, it is a contemporary analogue, a representation of the incomplete shell of Bramante's new Saint Peter's. The long-bearded figure of Plato in the center is a portrait of Leonardo da Vinci. In the foreground, on the Aristotelian right, bending over to work out a theorem on a slate, is the bald figure of Euclid, the great geometrician—it is a portrait of Donato Bramante (Raphael even included himself, peeking toward the viewer on the far right side). And on the Platonic left side, brooding over a block of stone in the foreground, is the figure of Michelangelo (who at that moment was painting the ceiling of the Sistine Chapel). What Raphael was suggesting was that the contemporary artist-architect of the new epoch should be seen as the equivalent of the ancient philosophers—but, in this instance, a philosopher who expressed his ideas in stone.

The ideal to which many aspired was achieved by Leon Battista Alberti (1404–1472), a well-trained humanist scholar and theorist.[13] His designs for churches and palaces set the standard for architecture for the next two hundred years, but he could not construct his own buildings, relying instead on masons such as Matteo de' Pasti to translate his designs into stone. On the one hand, this meant that ever afterward, architects were removed from direct involvement in the construction process; but on the other, it meant that they were freed from working only with established inherited conventions and could pursue instead intellectual exploration and creative artistry—what the Italians called *disegno.*

The Renaissance was a period of intellectual probing, of the reexamination of Classical literature, art, and architecture. The Renaissance artist-architect shared in this curiosity. Beginning with Brunelleschi, architects made the pilgrimage to ancient Rome, then a small, sleepy medieval town greatly shrunken from its imperial grandeur, to study and measure Roman ruins. They attempted to equal or surpass the artistic achievements of antiquity, though not to make literal copies of ancient architecture. The great irony is that, although they measured and recorded much, they also destroyed much; the modern notion of historic preservation had no attraction for them. In building a new Rome after 1500, they often reused the stones of old Rome.

The Renaissance was able to sweep across Europe by means of the printed page. Printing with movable type spelled the end of medieval orthodoxy and the rule of tradition in the West; architects would soon take advantage of this new technology.[14] As Victor Hugo, writing about the fifteenth century, has one of his characters say to another in his novel *Notre Dame de Paris* (Paris: 1831), "This will kill that," referring to how the new printing press will kill the transmission of knowledge through the traditional embellishment of buildings.[15] In the 1440s, Alberti wrote a manuscript in Latin, *De re aeadificatoria* ("concerning building"), in ten books. Patterned after Vitruvius, the work aimed at informing and improving the taste of classically educated patrons. Although it circulated in manuscript form among his friends, it was later published in Latin in 1485. It then appeared in translations in vernacular Italian in 1546 and 1550, which made the books available to a much wider audience. Meanwhile, several new Latin editions of Vitruvius had begun to appear, some of them illustrated (Leonardo's drawing of the man in the circle and square, [15.4], was intended as one such illustration). The ability to illustrate such publications with original copper engravings made these new books enormously effective, especially in an age when literacy was not customary for ordinary builders. An Italian translation of Vitruvius followed in 1521. In rapid succession, other original treatises by various authors appeared in Spanish, French, and German, along with translations of Vitruvius into the various vernacular European languages. These books were now intended not simply for the potential patron, but for the practicing architect and builder. In addition, detailed descriptions on how to proportion each of the Classical orders were quickly provided in the illustrated books published by Sebastiano Serlio and Giacomo Barozzi da Vignola [7.11].

The career of Andrea Palladio (1508–1580) and the book he published summarize well the goal of the Renaissance architect—the creation of ordered and balanced architecture that might serve as an example for subsequent architects. Compared to artist-architects such as Bramante or Michelangelo, Palladio is an exception. The son of a miller, he was not classically educated but apprenticed to a stonemason, and hence differed from his slightly older colleagues.[16] He was working in Vicenza, not far from Venice, where his abilities attracted the attention of a wealthy and cultivated humanist nobleman, Giangiorgio Trissino, who made Palladio his protégé. Trissino tutored him in Vitruvius and took him to Rome several times to measure Roman buildings. Palladio also later worked closely with humanist Daniele Barbaro in illustrating a translation of Vitruvius. The result of this combination of practical wisdom and theoretical study was that Palladio's architecture was clear in its harmonic mathematical proportions and comparatively simple in its form. Palladio collected his thoughts in a four-volume work, published in Italian as *I quattro libri dell' architettura* (The Four Books on Architecture) (Venice, 1570), which presented plans and elevations of his best work around Vicenza, as well as his restorations of some of the major Roman ruins [7.12]. It



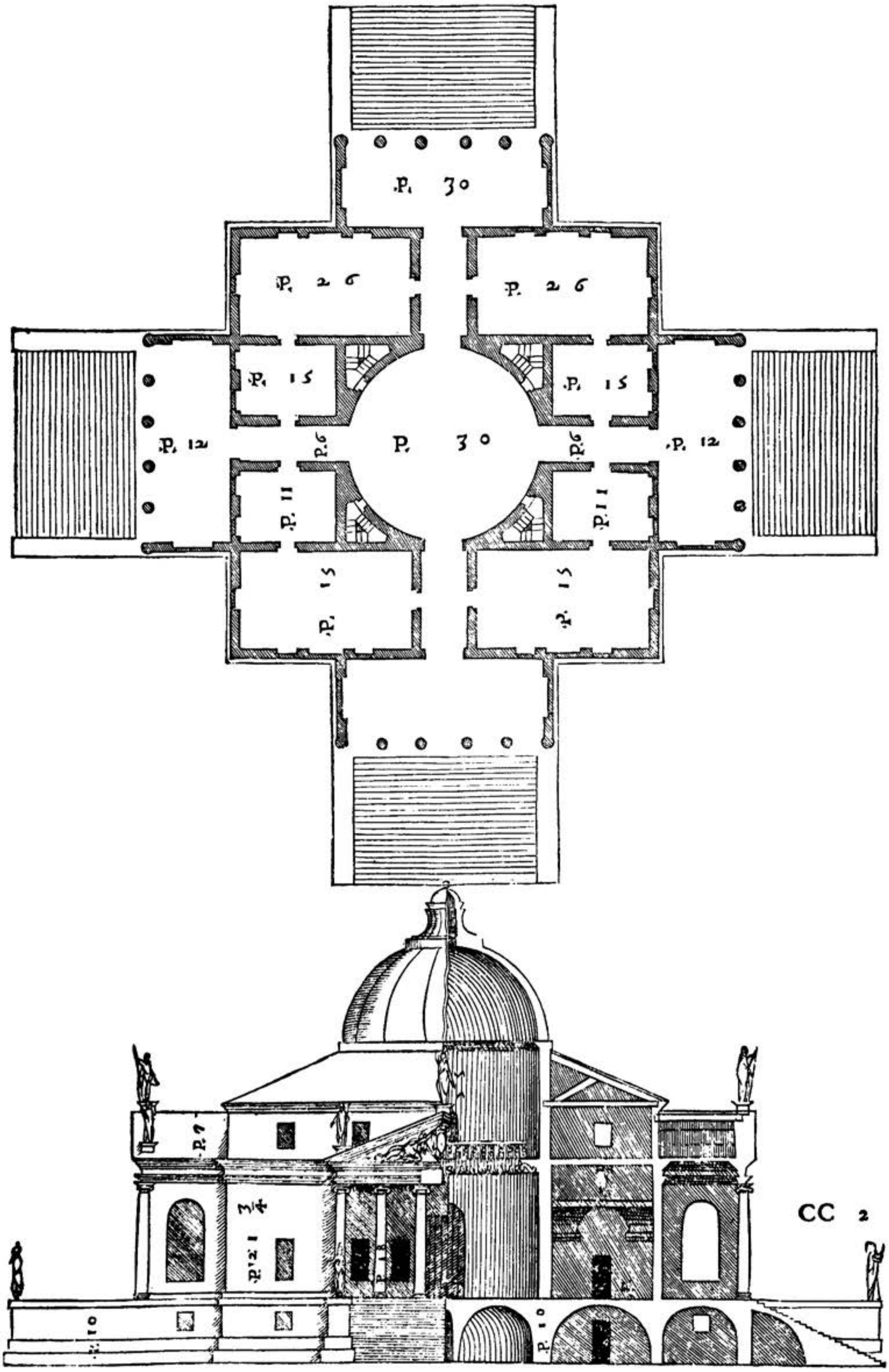
7.11. Giacomo Barozzi da Vignola, "The Tuscan Doric Order," Plate 4 from Regola delli cinque ordini d'architettura, *Book IV (Rome, 1562). This book along with others by Sebastiano Serlio, Vincenzo Scamozzi, and Claude Perrault, made the proportions of the Classical orders available to builders and gentlemen amateur architects. Vignola's plates were the first to show the relative proportions of each order clearly based on the diameter of the column. Courtesy, Avery Library, Columbia University.*

was richly illustrated with engravings. Except for the book by Vitruvius, Palladio's has had the greatest continuing impact of any from this period; translations and new editions appeared throughout the eighteenth century, the English translation of 1738 is still published in paperback, and an entirely new English translation was published in 1997, illustrated with reproductions of Palladio's original engraved plates.[17]

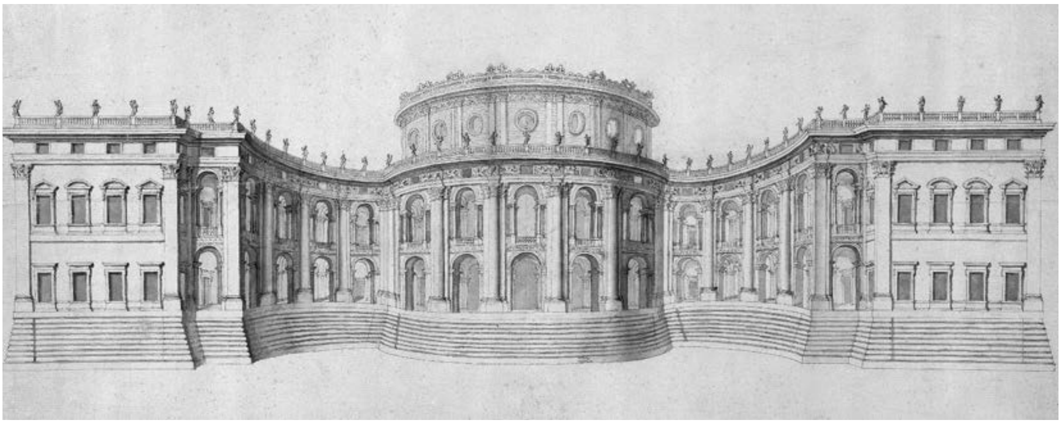
The Renaissance saw the evolution of architectural working methods similar to those used in design and construction today. Numerous drawings have survived, on parchment and on paper, showing sketches, plan studies, elevations, details, and perspectives. Leonardo da Vinci seems to have developed the technique of drawing small aerial perspectives that suggest both plan and building masses in one compact view. Understandably, while Renaissance architects were inventing a new humanist Classical architectural language, it was one that the traditionally trained guild workmen did not at first understand; remarkably, however, few surviving drawings for use in the field show ornamental details. Elaborate wood models were the preferred method of showing how work was to be done, and a number of these detailed wooden models survive, such as Michelangelo's model for completing the dome of Saint Peter's in Rome.

During the fifteenth century, in Spain and France, this renewed Classical architectural idiom was exploited to create a royal architecture. In France, the introduction of Renaissance Classicism necessitated the formation of a corps of architects and builders—the Royal Building Administration—to carry out the many royal building projects. By the time of Louis XIV's reign, in the seventeenth century, this had become a large organization, administered by Jean Baptiste Colbert, the chief minister. Under Colbert was Louis Le Vau, the king's chief architect, and under him were scores of lesser designers and administrators who worked on Versailles, Marly, and the many other royal building projects.

Aside from the continuing expansion of the royal château next to the village of Versailles, the other major French royal building project was the extension of the royal residence in Paris, the Louvre. Begun in 1547 and continued in 1624 for Louis XIII, it had proceeded in several stages under different successive royal architects, until the interior court had been completely enclosed by Le Vau. However, the east front, the principal face toward the city of Paris, had not been finished, and in 1665 a competition was held to obtain the best design. Various French and Italian architects submitted entries; the winning design was the work of the most famous Roman architect of the day, Gian Lorenzo Bernini [7.13]. His artistic reputation was such that, in journeying to Paris, Bernini was honored in cities along the way with festivities that rivaled the treatment given royalty. He made a triumphal entry into Paris, modified his design at the request of Colbert, and then returned home. Work began on the foundations, but soon Bernini's scheme was scrapped and a final, eighth design was prepared by a committee composed of the king's architect, Le Vau; the king's painter, Charles Le Brun; and Claude Perrault, a physician who was also a skilled amateur



7.12. Andrea Palladio, Villa Capra (Villa Rotonda), outside Vicenza, Italy, c. 1550, plate 13 from Book II of Palladio's Four Books of Architecture. *The English version, edited by Isaac Ware (London, 1738), carried Palladio's influence throughout Great Britain and on to the American colonies. Courtesy, Avery Library, Columbia University.*



7.13. Gian Lorenzo Bernini, first design for the east facade of the Louvre, Paris, France, 1664–1665. Bernini's curved and sculpturally molded facade incorporated the latest in Italian plasticity but was rejected by the French king and his advisors. Photo: © RMN-Grand Palais/Art Resource, NY.

architect well known for his architectural studies, including eventually his major publication presenting the five Classical orders as he interpreted them [7.14].

The confusion and false starts on the east front of the Louvre suggested that native French architects did not have the necessary professional training to undertake large-scale state-funded commissions the king and his ministers wanted. The result was the establishment of the Royal Academy of Architecture in 1671, which grew during the eighteenth century, was reorganized as the École des Beaux-Arts during the French Revolution, and went on to provide architectural instruction for students around the world during the nineteenth and early twentieth centuries. In France, the path to success in the profession required studying at the École, and, ideally, winning the culminating and coveted Grand Prix de Rome, which ensured that the recipient would thereafter receive successive public-building commissions and an appointment to teach at the École des Beaux-Arts.

7.14. Claude Perrault, Louis Le Vau, and Charles Le Brun, East Wing, the Louvre, Paris, 1667–1671. This restrained design, developed by a committee of architects, was considered by the king to be more appropriate for expressing the French national character in architecture. Photo: L. M. Roth, 2003.

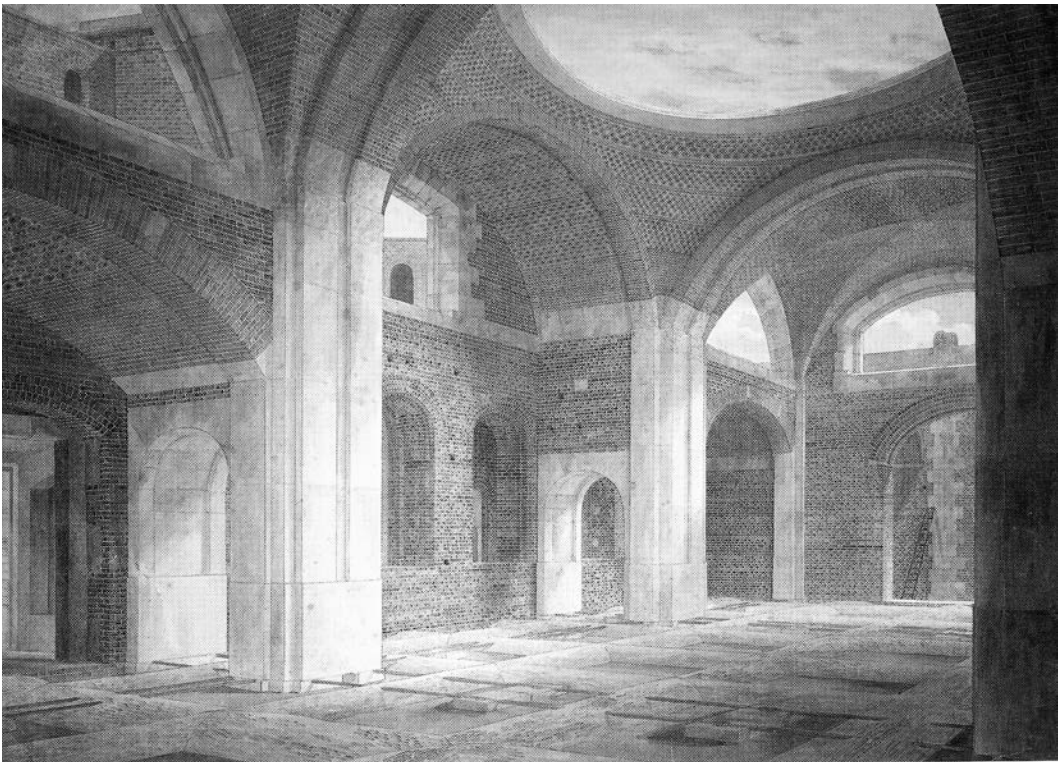
The method of architectural education in England (and, by extension, in the United States) was much different. During the eighteenth century, English buildings were often designed by gentlemen amateurs, mostly wealthy aristocrats who were widely traveled and well-read in Classical literature and architecture.[18] There were also professional architects who trained in architects' offices but who had little or no theoretical education. An excellent example of the former is Richard Boyle, Third Earl of Burlington (1694–1753), an aristocratic patron who made many trips to Italy, particularly to the region around Venice, where he closely studied the work of Palladio. In England, he built for himself Chiswick House, 1725, closely patterned on Palladio's Villa Rotonda, and he championed the cause of Palladian architecture [see 7.12]. A good example of an eighteenth-century professional architect in England would be Henry Holland (1745–1806), an architect and builder educated by his architect father.

Sir John Soane (1753–1837) represents a fusion of these two types, and his career marks the emergence of the modern architect in England.[19] The son of a builder, Soane was trained in the architectural offices of George Dance the Younger and Henry Holland. While working in Holland's office, Soane attended lectures on art at the new Royal Academy of Arts and participated in the design competitions sponsored by the Academy. He won a gold medal in such a competition in 1776 and was sent on a tour of Italy. In 1788, he was appointed architect to the Bank of England, a position he held for the remainder of his life, although he had a great deal of additional work as well. This combination of practical experience and theoretical education set Soane's work apart, and his ingenious original solutions to structural and lighting problems marked a new direction in architecture. For the Bank of England, especially, Soane relied on overhead skylights for illumination and devised lightweight domes constructed of hollow clay pots, later covered with layers of plaster [7.15]. At the same time, however, he conscientiously supervised the training of young architects in his office, approximately forty in all. This practice illustrates how at this time in England (and in the United States), the normal way to become an architect was to spend a period as an apprentice and assistant in an architect's office.

In England's American colonies during the eighteenth century, buildings also were designed by gentleman amateurs such as Peter Harrison, wealthy merchant and self-taught architect. Such gentlemen-amateur architectural designers, living comfortably from their business activities, plantation agricultural exports, or inherited wealth, took no payment for their efforts; they designed for the sheer love of the endeavor and the pleasurable satisfaction it provided. Perhaps the best-known American gentleman-amateur architect is Thomas Jefferson. He taught himself Italian, so he may have read Palladio in the original, though it was the English version he bought while still in college—perhaps one of the earliest architecture books he owned.

After 1790, several professionally trained architects, among them Joseph-Jacques Ramée and Joseph-François Maguin, emigrated from Europe, but the architect who had the most significant impact in the United States was Benjamin Henry Latrobe, who in 1797 arrived from England where he had been born and trained.[20] With the arrival of Latrobe, the United States had its first professional architect in the modern sense—an individual who derives a living solely by designing buildings for others to construct; who has received practical and theoretical training (academically, in an office, as well as on the job site); who supervises construction to make certain it follows the plans agreed on; and who is paid a monetary percentage fee based on the cost of the building being constructed (rather than being paid in goods or services). Working with carpenters' companies and builders rooted in the ancient guild tradition, Latrobe encountered resistance to the rights and prerogatives he claimed as an architect. Once, when he was away from Baltimore on business and unable to supervise work on the Baltimore Cathedral he designed in 1804 [7.16], the building contractor changed aspects of the building, following traditional practice. Upon his return, Latrobe threatened to resign unless his contract drawings were followed explicitly. Latrobe won this challenge to his authority.[21]

There were no architectural schools in the United States in the early nineteenth century, so aspiring architects trained themselves as best they could, working for other architects. Latrobe trained William Strickland, who in turn trained Thomas U. Walter. American architects faced a problem unknown to their European counterparts—the dispersal of their jobs over a much vaster landscape. Because architect Ithiel Town traveled extensively, supervising the construction of bridges that employed his patented truss pattern, in 1829 he took into full partnership Alexander Jackson Davis, thereby creating the first American architectural firm. Thereafter, architectural firms with two and three partners became increasingly common in the United States. Although national and municipal

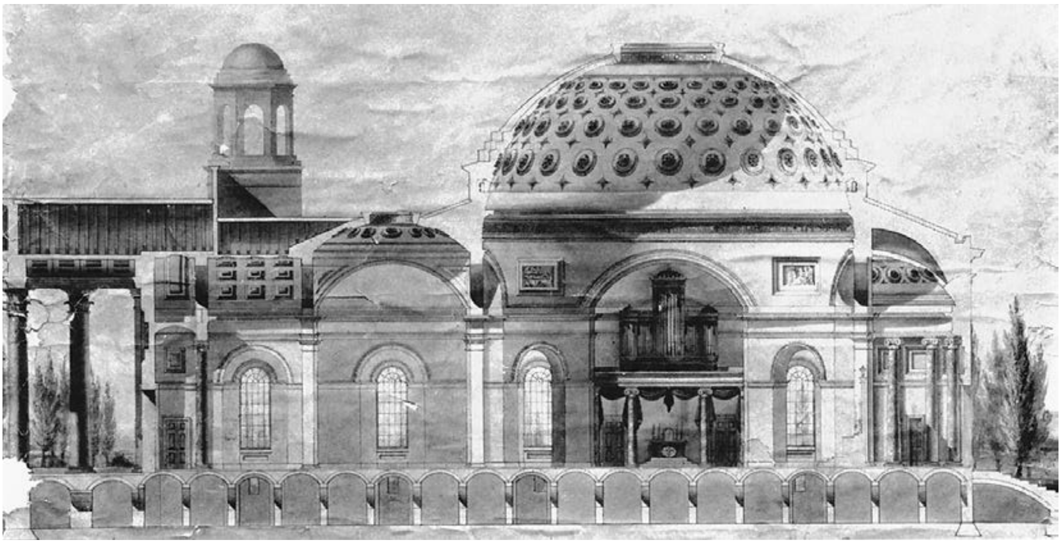


7.15. Sir John Soane, Bank of England, Consols Transfer Office, London, England, 1799. This detailed watercolor perspective by Joseph M. Gandy shows the masonry skeleton of the room, before application of the final plaster coat or installation of the windows and overhead light monitors. From M. Richardson and M. Steens, eds., John Soane, Architect: Master of Space and Light *(London, 1999).*

architectural agencies were already known in Europe, such private architecture partnerships were rare there until well into the twentieth century.

Around the mid-nineteenth century, American architects began to attend the École des Beaux-Arts in Paris, beginning with Richard Morris Hunt in 1845 and Henry Hobson Richardson in 1860. At the turn of the century, in fact, Americans made up the largest single group of non-French students at the École. These American graduates combined Yankee pragmatism and practicality with the sensitivity to plan organization and expression of building character that they learned at the French school. Architecture firms that exemplified these attributes were Adler & Sullivan of Chicago (Sullivan attended the École) and McKim, Mead & White of New York (McKim had also been at the École). Meanwhile, during the 1870s, schools of architecture were established in the United States, first at the Massachusetts Institute of Technology, Cambridge, and then at the University of Illinois, Urbana, with others soon following. French-trained instructors were hired, and when possible, French graduates of the École were brought over to teach École principles in these American schools.

By the end of the nineteenth century the character of the modern architectural profession had been established, and by the dawn of the twentieth century architects had achieved a professional status equivalent to medical doctors and lawyers, even to the point of having official licensing examinations. Normally, however (and especially in the United States), architects are not a direct part of the construction industry. Once the client (either an individual or a building committee) and the architect have settled on the final design, the typical process in realizing a building is to locate a general building contractor who signs a contract in which he or she agrees to erect the proposed building exactly as specified in the agreed-to drawings and written specifications at an agreed-upon price, though these construction documents can be changed with



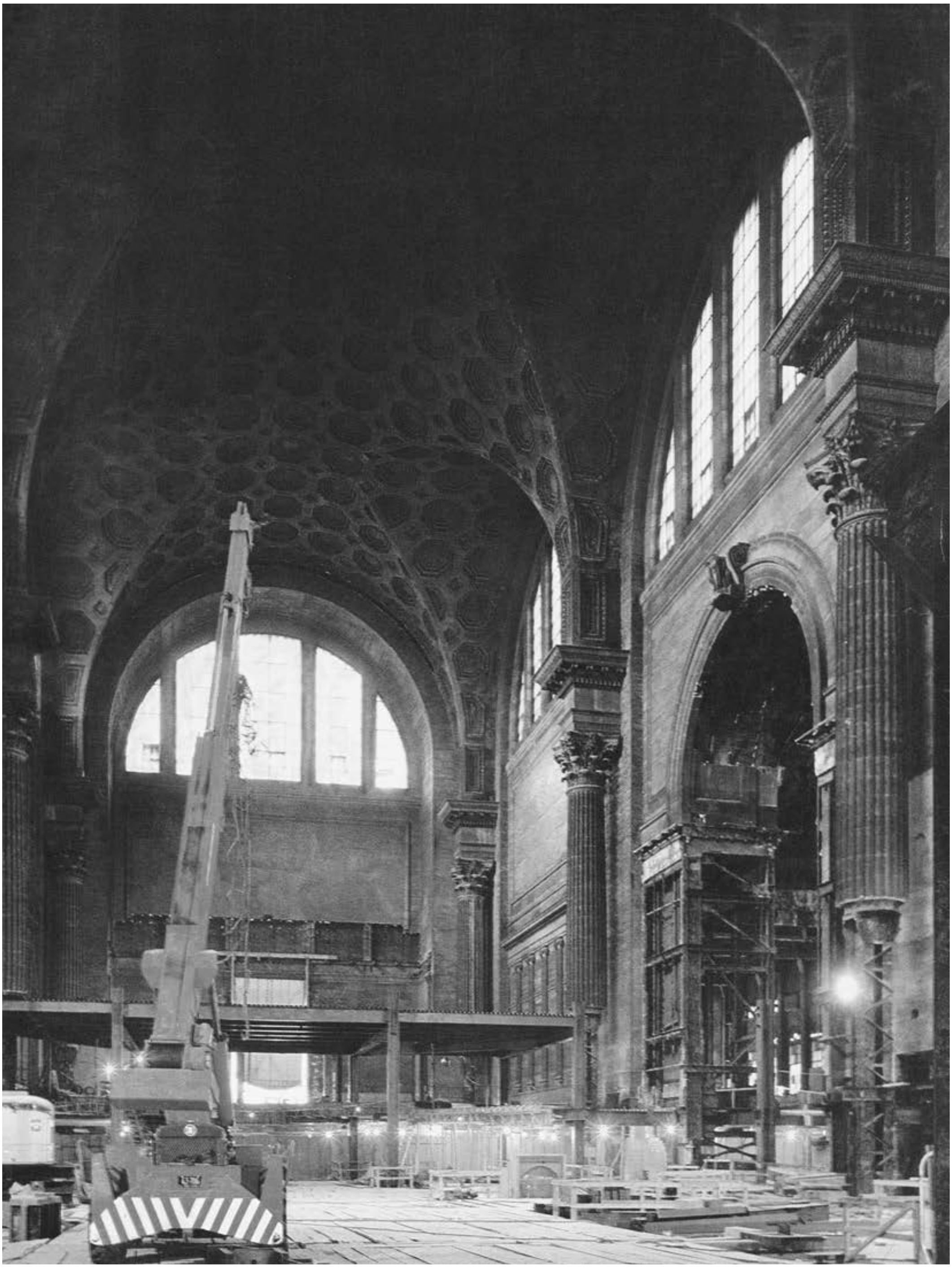
7.16. Benjamin Henry Latrobe, Baltimore Cathedral, Baltimore, Maryland, 1804–1821. Longitudinal section/elevation, 1805. The meticulously executed colored drawing testifies to Latrobe's extensive professional training in England and to the care with which he specified all the details of the design. Photo: Courtesy, Diocese of Baltimore and the Maryland Historical Society, Baltimore.

the alterations agreed to by all parties involved in the construction contract (with associated cost adjustments). The general contractor then makes further agreements with the scores of subcontractors who scrutinize the engineering and structural aspects of the work, who provide the various building materials, who fabricate and install the heating and cooling systems, and who manufacture the finishes and furnishings of the completed building. And, as Howard Davis has demonstrated in his study, *The Culture of Building* (1999), nearly equally important in the entire process of a building being realized are craftsworkers, bankers, financiers, public officials, and planners. Building is a detailed process that involves hundreds of people, and in large complexes, perhaps even thousands.

Early in the twentieth century, architects took on a social dimension in their work, facing the question of their social responsibility, a question that has remained unresolved. Should the architect assume the position of an activist and attempt to reform society, shaping environments according to how life *ought* to be lived (in the view of the architect), or should the architect reflect prevailing social values and shape environments according to how life actually *is* lived? With the rise of socialist-oriented European governments in the twentieth century, municipal building activity focused on housing complexes, prompted by the increase in urban populations coupled with the destruction of much of urban building due to the two enveloping world wars. Progressive-minded architects were active participants in this effort, and they interpreted their mission as providing the best housing for the largest number of people. This was especially true of those who formed the vanguard of the International Modern movement such as Walter Gropius, Max Taut, J.J.P. Oud, and others. Their apartment and housing estates have generally served well, though often the innovative building techniques they created have not weathered well. But it must be noted that the European residents who moved into these houses were already acclimated to apartment life, certainly in contrast to American urban populations. With the onset of urban renewal in the United States in the 1950s and 1960s, new apartment complexes were quickly needed to accommodate families then being displaced by the "urban renewal" of what were deemed by city planners as decayed neighborhoods. But the apartment complexes, carefully designed by upper-middle-class architects espousing high-minded philosophical ideals, too frequently turned out, in the long run, to be very poor living environments for the working-class poor. The best-known example is the Pruitt-Igoe housing complex in Saint Louis, Missouri, designed by architects Leinweber, Yamasaki & Hellmuth and built in 1952–1955, which provided residents no sense of identity and prevented them from supervising their immediate environment in the way they had been able to do from three-story street-front apartments. In fact, the apartment complex became so dangerous to live in that prospective residents refused to move there, and eventually, in 1972, the buildings had to be demolished[22] [19.56].

Since roughly 1965, architects have begun to take a more enlightened and more inclusive approach; some architects, particularly in the so-called Third World countries, have begun to discover that ancient traditional building methods and forms may have distinct practical advantages in the present day. For example, the traditional adobe mud brick architecture of Egypt was rediscovered and put to new use from the 1930s through the 1970s by the Egyptian architect Hassan Fathy for housing clusters and public buildings. And Geoffrey Bawa referred to the traditional vernacular Sri Lankan village council house in his new Parliament building for that country, 1979–1982.[23] Both architects rediscovered and reinvigorated traditional building materials and building forms that proved rich in meaning for the ordinary building users of their respective countries.

Another significant change that is reshaping the architectural profession is the increasing number of women who are achieving recognition in what, for centuries, was considered a male profession. Beginning with such American pioneers as Julia Morgan and Marion Mahony Griffin in the opening years of the twentieth century, and continuing with architects such as Eleanor Raymond and Natalie de Blois at mid-century, women are an increasing presence in the profession around the globe. In 2006 the female US graduate enrollment in architecture stood at nearly 45 percent, while figures for the United Kingdom and Australia were at around 39 percent. The rise of women architects to the pinnacle of international recognition was dramatically demonstrated by the award of the prestigious 2004 Pritzker Prize to Zaha Hadid, who was born in Baghdad, trained at the highly regarded Architectural Association in London, later became a partner in the avant-garde Office of Metropolitan Architecture with Rem Koolhaas, and now maintains an independent office in London. Awarded since 1979 and popularly called the Nobel Prize of the architectural world, the Pritzker Prize recognizes distinguished achievement on a global scale, and 2004 was the first year the prize was awarded to a woman. In 2010 the second woman to be named Pritzker Prize Laureate was Kazuyo Sejima, who shared the prize with her husband and partner, Ryue Nishizawa, at Sejima + Nishizawa and Associates (SANAA). As the twenty-first century opens, the role of the architect has expanded to embrace far more than the "master builder" of ancient Greece; it now includes such activities as being engineer, landscape designer, urban designer dealing with buildings in groups, and urban planner dealing with public policy and design on a regional scale. It has become a profession of open possibilities and enormous challenges.



8.0. Pennsylvania Station, New York, June, 1965, showing the construction of the new subterranean station spaces while demolition was already in progress. Despite the soiled dinginess of the vast original building, the low squat frame of the new replacement station empathically reveals how restricted was the vision of railroad officials in the early 1960s, compared to how upliftingly soaring had been the ambition of the railroad and its architects, McKim, Mead & White, in 1902–1910. Photo: Louis Reens, published on the cover of Progressive Architecture, *June 1965.*

Architecture, Memory, and Economics

> Therefore, when we build, let us think that we build for ever. . . . Let it be such work as our descendants will thank us for, and let us think, as we lay stone upon stone, that a time will come when . . . men will say as they look upon the labor and wrought substance of them, "See, this our fathers did for us."
>
> —*John Ruskin,* The Seven Lamps of Architecture, *1849*

In his most influential book on architecture, *The Seven Lamps of Architecture* (1849), John Ruskin drew a distinction in the opening sentences between architecture and building, making it clear that what he proposed to talk about was *Architecture.* The tendency since that time has been to assume that some buildings are more important than others, that the more important ones are worth detailed deliberation in their design, lavish expenditure on materials and craftsmanship, and unfailing preservation, while others are viewed as "Kleenex" buildings, deserving no second thought in design or any particular care in their use, and easily disposable. The result has been that we have a few splendid isolated buildings, but on the whole, we live and work and play in perfunctory environments made only as good as it is believed they absolutely must be. *Perfunctory* is the perfect word to describe much of what has been built since the beginning of the Industrial Revolution. Derived from a Latin root, *perfungi,* it means "to get through with, to be done with."

Just as we cannot properly understand the past without considering the "buildings" around the "architecture"—the houses around the cathedrals—we need to view all our built environment as a whole of interrelated parts. Some buildings may have more public presence than others, being the focus of communal or civic life, but all should be viewed as important. The act of building should not descend to being perfunctory but should seek to celebrate. The word *celebrate,* derived from the Latin *celeber,* originally referred to honoring someone or something by going in great numbers to praise and proclaim, to draw attention to something as being special, to assign high value, and to enjoy. In 1926, in one of his earliest writings about architecture, the social and architectural critic Lewis Mumford observed:

> The great problem of the architect is to mold the essential structural form in such a way as to perform all the purposes for which the building exists. It must fit its site, harmonize with or stand out from its neighbors, fulfill its own function as a shelter, a work-place, or a play-place, and give a special pleasure to every one who passes it or enters it.[1]

Economics and Historic Preservation

Mumford's suggestion that architecture should be a pleasurable experience raises the question of *economy.* Again, Roman architect Vitruvius offers valuable ancient advice, for he observed that economy (he used the Greek term *oikonomia*) is essential to good architecture, suggesting that economy would result from the selection of a good building site, the use of good materials, and the wise control of expenses. It also involves, he wrote, creating in the building a character appropriate to the building's use.[2] *Economy,* and all the modern derivatives drawn from this word, comes from the Greek *oikas,* "house," plus *nemein,* "to manage," referring to good stewardship of the household through wise management of resources. Yet in modern usage, to say something is economical is nearly synonymous with saying it is cheap (a very different word that comes from Old English and means "to haggle in the marketplace"). True economy, in the sense of good management, suggests that tearing down an old building may, in the long run, be very bad management on several counts. On a practical level, a considerable investment in human and mechanical energy was required to erect the building, and it may not be desirable to expend additional fiscal resources and energy merely to reduce it to rubble, haul the debris to a landfill, and then spend yet more money to replace it. On a deep psychological level, our architecture is our built memory; it is a legacy, both the acclaimed *architecture* and the anonymous *building.* When we remove any element, we erase part of that memory, performing an incremental cultural lobotomy.

In every period of human history, new buildings to accommodate prevailing needs replaced what had been built before. In the early Middle Ages, perhaps more buildings were adapted to new uses than had been customary before, but that was more a reflection of the generally depressed economic conditions than of a conscious conservationist ethic. One of the great ironies of the Renaissance was that, despite the interest in Roman architecture, much ancient architecture was destroyed or dismantled to reuse the stone for sixteenth-century buildings. With the rise of a more scientific interest in antiquity in the eighteenth century, however, the impulse arose to preserve old buildings as a way of retaining the knowledge of the past. The movement for historic preservation began in tandem with the cult of ruins and the interest in past architecture that arose in England in the eighteenth century and then spread to the rest of Europe. At first, preservation was an antiquarian pursuit of aristocrats and wealthy industrialists who saw so much threatened by the rise of industry in the nineteenth century. In 1882, Parliament passed the Ancient Monuments Protection Act. This interest was further formalized in 1894 by the creation of the National Trust in Great Britain, which grew in size, public impact, and scope of interest in subsequent decades. Over the years, various historic properties in Britain were acquired and opened to the public. Still active in calling attention to threatened national treasures, the National Trust is funded today by membership dues, admission fees, bequests, and legacies. In France the publication of Victor Hugo's novel *Notre Dame de Paris* (Paris, 1831), which included as much description of the church and its environs as it did the invented romantic story, incited strong interest in preserving such buildings, partly because they were viewed as part of the national patrimony. This interest was soon expressed in many nineteenth-century restoration projects of medieval French buildings—many undertaken by architect and writer Eugène-Emmanuel Viollet-le-Duc. Organizations and preservation efforts in other European countries soon followed these beginnings in Great Britain and France.

In the United States the historic preservation movement was initiated in 1876 by rising interest in the period of the nation's founding. Gradually the residences of the Founding Fathers were preserved by concerned citizens, beginning with saving George Washington's Mount Vernon and Jefferson's Monticello. During the 1920s this interest was spurred by the saving and detailed restoration of an entire colonial town, Williamsburg, Virginia, with the financial support of the Rockefeller family. This was soon followed by municipal legislation in Charleston, South Carolina, to preserve and protect its extensive eighteenth-century architectural legacy. However, federal authorization was needed to advance and encourage preservation activity across the nation. As in Britain earlier, the threat of rapid expansion of industries and the sprawl of suburbs following World War II was paralleled by the creation of the National Trust for Historic Preservation, chartered by Congress in 1949 as a private venture supported by membership fees, endowments, and incomes from historic properties. To provide muscle on a national level, the National Historic Preservation Act was passed in 1966, creating the National Register of Historic Places where significant sites—whether of architectural, historical, or cultural importance—can be listed and protected to a certain degree from wanton or impulsive destruction. The act also provided for creation of the State Historic Preservation Offices, which maintain inventories of buildings likely eligible for inclusion on the National Register. Although none of these developments, by themselves, ensure that buildings considered worthy of preservation will automatically be preserved, they do serve to delay demolition while the public and the experts have time to make their case for preservation. Sometimes it even happens that the building owner has a change of heart.

To promote preservation on a global scale, an analogous organizational meeting had been held in Athens, Greece, in 1931, to create an international body comparable to Britain's National Trust, but the political disruption of World War II, of course, interrupted implementation. Not until the mid-1960s was the world situation settled enough for a second meeting to be held in Venice for framing fundamental resolutions, and this action then prompted the United Nations in 1965 to create the agency charged with promoting preservation around the globe: ICOMOS, or the International Council on Monuments and Sites. It is in vigorous operation today.

The difficulty is that not every building can be frozen in time. The ancient buildings that have been passed on to us are those that were suitable for being put to new uses, and historical imagination is required to conceive of new uses for old buildings. New construction need not be halted, nor the past swept away entirely for the new, as some International Modernists proposed in the 1920s. What is needed is a flexible and tolerant affection for the past. In our cities, where space is limited, several questions arise: Should old buildings be refitted for a new use, should they be moved, or can they be incorporated into a new design? Good management requires an answer to yet another question: Is the new proposed building better than the old one it will replace? If not, we risk shortchanging not only ourselves but posterity.

In the aftermath of World War II and its extensive destruction, British architectural historian Sir John Summerson quickly saw the coming dilemma, as former *New York Times* architecture critic Paul Goldberger notes: "If a historic buildings stands in the way of a new one, who is to judge which has the right to occupy the land?"[3] The property owner alone, or some public agency that believes the older building serves a more important public good? As Goldberger further notes, Summerson, in 1947, observed that while art works and works of significant literature are comparatively easy to preserve, old buildings are different: "Like divorced wives they cost money to maintain. They are often dreadfully in the way. And the protection of one may exact as much sacrifice from the community as the preservation of a thousand pictures, books or musical scores."[4] The essential criteria supporting preservation as sketched out by Summerson in 1947 are remarkably similar to the Secretary of the Interior's criteria in the 1966 Historic Preservation Act. First, says Summerson, the building must be generally recognized "as a work of art [that is] the product of a distinct . . . creative mind." Or it should exemplify the characteristics of a particular school of design. Or, if not by itself truly distinguished, it brings together elements of distant times. Or the building is connected with seminal events or individuals of outstanding importance. Or the particular building is set in "a bleak tract of modernity, [such that] it alone gives depth of time."

In fact, the very existence of the National Register of Historic Places, even the creation of the New York City Landmarks Commission, can be connected to the loss of a nationally significant building in 1963 that drew the protests of people around the United States: New York's Pennsylvania Station, a huge transportation facility that had been designed by engineers of the Pennsylvania railroad working closely with architects McKim, Mead & White[5] [8.1]. Occupying two city blocks covering eight acres in the heart of midtown Manhattan, it was built in 1902–1910. A marvel of efficient transportation planning and incorporating the most advanced heavy-duty electric traction engines of the day (since the entire track system was in tunnels that ran 45 feet below the street), the station was lauded when it was featured in numerous articles after it opened. Even as late as 1958 it was praised by critic Lewis Mumford, who wrote that "McKim's plan had a crystal clarity that gave the circulation the effortless inevitability of a gravity flow system"[6] [see 18.46, 18.47].

For several decades up to 1945, as passenger rail travel expanded, the Pennsylvania Railroad prospered and the station was well maintained. But after the privations caused by the Great Depression and World War II, Americans were eager to purchase automobiles and to transport themselves. Additionally, long-distance air travel became generally affordable. Train travel began to drop, as did revenues, and maintenance of Pennsylvania Station was "deferred," a solution adopted by many other businesses. Layer upon layer of soot and grime accumulated over the once-honey-colored travertine, the marble, and the vast murals, besmirching the broad lunette windows as well. Penn Station began to slip into darkness.

Meanwhile, during the 1930s and '40s, the architectural profession, architectural magazines, and critical opinion in general quietly embraced the view that architecture should yearn for modernism, following the look of lean efficiency. Any architecture that referred to the past became viewed as functionally suspect and was considered ripe for replacement. In designing the great public spaces of Penn Station, McKim turned to ancient Roman examples, the last great public buildings that had been specifically designed to facilitate the movement of groups of people. In particular, McKim's huge waiting room at the very center was inspired by the *frigidarium* of the Baths of Caracalla. Soaring to 138 feet at the height of its groin vaults, it offered a tremendous vertical spatial release to passengers exiting the confinement of their rail cars below; moreover, the many operable panes in the eight broad semicircular lunette windows afforded abundant light as well as an escape for the hot air and exhausted steam rising from the train tunnels so far below. Two large open voids above the tracks in the center light courts of the building provided additional ventilation.

8.1. McKim, Mead & White, Pennsylvania Station, New York, NY, 1902–1910, demolished 1963–1965. Interior of the Waiting Room, once one of the grandest public spaces in the United States. Photo: Avery Library, Columbia University, New York.

Penn Station was a functionally efficient station, but, even better, it allowed its users, in taking in its grandeur, to feel better. The building offered visual pleasure to all, asserting that each individual—bootblack, janitor, railroad employee, shop keeper, commuter, urban investment banker, long-distance traveler—was worth being provided such architectural excess; the building gave its users a sense of feeling important.

But during the 1950s the railroad company allowed the building to get progressively more dingy, and large advertising installations were inserted that impeded the efficient flow of traffic. The only fiscally profitable solution, from the railroad's point of view, seemed to be removing the great excessive (read: not income-producing) public spaces and replacing them with a huge bland drum housing a new Madison Square Garden entertainment facility, plus a new tall office tower—everything depressingly common, built cheap and mean. The income generated by these new additions would offset the losses involved in running such a money-pit operation as a railroad station, or so it was believed. The remaining commuter and travelers' facilities could be squeezed into a cost-effective compressed horizontal 20-feet crypt underneath the added buildings.

The railroad company's announcement in mid-1961 that it planned to demolish Penn Station was met with stunned astonishment, disbelief, and the desperate hope that surely a better solution could be found. But at that time there was no legal way to temporarily prevent demolition and allow time for other alternatives to be explored. Ironically, only a few days after the railroad's demolition announcement, New York mayor Robert Walker formed a committee to advise on landmark preservation, the result of which was the passage of a city ordinance creating the New York Landmarks Preservation Commission in early 1965. But by then it was two years too late. Penn Station was already being torn apart [8.0, p. 152]. Meanwhile, the ongoing destruction generated repeated scathing editorial essays by *New York Times* critic Ada Louise Huxtable, who condemned the decision. After the replacement buildings went up and the "efficient" single-level subterranean station went into operation, historian and critic Vincent Scully spoke for many when he observed: "Through it one entered the city like a god. . . . One scuttles in now like a rat"[7] [8.2].

The furor raised by the destruction of Penn Station and the resultant creation of the New York Landmarks Preservation Commission provided the mechanism for saving the splendid Henry Villard houses in New York while alternative uses were explored, resulting in the retention of the townhouse group as the entryway to the otherwise undistinguished Hemsley Hotel. Meanwhile, since 1954 the New York Central Railroad had been working on its own proposal to construct a towering office building over Grand Central Station, a palace of grand public transport equal to the threatened Penn Station. In 1967, the new Landmark Commission designated Grand Central as a landmark, against the railroad's vigorous objections. A second office proposal was developed by architect Marcel Breuer; this and a subsequent revised tower design

*8.2. Charles Luckman Associates, Pennsylvania Station, New York, NY, 1966–1968. The soaring 150-foot spaces of the old station were replaced by efficient but cramped and graceless public spaces. Photo: William E. Sauro/*The New York Times/Redux.

8.3. Taj Mahal, Agra, India, 1630–1653. Built of white marble by Shah Jahan, this was a tomb for his consort Mumtaz I-Mahal. As was said by philosopher Rabindranath Tagore, "let this one teardrop, this Taj Mahal, glisten spotlessly bright on the cheek of time, forever and ever." Photo: Scala/Art Resource NY.

were turned down by the Landmarks Commission. While the railroad and its developer brought suit to negate the Commission's decision, a high-profile group of concerned citizens, including architect Philip Johnson and Jacqueline Kennedy Onassis, raised awareness and brought enormous pressure in support of the Landmarks Commission. Though the initial suit was decided in the railroad's favor, the decision was then overturned by the New York Appellate Court in the Landmark Commission's favor. So, the case was taken all the way to the United States Supreme Court, the first time such a preservation question was examined by that Court. In 1978, by a significant majority the Court ruled in favor of the Landmarks Commission and the city, reaffirming the legality of landmark designation as a facet of a municipality's zoning authority. Moreover, the Court found that the designation was not a taking of property without compensation, since the railroad still retained valuable air-rights that were transferable to adjoining properties. As Paul Goldberger put it, if Penn Station had become the martyr for historic preservation, Grand Central was now its triumphant savior.[8]

Regarding preservation of a nation's historic architecture, John Ruskin held very strong views, as shown in his writing about the ancient medieval architecture of England: "It is again no question of expediency or feeling whether we shall preserve the buildings of past times or not. *We have no right whatever to touch them.* They are not ours. They belong partly to those who built them, and partly to all the generations of mankind who are to follow us."[9] Blind veneration of the past is counterproductive, but Ruskin's injunction should prompt us to exercise informed appraisal before we destroy.

True economy must be measured in the quality of performance over the long run, not merely in initial cost, or the savings obtainable through demolition and replacement. In the preface to their historical survey *The Architecture of America* (Boston, 1961), John Burchard and Albert Bush-Brown emphasize that "a design that fails to provide full emotional and physical performance is not economical, however cheap. Indeed, cheapness has never been a criterion of great building."[10] So, what is true economy in architecture? John Kenneth Galbraith, one of the most enlightened economists of the mid-twentieth century, had served as ambassador of the United States to India and thus was keenly familiar with the social impact of both marked affluence and extreme poverty. Yet, he proposed an intriguing yardstick by which to measure economy, saying that beauty and elegance in public construction are worth having, even if they are not cheap. He illustrated his point by focusing on the Taj Mahal in India [8.3, Plate 16]:

The return on a public structure is not merely the task that it facilitates. It is the whole pleasure that it provides the community. Accordingly, a building can be very expensive but a rare bargain for the pleasure it provides. A modest structure at modest cost would have provided durable and hygienic protection for the mortal remains of Mumtaz Mahal and Shah Jahan. But by spending more—by some estimates, about $8 million—Shah Jahan got the Taj Mahal. It has rejoiced the whole world ever since. Surely this was sound economy. Our test should be similar. The most economical building is the one that promises to give the greatest total pleasure for the price.[11]

3000 | 2500 | 2000 | 1500 | 1000 | 50

Prehistoric

▲ *Stonehenge, 2600–2400 BCE Salisbury Plain, Wiltshire, England*

Ancient Far East

Greek

▼ *Palace at Knossos, Crete, c. 1700–1380 BCE*

▲ *Parthenon, Athens, Greece, 447–438 BCE*

◄ *Lanyon Quoit, Cornwall, England, c. 3200 BP*

Minoan

► *Hypostyle Hall, Temple of Amon, Karnak, Thebes, Egypt, c. 1315–1235 BCE*

▲ *Pyramid complex at Giza, Egypt, c. 2680–2560 BCE*

Egyptian

▼ *Temple of Poseidon, Paestum, Italy, c. 550 BCE*

Mesopotamian

◄ *Ziggurat of the moon god Nannar, Ur (in present-day southern Iraq), c. 2113–2006 BCE*

Prehistoric

3000 | 2500 | 2000 | 1500 | 1000 | 50

Chronology

0 | 0 | 500 | 1000 | 1500 | 2000

▲ *Pagoda, Hōryū-ji Monastery, Hōryū-ji, Japan, c. 607*

Tang China

◄ *Fogong Buddhist Monastery, Yingxian, Shanxi Province, China, 1056*

Late Imperial Far East

Han China

Medieval Far East

► *Nanchan Buddhist Temple, Nanchan Temple at Mt. Wutai, Shanxi Province, China, 782*

Ming-Qing China

Modernity

Medieval

▲ *30 St. Mary Axe ("The Gherkin"), London, England, 1996–2004*

Roman

Baroque

◄ *Flavian Amphitheater (the Colosseum), Rome, Italy, begun, c. 80 CE*

▲ *Notre-Dame de Amiens, Amiens, France, 1220–1269*

Early Christian & Byzantine

▲ *Church of Saints Vincent and Anastasius, Rome, Italy, 1646–1650*

Renaissance

▲ *Hagia Sophia (Church of Divine Wisdom), Istanbul, Turkey, 532–537*

◄ *Tempietto of San Pietro in Montorio, Rome, Italy, 1500–1502*

0 | 0 | 500 | 1000 | 1500 | 2000

Göbekli Tepe, southeastern Turkey. Built around 11,600 years ago, this earliest known permanent stone structure was neither a ruler's house nor a utilitarian granary, but apparently a temple, with unique T-shaped columns. Photo: Berthold Steinhilber/laif/Redux.

Part II

The History and Meaning of Architecture

9.15. Stonehenge, on the Salisbury plain of Wiltshire, England, built in several phases of construction lasting roughly from 5,000 to 3,500 years ago, manifests the early human desire to give permanent physical form to cosmological concepts. Photo: © Adam Woolfitt/Corbis.

Chapter 9

The Beginnings of Architecture

From Caves to Cities

> Early man's respect for the dead, itself an expression of fascination with his powerful images of daylight fantasy and nightly dream, perhaps had an even greater role than more practical needs in causing him to seek a fixed meeting place and eventually a continuous settlement. Mid the uneasy wanderings of Paleolithic man, the dead were the first to have a permanent dwelling: a cave, a mound marked by a cairn, a collective barrow. . . . Urban life spans the historic space between the earliest burial ground for the dawn man and the final cemetery, the Necropolis, in which one civilization after another has met its end.
>
> —*Lewis Mumford,* The City in History, *1961*

Human beings, among other animals, seem unique in the world. Eons ago, our hominid ancestors learned to control fire, to recognize a social link with each other, to maintain a bond with the remains of their dead, to engage in symbolic thought, and to fashion symbolic images and objects. We became persistent in our endeavors, developed the power of speech, devised codes of morals, and nurtured an ability to care for the helpless and aged. We also learned how to build, to create artificial environments that made our lives safer, more enjoyable, and more psychologically rewarding.

The exact time that we humans learned to build may never be known with certainty, for our earliest constructions were probably fashioned from organic materials—branches, brush, hides, and such—that quickly returned to the earth without a trace. Tantalizing examples of what so readily disappeared are the remains of dwellings at a site called Monte Verde, in present-day Chile. After being abandoned about 13,600 years ago, these dwellings were preserved because they were soon covered by water that quickly became a bog, sealing the building remains and preventing oxygen from getting to the wood, leather, and fiber materials, thereby stopping their decomposition.[1] They are, however, far from being the oldest human habitations.

Architecture is shelter, but it is also a symbol and a form of communication; as Sir Herbert Read observed, all art is "a mode of symbolic discourse."[2] Architecture is the crystallization of ideas, a physical representation of human thought and aspiration, a record of the beliefs and values of the culture that produces it. In an introductory study such as this, we must start at the beginning, but this raises the intriguing question of exactly when it was that humans began to develop ways of thinking and of making things to convey symbolic thought. We need to move well back from the period of recorded history, to the dim ages when the ancestors of *Homo sapiens* appeared. In doing so, we uncover traces of the origins of human society and human institutions. We discover, too, that what we build is shaped only in part by the private need to provide for a particular functional use; architecture may have been built from the earliest times as a symbol of communal social values. Architecture accommodates psychological as well as physiological needs of the human family, whose basic social institutions are at the very least a million years old. Thus, the strictly utilitarian or functional considerations of modern architecture defined during the last century are only the most inconsequential part of the broad social and cultural functions that architecture fulfills.

Early Hominids

The study of early protohumans is a rapidly expanding field, with new discoveries occurring continuously.[3] The first hominids appeared at least 5 million years ago in central Africa. The early human ancestors *Ardipithecus ramidus* and *Australopithecus* *anamensis* were most likely forest dwellers, consuming a vegetable diet of fruit and leaves. *Ardipithecus ramidus* lived in what is now Ethiopia, and *Australopithecus anamensis* in modern-day Kenya. About a million years later, *Australopithecus afarensis* appeared, named for the Afar region in Ethiopia, where the skeleton of the female affectionately named "Lucy" was uncovered. Judging from the scattered skeletal remains of this species found so far, the males stood 4.5 feet (137 cm) high, with the females shorter. These protohumans lived on the warm equatorial savannas and probably had no pressing need for shelter; nor, apparently, did they control or use fire.

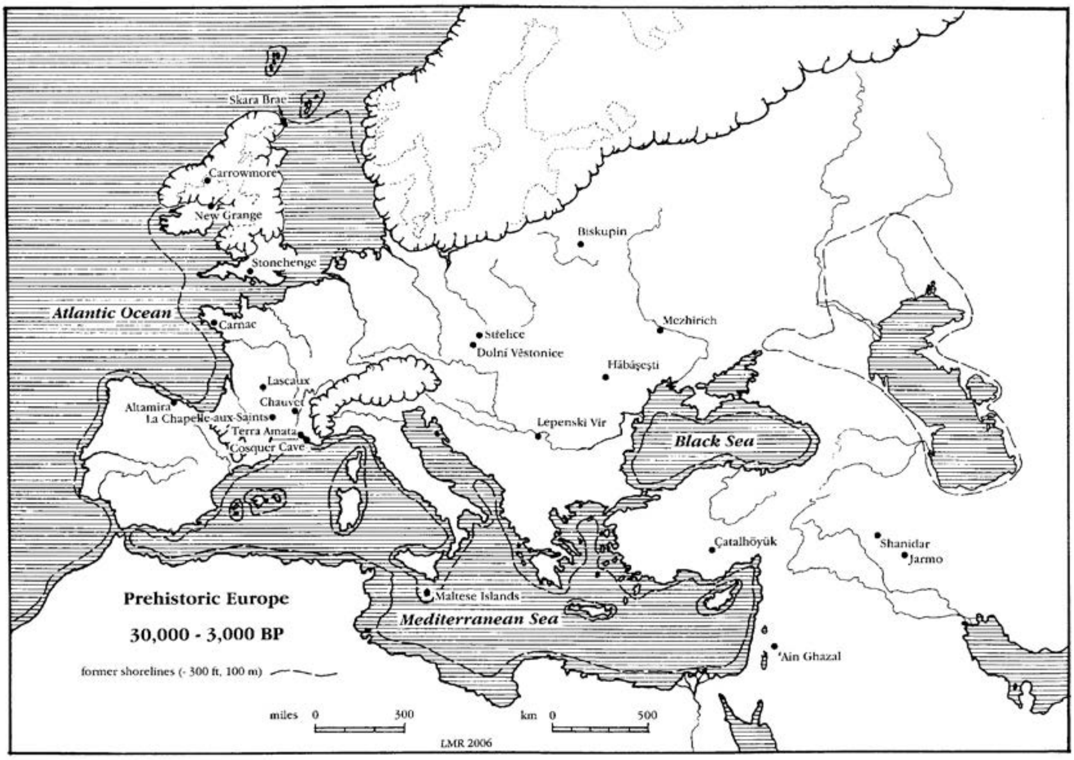
About half a million years later, roughly 3.5 million years ago, a parallel species, called *Australopithecus africanus,* developed in what is now South Africa. This hominid deserves particular mention because of a jasperite pebble about 2.4 inches (6 cm) in diameter. Through natural, geological processes, the piece of jasperite seems shaped like the face of this species. What makes this small stone so special is that it almost certainly came from a source nearly 20 miles (32 km) from where it was found in 1925 in a cave at Makapansgat, South Africa. The evidence suggests that the pebble was picked up by a member of *Australopithecus africanus* and kept perhaps because of the perceived resemblance to the hominid's facial features, and then perhaps was abandoned some distance away. This suggests the very beginnings of symbolic thought and self-awareness.

About 2 million years ago, there appeared a new species of early hominid, called *Homo habilis,* or "handy man," and this scientific name choice indicates that these individuals were much more like modern humans than the preceding "southern apes." Members of *Homo habilis* clearly made stone tools (and no doubt many others of wood), carrying their tool-making materials over long distances. They moved out of the forest into more open savannas—or, perhaps more accurately, the forests diminished in size in the drier, cooler climate that was part of the first ice age in the Northern Hemisphere. These hominids began to eat meat, a dietary change that greatly accelerated the physical and complex social changes required in hunting. The brains of this species increased in size, allowing individuals to hold a larger mental map of the territories they traversed and to track game.

Around 1.25 million years ago, a new descendant subspecies appeared in the Olduvai area of Tanzania. This group was given the name *Homo erectus* in reference to its clearly erect posture and bipedal locomotion.[4] Because of their mental planning abilities and tool-making skills, members of *Homo erectus* were unlike any creature that had lived before, for they were not genetically or physically limited to living in one fixed climatological area. They could control their immediate climate, capturing fire from natural sources such as lightning strikes. They could migrate, and did, gradually moving northward out of central Africa into southern Asia and China, and into Europe, where a variant now called *Homo heidelbergensis* emerged [9.1]. Evidence of hearth sites has been uncovered in South Africa, Israel, China, and Europe, variously dated from 700,000 to 300,000 years ago; each revealed evidence of cooking. In the Escale Cave at Saint-Estève-Janson, France, evidence was found of five hearths and reddened heat-altered earth dating to about 200,000 BP.[5] Use of fire allowed for roasting meat and plant material, opening up new nutritional sources for the early humans; the cooked proteins and complex carbohydrates in turn encouraged rapid new brain development. Around such fires, protected and warmed at night in these colder northern climates, early humans gathered and stronger social bonds formed. The light of night fires meant the workday was no longer limited to sunlight hours. Certainly by day, and perhaps at night by the light of these fires, *Homo erectus* made bifaced stone-cutting tools and began to form aesthetic judgments in the process of striking off the last additional flakes of the stone core to arrive at more pleasing mentally preconceived shapes. In fact, the movement of protohumans into Europe would not have been possible without the use and control of fire, for soon after *Homo erectus* arrived in Europe, the second great age of glaciation—the Günz glaciation—began, lasting from roughly 1 million to 900,000 years ago. With skills in tool-making, hunting, and the resultant knowledge of leather-making, *Homo heidelbergensis* (the European variant of *erectus*) survived this ice age and the next, the Mindel glaciation, which lasted from about 700,000 to 600,000 years ago, as well as the fourth ice age, the Riss glaciation, which lasted from 300,000 to 150,000 years ago.

Terra Amata, Nice, France

As *Homo erectus* groups moved into the more challenging climates of Europe, they had to find or make their own shelter. Because earlier excavations had turned up Paleolithic (Old Stone Age) tools in Nice on France's Mediterranean coast, anthropologist Henry de Lumley watched closely in October 1965 as bulldozers cut through ancient sand banks to prepare a site for new high-rise apartments.[6] When the excavation work uncovered tools, he had the work halted to allow for intensive and painstaking excavations. As a result, de Lumley and



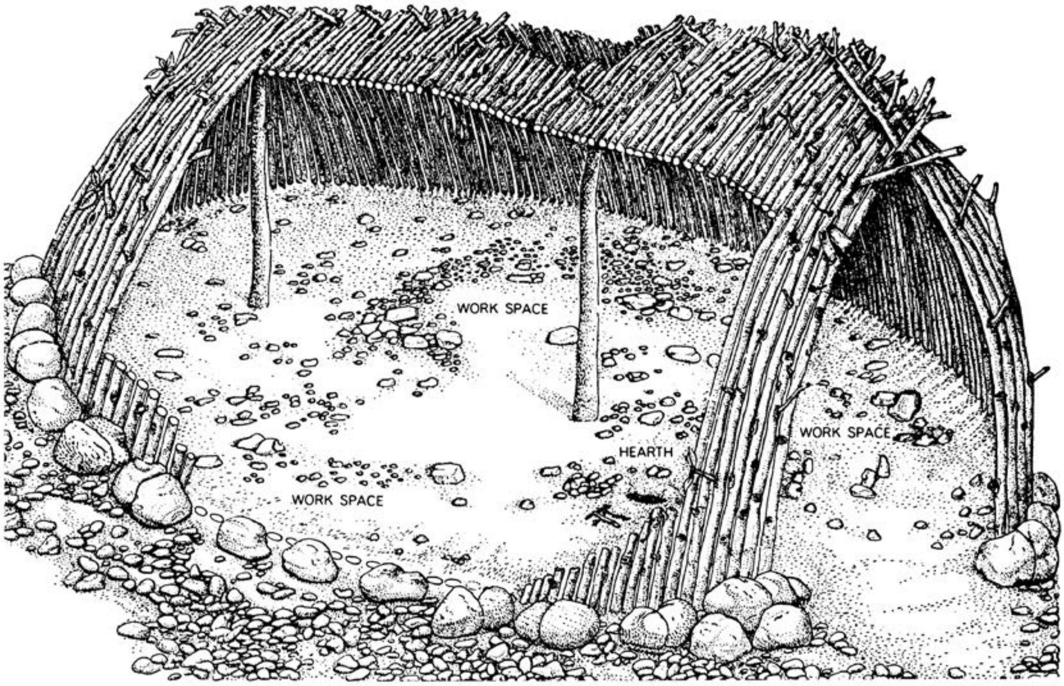
9.1. Map of Europe, 30,000–5,000 BP. The broken line offshore shows the ice age shoreline when sea levels were 300 feet (100 m) lower than in the twentieth century.

his associates discovered what turned out to be a springtime camping ground for a group of *Homo erectus* (or perhaps *Homo heidelbergensis*) hunters who visited this spot annually over a period of several decades, sometime around 400,000 to 300,000 years ago. At this spot, since called Terra Amata (Latin for "beloved land"), de Lumley found the remains of the oldest known fabricated shelter—what, perhaps by extension, might be called the first architecture. There were remains of twenty-one dwellings, eleven of which were rebuilt on the same spot year after year on the top of an ancient sand dune above the primeval Mediterranean coast. Roughly oval in plan and measuring about 26 to 49 feet (7.9 to 14.9 m) in length by 13 to 20 feet (4.0 to 6.1 m) in width, the dwellings had side walls made of a palisade of branches 3 inches (7.6 cm) in diameter and pushed into the sand [9.2]. Against the edges were piled rocks, some of which were 1 foot (0.3 m) in diameter. Down the center were posts up to 12 inches (30 cm) in diameter, although the roof they supported left no trace (perhaps the side branches leaned against a center ridge beam supported by the posts). In each shelter was a central hearth, with a windbreak of stones on the northwest side, the direction from which prevailing winds still blow in Nice. In one hut were indications of a toolmaker, for around a stone stool were chips and flakes of rock, some of which could be reassembled like a jigsaw puzzle to form the original cobble.

That a group of *Homo erectus* people returned to Terra Amata year after year suggests a regular hunting cycle, but even more important is the hearth. The fire suggests the gathering of the group, the establishment of a community. Pieces of ocher found within the huts suggest that the inhabitants used these to draw on their skin. In using fire and building artificial shelters, these human ancestors took control of their environment, shaping it to their own convenience and requirements. The first steps toward architecture—the deliberate shaping of the living environment—had been taken.

Neanderthals and *Homo Sapiens*

Out of the late erect humans such as *Homo heidelbergensis* came two sibling species (according to some paleontologists)—*Homo sapiens neanderthalensis* and *Homo sapiens sapiens.* The Neanderthals appeared



9.2. Terra Amata, Homo erectus dwelling, Nice, France, c. 400,000–300,000 before present (BP). Reconstructed from holes left by decayed wooden structural members and by the rocks placed around the perimeter, this represents the earliest known human-constructed dwelling. From Scientific American, *May 1969.*

about 200,000 years ago in Europe, and *Homo sapiens sapiens* appeared in Africa a little later, around 130,000 years ago. *Homo sapiens neanderthalensis* ("Neanderthal man") was so called because of the first remains found in 1856 in the Neander valley (*Thal*) in Germany. Though shorter and much more muscular than *Homo sapiens sapiens,* Neanderthals were not the brutish, hunched figures once imagined; it just happened that one of the first full skeletons found was that of a stooped, arthritic older man. The Neanderthals spread throughout upper Africa, Europe, and the Near East. There have been numerous finds of their work, including many stone tools of the Mousterian tool-making tradition they developed, but only scant finds of remains of built structures. For the most part, early Neanderthals seem to have been cave dwellers, as at Le Moustier, a rock shelter in the Dordogne, France.

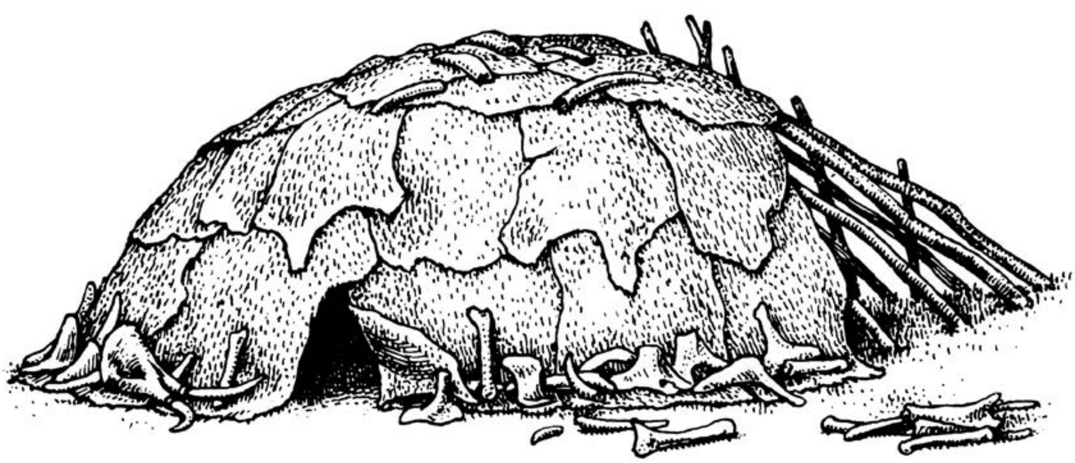
Through Neanderthal burials, however, much has been learned of their communal existence and something of their perception of life itself. The oldest deliberate Neanderthal burials found so far have been at Kaprina, Croatia, dating about 130,000 years ago. The question arises as to whether burial implies some form of early religious thought or practice. At La Chapelle-aux-Saints, France, the remains of a very elderly man, buried carefully with stone tools laid around him and with a bison leg placed on top of his body, was discovered in 1908. A great majority of the other burials have revealed bodies laid out on an east-west axis, suggesting perhaps an alignment with the movement of the sun. Perhaps the most suggestive is the burial in a cave at Shanidar, in the mountains of Iraq. Tests of the soil found around the male skeleton revealed that he had been interred resting on a bed of pine boughs and flowers and was then covered with blossoms of grape hyacinth, bachelor's buttons, hollyhock, and groundsel.[7] Another man buried in the same cave had a congenitally deformed arm that would have made hunting impossible, and yet he had lived a long life, supported by his familial group. This evidence, along with the old man buried at La Chapelle-aux-Saints, suggests a complex Neanderthal social structure in which the old and the infirm were valued, nurtured, and sustained. The flowers of Shanidar suggest that the Neanderthals imagined that life continued somehow after death, in a renewed cycle or on a different plane; the flowers indicate that the Neanderthals had come to think in symbolic terms.

Dwellings of Homo Sapiens

The Neanderthals as a distinct genetic species began to die out about 40,000 years ago, during the last ice age, the Würm glaciation. For a time, as burial evidence in caves in Israel and elsewhere indicates, they lived side by side with *Homo sapiens sapiens,* who had moved northward from Africa around 40,000 years ago. But the Neanderthals were dying out, surviving in northwestern Spain up to 27,000 years ago. Some scholars suggest that the two species interbred. Whatever the case, Neanderthals were replaced by modern humans, *Homo sapiens sapiens*. Various new tool-making traditions were perfected by *Homo sapiens sapiens,* or Cro-Magnon people, the name derived from a site in France where their remains were first identified. These new point-flaking technologies succeeded each other comparatively rapidly—the Perigordian, the Aurignacian, the more delicate Gravettian and Solutrean, and finally the Magdalenian—all falling into what is called the upper Paleolithic period, the Old Stone Age.

A number of dwelling sites of early humans (both Neanderthals and later Cro-Magnons) have been uncovered across Europe. Those of eastern Europe show a type of house that was apparently typical for that region. Round, perhaps domed or conical in shape, these houses had internal frames of wood covered presumably with hides; the dwellings were braced at the bottom with massive mammoth bones, often with rings of mammoth skulls locked together [9.3]. Remains of such houses have been found in several locations in Moravia (Czech Republic)—at Ostrava-Petřkovice and Dolní Věstonice—and also in the Ukraine in Russia, near the Dniester River. The Ukraine site revealed superimposed habitation levels going back as far as 46,000 years ago, with the most recent dating from about 12,000 years ago. These dwellings may have accommodated extended family groups, for some houses measured roughly 30 feet (9.1 m) in diameter. Both Moravian sites were occupied by successive generations from roughly 29,000 to 24,000 years ago. These dwellings were nearly the same as those found in the Ukraine. They were ringed with massive bones and measured about 20 feet (6.1 m) in diameter; one house, however, measured about 50 by 20 feet (15.2 by 6.1 m) and had five hearths. These early *Homo sapiens* clearly knew how to create fire quickly and at will, for they left flints and iron pyrites used to strike sparks; one piece of pyrite found in a Belgian cave had a groove in it from repeated striking.

The site at Dolní-Věstonice proved to be especially important archaeologically, for set apart from the five residential huts was a sixth house built into the side of a hill, with a larger hearth covered with an earthen dome. Lying about on the floor was ample evidence of what was fabricated there—hundreds of bits of fired clay, some bearing the fingerprints of the primeval potter. Nor was pure clay alone used for the implements; rather, it was clay mixed with crushed bone, perhaps the oldest example of what might be called industrial production in which two dissimilar substances were deliberately intermixed to create a new and stronger artificial material.



9.3. Cro-Magnon dwelling, Ukraine, c. 46,000–14,000 BP. Such dwellings, some of them 30 feet (9.1 m) across, had masses of mammoth bones piled around the perimeter and apparently were covered with hides. From Scientific American, *June 1974.*

Cro-Magnon humans, our *Homo sapiens sapiens* ancestors, also buried their dead with elaborate ceremony, to judge by the intricate ivory and bead jewelry and tools with which they were interred. Perhaps they took leave of the dead with song, playing the bone flutes they left in the graves. But the most compelling evidence of the intellectual capacity of these forefathers is found not in their huts, stone tools, or burials but in the visual evidence they left, the painting and sculpture they created. They seem to have become aware of a cycle of life, perhaps perceiving a oneness with the cosmos, in which male and female entities participated in the renewal of life. Across Europe have been found carved figures, described now as fertility figures, of women with enlarged breasts and buttocks, most with no clearly discernible faces. The oldest portable art object uncovered so far is a mammoth-ivory statuette found in a cave at Hohlenstrin-Stadel, Germany. Standing about 12 inches (30 cm) high, it is a human figure with a feline head. Dating to about 32,000 years ago, it depicts perhaps a shamanistic figure wearing a mask. Some of the portable figures are female images, small figures carved in stone or ivory, such as the rounded so-called Venus found in Willendorf, Austria, while others were mural art, carved into the rock on the walls of caves. The most imposing and intriguing of these is the Venus of Laussel, France, carved 22,000 to 18,000 years ago in the rock of the cave wall. She raises aloft in her right hand a horn marked with thirteen grooves.

Even more impressive than these carved figures are paintings discovered in caves in southern France and northern Spain, which continue to be found as recently as the closing decade of the twentieth century. The first were seen in 1879, when the daughter of a Spanish nobleman, exploring a cave with her father on his estate at Altamira, Spain, looked up and saw the images of twenty-five bison, deer, boars, and other animals painted on the cave ceiling. It seemed at first impossible that images of such grace in execution could be of the same date as the incredibly ancient remains found on the floor of the caves. As other caves were discovered subsequently, it became clear that the images were painted sometime between 14,000 and 12,000 years ago.

Over the decades numerous other decorated caves were discovered in southern France. Then, in 1940, perhaps the most famous cave of all was discovered, at Lascaux, France, in Dordogne at the edge of the Massif Central above the Vézère River, not far from Montignac.[8] By the light of small lamps, which in places left smudges on the walls of the cave, Cro-Magnon humans had painted hundreds of images of aurochs (prehistoric oxen), woolly rhinoceroses, prehistoric horses, deer, elk, and other animals. The colors were achieved using pigments of powdered minerals—iron oxide or ocher ranging from bright red, orange, yellow to warm browns, and manganese oxide (or charcoal) for black—often packed in tubes made of hollowed-out bone. Some pigments were left as powder and blown onto the walls; others were mixed with animal fat, egg white, or other liquids and brushed or daubed on with the fingers. There is some evidence to suggest that the higher portions of the cave "vault" were painted from a wooden scaffold—architecture in the service of art. The artists and their assistants fashioned images unsurpassed for clarity of outline, grace of form, and sensitivity to perspective until the time of the Greeks and Romans. A good representative example is the so-called Chinese Horse at Lascaux, in which the outlines of the rear legs fade away as they near the mass of the body to suggest the distance from the legs in the foreground.

In the 1990s, two more caves were discovered in France, untouched and unparalleled in the technical skill demonstrated in their animal imagery. One was found in 1991 just below the sea cliffs midway between Marseilles and Cassis on the Riviera coast. We need to remember that during the last ice age, when so much water was locked up in the polar ice caps, sea level was nearly 300 feet (91 m) lower than it is today, and myriad coastal Stone Age sites were later obliterated by the rising sea. This Cosquer Cave, so called because of its discoverer, was protected because its mouth was lower than the main body of the cave, so the rising sea trapped air into the higher portion of the cave; the abundant hand prints made with charcoal permitted radiocarbon dating to 27,000 years ago. Even older, and so far the oldest mural painting discovered, is that in the Chauvet Cave, discovered in 1994 in the gorge of the Ardèche in southeast France. Here the images have been securely dated as having been made in a period extending from 32,500 to 32,100 years ago, with a second major period of painting activity lasting from roughly 26,500 to 24,000 years ago.

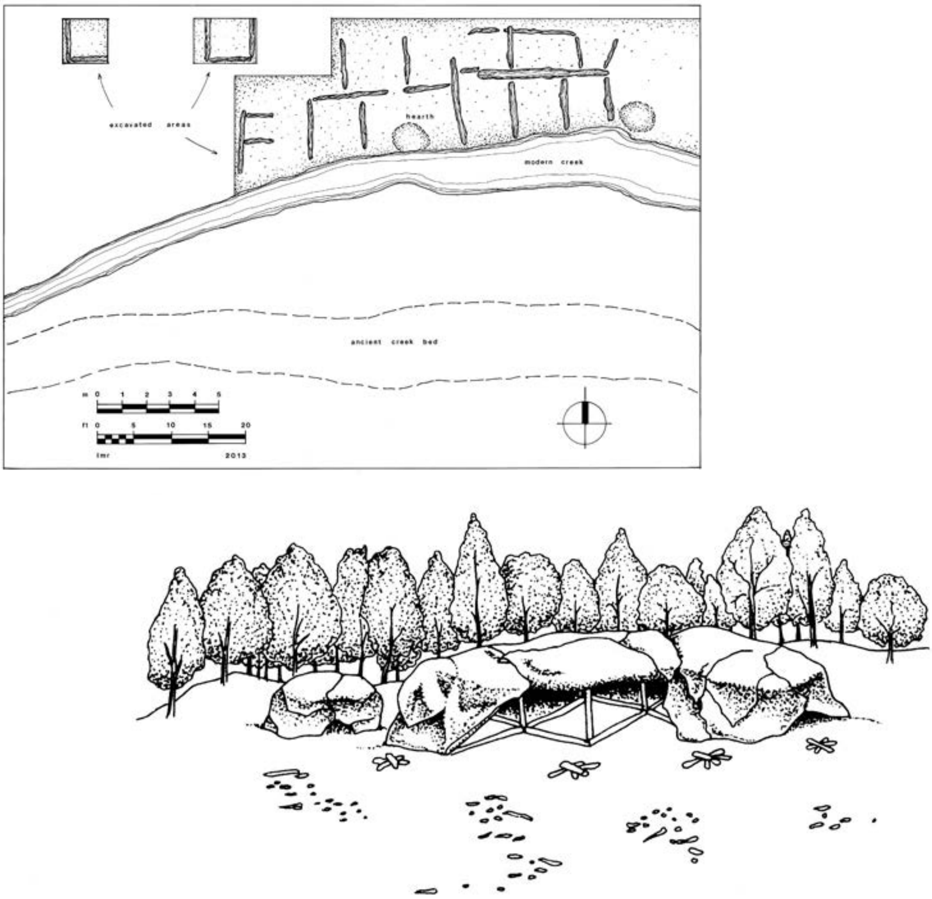
The question that has puzzled anthropologists since the discovery of these caves is *why* such striking and realistic images were painted. They were not scribbled in idle moments on the ceilings of inhabited caves. Nor were the paintings opportunistic, created during chance moments in easily accessible places. Most images are found deep in the innermost recesses of special caves, in secluded chambers reached only by arduous crawling. The lamps, pigments, and scaffold materials had to be carried into the caves with care and deliberation. In some caves, there is evidence to suggest the practice of fertility or initiation rites. Are these images of hunting magic, in which the spirit of the animal is captured and killed before the actual hunt, or are these images meant to impregnate the earth with the spirit of the animal after the hunt to ensure its continued survival? Perhaps they are spiritual images used in shamanistic rituals communing with the animal spirits.[9] If this was hunting magic, why are there no bones of the painted animals in the middens, the refuse piles adjacent to the settlements? Conversely, images of reindeer, whose bones *are* found in human settlements, are comparatively rare. Perhaps these life-like images are the first human expression of a redemptive endeavor, for something may have seemed terribly wrong in the ecological balance perceived by the artists; perhaps the images were a desperate attempt to propagate the huge animals that were disappearing from the face of the earth. The womb of mother earth was being carefully impregnated with the images of the great disappearing beasts. Perhaps this is why the caves themselves were never altered, the narrow openings never widened, the difficult passages never made easy. Cro-Magnon people seem not to have built sacred buildings as such, at least not using permanent materials that might have come down to us; they seem to have practiced their religion in the dark inner sacred sanctuaries of their earth mother.

Neolithic Dwellings and Structures

As mentioned, remains of dwellings incorporating durable bone and stone have been discovered at various sites in what is now Eastern Europe and the Ukraine, ranging in date from 46,000 to 12,000 years ago. Clearer evidence of how organic materials were likely used in dwelling construction was discovered in late 1975, not in Europe but at a site called Monte Verde in southern Chile, in a village complex built by humans moving into the Western Hemisphere. Through extraordinary chance conditions at this particular village site, the organic materials used in construction—dwelling base timbers, portions of the mammoth hide covers, and even wood stakes and fiber cordage—survived for 13,000 years[10] [9.4]. The village, apparently occupied over several years, was abandoned when the nearby creek changed course and subsequent rapid flooding covered this ancient camp. The shelters, their wood supports, the hide covering, and even the braided cords that attached the skins to the wood frames were remarkably well preserved due to the peat formation that quickly developed and encased the collapsed dwellings. This peat prevented oxygen from coming into contact with the organic materials, and the anaerobic environment prevented bacterial action and decay. When excavated in the late 1970s and opened further in the 1980s, dwelling remains and hearths indicated that a long extended structure, with interior hide partitions, had been constructed to house a group of about thirty people. When the organic samples were radiocarbon-dated, the astounding results yielded dates ranging from 14,800 to 13,800 years ago, making these the oldest dwellings built of wood and skins to survive and be uncovered so far. The chance preservation of these wood and skin dwellings suggests that there must have been untold numbers of such dwellings, built over thousands of years in North and South America, almost all of which disappeared without a trace.

Beginning about 10,000 years ago (8000 BCE), as the Würm glaciation ended and the ice gradually retreated again, the harsh northern climate moderated. Lush forests gradually replaced tundra and steppes. A new age had begun, the Neolithic or New Stone Age, and humans increasingly settled for extended periods and began to build more permanent settlements.

In some areas the old hunting and gathering traditions lingered, as indicated by the remains of a settlement at Lepenski Vir, dating from about 7,000 to 6,600 years ago (5000–4600 BCE), at a prime fishing location on the Danube, in the Iron Gates region in present-day Serbia. Facing the river, a group of about twenty dwellings of trapezoidal plan were built in a technique resembling that used by *Homo erectus* at Terra Amata, with a palisade of branches on either side of the house leaning against an inclined central ridge pole. Here the floors of the huts were of packed earth plastered hard around a central stone-lined hearth [9.5]. At Střelice, in the Czech Republic, in the remains of a Neolithic settlement of about 6,500 years ago (4500 BCE) was found a clay model of a rectangular house [9.6]. It had straight, vertical walls and a double-pitched, or gable, roof. The walls of the model suggest that actual houses may have had walls made of woven wood mats covered with mud plaster, perhaps with a roof of thatch. Fragments of a similar clay model found at Ariuçd, Romania, are inscribed with curved geometric patterns, suggesting that the houses may have been painted.[11] Remains of houses of this type have been found at the Cucuteni Tripolye settlement at Hăbăşeşti, Romania. At Sittard, in what is now the Netherlands, and at many other sites in places such as Poland, Hungary, and the Ukraine, wood longhouses were built with substantial timber frames, up to 260 feet (80 m) long, with walls and inner partitions of wattle and daub (a basketwork of

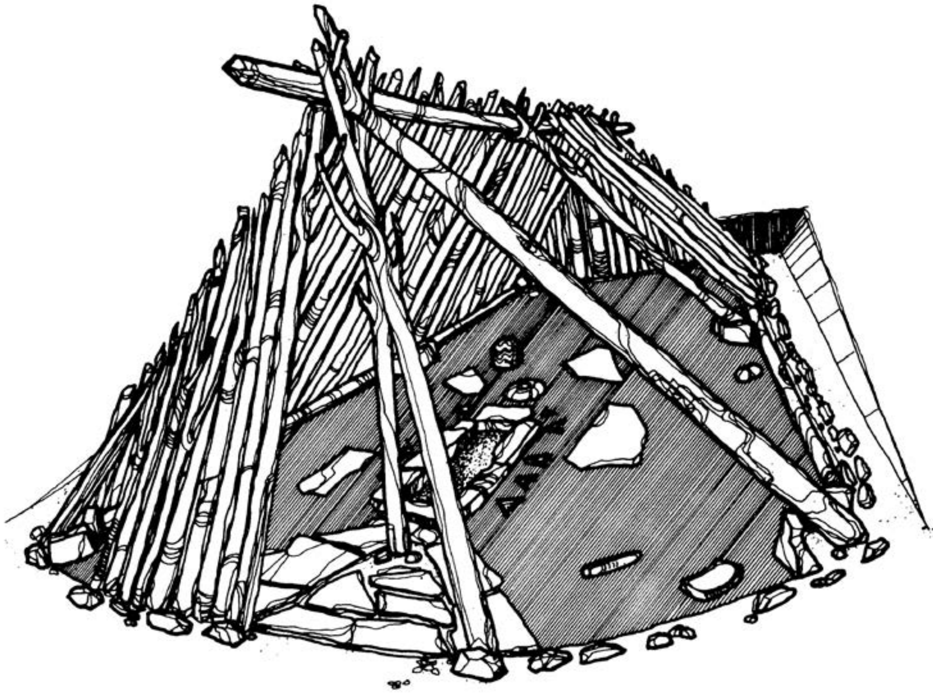


9.4. Monte Verde dwellings plan, together with reconstructed view, Monte Verde site, Chile, c. 14,800 to 13,800 years ago. Here the oldest yet-discovered organic dwelling fragments were found under a layer of peat that had sealed off oxygen, thus preserving the fugitive wood and leather remains. Drawing: L. M. Roth after T. Dillehay, Monte Verde *(Washington, DC, 1997); with conjectural perspective view from* Scientific American, *October, 1984, with permission.*

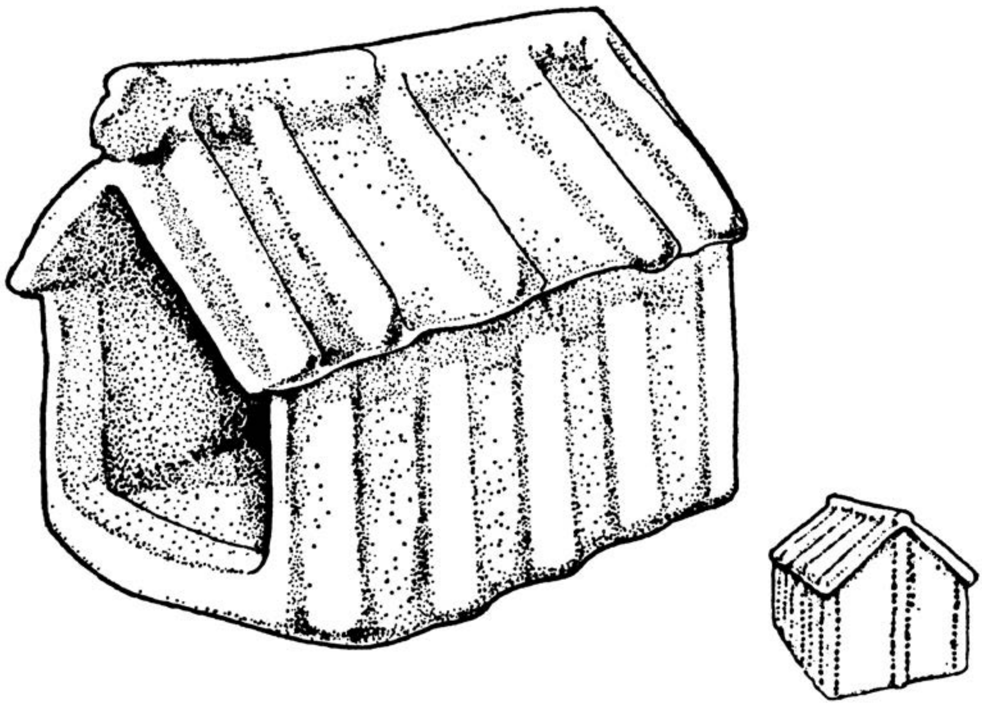
sticks covered with clay plaster). Dating from around 7,300 years ago (5300 BCE), these longhouses accommodated several families or perhaps one extended family in each building.

Another village survived in remarkable detail, covered by a lake at Biskupin, Poland, about 90 km northeast of Poznań. Discovered during an extended drought in 1933 that lowered the water level, the village had been built about 3,000 to 2,500 years ago (1000–500 BCE). More than one hundred large oak and pine longhouses, with individual family chambers, about 26 × 33 ft (8 × 10 m) each, were arranged in rows on wood-paved streets about 10 feet wide, all facing south. The entire village was enclosed within an oval-shaped protective log wall, with one entry protected by a watchtower. Following extensive excavations by a Polish team (1934–1936), followed by a German team (1940–1942) and then again by Polish archaeologists (until 1974), the village has been rebuilt as an open-air museum[12] [9.7].

The early development of a complex social structure in these settled communities is suggested by evidence of a division and specialization of labor. Whether these groups were egalitarian or whether ruling families emerged is difficult to tell, but the structures that the communities built clearly reveal a communal purpose and the ability to devote substantial energy to the building process. The community as a whole was no longer involved solely in physical sustenance, so that a growing portion of villagers' energies could be directed at expressing, in increasingly durable and symbolic ways, the values of the community.



9.5. Middle Stone Age village, Lepenski Vir, Serbia, c. 5200–4800 BP. Groups of such dwellings were built in terraces on the banks of the Danube. The houses had trapezoidal plans, measuring from 8 to 11 feet lengthwise, and hard limestone plaster floors, with central stone-lined hearths. From D. Srejović, New Discoveries at Lepenski Vir *(New York, 1972).*



9.6. *Clay model of a house, Střelice (near Brno), Czech Republic, c. 4700 BP. From N. K. Sandars,* Prehistoric Art in Europe *(Harmondsworth, England, 1968).*

9.7. View of the reconstructed village at Lake Biskupion, Poland, archaeological remains dated 1000–500 BCE. Because the site was flooded with water for two millennia, the wood structural members did not disappear through decay. Photo: Ludek.

Connecting with the Dead and the Cosmos

As Lewis Mumford noted: "Mid the uneasy wanderings of Paleolithic man, the dead were the first to have a permanent dwelling: a cave, a mound marked by a cairn, a collective barrow."[13] Since that was written in the 1950s, new archaeological discoveries have proven Mumford perceptive beyond even his most extreme projections. What Mumford proposed was that the earliest permanent human-built structures were not intended for individuals: they were not houses for the chiefs in the villages but, rather, communal undertakings—structures that focused on shamanistic rituals or served as places for the dead or even as devices for tracking the course of time. While stone was not used in the oldest solar observatory yet discovered, its antiquity and that of the most ancient ritual temples recently discovered have pushed our understanding of human sacred construction back several millennia from the Pyramids in Egypt or the stone megaliths of Stonehenge.

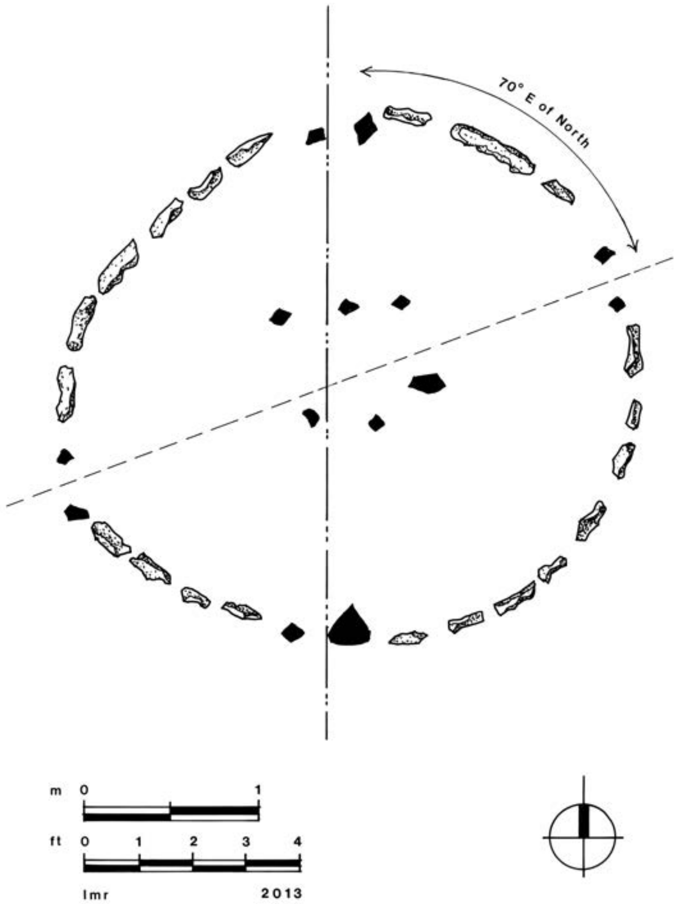
The Göbekli Tepe Sanctuary (Southwestern Turkey). It was once assumed that cities and the significant religious structures within them did not arise until *after* agriculture was developed and cattle, sheep, and goats were domesticated; in other words, it seemed impossible that hunter-gatherers in their nomadic movements could have engaged in significant permanent building, much less the establishment of fixed religious centers. Impossible, that is, until the late 1990s, when intensive excavations were begun at the Göbekli Tepe site in southeastern Turkey. Very quickly it became clear from the material being unearthed that the highly unusual structures had been built around 11,600 years ago (9600 BCE) and that, in fact, the first work on the site had been started another 2,000 years before that. It quickly became known as the oldest temple site in the world [9.8 and p. 162].

Excavation work is still ongoing, and the archaeologists caution that since less than 5 percent of the total 22-acre site has been opened, the interpretations now emerging are incomplete; nevertheless, the extremely early dates seem well established. The geography in southeastern Turkey twelve millennia ago was far more lush and rich with game animals than the arid landscape of today; nomadic people came together here at intervals and created a shrine or sanctuary dedicated to the dead. They built using

9.8. Temple structure, Göbekli Tepe, southeastern Turkey, c. 9,600 BCE. Built as a group of several round ceremonial structures (possibly temples), these buildings were abandoned and deliberately buried. Photo: © National Geographic Image Collection/Alamy.

large T-shaped stone piers set in rings on bedrock or a prepared hard floor, positioned radially like spokes, each carved with various animal images including foxes, lions, cattle, hyenas, wild boar, wild asses, cranes, ducks, scorpions, spiders, phalluses, geometric patterns, and many snakes. These T-shaped pier stones reach lengths of 23 feet (7 m) and weights of 11 to 22 tons (10 to 20 metric tons). Taken from scattered quarry sites around the sanctuary complex, the stones were moved as far as 1,640 feet (500 meters) away to construct six or more "temples" (perhaps as many as sixteen), ranging from 30 to 100 feet in diameter. Estimates suggest that as many as five hundred people worked here at times. What makes this achievement astonishing is that it was accomplished over a span of three millennia, without metal tools and before the wheel—the pier stones and carvings shaped through a process of pounding stone against stone. Even more curious, it seems that after about 3,000 years of use the temples were deliberately backfilled with stone debris and bones. Apparently as towns appeared in the region about 9,500 years ago (see the discussion of Çatalhöyük below), the purpose of the round temples faded away and accordingly they were deliberately closed. In defiance of all conventional wisdom, it seems that at Göbekli Tepe, as excavator Klaus Schmidt expressed it in the title of his report on the subject: "First came the temple, *then* the city."[14]

Nabta Playa (Southwestern Egypt). The desire to understand the cycles of the sun led to the creation of a solar and stellar "observatory" at a time much earlier than was once supposed. It was found at a surprising location, about 100 miles (160 km) east of Abu Simbel on the Nile in southern Egypt, deep in the interior of today's nearly completely dry Nubian Desert. Toward the end of the last ice age, however, around 12,000 years ago, weather patterns shifted northward, lasting up to about 5,600 years ago (4600 BCE). During this interval, summer monsoon rains brought as much as six inches of water each year, creating an intermittent lake there. With the water a seasonal verdant savannah existed, a *playa* that supported extinct buffalo, large giraffes, and varieties of antelope and gazelle. Evidence indicates that humans used that area 10,000 years ago, first in nomadic groups and then, by 7,000 years ago (5000 BCE), keeping numbers of wild cattle and wild Barbary sheep in more permanent settlements. Communities formed around deep wells, and houses were built in straight lines using stone, though there may still have been nomadic movement with the cycle of the monsoon rains.



9.9. *Star observatory, Nabta Playa, Egypt, 4,800–4,000 BCE. Stone slabs removed from nearby exposed outcrops were set upright at critical spots to mark out alignments of sun positions and star rising points. Drawing: L. M. Roth after T. G. Brophy,* The Origin Map . . . *(2002).*

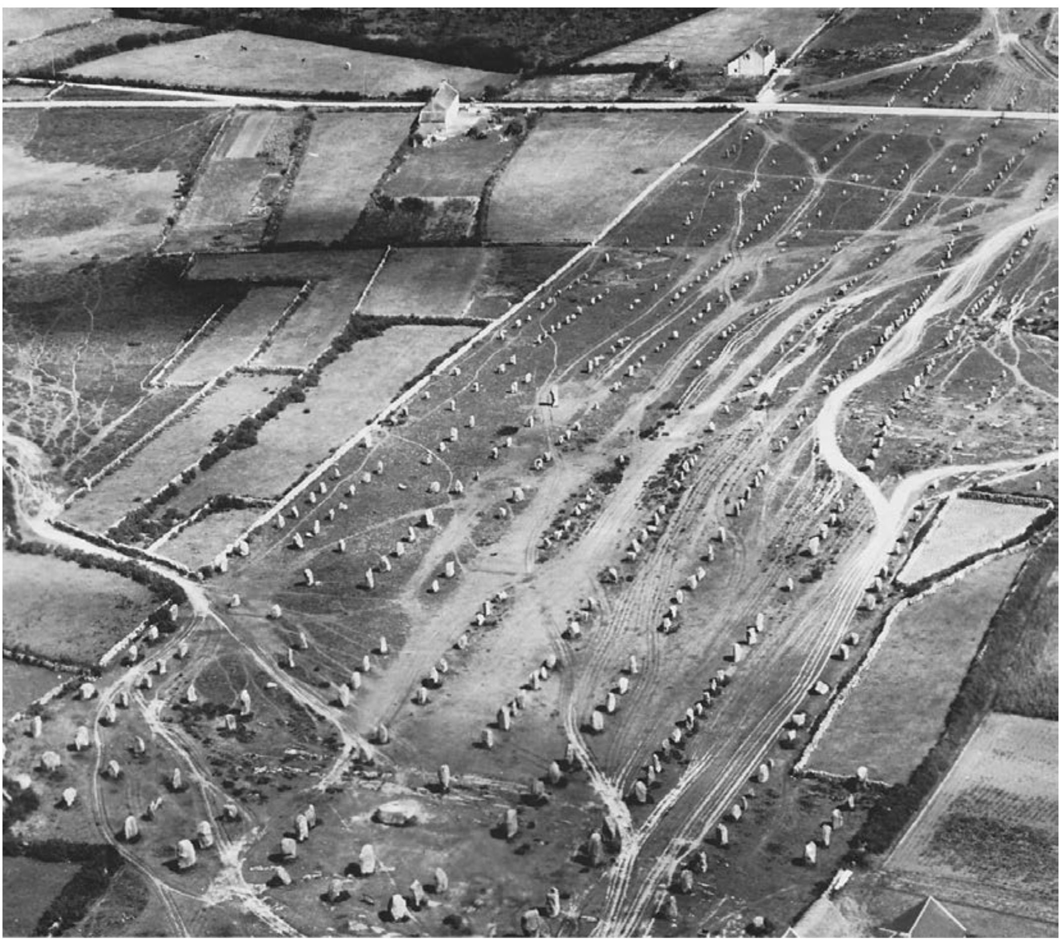
Over the centuries about thirty megalithic structures were built in the region, and particularly about 6,800 to 6,000 years ago (4800–4000 BCE) a sun and star observatory was constructed among the villages [9.9]. Naturally occurring broken stone slabs of sandstone from an exposed outcrop located over a mile away were dragged to the site, some laid flat and others set vertical in the earth. The observatory consisted of a roughly 12-foot-diameter ring of about thirty stones, with two pairs of vertical stone slabs, one pair aligned with true north and the second pair arranged toward the summer solstice horizon, marking the time when the annual monsoons started. Other alignments were made with separate vertical stone slabs erected a mile or so distant; these alignments were at that time oriented toward Sirius (the brightest night star), Dubhe (the brightest star in Ursa Major), and stars in the belt of Orion.[15] By 4,800 years ago (2800 BCE), however, the monsoons had shifted well to the south and the Nubian Desert reemerged, with people abandoning the Nabta, perhaps moving east to the dependable water of the Nile.

The Goseck Circle (Germany). Far to the north, at nearly the same time—roughly 6,900 years ago (4900 BCE)—in the Burgenlandkreis district in Saxony-Anhalt, Germany, people built a very similar construction for observing the mid-winter solstice to mark the moment when the sun stopped its southern movement and began its return north with ever-lengthening days.[16] Called today the Goseck Circle, it was built of earth and wood; but even after millennia of farming the overlying ground, sufficient alteration remained in the soil to show up in aerial photographs in 1991, leading to painstaking excavation. This northern observatory consisted of ditches dug in the earth in four concentric circles with an outer diameter of 246 feet (75 m). Included in the centric rings were two parallel wood palisades opened up with three gates, one pointing southwest, another pointing southeast, and the third pointing due north. Sometime after construction a moat was dug around the whole.

Western European Megaliths

While hides and wood timbers may have been suitable for dwellings and other utilitarian structures, monumental architecture in stone was invented for more symbolic ritual structures. Where typically one or two individuals could put up a wood-framed and hide-covered house in a day or two, now the efforts of specialized workers began to be devoted to quarrying massive stone *megaliths* (from the Greek *mega,* "great," plus *lithos,* "stone") and transporting them to the building site; construction could take weeks, months, years, even decades. Among the oldest of these megalithic sites is the cluster of as many as two hundred tombs (now reduced to around one hundred) at Carrowmore, County Sligo, northern Ireland. Some archaeological evidence suggests that building started as early as 7,400 years ago, but more secure dating suggests 6,000 to 5,500 years ago (4000–3500 BCE).

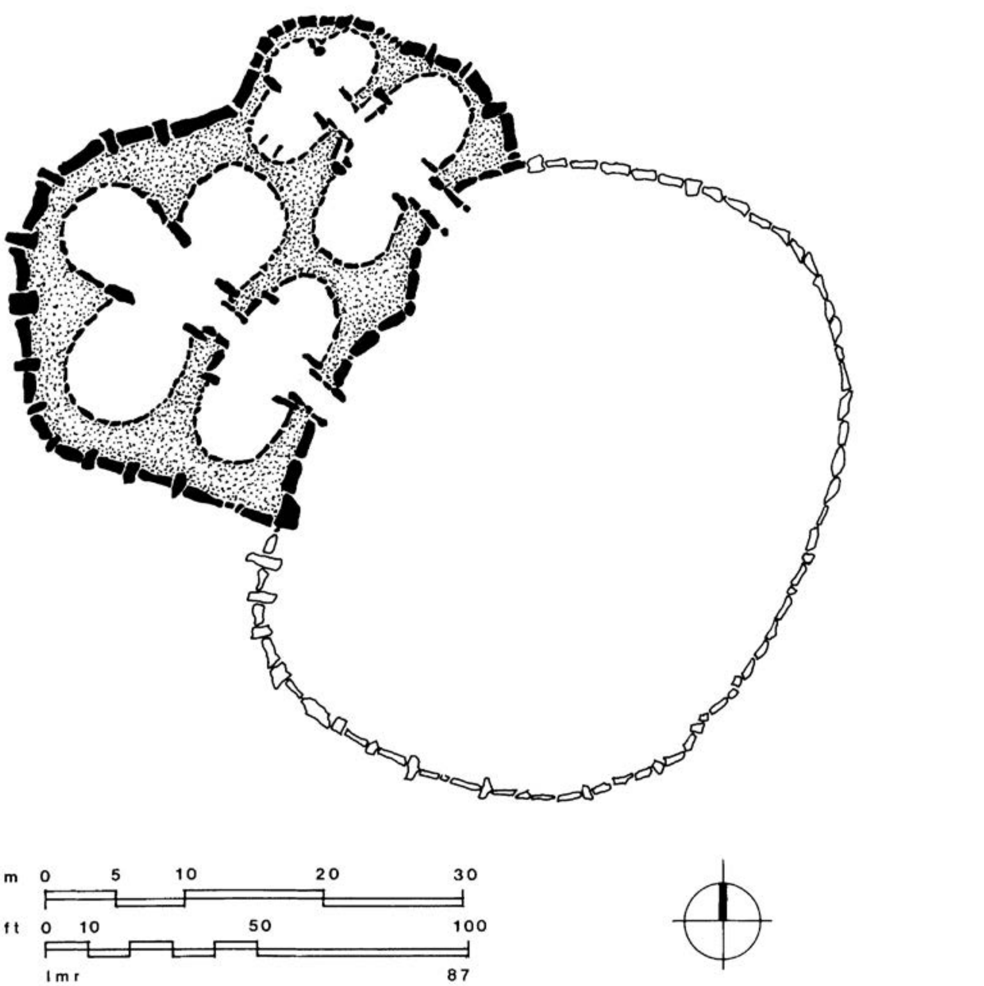
One type of megalithic construction was the freestanding stone columns called *menhirs* (a Celtic word meaning "long stone"), cut in large numbers and erected vertically in circular patterns or parallel rows, marking a spot for some ritual purpose whose precise meaning is now lost to us. Such megalithic arrangements, the most numerous of all ancient stone constructions, appear across northern Europe, but the oldest are those of Brittany in northeastern France. There, at Carnac, are rows of stones stretching 4 miles (6.4 km), some erected as early as 6500, but most likely around 5,300 years ago (4500–3300 BCE) [9.10]. Nearby, at Kerloas, is the



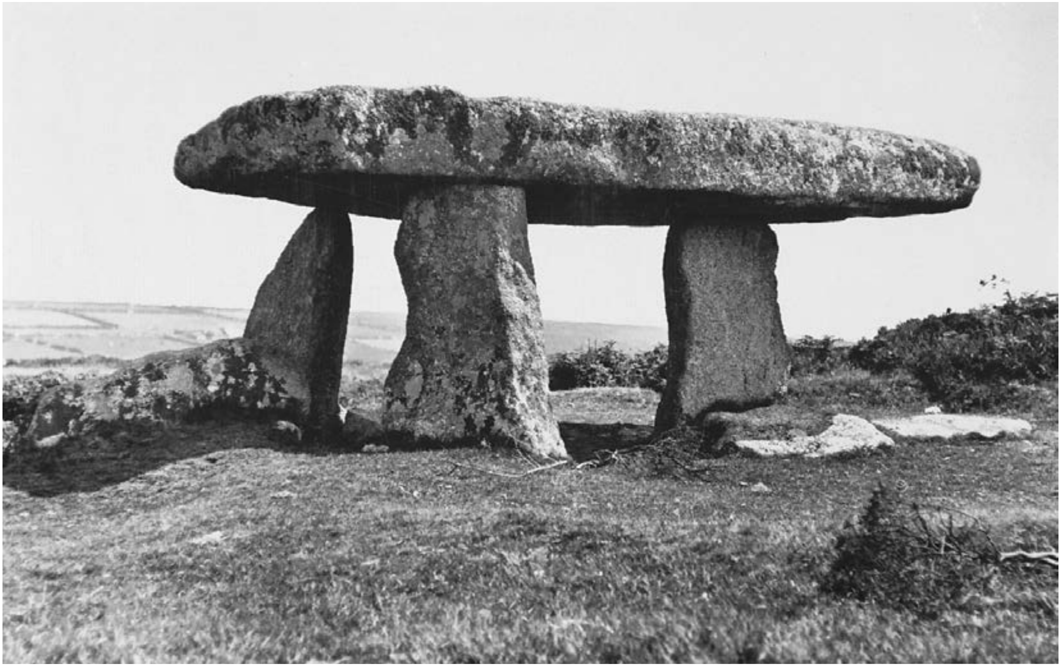
9.10. Aerial view of aligned stone uprights, Carnac, Brittany, France, c. 4700 BP and after. Over three thousand stones are fixed upright in eleven rows, but the purpose of this building activity remains unknown. Photo: French Government Tourist Office, New York.

largest megalith still standing, 39 feet high (11.9 m), but the biggest of them all was Le Grand Menhir, today broken into five pieces but originally 70 feet (21 m) long. Erected at Locmariaquer in Brittany, it would have been visible for miles around the Bay of Morbihan. The megalith was partly worked and smoothed, of a granite not native to this area but from central Brittany. Moving it and erecting it in its present location was a considerable feat, considering that it would have weighed 345 tons. This was clearly the work of sophisticated minds exercising careful preparation and organization.

About 5,500 years ago (3500 BCE), a group of temples was begun on the islands of Malta, in the middle of the Mediterranean Sea. By 3,500 years ago (1500 BCE), these sites were built over with the temple ruins we see at Malta today. These Maltese temples are spatially more complex than any of the other buildings of the Neolithic period. One of the temples, in fact, is carved into the limestone hill at Hal Saflieni. Given the Greek name *hypogeum*, "cellar," it was a catacomb for housing seven thousand dead. On the Maltese island of Gozo is found the temple complex called Ggantija, Maltese for "gigantic." [9.11]. Somewhat similar to many of the thirty other Maltese temples, this complex was built in stages, with connected clusters of rounded rooms defined by parallel walls of large, limestone facing-blocks, the space between them filled with stone rubble and earth. The inner walls were partially finished in more carefully cut blocks of a deep-yellow limestone, some carved with spirals and other curvi-



9.11. Temple complex called Ggantija, Malta, c. 4200–2900 BP. This is only one of many buildings in stone on the Maltese islands, built over several centuries, apparently as religious centers. Drawing: L. M. Roth.

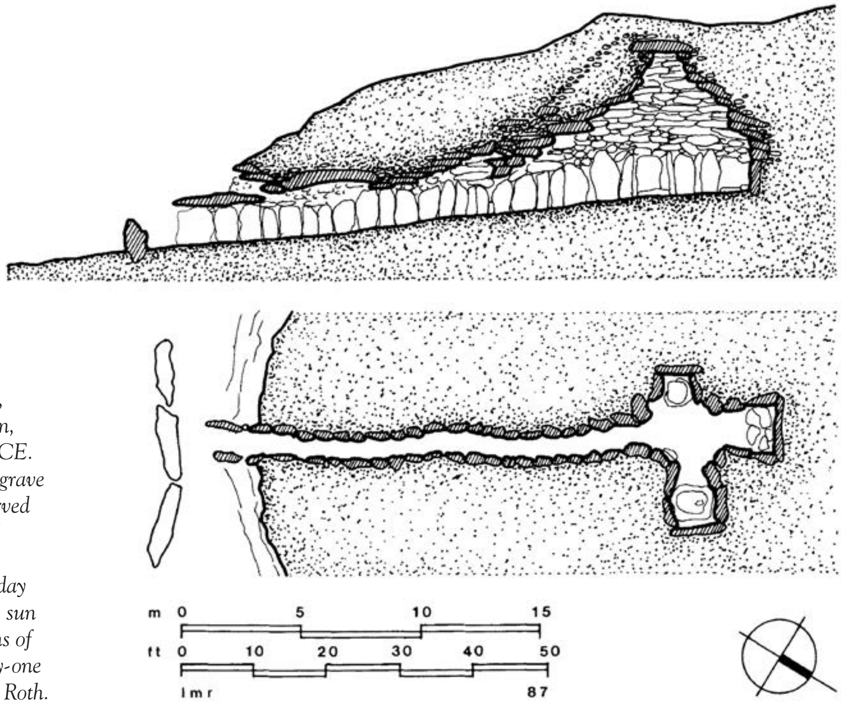


9.12. Lanyon Quoit, Cornwall, England, c. 3200 BP. Originally covered by great mounds of soil, such stone structures seem to have been burial chambers (judging from the few artifacts found in some examples). Photo: Visual Resources Collection, Architecture & Allied Arts, University of Oregon.

linear patterns. Massive superimposed stone lintels, carried on huge vertical jamb stones on either side, form the door to the Hagar Qim temple on the island of Malta, the world's oldest monumental entrance. What the upper structure of these temples may have been is not clear, but beams and rafters of wood may have formed the roofs.

In northern Europe, the roofed tomb structures are known as *dolmens* (Celtic for "table stones") and consisted of at least three vertical stone slabs supporting a massive horizontal roof slab or boulder [9.12]. This type is found at the Carrowmore site noted earlier; Lanyon Quoit is located in Cornwall, England. Originally each dolmen was covered with a mound of earth, which has long since eroded away. In some cases, four large, roughly rectangular slabs make up the base, forming something like a gigantic stone box, with an immense stone lid. Sometimes these dolmens were extended, with a series of stone slabs forming two parallel walls that were capped with numerous roof slabs, all covered with earth. These long barrows were gallery graves, with a series of bodies placed in the extended chamber. In several locations, the barrows ended in a roughly circular chamber roofed with small stones laid in rings that closed in as they rose, each stone cantilevered over the one below, forming a corbeled vault.

One of the most impressive of these passage graves, the New Grange tomb near Dublin, Ireland, has survived nearly intact in the core of a huge earthen mound. Begun about 5,200 to 5,000 years ago (3200–3000 BCE), the tomb is one of three huge mounds found about 16 miles (25.7 km) up the River Boyne from its mouth at Drogheda. Within the mound, which measures variously 260 to 280 feet (79 to 85 m) in diameter, is a long rising entrance passage, roughly 60 feet (19 m) in length, leading to a corbel-domed, cruciform (three-lobed) inner chamber [9.13]. The tomb is carefully oriented to the southeast, with its entrance partially but precisely blocked by an external curbstone. The components of the passage are aligned in such a way that once a year, on the morning of the winter solstice, at 9:58 a.m. local time, a beam of sunlight penetrates all the way to the back of the passage, striking the rear wall of the central "apse." For twenty-one minutes, the beam slowly sweeps across the rear wall and then darkness falls for another year. Only on that one day, of all the days of the year, does the sun reach into the depths of the tomb. When the tomb was completed, it was sealed



9.13. New Grange tomb, Boyne Valley, near Dublin, Ireland, c. 3200–3000 BCE. The entry passage of this grave was so positioned and curved upward that at the rise of the winter solstice in late December—and on that day only—the first rays of the sun would penetrate the depths of the tomb for about twenty-one minutes. Drawing: L. M. Roth.

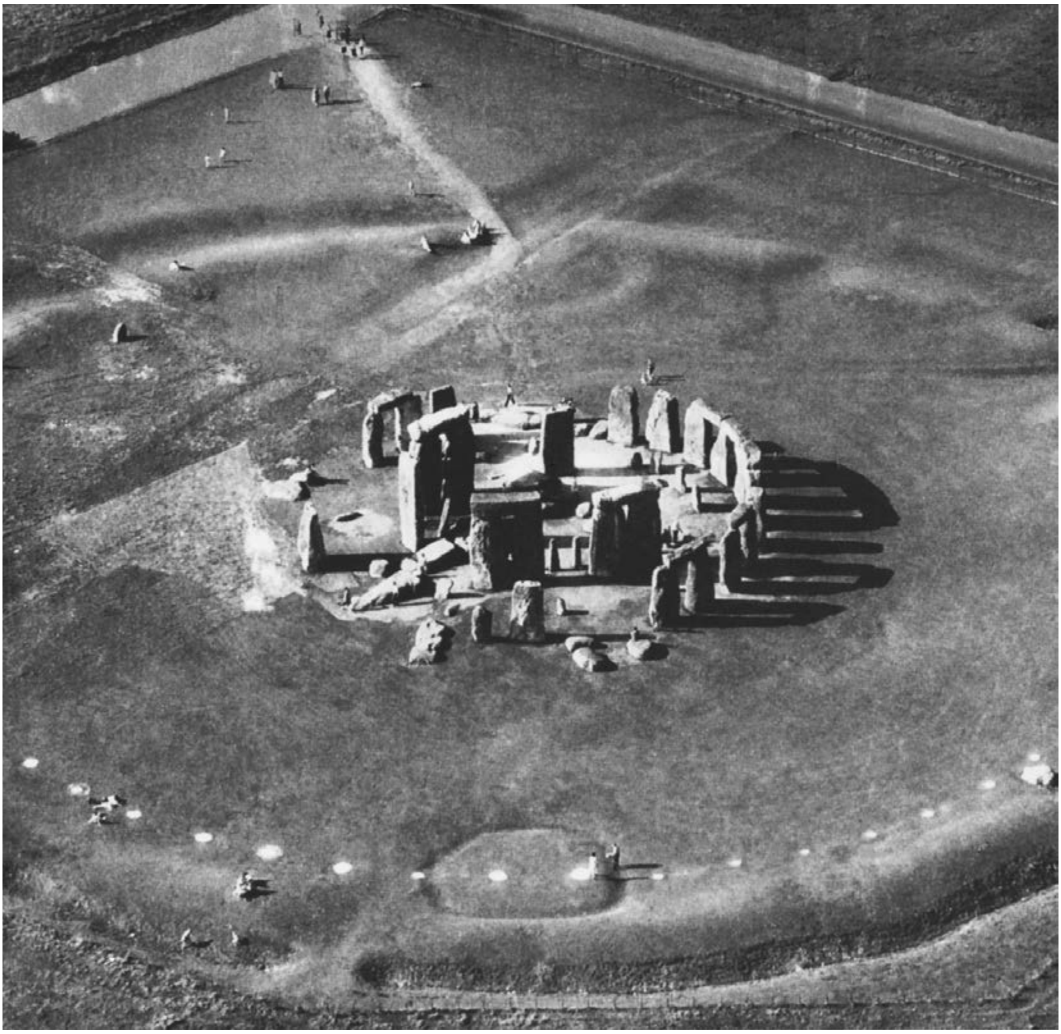
at the entrance, leaving only a narrow slit open at the top, so that thereafter, the opening for the shaft of solstice light served as a "channel of communication" between the living outside and dead within.

Stonehenge

Of all the prehistoric megalithic constructions, certainly the best known is Stonehenge, on the chalk downs of Salisbury Plain, not far from Salisbury, England. Strictly speaking, there are three consecutive Stonehenges at this location, for the complex was built in three major stages over a period of more than 1,200 years, not by one group of people but by successive generations living in the area. The first stage consisted of marking out the location, sometime around 5,100–5,050 years ago (3100–3050 BCE). By means of a leather thong or a woven rope 160 feet (48.8 m) long affixed to a central stake, a circle was drawn 320 feet (97.5 m) in diameter. A circular trench was dug into the white chalk, with the chips piled up on the inside, creating an inner wall originally about 6 feet (1.8 m) high. An opening was left at the northeast side and a large menhir, the heelstone, was erected just outside the entrance. In addition, fifty-six holes were excavated just inside the embankment for the placement of wood posts, creating a "woodhenge."

Then, between 4,100 and 4,075 years ago (2100–2075 BCE), in the second phase of construction, a crescent of blue stone uprights was erected inside the circle, including a large upright stone aligned with two others outside the entrance near the heelstone. The blue stones are of special significance, since they could only have come from the Prescelli Mountains in Pembroke, southwestern Wales, nearly 245 miles (380 km) away. It seems most likely that they were dragged from the quarry to what is now Milford Haven in Wales, and then moved by sea to the vicinity of Bristol, on the Avon River; from there the stones were hauled overland to the plain of Salisbury and then along a long, curved causeway or avenue to the site.

The third and last phase of Stonehenge created the complex we are familiar with today. The building phase started as early as 2000 BCE and was finished by 1500 BCE [9.14 and 19.15, p. 164]. The blue stones were temporarily removed, and immense sandstone sarsens or stone uprights (quarried in Marlborough Downs about 20 miles [16.1 km] away) were raised to form a circular colonnade 20 feet (6 m) high, with curved lintels. Within the enclosure were erected five even larger trilithons (two uprights carrying a lintel) enclosing a horseshoe that opens toward the heelstone to the northeast [p. 6]. It was a prodigious effort, requiring the labor of roughly 1,100



9.14. Stonehenge III, Salisbury plain, Wiltshire, England, c. 2000–1500 BCE. The present Stonehenge is simply the last of three distinct building phases carried out over almost one and a half thousand years. Photo: Aerofilms, London.

laborers over a period of seven weeks to move each individual stone from quarry to building site, not to mention the stonecutters at work in the quarry and the finishers carrying out the final dressing of the monoliths at the site. Each upright had to be tilted, in small increments, perhaps supported by wooden towers or cribs of crossed logs until it slid into its waiting hole and then was made properly plumb. The lintels were likely levered up on similar log cribs and moved sideways into place. The stone surfaces may appear to us rough compared to contemporaneous work in Egypt or Greece, but this was not the handiwork of primitive people. Building Stonehenge required detailed social organization and cooperation of a high order over an extended period.

Yet the essential question remains: What was it for? The effort of many generations, extended over so many centuries, was undertaken for some compelling purpose. As recent investigations suggest, this complex served as an astronomical observatory, for the alignment of the heelstone with the stones in the center of the circle is such that at the summer solstice, about 4,000 years ago, the sun would have risen directly over the heelstone, as viewed from the center of the trilithons. Other alignments within the complex suggest that Stonehenge might have been used to mark phases and eclipses of the moon and other astronomical phenomena. But, as archaeological evidence of a similar enormous, round structure—this one made of wood—just 2 miles

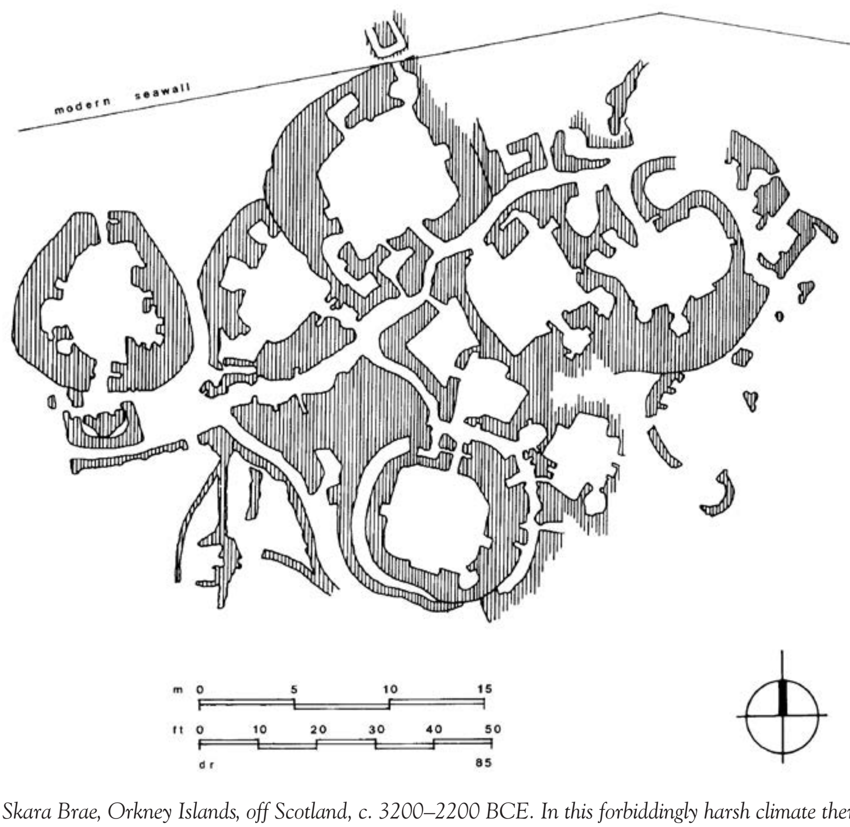
(3.2 km) away makes clear, the same results could have been achieved with much less effort. Stonehenge may indeed have served such an astronomical function, but it was built with such care and expenditure of labor that it also became a tribal expression of identity, the physical manifestation of a social covenant, a symbol of communal purpose. It was a gathering place where each year the recurring cycle of the sun and of life was celebrated by the assembled people.

A Neolithic Village: Skara Brae

The prodigious effort involved in building in stone seems to have been expended only on structures for the dead and on sacred monuments. The houses of the workers who built the dolmens, the barrows, and Stonehenge were most likely made of timbers, hides, and thatch and have long since disappeared. We do have the remarkable survival of at least one village, however, dating from about 5,200 years ago (3200 BCE) and abandoned about 4,200 years ago (2200 BCE). Portions of the village remain only because it was built almost entirely of stone owing to the absence of locally available wood. Skara Brae, located in the forbiddingly harsh and stony Orkney Islands north of Scotland, was revealed by accident after a lashing storm in 1850 blew off the sand that had covered the village for more than 3,000 years (it had most likely been buried by just such a storm). Because there is virtually no wood on the islands, the houses were built almost entirely of stone, with stone shelving, tables, and beds. Hence, they were preserved from decay, affording us an intimate glimpse of how life was lived in northern Neolithic Britain [9.16, 9.17]. There were ten houses in all, with narrow alleys winding between them. When the site was excavated, the walls were partially collapsed, but judging by the whale bones found in the dwellings, the roofs may have been of hides or thatch supported by rafters made of whale bones.

From Villages to Cities

The deliberate cultivation of collected grains began in southern Egypt as early as 19,000 to 12,000 years



9.16. Skara Brae, Orkney Islands, off Scotland, c. 3200–2200 BCE. In this forbiddingly harsh climate there is little wood, so almost all parts of the houses were made of stone and thus have been preserved. Drawing: David Rabbitt.

9.17. Skara Brae. View into one of the dwellings. Photo: Courtesy, Marian Card Donnelly.

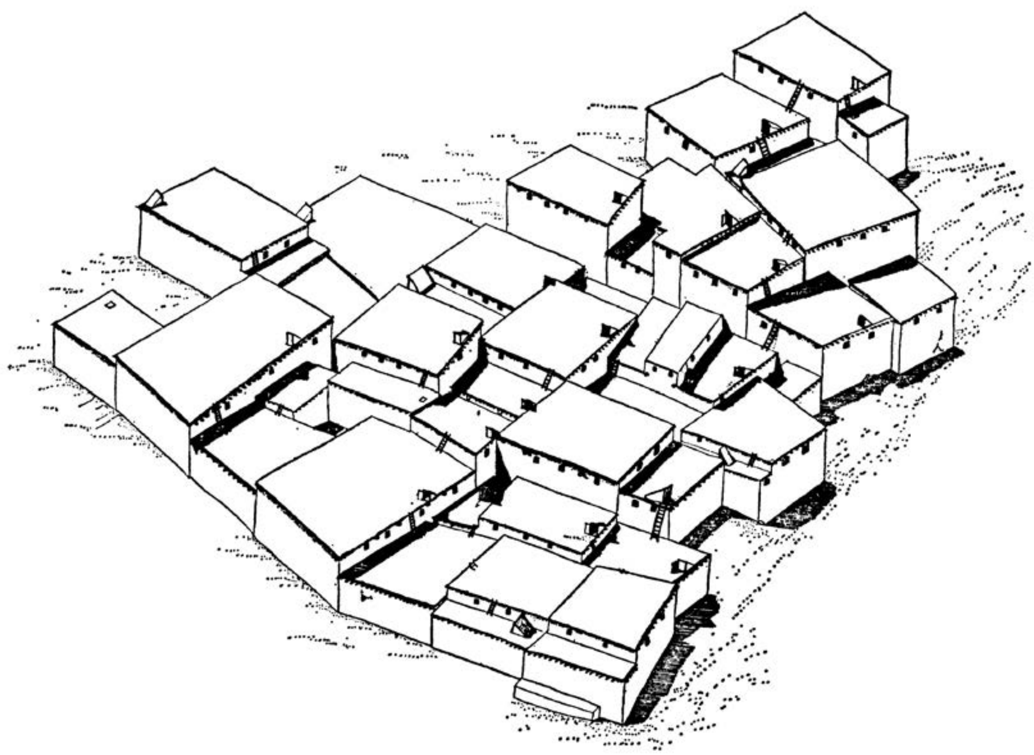
ago, as evidenced by the well-used grinding stones found there. By 10,000 years ago, agriculture had been firmly established in what is called the Fertile Crescent—the area along the valley of the Nile, up the coast of the eastern Mediterranean, across what is now southeastern Turkey, and down the valleys of the Tigris and Euphrates Rivers. Once this Neolithic period, or what the historian V. Gordon Childe called the "Neolithic revolution,"[17] had begun, the patterns of human activity were profoundly changed. Examination of sites uncovered since the 1930s and 1940s suggests that formation of permanent settled communities in fact predated the development of agriculture, meaning that profound changes were occurring in how human beings thought about and cared for each other, and how they wished to live together. Bulky stone tools were replaced by implements with small cutting pieces of volcanic glass—obsidian—fitted into wood or bone armatures, allowing for easy replacement of broken or dull cutting segments. The most sweeping social changes grew directly out of the development of agriculture. No longer spending their lives moving cyclically with the rhythms of nature, people now resided in relatively fixed settlements, close to the planted fields. This encouraged more substantial buildings, and as villages, towns, and cities grew in size, social organization became more complex, requiring varied building types. Modern civilization has added very few new basic building types to those that arose from the needs created in Neolithic times—houses, storage facilities, governmental and civic buildings, and religious shrines. Only in the areas of mechanized transport have wholly new building types been developed just in the last two centuries.

Çatalhöyük (Southwest Turkey)

Large, permanently inhabited cities appeared at almost the same geological moment the glaciers retreated. Remains of the earliest stone-built communities have emerged in modern-day Turkey, Israel, and Jordan, dating back as much as 14,000 years ago. Archaeological excavations down through the mound of the ancient city of Jericho in Israel have shown that this was an established city as early as 11,000 years ago. Our most detailed understanding of how a Neolithic city functioned, however, comes from the successive layers of the well-preserved town of Çatalhöyük, a city built next to the Çarsamba River on the Konya Plain of south-central Turkey. Settled by at least 9,500 years ago (7500 BCE), this city had perhaps eight thousand residents a thousand years later. Despite being miles from the fields, the town was built on a mound in the midst of marshes that provided a good grade of clay used everywhere to plaster walls and floors. Çatalhöyük was not only a farming community but also a vital link in the trade network that transported highly prized obsidian from the northern volcanic areas to cities throughout the Fertile Crescent of Palestine and Mesopotamia. But besides obsidian and the Neolithic technology that this material implies, implements of copper and lead were found at Çatalhöyük, hinting at the beginnings of the Bronze Age.

Çatalhöyük covered an area of 32 acres (12.9 hectares), of which about a quarter was excavated during 1961–1966, an area that turned out to be a residential quarter. Excavation was resumed in earnest in 1993.[18] There were no streets as such through the town, but tightly clustered rectangular houses instead, with an occasional courtyard between them that served as a rubbish dump [9.18]. Entry to each house was by means of a hole in the roof that also served as the vent for the smoke of the central hearth. The residences were built with timber frames, the panels between the posts and beams filled with mud brick, plastered, and often painted. In one house, a wall was painted with a landscape of the view toward the volcanic mountains in the distance, with a plan of the city depicted in the foreground; in another house were painted figures of dancers. It is interesting that nearly a quarter of the chambers excavated by 1966 had shrines devoted to a mother goddess and a bull cult, though subsequent excavation indicates no particular emphasis on a mother goddess.

Çatalhöyük was only one of scores of similar small cities that flourished in the area of Palestine, southern central Turkey, and modern Iraq. Particularly old, however, was the town now known as Abu Hureyra, on the Euphrates in present-day Syria (the site is now flooded). From a small settlement whose establishment dates to around 13,000 years ago, there developed a larger community by 11,000 to 9,000 years



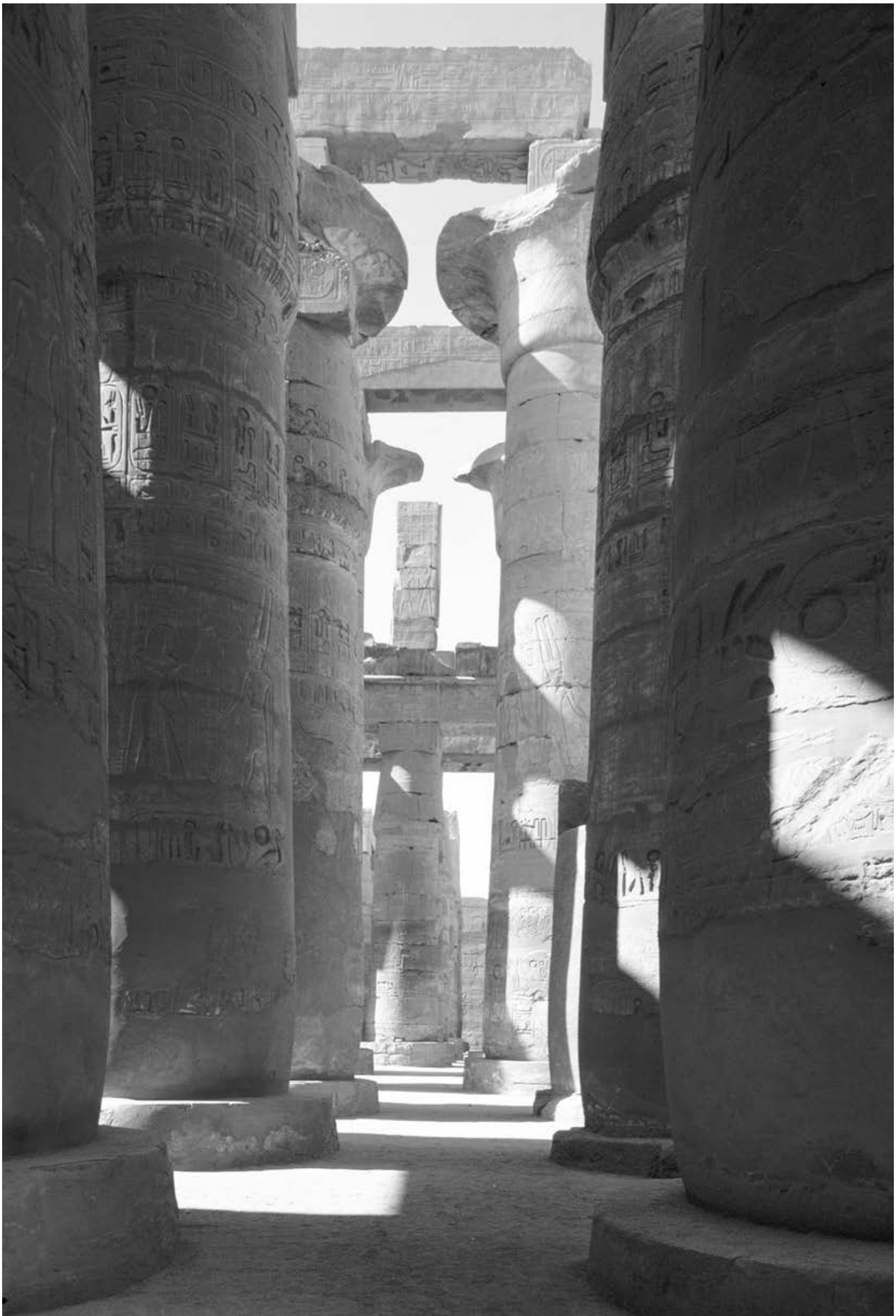
9.18. View of Level I, Çatalhöyük, Turkey, c. 7500 BCE. The houses were packed tightly together, with no streets; access to the dwellings was through openings in the roof. From J. Mellaart, Çatal Hüyük *(New York, 1967).*

ago. Evidence suggests a clear transition from hunting to the consumption of cultivated grains during this period. Another town was Çayönü, near Diyarbakir, southeastern Turkey, which was occupied as early as 9,250 years ago (7250 BCE). Over several centuries, its inhabitants, similar to those in many other locations, gradually made a transition from consuming wild animals to raising domesticated animals and from using stone to forging copper to make small tools. Another village was 'Ain Ghazal, in modern Jordan, also settled as early as 9,250 years ago with a population of perhaps two thousand people. Yet another small city is today called Jarmo, east of present-day Kirkut in northeastern Iraq. Jarmo flourished about 9,000 years ago but probably never had more than twenty-five houses, with a population of perhaps 150 people.

Areas with population figures ranging from 150 to 10,000 inhabitants may seem like small villages today, not cities in modern terms. Use of the words *city* and *urban,* however, connotes not simply a large congregation of people but the rise of a complex social system. In this communal structure, numerous essential tasks are taken up by specific individuals so that no one exists in isolation whereas, together, people provide services for each other. These services include tasks that make a comfortable city life possible—growing food, managing irrigation, producing bread, making clay pots for storage, smelting copper or making bronze and fashioning tools, tending to ritual observances, maintaining shrines, and building houses—in short, all the myriad activities that make city living possible. By 6,000 years ago (4000 BCE), however, as economic and agricultural conditions changed, and with the surrounding fields presumably exhausted, cities like Çatalhöyük were gradually abandoned. But the crucial first steps in living together in settled communities had been taken. As Michael Balter notes, "nearly everything that came afterward, including organized religion, writing, cities, social inequality, population explosions, traffic jams, mobile phones, and the Internet, has roots in the moment that people decided to live together in communities. And once they did so, as Çatalhöyük indicates, there was no turning back."[19] The next steps in the formation of a truly urban culture would take place in the region watered by the Tigris and the Euphrates, the land between the rivers: Mesopotamia.

The Invention of Architecture

Once human precursors had developed techniques for hunting and had mastered the control of fire, they began to leave their African savanna homeland in an exodus that would take them to central and far-eastern Asia, as well as into Europe. As they left the benign climate of the lower latitudes for the more challenging northerly exposures, and as the ice ages made Europe a cold, forbidding place, the need for finding or making shelter became urgent. The first human-crafted (or, we could say, hominid-crafted) shelters were made, and architecture had begun. As modern human beings moved into Europe, the Middle East, and Asia, structures that were more developed were crafted, and, with the growing division and specialization of labor—not to mention the emergence of increasingly complex, centralized social organizations—energy could be devoted to fashioning more permanent structures of stone for ceremonial purposes and ritual celebrations. The next step was an increased concentration of peoples in towns that grew into cities. Monumental architecture had begun.



10.21. Hypostyle Hall, Temple of Amon, Karnak, Thebes, Egypt, c. 1315–1235 BCE. Photo: Erich Lessing/Art Resource, NY.

The Architecture of Mesopotamia and Ancient Egypt

At the temples' centers stood airless complexes of sunless rooms, chambers that only the ritually pure could enter, surrounding the small central shrines. In these dark sanctuaries elaborate rituals were celebrated through days and nights: rites that spanned years, decades and centuries, communions with eternity, the designs of numberless lives absorbed in deep pieties, built upon the impulses that sustained life in the Nile Valley: the tremendous power of the gods, the daily passage of the sun over the river valley, the river's annual flood and liquefaction of its fields, the germination of the seed, the ripening of the crop. The endless rhythms of the ancient state.

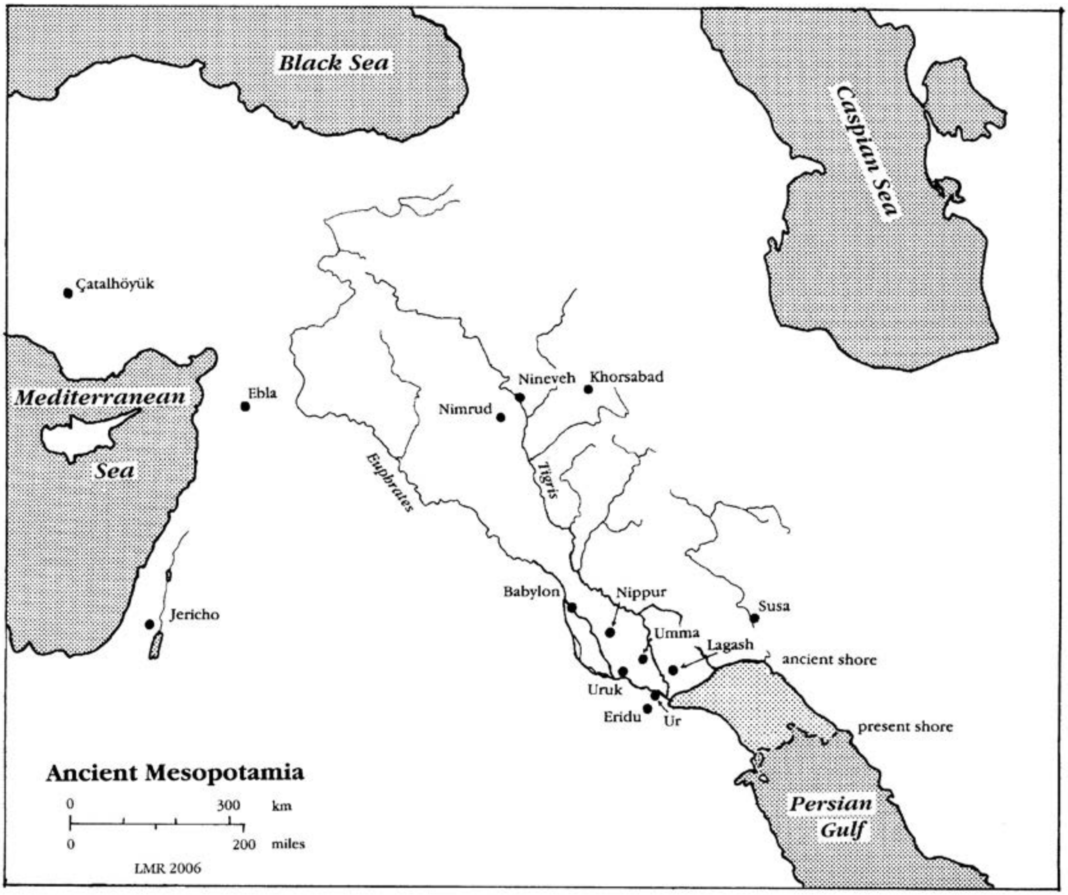
—*John Romer,* Ancient Lives, *1984*

The two great Western civilizations that followed the dramatic agricultural changes of the Neolithic period both arose in the Middle East, in arid regions watered by great rivers: Egypt along the banks of the Nile; and the successive cultures of Mesopotamia in the broad valley watered by two parallel rivers, the Tigris and the Euphrates. It was the control of these river waters that made intensive agriculture possible in both regions and, with the resulting abundance of food, the rise of urban cultures and the art and architecture supported by them.

Although nearly contemporary in their historical development, Egypt and Mesopotamia developed in quite different ways, and much of this difference can be attributed to geography. Egypt is a long, narrow oasis surrounded by extensive and forbidding deserts east and west, mountains to the south, and the Mediterranean to the north. It was thus largely protected from opportunistic incursion by neighboring people. Moreover, its soil was replenished annually by the rising flood of the Nile. Mesopotamia had a different geography and suffered a less benevolent history.

Mesopotamia: The Land Between the Rivers

Mesopotamia (essentially modern Iraq) is a broad, generally level land enclosed by the Syrian Desert to the west, the mountains of eastern Turkey to the north, and the Zagros Mountains in western Iran. During its long history, hostile groups repeatedly invaded from the north and east, producing periodic dramatic political changes [10.1]. From the mountains in eastern Turkey flows the Euphrates, while roughly parallel to it flows the Tigris, fed by numerous tributaries coming down from the Zagros Mountains. This unique circumstance of the two great parallel rivers led the Greeks later to call this region *mesopotamia,* "land between the rivers." Whereas the rising of the Nile could be predicted with regularity, the flow of the Euphrates and Tigris was never so predictable, with droughts punctuated by sudden random damaging floods. The comforting predictability of the Nile and the lack of external threats in Egypt contrasted sharply with the unpredictability of Mesopotamia's two rivers and its vulnerable political exposure; as a result, the two regions developed quite different cultures. Despite their marked differences, however, both civilizations developed their own system of writing early on. This advancement may have been the result of both cultures' early reliance on irrigation and agriculture, the secure definitions of parcels of land, and the need for tallying and taxing yields of grain. The oldest writing seems to have been developed in Mesopotamia, perhaps around 3500 BCE.



10.1. Map of Ancient Mesopotamia.

The Sumerian Period, Circa 4000 BCE to Circa 2370 BCE

At the end of the Neolithic period, from about 6000 BCE to 5500 BCE, a number of small villages in the upper half of the Tigris-Euphrates valley received sufficient rainfall to permit cultivation, but these groups of people also continued to hunt for food. Somewhat later, there appeared a village culture in the more southerly (and more arid) portion of the Euphrates valley, where carefully controlled irrigation was essential for agriculture. Eridu, one of the early major towns in the Sumer region, with perhaps four to five thousand inhabitants, was established around 5000 BCE. Other early significant cities were Uruk, Larsa, Umma, Tel Jidr, Nippur, and Kish, among many others. Over time, other towns grew, and governance was achieved through confederations of these small city-states. Some cities grew rapidly, as did Uruk, which expanded fourfold between 3000 and 2700 BCE. We speak of Sumerian *civilization,* for life was focused on the political, mercantile, and religious activities and achievements in these city settlements. Our term *civilization* derives from the Latin *civitas,* "pertaining to the citizens of a community," for life was increasingly now governed by actions taken and rules set down in the city settlements.

The growing reliance on grain agriculture meant that, after harvest, the surplus of seeds had to be stored, encouraging the development of clay pottery vessels that resisted moisture and attack by insects and rodents. Even more important was the need for some permanent way of recording grain tallies and communal decisions. Cuneiform writing was developed, using a wedge-shaped stylus pressed into soft clay tablets. Literary writing followed later, augmenting (and eventually replacing) ritual, dance, and song as the primary ways of transmitting human memory. The epic story of Gilgamesh, perhaps already centuries old, was first recorded in an early version of cuneiform by the Sumerians around

3000 BCE, making it the oldest known Western literary work. The far greater bulk of cuneiform writings found so far, however, consists mainly of legal decrees, lists, tallies, inventories, and measurements of land parcels down to the smallest increment. In some respects, the prosaic nature of most Sumerian writing is what makes the poetic story of Gilgamesh so special.[1]

For the sake of clarity, certain generalizations are made in the paragraphs that follow, for the political situation in Mesopotamia is complex in the extreme, partly the result of the numerous gradual incursions of outside peoples as well as periodic sudden and overwhelming military invasions. Each of these shifts affected differing parts of the region, while cities in other areas continued much as before, perhaps paying tribute to neighboring invaders. Over the last century and a half, a great abundance of cuneiform records have been found, since the engraved clay tablets can survive thousands of years when not broken into fragments. Translation and study continue today, so the story is an unfolding one. Nonetheless, some broad chronological designations need to be adopted if we are to make some sense of the long history of this region.

The oldest cities in Sumer were, at the time of their establishment, near the mouths of the two great rivers, but the burden of silt deposited by the Euphrates and the Tigris in the subsequent millennia has gradually moved the shore of the Gulf of Arabia 140 miles (225 km) to the southeast. This rich silt provided the only readily available building material—clay. The only native source of wood was the date palm, and because of the relative absence of structural wood in the marshes and flat expanses of Sumer, the earliest architecture was constructed of mud or clay (adobe) brick dried in the sun for several weeks and laid with mud mortar. Extremely fragile and easily reduced to dust if not constantly maintained, this mud-brick architecture has eroded over the millennia, and often only the building foundations remain. Although wood beams, or beams made of bundled reeds, were sometimes used to support roofs, more typical were mud-brick barrel vaults of short span, resulting in long, narrow rooms with the doors on the long sides. This design approach may have derived from the ancient technique, used in the marshlands formed where the two rivers deposited their silt, of building houses of bundled reeds, with spaced arches of bundled reeds supporting barrel-vaulted roofs. In fact, after five thousand years, this technique remains the way many ordinary people in this region of southern Iraq still build their houses and villages[2] [10.2].

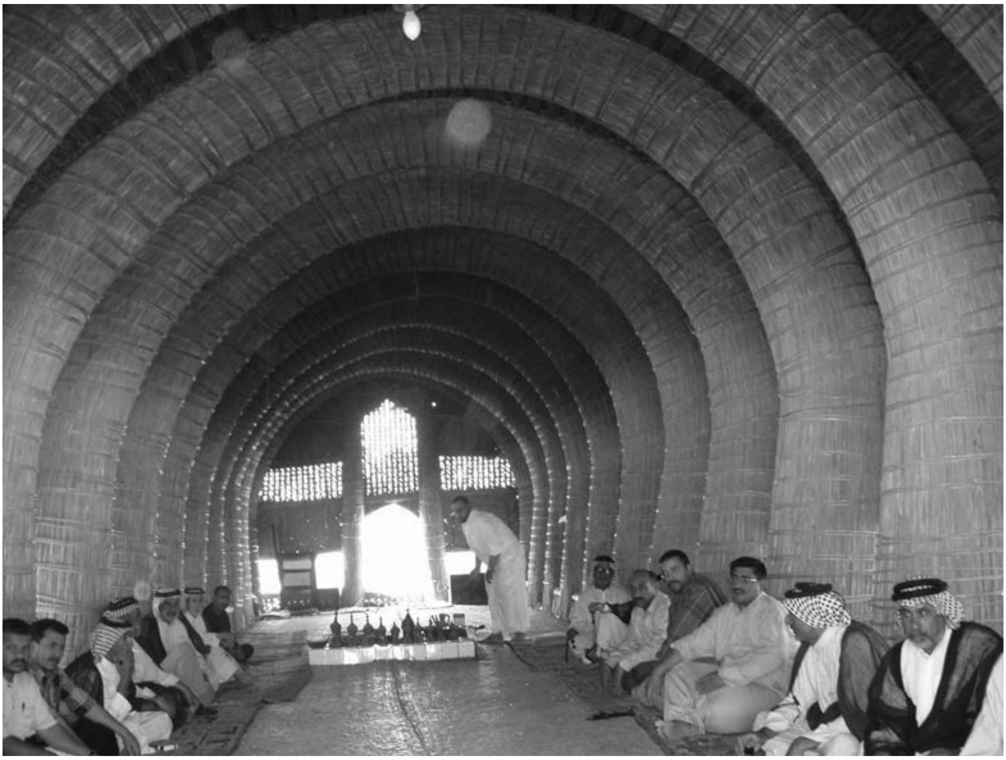
Evidence found at the deepest levels of excavation, where the remains of the oldest settlements are found, suggests that each of these settlements formed around an important central ritual or religious shrine. Hence, each of the oldest cities is dedicated to a particular deity. Eridu (established in about 5400 BCE) was sacred to Enki, the archaic god of water, for when it was founded the marshes and shore of the Arabian Gulf were not too far to the south; Ur (established in about 3800 BCE) was sacred to Nannar, the moon god; and Nippur (established in about 3500 BCE) was focused on a temple to Enlil, god of wind. Ordinary dwellings were clustered around courts where the temple was situated. The adobe brick walls of the early temples were protected from weathering by layers of whitewash or, in some instances, mud-brick cones with the ends dipped in colored glazes and laid with the points in the walls, forming linear or zigzag patterns, as found in the Pillared Hall at Uruk. The early temples were built on artificial platforms, perhaps so that they would be raised above floods, but in time, these artificial mounds were enlarged, rising through several set-back stages forming what are called ***ziggurats***. These artificial hills served as a way of elevating the temples to make a link between the human realm and the heavenly realm of the gods. All this is well illustrated in the so-called White Temple at Uruk (the biblical Erech, in modern times called Warka). With its whitewashed brick walls, built between 3500 BCE and 3100 BCE, the structure is among the first examples of a ziggurat surmounted by a temple [10.3].

The Akkadian Period, Circa 2370 BCE to Circa 2150 BCE

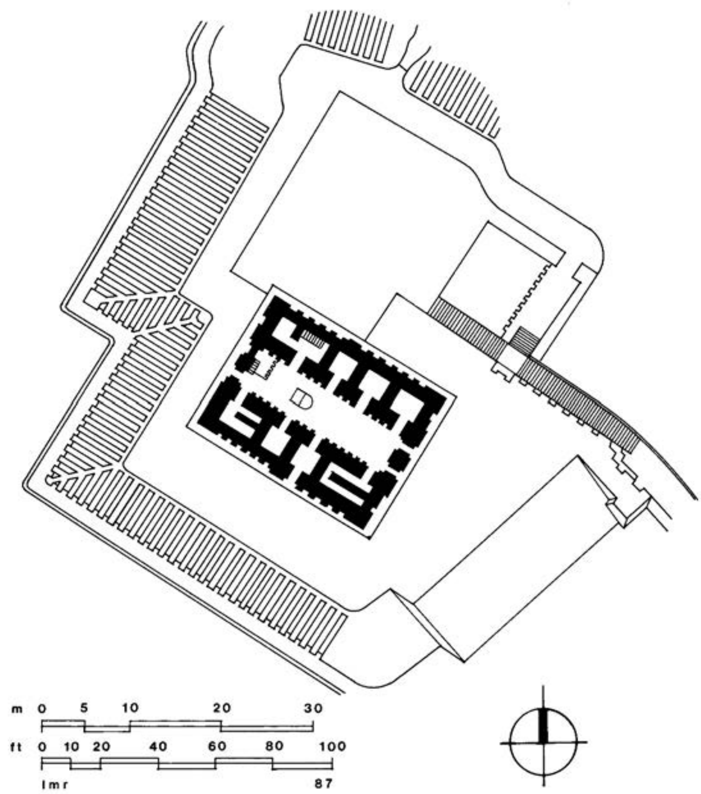
About 2350 BCE, a fierce warrior people overran the Sumerian settlements and created several new cities, particularly at Sippar and Akkad, the latter of which gives its name to this period. As would happen many times later, the underlying Sumerian culture, including cuneiform writing and major aspects of religion, was absorbed, but the most significant change was toward a strong priestly class and rule by a single warrior-king. This dramatic change of governance laid the basis for later imperial states in the region. While there is significant art from this period, particularly emphasizing the imperial rule of the kings and scenes of combat, the architecture of adobe brick did not fare well in succeeding centuries.

The Neo-Sumerian Period, Circa 2150 BCE to Circa 2000 BCE

The Akkadians were in turn overthrown by the Guti, who moved in from the mountains of present-day



10.2. A view of the inside of a "vaulted" house in the southern delta of the Tigris and Euphrates Rivers. Such a mudhif, *a traditional Marsh Arab guesthouse, is made entirely out of reeds. Source: US Army Corps of Engineers.*



10.3. White Temple, Uruk (in present-day southern Iraq), c. 3500–3100 BCE. The temple itself was built atop a ziggurat mound, a surrogate mountain. Drawing: L. M. Roth, after H. Frankfurt, Art and Architecture of the Ancient Orient *(New Haven, 1966).*

Iran, but their military control weakened after about a century and the old political alliances between the various city-states reestablished themselves in what is called the neo-Sumerian period. It was at this time that ziggurat construction expanded greatly. An excellent example that survived in fairly good condition is the ziggurat of the moon god Nannar in the city of Ur, built by King Urnammu in about 2113–2006 BCE [10.4]. Although built with a core of earth and soft brick, it was given an outer facing of hard-fired brick laid in bitumen, the thick form of crude oil that oozed from scattered springs, as at Hit, north of modern Baghdad. The great ziggurat at Ur rises in a series of terraces ascended by three long, straight stairs and originally was surmounted by a temple. Although the temple weathered away, other examples survive in part because they had thick outer walls like those carved on the plaque held by Gudea, the ruler of Lagash, one of the many city-states that flourished in this period [see 7.5].

The Babylonian Period, Circa 2000 BCE to Circa 1503 BCE

Yet again, around 2000 BCE, the Sumerian cities fell to invading Amorites. But as before, the old patterns eventually reestablished themselves. An empire was created around the capital city of Babylon, whose best-known ruler, Hammurabi, is remembered for the detailed code of laws he had engraved in cuneiform on a stone stele.

The Hittite Period, Circa 1503 BCE to 1200 BCE

About 1503 BCE, the militarily superior Hittites invaded from Anatolia (western Turkey), establishing their capital at Hattusas (now Bogazköy, near present-day Ankara, Turkey). Armed through their technology of smelting iron as early as the fourteenth century BCE, the Hittites overran their surrounding neighbors, even successfully holding off Egyptian armies. In short, their iron weapons made their opponents' bronze swords useless. At Hattusas the Hittites built a large central palace including a library, archives, and a granary, all of stone but with long, narrow rooms covered by corbeled stone vaults in which the successive courses of stone are cantilevered slightly over the next lower course until they meet. Over time, the Hittites extended their empire, struggling with Egypt for control over Syria. Because of the distance from Hattusas, and as Hittite control gradually weakened, individual cities in the region around Babylon regained local autonomy. But even the Hittites, much less the old Sumerian and Babylonian cities to the south, were no match for the fiercely militaristic Assyrians, who rose to power in about 900 BCE.

Assyrian Empire, 900 BCE to 612 BCE

The Assyrians, originally from northern Mesopotamia with their center in the city of Ashur, established a true empire with strongly fortified capitals built successively at various locations including Cala (today Nimrud), Dur-Sharrukin (today Khorsabad), and then Nineveh (today Kuyunjik). Their principal interests seem to have been trade and military conquest, and Khorsabad, the royal city built by Sargon II around 720 BCE, had a royal palace complex covering twenty-five acres, its rooms arranged around large, open courts, all laid out in ordered orthogonal geometry. Part of this palace complex was

10.4. Ziggurat of the moon god Nannar, Ur (in present-day southern Iraq), c. 2113–2006 BCE. Here, too, the temple proper was built atop a ziggurat mound. Photo: Hirmer Fotoarchiv, Munich.

a large temple and a freestanding ziggurat. Regrettably, few Assyrian buildings remain, though some city gates have been reconstructed.

The Neo-Babylonian Period, 612 BCE to Circa 560 BCE

In 612 BCE, the stern rule of the detested Assyrians ended with the fall of Nineveh to the combined forces of Medes and Babylonians. Babylon was then magnificently rebuilt by Nebuchadnezzar II. At its center was an expansive temple complex sacred to Marduk, then the chief Babylonian god, and a soaring ziggurat of five levels, 300 feet square at its base and rising 300 feet, remembered in the Bible as, perhaps, the Tower of Babel. Another marvel was the elevated Terrace Gardens, the fabled "Hanging Gardens" described in antiquity as one of the Seven Wonders of the World. Now lost, this marvel was apparently a ziggurat-like arched substructure supporting terraces heavily planted in trees. The gardens were described by Greek geographer Strabo as being "quadrangular in shape, and each side is four *plethra* in length [almost 405 feet, or 123.3 m]. It consists of arched vaults, which are situated, one after another, on checkered, cube-like foundations. The checkered foundations, which are hollowed out, are covered so deep with earth that they admit of the largest trees, having been constructed of baked brick and asphalt—the foundations themselves and the vaults and the arches." Such plantings would have required near constant irrigation, which Strabo explains thus: "The ascent to the uppermost terrace-roofs is made by a stairway; alongside these stairs there were screws [screw pumps], through which the water was continually conducted up to the garden from the Euphrates by those [workers] appointed for this purpose. For the river, a stadium in width, flows through the middle of the city; and the garden is on the back of the river."[3]

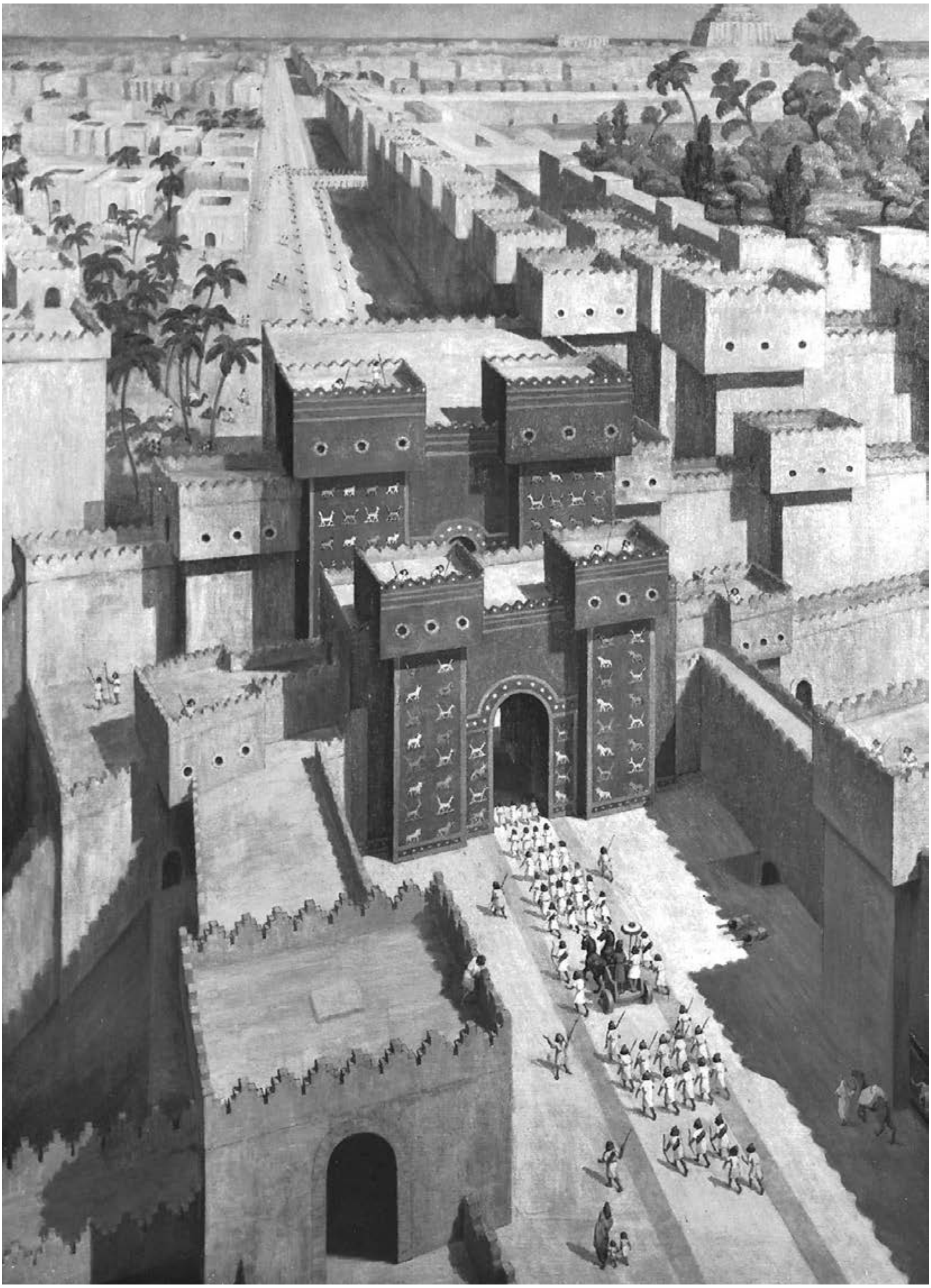
Particularly notable were the massive walls enclosing the new Babylon, 11 miles (17.7 km) in circumference and wide enough at the top that a chariot drawn by four horses could pass a similar chariot coming from the opposite direction; the walls of Babylon themselves were listed by some ancient writers as one of the Seven Wonders. The encircling wall was pierced by eight gates, each dedicated to one of the principal deities. Best known today because of its partial reconstruction in Berlin is the Ishtar Gate, clad in glazed brick with a deep-blue background and colored bands at the base and top, the wall surface embellished by low-relief animal figures spaced across its imposing surface [10.5].

The Persian Empire, Conquest by Alexander, and Afterward, 560 BCE to 224 CE

In 560 BCE, Babylon was swallowed up in the Persian Empire created by Cyrus the Great (founder of Achaemenid dynastic rule), whose cavalry swept out of the region of Elam to the east of Sumer. The Persian Empire was expanded by Cyrus's successors Darius I and Xerxes, who extended it from the Indus River in the east to the Danube in the west but whose push into Greece was temporarily stopped by the Greeks at Marathon in 490 BCE. After the conquest of the Persians by Alexander the Great in 330 BCE, Greek culture and language spread across the new Alexandrian Empire and dominated in Mesopotamia. This philhellenism continued under the Seleucid rulers (the successors to Alexander) and even the Parthians, up to 224 CE, when they fell to the Sassanian dynasty. By this time, other languages had supplanted the ancient tongues born in Mesopotamia, and although cuneiform continued to be written for several centuries after the Persian and Alexandrian conquests, the absorption of the "Land Between the Rivers" into the Hellenistic world meant that architectural forms in the region of Mesopotamia became heavily affected by outside influences, particularly Greece. By the time Strabo was writing his description of Babylon around the years 10 to 20 CE, he observed that "the greater part of Babylon is . . . deserted."[4]

Influence of Ancient Mesopotamian Cultures

What had been accomplished in the successive Mesopotamian city-states, kingdoms, and empires, however, profoundly shaped Western civilization: the gathering together of populations in cities; the pooling of human resources releasing an inventive energy formerly consumed in eking out individual subsistence livings; and, most important, the development of writing, which made it possible to carry human thought and memory from generation to generation in fixed symbols. One could argue that the most important legacy of the ancient Mesopotamians to later civilizations was not their architectural building models and structural innovations but, instead, these underlying concepts of civil life and the rule of law. They invented the wheel and devised a system of spatial and time measurement in units divisible by 60 that is still used worldwide in measuring time and angular geometry. The ancient Mesopotamians also first expressed the tragic poignancy of human existence, which is summed



10.5. The Babylon of Nebuchadnezzar with the Ishtar Gate, c. 575 BCE. Reconstructed perspective. Now reconstructed in its original form in the State Museum, Berlin, the imposing Ishtar Gate, clad in brilliantly colored tiles with heraldic bulls and dragons on a deep blue background, illustrates well the rise of Mesopotamian civilization; this hard tile envelope exterior protected an inner core of soft brick. Photo: Courtesy, the Oriental Institute, University of Chicago.

up at the conclusion of *The Epic of Gilgamesh,* an adventure story that was already ancient when it was written down around 2000 BCE. Entreating the divine maker of wine for the knowledge of eternal life, Gilgamesh receives this answer:

> You will never find the eternal life
> that you seek. When the gods created mankind,
> they also created death, and they held back
> eternal life for themselves alone.
> Humans are born, they live, then they die,
> this is the order that the gods have decreed.
> But until the end comes, enjoy your life,
> spend it in happiness, not despair.
> Savor your food, make each of your days
> a delight . . . let music and dancing fill your house,
> love the child who holds you by the hand,
> and give your wife pleasure in your embrace.
> That is the best way for a man to live.[5]

In addition, the Sumerian creation stories describe how, when the Sumerian god of wisdom offered to humankind the noblest gifts of civilization, he also pronounced these words of warning, cautioning that the gifts included violence, greed, and destruction as well: "All these things I will give you, . . . but once you have taken them, there can be no dispute, and you cannot give them back."[6] A similar sentiment is reiterated in the opening words of Genesis, for once Adam and Eve ate the fruit of knowledge, they could never recapture that quality of innocence and direct communication with God; they and their progeny would be permanently changed.

As with megalithic building in Europe, the first permanent buildings in Mesopotamia served the most compelling and encompassing public needs, attempting to bridge the gulf between humans and the gods. Even when the individual buildings were sponsored by individual kings, these places were still the embodiment of public communal purpose. Human civilization and its most fundamental architectural expressions had been invented.

Egypt: The Gift of the Nile

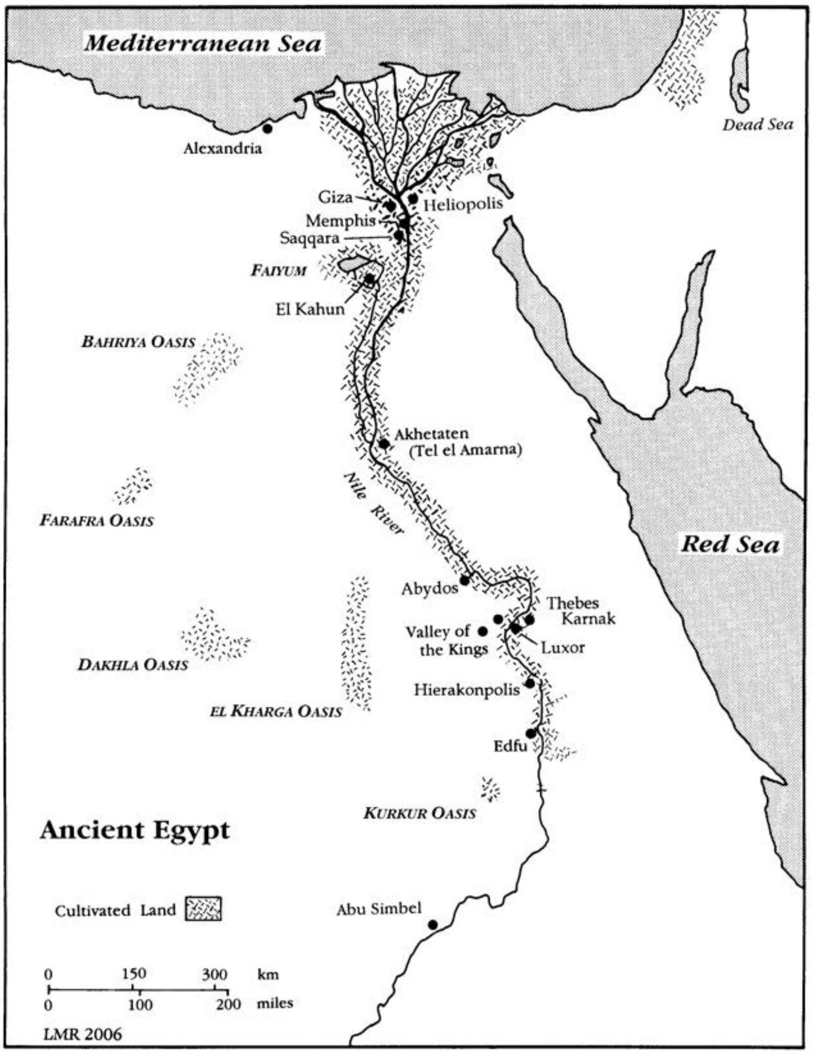
For most people, to think of ancient Egypt is to evoke the enormous, crouching figure of the Sphinx or the great pyramids rising from the edge of the desert on the west bank of the Nile. Egypt is not only an ancient nation but a state of mind, a mystery wrapped like a mummy in a mystique of death. Its greatest architectural remnants are buildings dedicated to funerary practices, its pyramids serving as man-made mountains of burial, its temples lining the Nile with endless repetitions of column after column, of court and chamber leading to yet more courts and chambers. It is an architecture of great mass and monotonous regularity, deliberately and determinedly adhering to established forms and details over a time span equal in length to everything that has followed it up to the present day. The contribution of Egyptian architecture to the development of the architectural traditions of the West is perhaps less evident than that of ancient Greece, Rome, or medieval Europe; yet, Egypt is where Western architecture begins, rooted in ancient Egyptian religion and science.

Egypt is for most people a great mystery, for it is remote in both time and culture. When the ancient Greeks, such as Herodotus, visited Egypt in 500 BCE or, later, when the Romans annexed it to their empire just before the Christian era, Egypt was already an ancient land with a culture three thousand years old. Herodotus himself understood Egyptian life imperfectly, and since his time, another twenty-five hundred years have passed, so that Egypt is for us that much more exotic and remote.

The Landscape of Egypt

As Herodotus wrote in his *Histories,* Egypt "is the gift of the river."[7] Egypt *is* the Nile, and to understand the land, its ancient inhabitants, and the architecture they created, we must first understand the river and the geography it traverses [10.6]. The Nile is arguably the longest river in the world, 4,130 miles (6,648 km), formed by three tributaries: the Blue Nile and the Atbara, which originate in the mountains of Ethiopia (what the ancient Egyptians called Abyssinia), together with the White Nile, which flows from Lakes Albert and Victoria in equatorial Africa.

In what is now the Sudan, the Nile makes a large S-curve, cutting its way through a valley with steep cliff sides and passing over four cataracts. It passes over another cataract just north of the Aswan High Dam, whose impounded waters now cover a former cataract south of the dam. The last and most northerly cataract marked the edge of the ancient land of Egypt. From that point, the river flows 750 miles (1,207 km) to the north and into the Mediterranean Sea. This passage is through two distinctly different landscapes. For the greater distance, about 650 miles (1,046 km), the landscape is a valley cut in the surrounding limestone, varying in width from 1 to 14 miles (1.6 to 22.5 km), with cliffs rising sometimes to 1,500 feet (457 m) on either side. Beyond the cliffs,



10.6. Map of Ancient Egypt.

to the east and west, is desert. Just north of modern Cairo, the cliffs end and the river splits into branches, spreading out in a delta 100 miles (161 km) long and 155 miles (249 km) wide at the Mediterranean Sea.

In Egypt, rainfall is negligible, decreasing from 8 inches (20.3 cm) a year at Cairo to 1 inch (2.54 cm) or less in the valley to the south, so the Nile is the major source of water. In the Abyssinian uplands far to the south, however, 60 inches (152 cm) of rain fall in a typical summer. The result was (until massive dams were put in the path of the Nile in the middle of the twentieth century) that year after year, the water of the Nile was laden with the eroded soil of the Abyssinian highlands, and this sediment was carried down to the valley below. The waters rose in a flood that began late in June, crested in mid-August, and ended by November. The river gave the ancient Egyptians their three seasons, beginning with *Inundation* from June through October; followed by *Emergence of the Fields from the Water* from November through February, during which time the fields were planted and tended; and *Drought,* when there was harvest and threshing. The relatively benign if hot climate also meant that two or three crops could be harvested a year. Some years, the crest was higher than normal, and sometimes it was less, but the cycle of inundation and drying repeated itself endlessly year after year, decade after decade, century after century. When the waters receded, they left a precious gift: the black soil carried down from Ethiopia. The Egyptians themselves called their river Ar, or Aur, one of their words for "black," because of the river's burden of soil (the word *Nile* is from the Greek *Neilos,* from an ancient root word meaning "river valley"). The Egyptians called their country Kemet, meaning "the black land"; what lay beyond to the east and west was the desert, "the red land."

Egypt can be thought of as a great, linear oasis in the desert, running north and south, 750 miles long and (except for the broad delta) only 1 to 14 miles wide. Every year, the new soil deposited by *Inundation* swept away the landmarks that established field boundaries, so very early, the Egyptians perfected a system of geometry and mathematics to redefine the boundaries the river had obliterated. The bureaucracy and the science this surveying required would later be put to the service of building the pyramids.

The Nile, then, was one cultural determinant, flowing south to north, from the higher lands that the Egyptians called Upper Egypt to the flat delta, or Lower Egypt, flowing in a rhythm of rise and fall and replenishment that never significantly varied. The other major determinant was the sun, which moved with similarly unvarying precision, east to west, perpendicular to the river, in a usually cloudless sky, day after day, pursuing its own timeless cycle. The river and the sun thus established the two perpendicular axes that dominated Egyptian life and architecture. As a study of the Egyptian temple reveals, it is a linear, axial architecture, turned at right angles to the axis of the river. And those two axes of river and sun form the basis of the orthogonal grid of Egyptian fields and cities, exemplified by the city built by the Twelfth Dynasty pharaoh, Sesostris II (also called Senusert II), 1897–1878 BCE, at what is now El Kahun, across the river from his pyramid, on which the workers labored [10.7].

The Egyptian climate normally varied little, and with the annual gift of water and fresh soil, life could be pursued with comparative ease. As historian Michael Wood has characterized the two parallel civilizations, in Mesopotamia a general spirit of pessimism prevailed, but in Egypt a general spirit of optimism was the norm. There were occasional periods of turmoil, but for century after century, life went on in peaceful monotony. To the Egyptian, time flowed in endless, repeating cycles; a phrase from the early Christian liturgy sums up a view the ancient Egyptian would have easily understood: "As it was in the beginning, is now, and ever shall be, world without end."

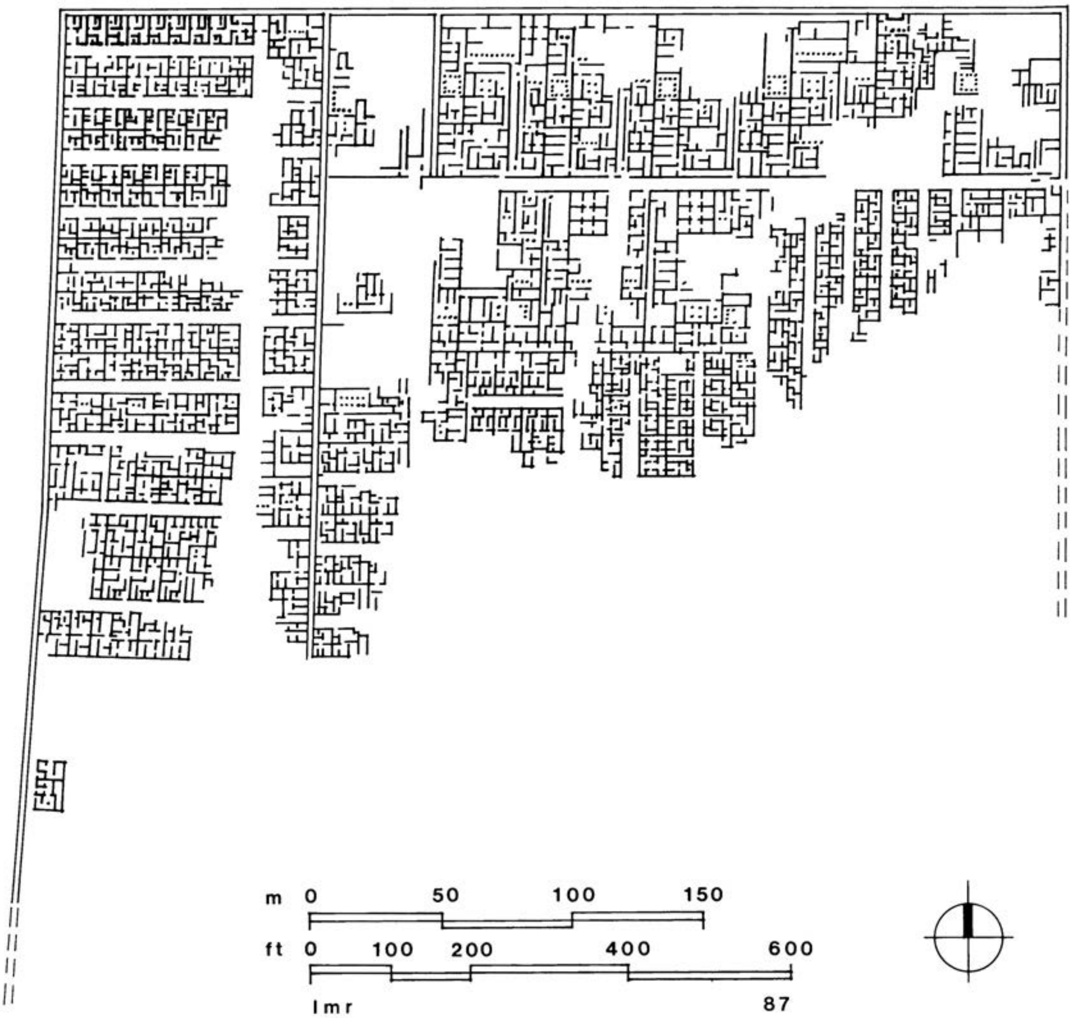
The broad valley of Mesopotamia had given easy access to successive invaders, and the history of that region is one of successive invasive peoples, each being modified by the culture they absorbed. In contrast, Egypt was protected by desert to the east and west, by mountains and cataracts to the south, and by the Mediterranean to the north; until relatively late in their history, the Egyptians kept no standing army. Although trade was actively carried on with the rest of their known world, Egypt was geographically isolated. Thus protected, the Egyptians very early began to develop a civilization that survived nearly three thousand years.[8]

The Culture of Egypt

Secure in their desert-protected paradise, the ancient Egyptians were content in the endless cycles of life determined by sun and river; the people perceived the cosmos not as subject to the whims of the gods but as an unchanging continuum. As a result, they developed early a deeply conservative view of life. Unlike the citizens of twenty-first-century Western civilization, who believe in progress, in things getting progressively better through the application of human ingenuity, the ancient Egyptians had no such concept. To them, things were never as good as they had been at the time of creation. That had been a golden age, when the gods inhabited the earth. The Egyptians continually tried to re-create that perfect time. Indeed, the ancient Egyptian came to desire a world in which things did not change, could not be allowed to change. At the moment of creation, a pattern of a stable society had been handed down to humankind, a pattern that was to be maintained eternally by kingship, law, religion, and ritual. The ideal world made at creation would remain fixed for eternity as long as all the necessary ceremonies were correctly performed. The universe and human society were conceived as static. As Michael Wood put it: "Progress, change, new questions, and new answers were simply not needed."[9] As a consequence, once the forms of Egyptian religion, literature, art, and architecture had been defined—from the predynastic period through the Fourth Dynasty—they changed very little for almost three thousand years.

Almost imperceptibly over the centuries, however, the details of painted or carved images did shift to a degree, and the proportions of building parts varied subtly, allowing scholars of Egyptian art to identify a statue or building as belonging to the Fourth Dynasty or the Eighteenth Dynasty. But the essential form was fixed. Even as late as the Hellenistic Ptolemaic period, in 237 BCE, when the Temple of Horus at Edfu was begun, inscriptions on the temple walls declared that great care had been taken to ensure observance of traditional architectural forms and iconography.

This conservatism was reinforced by Egyptian religion. Most of the many gods represented forces



10.7. Village at El Kahun, Egypt, c. 1897–1878 BCE. This village, built by Sesostris II just east of his pyramid, was to house officials, craftsmen, and laborers working on his burial place. Drawing: L. M. Roth, after W.M.F. Petrie, Illahun, Kahun, and Gurob *(London, 1891).*

of nature, and their images incorporated aspects and images of humans and animals. Supremely important during the Old Kingdom (Third to Sixth Dynasties) was Ra, the sun god, usually shown as a hawk-headed human, with a sun disk resting on his head. Later, during the Middle Kingdom and the Empire, Amon became chief among the gods. More of a pervasive spirit, he was shown as a human figure with a tall headdress shaped like two feathers. Amon was often associated and fused with other gods as well, particularly with the older Ra, resulting in Amon-Ra, who combined aspects of both. The god Osiris, slain and dismembered by his jealous brother, Seth, was restored to life by his wife, Isis, who carefully gathered the parts of his body. Hence, Osiris came to symbolize the land and its cyclical death and rebirth after the flood; he presided over the judgment of the dead. The pharaoh was believed to embody all these gods. He *was* Ra and Amon, so that the priests in the temples throughout the land, in elevating, feeding, and dressing the images of Amon in their temples, were enacting what the pharaoh, Amon-Ra incarnate, was doing himself at that very moment in his own palace—rising, dressing, and eating. These priestly ceremonies of the state religion were not public ceremonies. In contrast, the peasants and artisans worshipped any of the scores of local gods associated with their particular province. Yet, several times during the year, the great temple complexes were the sites of public festivals that went on for days.

What served to reinforce the inherent conservatism of Egyptian religion and life was the concept of *ma'at*. It is a term impossible to translate into any European language, for it combines aspects of truth, justice, order, stability, security, a cosmic order of harmony, a created and an inherited rightness. It was the goal of the Egyptian farmer, artisan, noble, and priest alike to live in accordance with *ma'at,* the right order of things created at the beginning of the world. Thus, to advocate radical change, whether material, social, or religious, was to violate *ma'at*. This is no doubt partly why the imposition of a radical new monotheism in religion, and a dramatic realism in art, undertaken by the Pharaoh Akhenaton in the Eighteenth Dynasty, was quickly swept away after his death by the priests of Amon, who reestablished their temples.

Another concept that resists adequate comprehension in contemporary society is the fusion of religion and daily life in ancient Egypt; perhaps today only Orthodox Jews, conservative Mormons, and those who adhere to fundamentalist Islam similarly intertwine civil and religious life. The daily life of the ancient Egyptian was filled with religion—with the worship of Amon-Ra, of the god-king Pharaoh, and of the many local deities.

The Egyptian not only reveled in the pleasures of this life but also worked to ensure that those pleasures would continue into the next. Perhaps the sense of the continuity of life and the pervasive nature of religion arose in response to what the predynastic peoples observed happened to the bodies of the dead placed in pit graves dug in the desert sands. The bodies were rapidly and naturally desiccated. Thus dried out, the bodies were no longer susceptible to attack by bacteria—they did not rot. Perhaps this survival of the body after death promoted the idea that the human spirit likewise endured, passing to a different realm of existence. The Egyptians conceived of a soul with four distinct attributes. The *Ka* resided with the body in the tomb or nearby, perhaps occupying one of the statues placed in the later, more elaborate tombs. The *Ba* was a more active physical vitality, which left the body at death and could move about. The two other aspects of the soul were *Akh* ("effective spirit") and *Sekham,* an apparent twin of the *Ka*. Predynastic burials were made with the bodies surrounded by tools and jars filled with provisions for the next life. Soon, the people developed the practice of artificially drying and wrapping the body, preparing it for the long afterlife. For the most elaborate burials of the pharaohs, several months were required for the many rituals observed by the priests. (Concerning the ancient dried and wrapped bodies, Arabs used the word *mumiyah,* "bitumen," for by the time of the Roman conquest, the practice had degenerated to dipping bodies in pitch as a preservative; the English word *mummy* comes from this.) Even after death, priests provided for the daily symbolic feeding of the dead. The present life, in all its security and comforts, was lived to the full, but the next life, stretching out to eternity, was ultimately more important. Hence, while adobe brick was sufficient for the houses of peasants, nobles, priests, and even the pharaoh and his family, only carefully dressed stone was proper for the houses of the gods and of the dead, beginning with the Third Dynasty.

It is all too easy for modern observers to see in mummification, elaborately decorated tombs, and costly funereal stone architecture a morbid fixation with death on the part of the ancient Egyptians. Their sensibility was in fact quite the reverse; the Egyptians held on to a fixation with life. The easy and relatively carefree life made possible by the Nile was simply too good to end. Properly provided for, the dead could enjoy the warm kiss of the sun; the pleasant taste of onions, figs, and beer; the sound of music; and the embrace of loved ones for all eternity.

Egyptian History

The Nile Valley as well as the then-fertile Saharan savannas were inhabited as early as twenty thousand years ago, but as the last glaciers withdrew and the climate turned warmer and dryer, oasis savannas like Nabta Playa disappeared and people were drawn to the more reliable waters of the Nile Valley. Farming villages began to appear along the Nile as early as 5500 BCE, with the cultivation of domesticated barley and wheat and the raising of domesticated sheep and goats. Around 4000 BCE, there was a substantial increase in population. Two cultures (and, eventually, two kingdoms) gradually developed, one in the harsher geography of the southern valley of Upper Egypt (upper because it is higher in elevation) and another in the more moderate climate of the flat, northern delta marshes of Lower Egypt. Forty provinces were defined (called *nomes* by the later Greeks and administered by regional *nomarchs*). Towns flourished, agriculture became organized, and writing was developed around 3250 BCE with pictorial imagery. As in Mesopotamia, the first writing was created principally to tally the taxes received. An architecture of adobe bricks reinforced with straw emerged. Coated with a hard plaster, this material was sufficiently durable in a climate with little rain, and some of these structures have been in use for four thousand years. Portions of the valley came under the control of strong local chieftains or kings in the predynastic period, roughly 3500–3100 BCE, with several kings taking animal names to associate themselves with the creatures' strengths. Among these were regional kings known such as Falcon, Double Falcon, and Scorpion, who ruled in the area of Abydos and Hierakonpolis, about 50 miles (80.5 km) south of Luxor.

About 3100 BCE, the forty nomes of the two separate kingdoms were united by the legendary King Menes (known also as Narmer), the first of the pharaohs of the thirty subsequent dynasties.[10] Abandoning the previous administrative capital at Hierakonpolis in Upper Egypt, Menes/Narmer established a new capital at Memphis, just south of the delta in Lower Egypt. There followed a near-thousand-year period of peace and prosperity known as the Old Kingdom, from around 3100 to 2000 BCE.

Because control of the Nile's floodwater was essential, Egypt very early developed a centralized government to administer the water. The measurement of the river flow, the annual surveying of the land after the crest, and the stockpiling of surplus grain against lean years all encouraged the rapid development of a large bureaucracy and fostered the creation of an absolute monarchy in which the ruler was more than mortal, serving as the representative of the gods. The pharaoh was viewed as a god, the son of Ra the sun god, and upon the pharaoh's death, his place as the living god was taken by his son, while the spirit of the dead pharaoh became an even more powerful deity, joining Ra in his boat or barge in the heavens. Governing such a far-flung nation required the pharaoh to give gradually more power to the regional monarchs. By the end of the Sixth Dynasty, 2200 BCE, this had led to a breakdown in the administration of the Old Kingdom and to the decentralization of power. This decentralization was known as the First Intermediate Period, from around 2200 BCE to 2052 BCE. During the Twelfth Dynasty, strong centralized government was restored and the Middle Kingdom began, lasting from 2052 BCE to 1786 BCE. The center of power now shifted to a new capital at Thebes in Upper Egypt. The once unquestioned and absolute authority of the pharaoh of the Old Kingdom was replaced by the increasing power of the priests of Amon, who trained and operated the vast bureaucracy. Another bureaucratic breakdown began in 1786 BCE, resulting in the Second Intermediate Period, which lasted until 1757 BCE.[11]

With the return of strong central government during the Eighteenth Dynasty in 1575 BCE, Egypt began to extend its influence south into Nubia (the Sudan) and north through Palestine to the edge of Mesopotamia. This period is called the New Kingdom or the Empire, and it lasted from 1757 BCE to 1087 BCE. Among its vigorous rulers were Thutmose III and Hatshepsut, the only woman to rule as pharaoh in her own right. But most remarkable during this period was the attempt at a most radical total social reform, with religious, administrative, and artistic transformation by Amenhotep IV, who changed his name to Akhenaton and attempted to introduce a monotheistic religion, focused solely on Aton or Aten, god of the sun. This pharaoh's original given name had meant "Amon is satisfied with this person," whereas the new name he created for himself meant "He who is serviceable to Aton." However, the dramatic changes in religion and art he initiated did not survive his reign and were actively suppressed after his death. Akhenaton was succeeded by the young Tutankhamen, whose short reign ended with his unexpected death at age eighteen (it has been theorized that perhaps he was murdered by court officials who were intent on obliterating Akhenaton's influence). Deprived of the opportunity of spending a long reign preparing an elaborate tomb, Tutankhamen was hastily buried in a small tomb cut in the cliffs of the Valley of the Kings. Later, the entrance to Tutankhamen's tomb was buried in the debris of a larger tomb cut above it and so was hidden from grave robbers until it was found by the archaeologist Howard Carter in 1922. It was a minor tomb of a very minor pharaoh, and yet his was the only tomb to survive virtually untouched by ancient grave robbers. A measure of its wealth is that it took Carter eight years to remove and catalog the two thousand priceless objects he found there. One can only imagine the surpassing wealth originally placed in the tombs of such great and long-lived pharaohs as Ramses II.

Among the most active builders of the Empire was Ramses II (Ramses the Great), 1304–1237 BCE; the Egyptian landscape is dotted with temples he erected. So potent did his name become that nine successive pharaohs after him adopted it. By 1000 BCE, the Empire had ended, however, and Egypt began a slow decline in power until it was conquered by the Persians in 525 BCE, made part of Alexander's empire in 332 BCE, and then annexed by the Romans in 30 BCE. Nonetheless, so great had been the power of the culture of Egypt that it took a thousand years for its influence to subside.

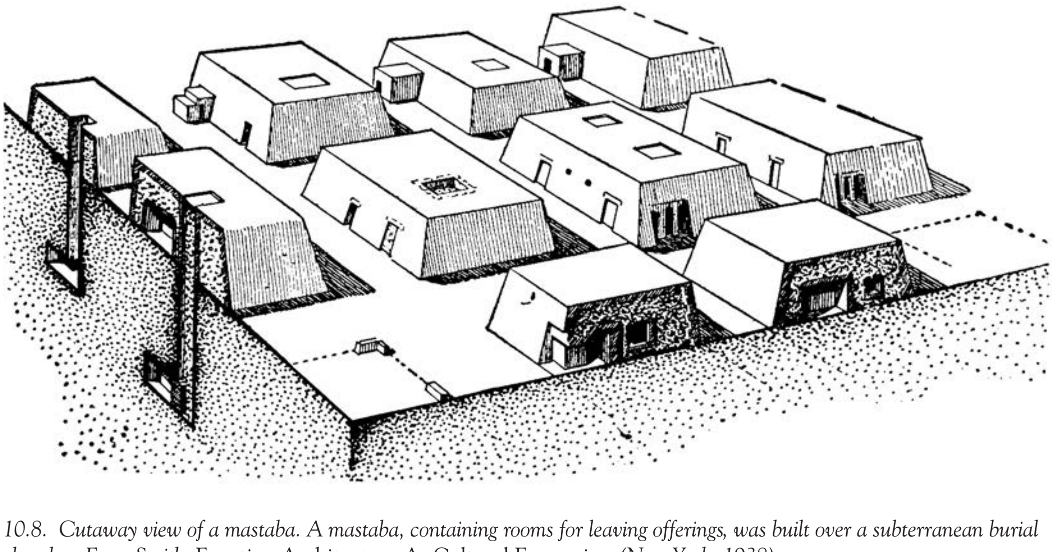
Egyptian Funerary Architecture

Monumental Stone Architecture and the Step Pyramid of Zoser at Saqqara

The earliest predynastic burials had been made in graves scooped out of the sand. Sometimes, the graves were covered with rough stone slabs, but jackals made short work of digging up the bodies. Early Egyptians then began to build earth mound structures over the graves, which were then encased by sloping mud-brick walls. As these grew larger, small rooms were incorporated to contain offerings of food and perhaps a chamber to contain a sculpture of the deceased. These early tombs were rectangular and resembled the benches much later found outside Arab houses, and so came to be called *mastabas* ("bench" in Arabic) [10.8]. At first, the more elaborate tombs were built for kings and the first pharaohs. In the 1990s, ongoing excavations near Abydos in Upper Egypt uncovered the tombs of some of the oldest kings, including that of King Scorpion, an important predynastic ruler. His tomb established a pattern that all the later rulers built on. It consisted of a miniature, palace-like series of room chambers, built in an excavated depression lined with mud-brick walls. Within this room complex a burial shrine of wood was built, and the adjoining rooms were filled with grave goods and regalia for use in the next world, and then a roof of imported cedar beams was laid over the tomb. The tomb was then covered with earth and sand, and a mound placed on top that recalled the primeval mound of emergence at the time of creation. The tomb of Pharaoh Den of the First Dynasty had its mound covering encased in sloping walls of adobe brick. The subsequent tomb of Pharaoh Khasekhemwy of the Second Dynasty, circa 2686 BCE, had its subterranean burial chamber lined with stone walls, with its superimposed mastaba mound also encased in stone blocks. Gradually, stone replaced adobe brick in these tomb structures, which were intended to last through eternity. In subsequent decades, as burials extended to members of the royal family, clusters of mastabas would be built together, so that in death the family group maintained the physical proximity it had enjoyed in life.

At the ancient Abydos royal necropolis, there were even larger funerary buildings built about a mile from the tombs. Khasekhemwy, for example, also had built a huge, palace-like structure, a sort of Palace of Eternity, that measured 400 by 213 feet (122 by 65 m), with mud-brick walls 36 feet high and 18 feet thick (11 by 5.5 m) [10.9]. After nearly five thousand years, it still stands, somewhat crumbled away in part.

If there was one successful and abrupt artistic-cultural revolution in Egyptian architecture, it was the architectural revolution created during the Third Dynasty by Pharaoh Zoser (also spelled Djoser or Djéser) and his architect and chief minister, Imhotep, in the construction of a tomb complex at Saqqara just south of the capital city of Memphis. Construction began in about 2750 BCE, twenty years after Zoser came to the throne. Imhotep's in-



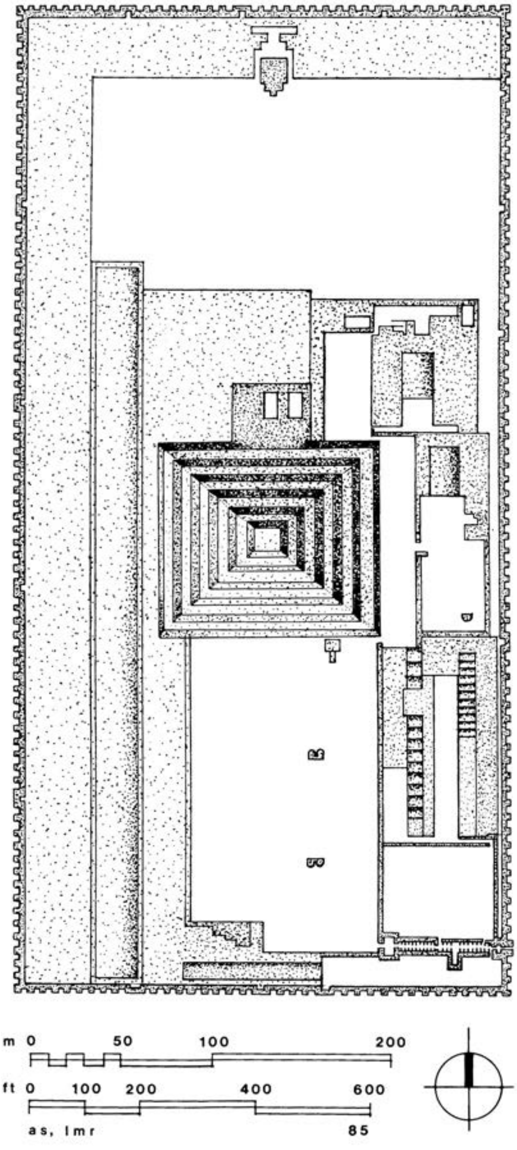
10.8. Cutaway view of a mastaba. A mastaba, containing rooms for leaving offerings, was built over a subterranean burial chamber. From Smith, Egyptian Architecture As Cultural Expression *(New York, 1938).*

10.9. Palace of Khasekhemwy, Abydos, Egypt, c. 2780 BCE. This is one of the oldest ancient Egyptian buildings, now exposed with the sand removed; the ancient adobe brick walls are being given a new veneer of fresh adobe bricks as protection. Photo: © Mike P. Shepherd/Alamy.

novations were twofold. First, he substituted limestone throughout for the mud brick, bundled reeds, and wood that had been used in royal buildings up to that time (although the stone was cut in small blocks and used like bricks). Second, and more dramatic, Imhotep, working with Zoser, literally invented the pyramid.

Zoser's tomb and pyramid complex were enclosed in a wall 34 feet high (10.4 m), measuring 1,788 feet (545 m) north to south and 909 feet (277 m) east to west [10.10]. There were several false gates but only one true entrance, at the southeast corner. This entrance led to a long, covered corridor with twenty projecting spur-walls on each side, ending in tapered engaged columns resembling bundles of reeds; at the end was a broader chamber. It is believed that this passage was a symbolic representation of the Nile, with the forty nomes along its banks and the broad delta at the end. Beyond the entry hall was a large, open court, perhaps used in the Heb-Sed running and dancing ceremonies to symbolically rejuvenate the pharaoh (he had to perform all rituals twice, as king of both Upper and Lower Egypt). Immediately to the right of the entrance gate was another long, narrow passage, running north to another court; beyond this passage and farther to the north were two identical buildings, called House of the South and House of the North, another reference to the pharaoh's dual reign. The engaged columns in these buildings have lotus bud capitals (symbolic of Upper Egypt) and papyrus-plant capitals (typical of Lower Egypt's delta). Just west of the House of the North was another court; at its southwest corner, up against the base of the pyramid was the Serdab chamber.[12] Just west of the Serdab room, and on the axis of the pyramid, is a building seeming to be a stone replica of the king's palace in Memphis, but with all rooms doubled for the king in his dual role as ruler of both Upper and Lower Egypt.

The stepped pyramid itself was started as a broad mastaba with a subterranean tomb chamber cut into the rock plateau; the walls of this chamber were lined with green glazed tile, recalling the reed mats on the walls of the king's palace. To contain burials of other members of Zoser's family, the original mastaba was then extended at its sides, but then the decision was made to transform the traditional horizontal mastaba into a vertical monument by placing four more mastabas on top of the original mastaba [10.11]. Another change was made, further enlarging the base and changing the number of superimposed mastabas to five. The final result,



10.10. Imhotep, Pyramid of Zoser, Saqqara, Egypt, c. 2750 BCE. Plan of the pyramid sanctuary complex. Aside from the pyramid itself, nearly everything inside the walls was doubled, representing the two united kingdoms of Upper and Lower Egypt. Drawing: A. Stockler and L. M. Roth.

sheathed in fine, white limestone, was a stepped pyramid measuring 459 feet (140 m) east to west, 387 feet (118 m) north to south, with an original height of 197 feet (60 m).

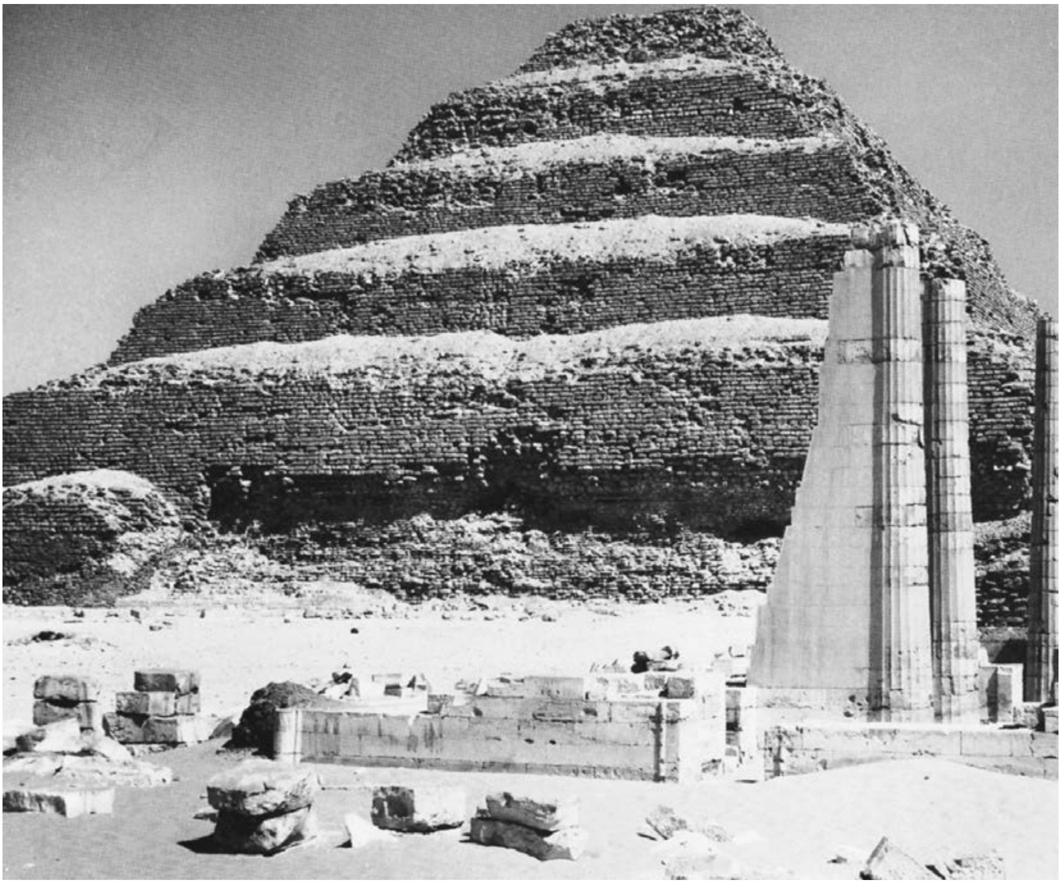
Why Zoser should have ordered this unprecedented change, and why Imhotep should have devised it, are impossible to tell. It is just possible that through trade, Egyptians had learned of early ziggurat construction in Sumer. But the pyramid form was immediately seized upon by successive rulers, who further modified it by filling in the steps to arrive at the familiar smooth angled surface.

The Pyramids at Giza

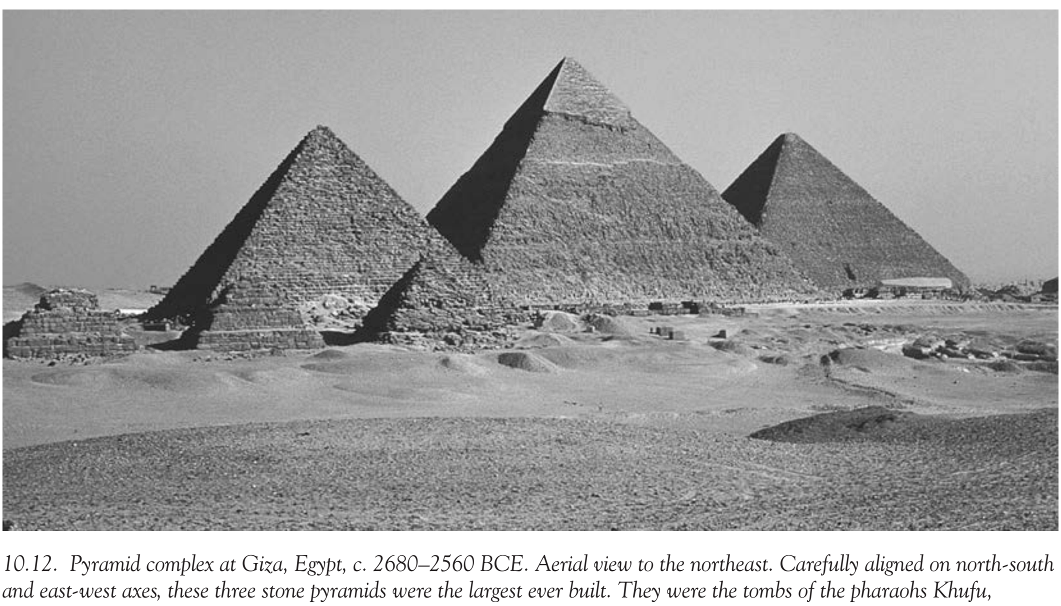
The historians of the ancient world recognized the unique character of the pyramids at Giza; the structures were foremost among the Seven Wonders of the World [10.12, 10.13]. Perhaps no other monument has been subjected to such probing analysis and serious scientific study, as well as silly romantic conjecture. The Giza trio represent the culmination of pyramid building by the Egyptians. Each of the great masses is perfectly aligned toward the North Star and the perpendicular axis of the sun. The first pyramid constructed was the northernmost and the largest of the three; it was built for Khufu (called Cheops by Herodotus), the second pharaoh of the Fourth Dynasty, which lasted from circa 2680 BCE to circa 2560 BCE. Next, to the south was built the pyramid for Khufu's son, Khafre (called Chephren by Herodotus), the third pharaoh of the Fourth Dynasty. Then, south and west of the center pyramid, the last and smallest of the three pyramids was built by Khafre's son, Menkare (called Mycerinus by Herodotus).The unending fascination with the Giza pyramids is due no doubt to two factors: their sheer size and the precision with which they were built. The pyramid of Khufu, the largest before its outer casing stones were removed, originally measured 440 Egyptian cubits on each side (775 feet, or 230 m) and rose to a height of 479 feet (146 m); today, it is shorter since the outer casing of finely fitted limestone was later removed to build portions of Cairo. The pyramid's sides have an angle of 51°50'. At first, Khufu's pyramid was to cover a subterranean burial chamber cut deep into the rock of the plateau, but as the layers of blocks were put in place, this arrangement was changed to a slightly elevated burial chamber, and then there was a further change to an even more elevated chamber at almost the exact center of the pyramid's mass [10.14].

The pyramid of Khafre was 707 feet square (215.5 m) and rose 470 feet (143.5 m). It is the only one of the three to retain a portion of its original limestone casing at the top; in places, this still has something of its original polish, now weathered. The pyramid's sides have a slope of 53°10'. The smaller pyramid for Menkare measured 356 feet square (108.5 m) and rose 281 feet (66.5 m), with slides sloping 50°; it too is missing its casing, the lower sixteen courses of which were of granite.

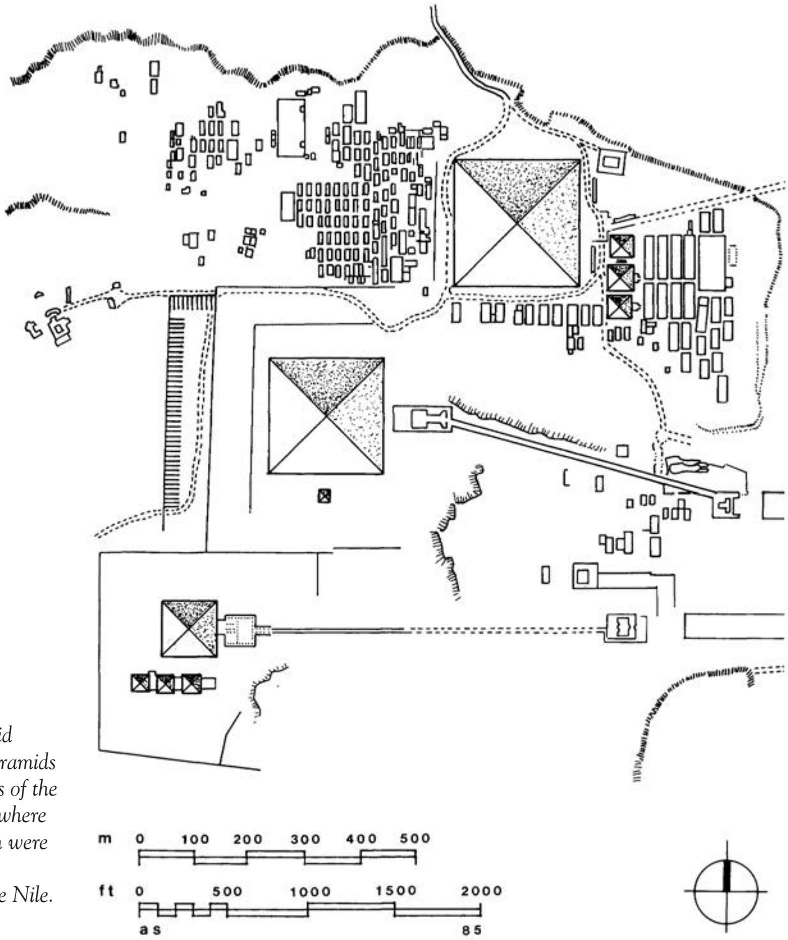
The pyramids are virtual mountains, at the time the largest buildings in the world, hauled block by



10.11. Pyramid of Zoser. View of the pyramid. Now missing much of the outer casing, the steps of the pyramid once rose to a height of 197 feet (60 m). Photo: Hirmer Fotoarchiv, Munich.



10.12. Pyramid complex at Giza, Egypt, c. 2680–2560 BCE. Aerial view to the northeast. Carefully aligned on north-south and east-west axes, these three stone pyramids were the largest ever built. They were the tombs of the pharaohs Khufu, Khafre, and Menkare. Photo: Werner Forman/Art Resource, NY.



10.13. Plan of the Giza pyramid group. Surrounding the large pyramids were smaller tombs for members of the royal family, mortuary temples where the last stages of mummification were completed, and causeways that reached to the floodwaters of the Nile. Drawing: A. Stockler.

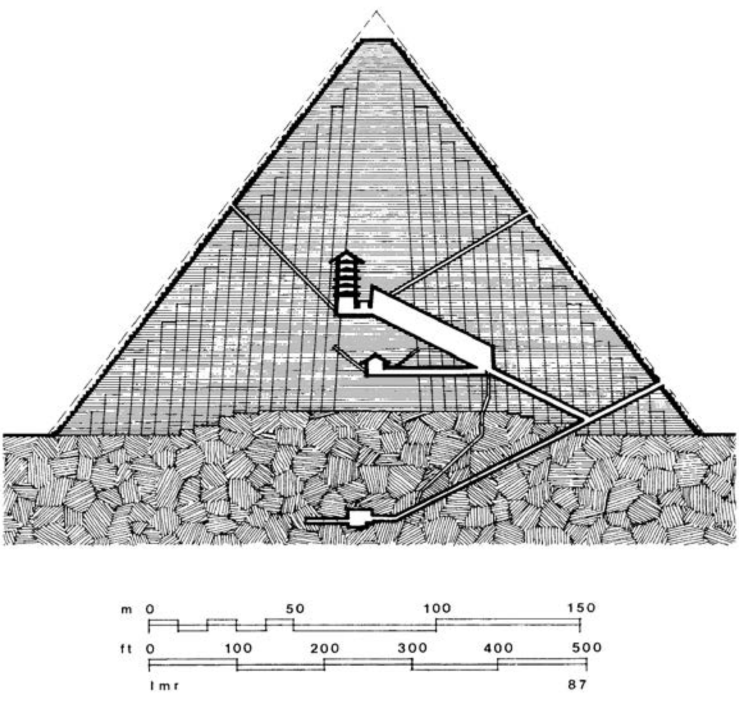
block up to the plateau from the Nile. The base of Khufu's pyramid covers just over 13 acres (5.3 hectares); it is big enough to contain the plans of the cathedrals of Florence and Milan, the basilica of Saint Peter in Rome, as well as Saint Paul's and Westminster Abbey in London, and still have room left over. Including the casing stones, it contained about 2.3 million blocks, each weighing about 2.5 tons (2,268 kg), although some weigh as much as 15 tons (13,608 kg); the total weight is estimated at 6.5 million tons. When Napoleon sat at the foot of the pyramids in 1798, he reportedly calculated that there was enough material in all three to build a wall 3 meters high and 1 meter thick around the whole of France.

The individual pyramids were the most visible part of extensive surrounding funereal complexes. Each was approached through a canal cut from the high-water bank of the Nile. At the end of this canal was a valley temple with auxiliary structures connecting to a causeway sloping up to the foot of the pyramid over which the stones for the pyramid were dragged. At the end of the causeway and at the base of the pyramid was a mortuary temple and a surrounding necropolis (Greek for "city of the dead") of small pyramids, tombs, and mastabas for members of the royal family. The Valley Temple of Khafre, mentioned in Chapter 3 as an example of pure post and lintel construction, has columns and beams cut of red granite placed on a floor of alabaster [3.10]. Inside were twenty-three statues of the king, temporary abodes of the *Ka,* and in this temple, it is likely that Khafre's body was ritually washed and the complex process of mummification carried out. Just to the north of Khafre's Valley Temple, the king's sculptors took advantage of a rock outcropping and carved an enormous figure, the Sphinx, with the body of a crouching lion and the head of the pharaoh, with the forepaws built of stone blocks.

Two questions arise: *How* was the stupendous construction of the pyramids accomplished? More important: *Why* was nearly the whole of the working force of Egypt occupied with such a gargantuan task for years on end? To appreciate the scope of the workers' accomplishment, one must remember that the Egyptians used only tools of wood, stone, and copper and employed no wheeled vehicles (they adopted the war chariot only after 1750 BCE). Either the stone blocks were lashed to sledges and rolled over logs or perhaps four crescent-shaped wooden pallets were tied to square stone blocks, a setup that might have enabled a few workmen to roll the stones. Most of the journey, from quarry to building site, however, was made possible by shipment along the Nile. One of the most critical steps was leveling the platform of the plateau to receive the base of the pyramid, for the slightest misalignment would cause increasingly severe compounded problems toward the top of the pyramid. The leveling was achieved by means of trenches filled with water, and so exact was this work that modern surveying instruments have detected a rise of only ½ inch (less than 2 cm) at the northwest corner of Khufu's pyramid. Once the huge stone platform was dressed and made ready, the blocks were put in place, layer upon layer, year after year.

How were the stones lifted, layer upon layer? A conventional notion is of a single, long ramp of earth, but as the pyramid rose, this would have necessitated the continual raising and lengthening of the ramp at each level; half the workers would have been doing nothing but building the ramp. A more logical procedure would have been to construct four helical ramps going up each side of the pyramid and wrapping around it—three ramps for teams hauling sledges or rollers up to the working level and one for the empty sledges to come down. Once the capstone at the top of the finished pyramid was put in place and the final casing was polished, the earth ramps could be removed from the top down.

There are no contemporary accounts of how the pyramids were built or how many workmen were employed. Two thousand years after the fact, Herodotus was told that 100,000 men were engaged for "periods of three months," and that it took twenty years to erect Khufu's pyramid, but no details as to how the stones were moved or fitted into position were (nor probably could be) passed on to him. Herodotus believed that four crews of 100,000 worked year-round, but it now seems more likely that most of the workers were employed during the height of *Inundation,* when farming came to a halt and when the waters rose closest to the quarry sites and to the pyramid plateau. Based on estimates of the weight of the blocks, the distances they had to be moved, and the capacity of teams of eight or ten workmen, it seems likely that 100,000 men moved



10.14. Pyramid of Khufu, Giza, Egypt, c. 2680–2560 BCE. Cross section. The cross section reveals the changes in the design, with the first proposed burial chamber deep below the pyramid, the second shifted to a position above the initial layers of stone blocks, and the final burial chamber shifted to a point nearly at the center of the mass. Drawing: L. M. Roth, after A. Fahkry, The Pyramids *(1961).*

a single year's production of rough-cut stones from quarry to building site during *Inundation.* Excavations have revealed what appear to have been lodges housing up to 4,000 workmen at the base of the pyramid of Khafre. This would be approximately the correct number of skilled masons required year-round to do the finishing work.

The most essential question remains: Why was such stupendous effort expended? Conventional wisdom, reinforced in numerous fictional depictions and motion pictures, tells us that the workmen were under the whip, that they were slaves forced to build for the aggrandizement of the pharaoh. The Old Testament informs us that the Israelites performed labor of this kind, but the Israelites were slaves in Egypt at least 850 years after the pyramids were built, during a very unsettled time in Egypt. The Fourth Dynasty was a kind of golden age in Egypt, a time of peace, security, and plenty. During the Old Kingdom, the god-king pharaoh ruled supreme, aided by the priests of Ra. At this point, the idea of an afterlife was confined largely to the pharaoh and his immediate family (only after the upsets of the First Intermediate Period and the emergence of the Middle Kingdom did there arise the egalitarian notion of an afterlife for everyone). In the Old Kingdom, at death the pharaoh became a god, joining Ra in his daily passage through the heavens; the spirit of the dead pharaoh became an intercessor to the gods on behalf of his people, their sole link to the gods.

For three months of the year, farming work in the fields came to a halt. In all but the worst times, the fields yielded more food than was required in a year, so that by attentive study of the river flooding and diversion of water to fields, and through careful management of the surplus of grain, it was possible to have levies of men from each of the forty nomes sent to Giza during *Inundation* as a kind of public works project during the flood. There were likely no whips, but willing laborers instead. For the workmen, this was an investment in their families' future, since if the pharaoh were properly conveyed to Ra, it would benefit them all. One foreman wrote that the men worked "without a single man getting exhausted, without a man thirsting" and that they "came home in good spirits, sated with bread, drunk with beer, as if it were a beautiful festival of a god."[13]

The pyramids may also have been viewed as serving a purely practical purpose. In the ancient Temple of Ra, in the sacred delta city that the Greeks called Heliopolis (City of the Sun), was a pointed stone called the *ben-ben,* said to symbolize the primordial mound that first emerged from the water at creation, catching the first light of the sun. The pyramids were possibly considered gigantic *ben-bens*. Their capstones were covered in glistening gold leaf, and from them, the spirit of the pharaoh greeted Ra on the dawn after his burial. This interpretation is suggested by the Egyptian word for pyramid, *m(e)r* (our word *pyramid* is a Greek term). In Egyptian hieroglyphs, the prefix *m* means "place" or "instrument." The character *'r*, meaning "place to ascend," was written with the symbol resembling back-to-back stairs  or perhaps a side view of a step pyramid. This suggests that when the Egyptians spoke of the *m(e)r* of Khufu, they meant literally "the instrument by which Khufu ascends." And the texts inscribed in the chambers and passageways of later Fourth Dynasty pyramids (the so-called Pyramid Texts) contain passages that reinforce this interpretation. For example, Spell 267 reads: "A staircase to heaven is laid [for Pharaoh] so that he may mount up to heaven thereby." Under certain afternoon conditions, with dust in the air catching the light of the lowering sun as it pierces an opening in clouds, a pyramid of light seems to reach to earth; perhaps this is what Spell 508 means: "I have trodden thy rays as a ramp under my feet whereupon I mount up." And as Spell 523 relates, "Heaven hath strengthened for thee the rays of the sun in order that thou mayest lift thyself to heaven as the eye of Ra."[14] In other words, the pyramid was the king's launching place, the man-made mountain whose gilded summit would catch the first rays of the sun, from which the soul of the pharaoh would rise to greet Ra in his eternal endeavor to ensure *ma'at,* the never-ending rightness of all things for his living subjects below.

Egyptian Tombs

Pyramid building essentially ceased following the end of the Old Kingdom. By the Middle Kingdom, the pyramids had already been penetrated by determined thieves and their treasures stolen and the tombs stripped bare. The looming presence of the pyramids was a permanent advertisement as to where untold riches were available for the taking, and so by the Middle Kingdom the tombs of the pharaohs were carved deep below the cliffs of the Valley of the Kings on the west side of the Nile, across from the huge temple complexes of Karnak and Luxor. The nearby village at Deir el-Medina housed the small army of artisans and scribes who were basically permanently employed cutting and decorating those tombs. Even those royal tombs, with their hidden entrances, were eventually located and looted, although the thieves did set aside the royal mummies, many of which survive even though their unimaginable treasures do not. It was only the tomb of a minor forgotten pharaoh who died mysteriously at the age of eighteen that remained virtually untouched, and it survived only because its entrance was completely covered by the debris cut out of the rock above to create the tomb of a much greater, later pharaoh.[15] Of course, as is well known today, this tomb that survived essentially unscathed was the one made hastily for Tutankhamen after his untimely death. It must be remembered that the other pharaohs who ruled long and powerfully—Ramses II, for example—devoted decades to having their tombs prepared and decorated and had countless precious objects made to accompany them into the afterlife—all of which, save the tombs themselves, disappeared. This is what makes the hastily assembled splendors of Tutankhamen's tomb all the more remarkable.

The Tomb of Hatshepsut at Deir el Bahri

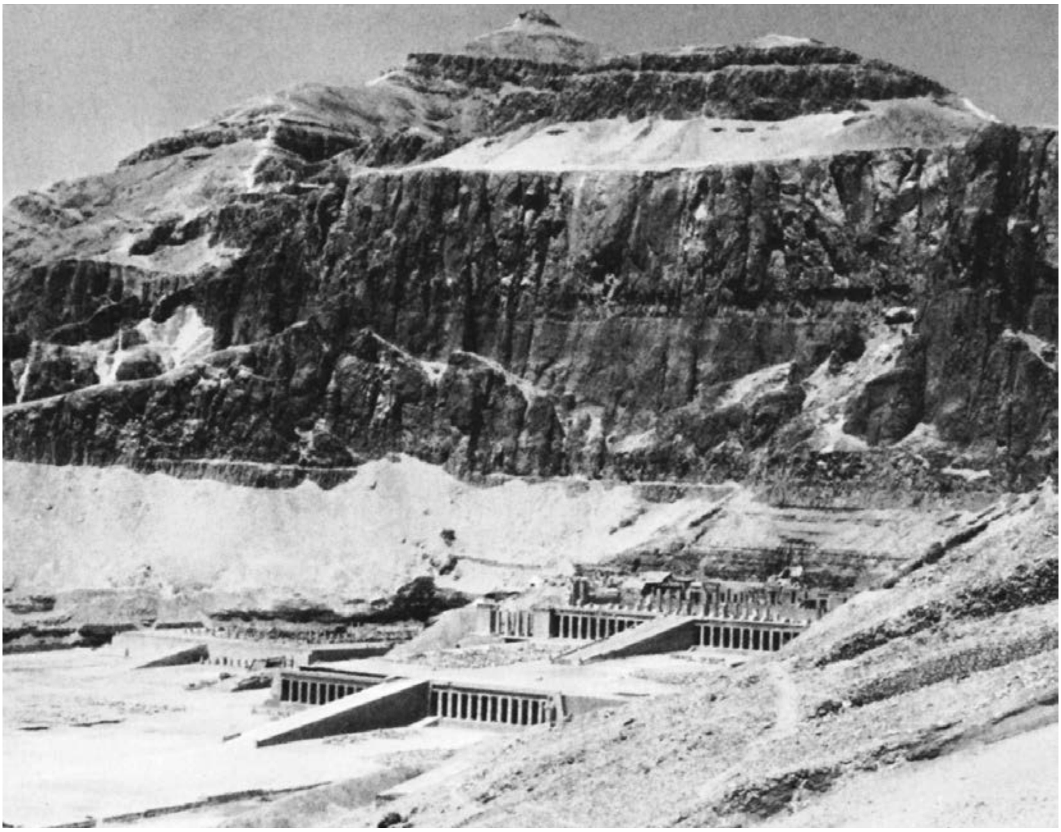
The absolute theocratic power of the pharaohs during the Fourth Dynasty was never equaled, and as a consequence, the Giza pyramids were never surpassed. Smaller pyramids were built by subsequent kings, but after the disruption of the First Intermediate Period, tombs and temples replaced pyramids as the major royal building enterprises. Even the gods felt this upheaval, for Ra was displaced as the principal god by Amon, whose priests were centered at Thebes, the new city in middle Upper Egypt. In the Middle Kingdom, the political center shifted to Thebes, and south of it two large temples to Amon arose, at Karnak and at Luxor. Across from the temples, on the west bank of the Nile, beyond which the sun set, tombs were built at the edge of the cultivated valley floor, cut into the face of the cliffs. The model for this type of tomb was provided by the terraced complex built against the base of the western cliff at Deir el Bahri by the Eleventh Dynasty pharaoh, Mentuhotep, in about 2120 BCE. Its large middle colonnaded terrace, aligned on the axis of the Temple of Amon at Karnak across the river, was once perhaps pierced by a pyramid measuring 70 feet square (21.5 m) at its base.[16]

Mentuhotep's tomb now survives in fragments, but next to it, in much better condition, is the tomb of Queen Hatshepsut, pharaoh of the Eighteenth Dynasty, who ruled from 1503 to 1482 BCE [10.15, 10.16]. Perhaps her most singular accomplishment was becoming a pharaoh, a woman ruling in a patriarchal society that had been ruled by men for many centuries, and would continue to be for centuries after her reign. Among her many other accomplishments was a commercial expedition to the Land of Punt (modern Somalia), which brought back myrrh trees. Hatshepsut gave her architect and chief administrator, Senmut, the task of building a terraced mortuary chapel complex next to that of Mentuhotep, to serve also as an earthly paradise for Amon, with a myrrh tree garden recalling those of Punt. Along the axis that runs to the Temple of Amon at Karnak across the river, Senmut laid out a Valley Temple opening to a long causeway lined with figures of sphinxes, leading to a broad forecourt lined with trees. Along the west wall runs a colonnade of blunt square piers, behind which are more delicate faceted sixteen-sided columns (they begin to approach the severity of early Greek Doric columns); the colonnade is interrupted at its center by a ramp that rises to an upper terrace. Along the west side of this terrace, too, is a double colonnade, serving as a porch to temples at the far ends. These temples were dedicated to Hathor, the goddess of love and associated with the arts and music, and to Anubis, the god of mummification. Deeper inside this porch was an open peristyle court flanked by temples of Amon and Ra cut into the face of the cliff. The entire mortuary temple complex is rooted in the axial and orthogonal traditions of Egyptian geometry and spatial organization. But its unique features consist of how Senmut integrated the terraces into the horizontal layers of the cliff, with the vertical lines of the colonnades echoing the vertical weathered grooves of the cliff faces, making temple and cliff seem to be extensions of each other.

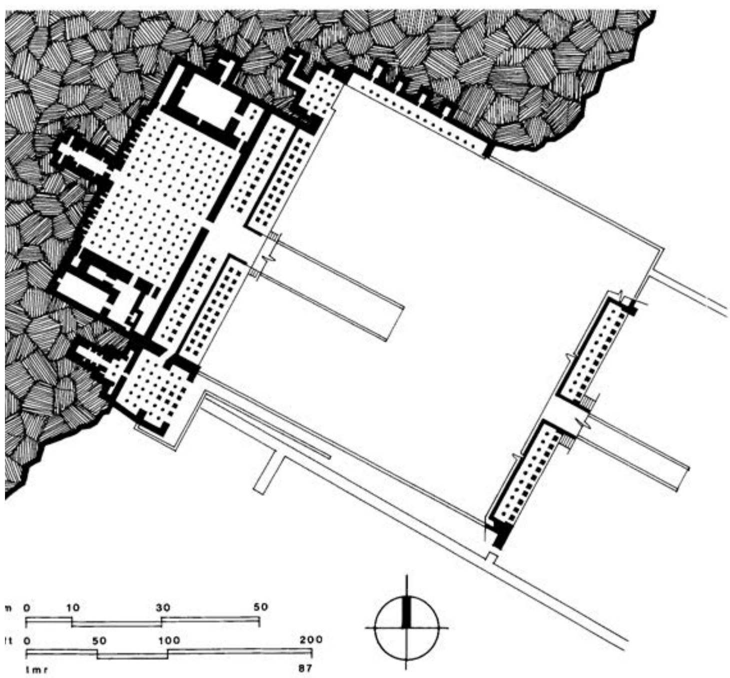
Building a temple-tomb at the base of a cliff—and, even more, the raising of a huge artificial stone mountain over one's tomb—simply advertised where the treasure was stored. Despite having guards posted, the tombs were invariably robbed, and so the previous practice of building imposing visible tombs shifted to the cutting of tombs, hidden deep into the cliffs that surrounded the Valley of the Kings, located behind where Queen Hatshepsut's tomb was built. Most of the royal tombs of the Middle Kingdom were dug into these cliffs. For centuries, an elite cadre of scribes, stone carvers, painters, and artisans of various skills was kept busy preparing these tombs.

The Temple of Amon at Karnak and Other Egyptian Temples

Temples were more than places of worship; they combined centers of learning and administration



10.15. Senmut, Tomb of Queen Hatshepsut, Deir el Bahri, Egypt, c. 1500 BCE. This remarkable tomb-temple complex is integrated into the base of the cliff west of the Nile, and originally included a grove of myrrh trees brought back by the queen from Punt (Somalia). Photo: Hirmer Verlag, Munich.



10.16. Plan of the Tomb of Queen Hatshepsut. Drawing: L. M. Roth, after J. L. de Cenival, Living Architecture: Egyptian *(New York, 1964).*

for the nation. The Egyptian temple, the most important public building by the time of the Middle Kingdom, was far more than a church—as we might imagine. It was the residence and training ground of the immense bureaucracy that ran the country. Priests taught writing and painting (to ensure that the images and inscriptions in the tombs were correct). The large temples included schools, universities, libraries, and archives; they were centers for government administration, scientific and medical study, and agricultural administration; and they served as public granaries and workshops. The temples were also the site of elaborate, prolonged theatrical religious festivals celebrated at *Inundation,* when work came to a halt in the fields.

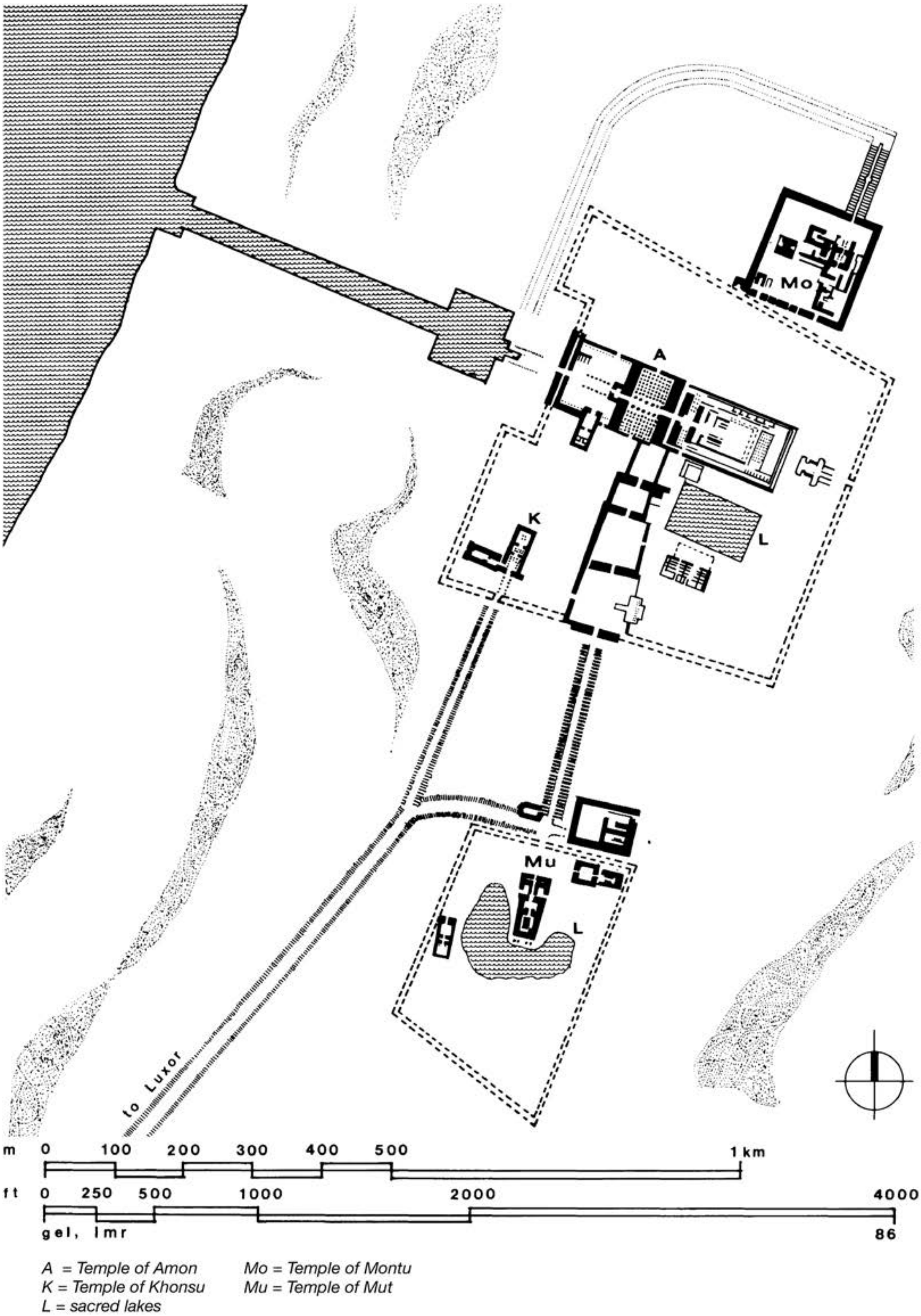
At Karnak, south of Thebes, the great Temple of Amon gradually became the religious and administrative center of the Egyptian Empire [10.17]. As a temple of Amon, it had been a sacred site since the Old Kingdom, but after the Tenth Dynasty, it steadily rose in prominence as the major sacred site in Egypt. As Thebes prospered with the influx of the spoils of war and the trade of the expanding Egyptian Empire, the temples to Amon at Karnak and Luxor were enlarged by succeeding pharaohs.

There were two principal sacred areas immediately south of Thebes on the east bank of the Nile: In addition to the Temple of Amon at Karnak, another temple was situated about half a mile further to the south, at Luxor. The temple at Luxor was aligned roughly parallel to the bank of the Nile, but the one at Karnak had its axis pointing toward the winter solstice sunrise. Both temples were rebuilt during the Eighteenth Dynasty and then successively enlarged. Several additional temples, including smaller temples dedicated to Montu, Mut, Ptah, and Khonsu, were placed around the compound at Karnak.

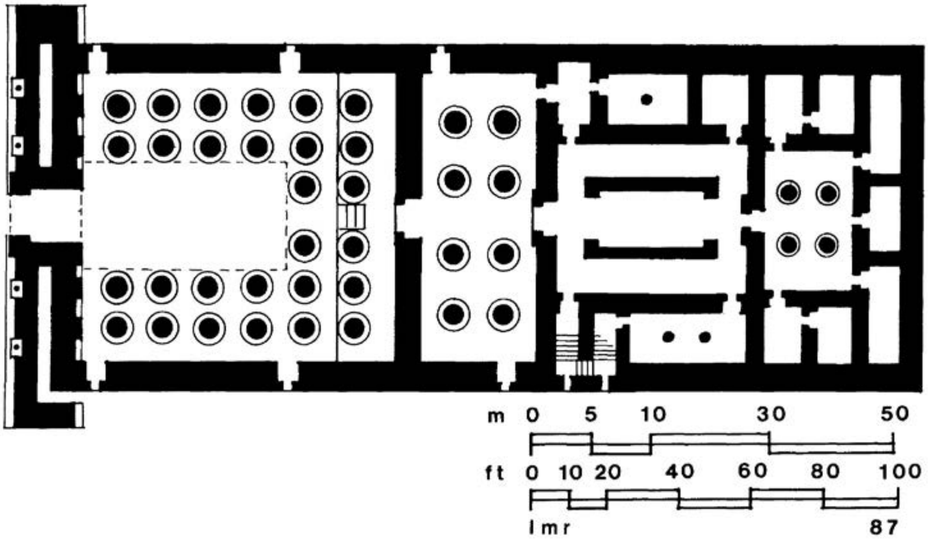
Because the larger Temple of Amon at Karnak became exceedingly complex as it was enlarged, the smaller Temple of Khonsu—which was integrated into the larger temple system and was built by Ramses III in about 1170 BCE—illustrates more clearly the basic components of the New Kingdom temple. The temple was approached along an avenue marked by sphinxes and leading to an entrance ***pylon***, or a massive, sloped (battered) wall pierced by a narrow door. Slots in the battered wall accommodated flagpoles from which brightly colored banners hung. One passed through the pylon into an open forecourt that was enclosed by massive colonnades. Proceeding along the axis through this colonnade, one reached the ***hypostyle*** hall, a roofed chamber filled with columns and lit by clerestory windows [10.18, 10.19]. Beyond this lay the *sekos,* the sanctuary reserved for the priests, focusing on a chamber containing the ceremonial boat, or barge, in which the statue of the god was moved during festivals.[17] At the very rear of the temple was a chamber in which resided the image of the god, typically a wooden statue covered with gold. At daybreak, the statue would be removed from its chamber for ritual washing, dressing, and feeding, before being returned.

As this description suggests, the main sections of the temple were much like those of a typical Egyptian house (for this was the house of the god, after all), with an entrance garden court, a formal reception hall whose roof was supported by a series of painted columns, and private chambers. Once perfected in the Middle and New Kingdoms, the temple form was used for fifteen hundred years, into the period of Roman annexation. Most temples were built on an axis that ran perpendicular to the river, so that in the ritual washing of the image of Amon-Ra in the morning, the priest faced in the direction of the rising sun.

The huge Temple of Amon at Karnak follows this same pattern [10.20]. The core of the sanctuary, already of considerable size, about 265 by 170 feet (81 by 52 m), apparently survived from the Middle Kingdom. In front of this sanctuary, Thutmose I added two massive entrance pylons in about 1520 BCE, enclosing a narrow forecourt. All of this was then encased in a new outer wall, with additional sanctuary chambers added to the rear by Thutmose III in about 1460 BCE, which brought the overall dimensions to about 548 by 275 feet (167 by 84 m). An even larger entrance pylon was built 48 feet (14.5 m) to the front by Amenhotep III in about 1400 BCE. Then, about eighty years later, Ramses I added yet another, even larger entrance pylon, nearly 41 feet (12.5 me) thick at its base, roughly 161 feet (49 m) farther to the northwest. From 1315 BCE to 1235 BCE, Seti I and his son, the prodigious builder Ramses II, connected this pylon to that of Amenhotep III with an enclosing wall and built between them the great hypostyle hall enclosing an area measuring 320 by 160 feet (97.5 by 48.75 m). In this hall were placed 134 enormous columns [10.21, p. 186; 10.22]. The 122 shorter, lotus-bud columns rise 42 feet and are 9 feet in diameter (12.8 by 2.75 m), whereas the 12 lotus-blossom, or bell, columns defining the central axis are 69 feet high and 11.75 feet in diameter (21 by 3.6 m). All the columns were carved and painted with inscriptions, and in this Hall of the Two Crowns the pharaohs' coronations were celebrated. The taller central columns permitted clerestory



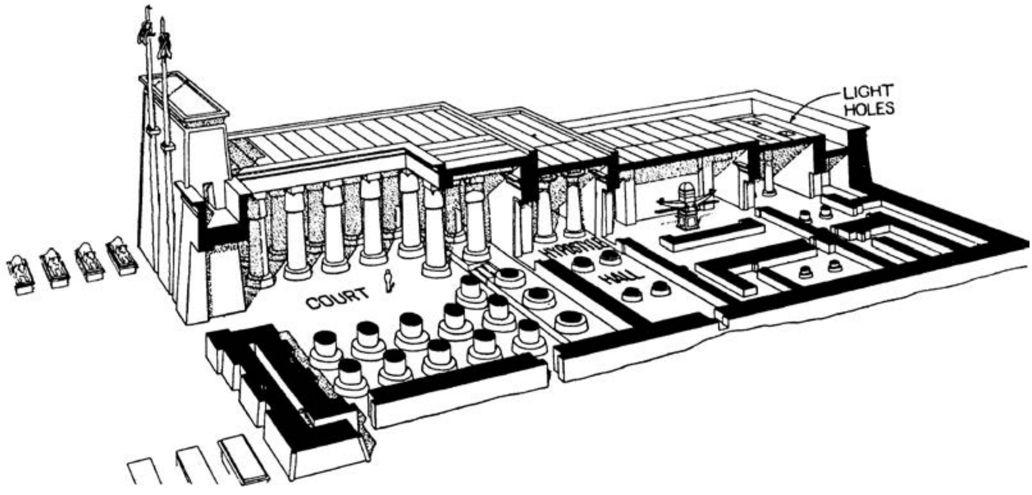
10.17. General plan of the temple complex at Karnak, Thebes, Egypt, c. 2000–323 BCE. The core of the ancient Middle Kingdom temple was wrapped with new chambers, courts, and pylons by successive pharaohs for more than 1,700 years. This was the greatest and richest administrative/religious center in ancient Egypt. Drawing: A. Stockler and L. M. Roth, after Badawy, Architecture in Ancient Egypt *(Cambridge, MA, 1966).*



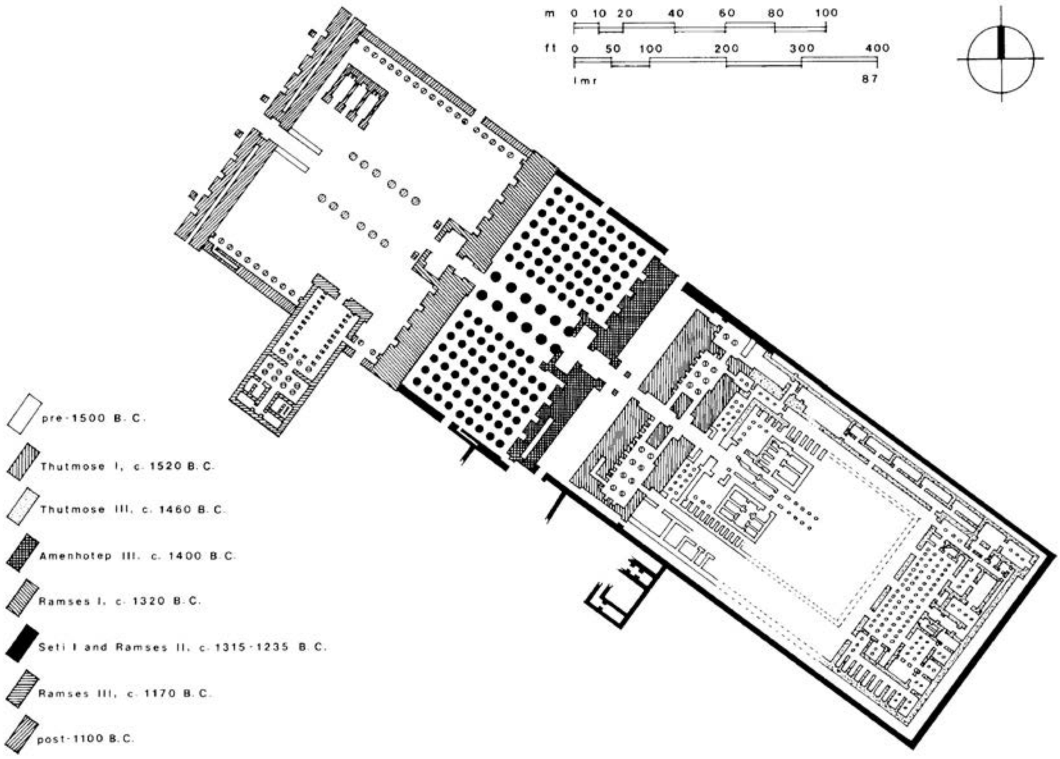
10.18. Temple of Khonsu at Karnak, Thebes, Egypt, c. 1170 BCE. Plan. This relatively small temple illustrates the basic elements of all Egyptian temple design, with an entry forecourt, a public hypostyle hall, and the inner sekos, *a chamber reserved for the priests. Drawing: L. M. Roth, after B. Fletcher,* A History of Architecture *(New York, 1931).*

lighting through stone louvers. Ramses II added yet another enclosing wall around the temple at Karnak. About 1170 BCE, Ramses III built a small temple house for himself south of the entrance axis and adjacent to the entrance pylon of Ramses I. Two and a half centuries later, during the Twenty-First Dynasty, the walls enclosing the great entrance forecourt were built, and the enclosure of this vast space, 330 by 275 feet (100.5 by 84 m), was made complete by the erection of the entrance pylon just after the conquest by Alexander, in 332 BCE. Altogether, construction continued for more than seventeen hundred years, with the final dimensions reaching 1,200 by 320 feet (366 by 98 m).

Around the temple itself were smaller auxiliary temples, a sacred lake or pool, gardens, granaries, administrative buildings, schools, and other buildings in an enclosed compound more than a quarter of a mile square, or 160 acres. The sacred lake and the ceremonial boats housed in the temple for



10.19. Cutaway perspective of Temple of Khonsu. From B. Fletcher, A History of Architecture *(New York, 1931).*



10.20. Temple of Amon at Karnak, Thebes, Egypt, c. 2000–323 BCE. Plan. The parts of the temple still standing include the middle sanctuary built by Thutmose III (c. 1460 BCE) and the soaring Hypostyle Hall built by Ramses II (c. 1315–1235 BCE). Drawing: L. M. Roth, after B. Fletcher, A History of Architecture *(New York, 1931).*

carrying the images of the gods from temple to temple during festivals reaffirmed the connection with the river, which lapped at the eastern boundary of the temple. The entire temple complex, with its lotus- and papyrus-shaped columns connoting marsh vegetation and its sacred lake and pools, was in fact a formal representation of "the island of creation" when the world first appeared. The orientation of the Karnak temple axis toward the winter solstice sunrise makes clear the connection with the sun. This relationship is confirmed by the descriptions given to the parts of the temple, for as the temple complex was extended to the west, its constituent parts were said to represent the hours of the day. For nearly three thousand years, Egyptian builders continually reasserted the primeval rhythm of sun and river, guarding against change and perpetuating *ma'at*.

Egyptian Villages and Houses

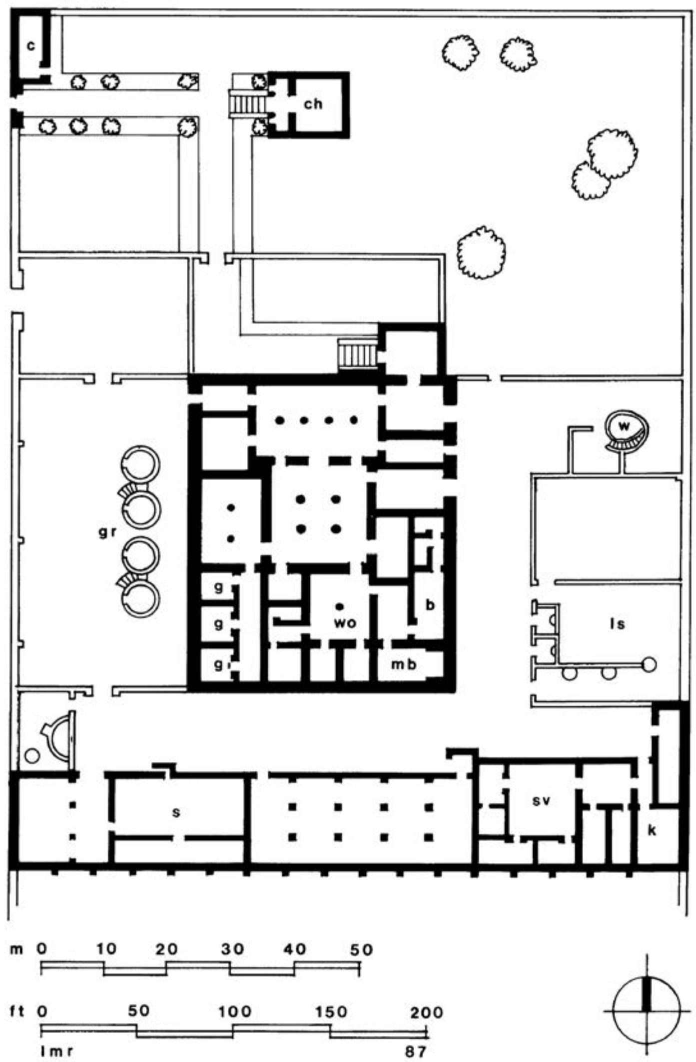
The ancient Egyptian metropolises of Memphis and Thebes have disappeared, for they were built of adobe mud brick. Under Pharaoh Akhenaton, a new capital city, called Akhetaten (The Horizon of Aton), was built around 1379–1362 BCE at a site located in the virtual geographic center of ancient Egypt, now called Tel el Amarna. It was to be the headquarters for the religious revolution being attempted by Akhenaton. After Akhenaton's death, the city and its new temples were deliberately pulled down by the priests of Amon, and the stones of the temple were reused in later buildings.[18] Yet fragments of Tel el Amarna survive, permitting a reconstruction of one commodious villa in a northern "suburb" [10.23, 10.24]. From the street, one entered through a gate in the surrounding wall; immediately to the left was a small gatekeeper's lodge. Within a walled garden was a small temple to Aton, the new god. Past an inner garden court was the house complex, focused on the North Room and the Central Room at the core of the house. Around this core were arranged a West Room for guests, the wives' quarters on the south side, and the master's suite in the southeast corner. Windows in the thick adobe-brick walls were evidently quite small to re-

10.22. Hypostyle Hall, Temple of Amon, Karnak, Thebes, Egypt, c. 1315–1235 BCE. The huge columns along the central axis are 11.75 feet (3.6 m) in diameter and rise 69 feet (21 m); the axis they define is aligned to the rising sun at midwinter, pointing directly to the Valley of the Kings on the west side of the Nile. Photo: Gianni Dagli Orti/The Art Archive at Art Resource, NY.

duce heat gain, and the center portions rose to permit light and ventilation through clerestory windows. Around the principal house were a granary on the west side, stables and a chariot room in the southwest corner of the compound, servants' quarters in the south-central portion, and storerooms and the kitchen in the southeast corner, with a cattle barn and a well along the east side. This was clearly the abode of a favored and successful administrator, perhaps a priest who served in the temple.

Scribes and artisans also lived reasonably well, for their skills were crucial to the operation of temple

10.23. Suburban villa, Akhetaten (today's Tel el Amarna), "Horizon of the Aten," Egypt, c. 1379–1362 BCE. This model (Oriental Institute, University of Chicago) of a villa outside Akhenaton's new capital city shows the basic elements of a large household, including a small private temple for worship of the newly declared god Aton. Photo: Courtesy, University of Chicago.



10.24. Plan of villa at Akhetaten (Tel el Amarna). Plan Drawing: L. M. Roth, after Lloyd, Muller, and Martin, Ancient Architecture *(New York, 1973).*

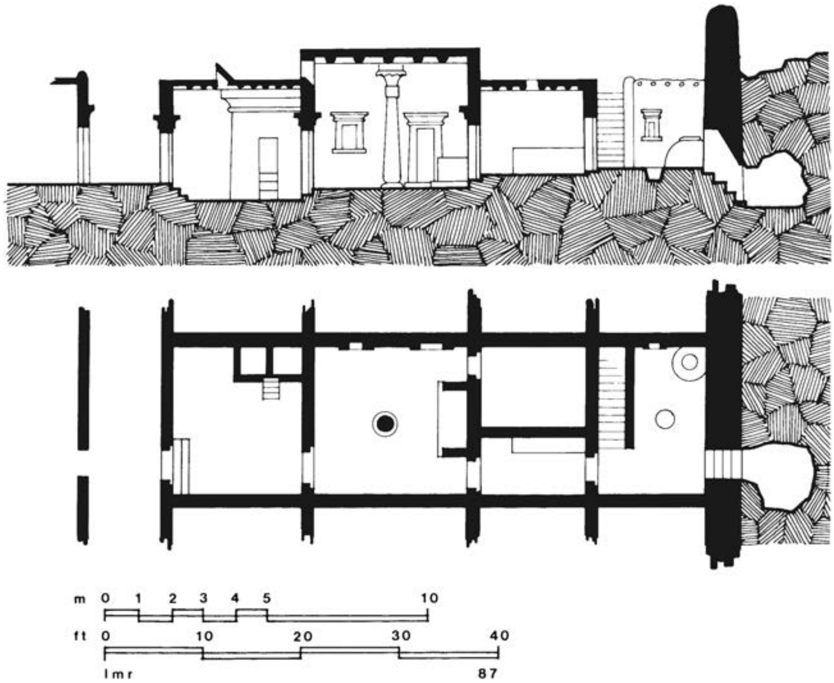
b = bathing room
c = caretaker's room
ch = chapel
g = guest room
gr = granaries
k = kitchen
ls = livestock
mb = master's bedroom
s = store rooms
sv = servants room
w = well
wo = wives' quarters

services and the creation of inscriptions and paintings in the temples and tombs. The temple artisans' quarter in Thebes has long since disappeared, but the special town built for the artisans working on the tombs in the Valley of the Kings has survived in part [10.25]. The town was founded by Tuthmose I in about 1530 BCE to house this special corps of artists, craftsmen, and scribes. Now called Deir el-Medina, it was placed in a depression atop the cliffs overlooking the green fields of the Nile valley and Thebes and Karnak to the east, with a path leading down to the desert Valley of the Kings just to the north. The town's elevated position allowed breezes to reach it. The artisans' houses, one room wide and several rooms deep [10.26], have the same major parts as the larger Amarna villa. The dimensions range from 13 to 20 feet wide (4 to 6 m) and 65 to 83 feet long (20 to 25 m). The front room, with a door to the narrow street, was a reception room with a small shrine to the household god Bes. Beyond the front room was a taller, larger room, presumed to have had clerestory lighting, with a bedroom behind it. To the rear was a court with stairs to the roof and the kitchen open to the sky for ventilation. Often, a small storage cellar was excavated beneath the house.

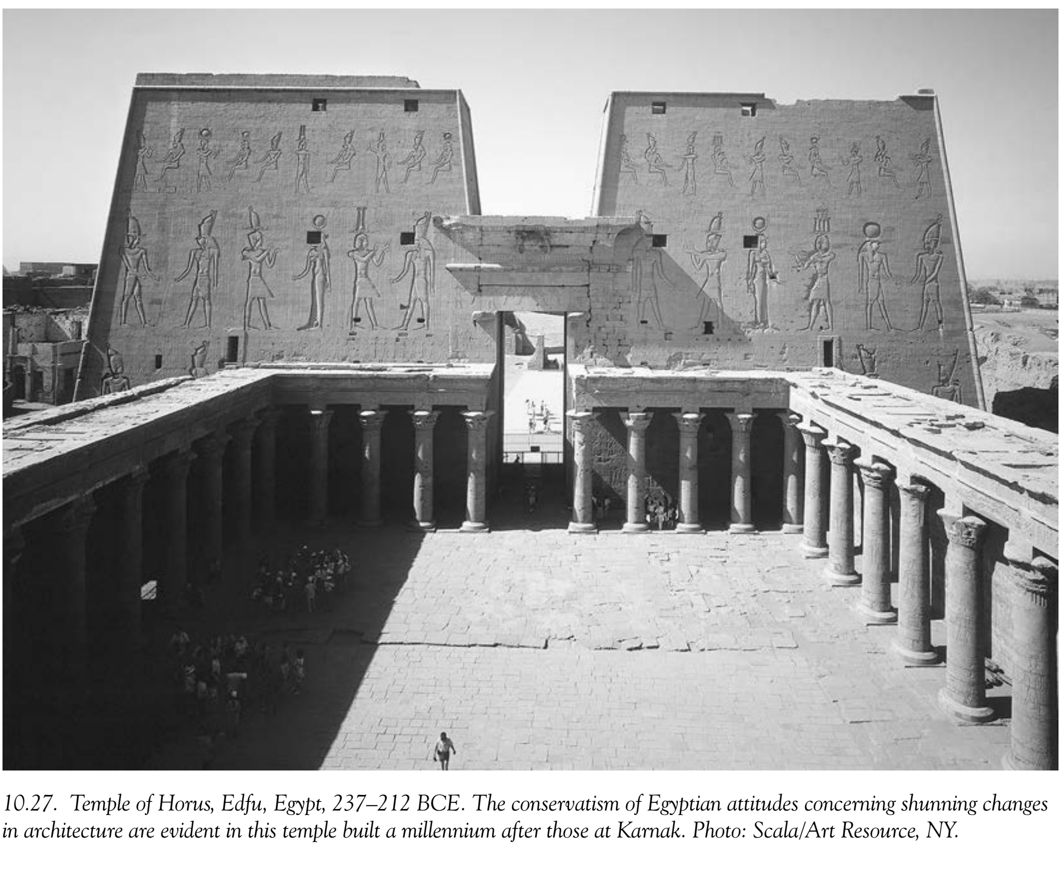
Late Egyptian Architecture

What so distinguishes Egyptian architecture is the deliberate resistance to change, or rather the acceptance of only the most gradual modifications in architectural form over a span of almost twenty-seven hundred years. This persistence of form, especially in temple design, is well illustrated by structures built during the Ptolemaic period, after Egypt had been conquered by Alexander and was then administered by Greeks. The new Temple of Horus, at Edfu, 237–212 BCE, might pass, at first glance, for a temple of a thousand years earlier [10.27]. As noted above, its walls carry inscriptions noting the care taken in following the ancient traditions. Like the Temple of Khonsu at Karnak, it is entered through a massive

10.25. Plan of the tomb-artisans' village of Deir el-Medina, Egypt, begun c. 1530 BCE. This village was inhabited by the scribes, painters, and sculptors who constructed the tombs of the kings and queens of Egypt; it was located on the cliffs overlooking the green Nile valley to the east and the Valley of the Kings to the west. Plan Drawing: L. M. Roth, after Lloyd, Muller, and Martin, Ancient Architecture *(New York, 1973).*



10.26. One of the artisans' houses at Deir el-Medina. Plan and section. Drawing: L. M. Roth, after James, Introduction to Ancient Egypt *(New York, 1989).*



10.27. Temple of Horus, Edfu, Egypt, 237–212 BCE. The conservatism of Egyptian attitudes concerning shunning changes in architecture are evident in this temple built a millennium after those at Karnak. Photo: Scala/Art Resource, NY.

pylon forming the end of the entrance court; beyond this is a shallow hypostyle hall connecting with the inner sanctuary. All parts are aligned on an orthogonal grid, and everything is organized along a dominant axis. Yet one detail suggests its late period and a sense of experimentation among its designers: the columns of the court do not carry the lintels directly on their open palm capitals but instead tall blocks are inserted, lifting the lintels higher and seeming to deny the weight of the massive stone beams.

The sense of mass and timelessness that had characterized Egyptian architecture since the Third Dynasty began to dissipate after the end of the Thirty-First Dynasty. The world was no longer viewed as changeless, following an endlessly recurring cycle, for indeed these temples were built not at the direction of Egyptian pharaohs but by Greek rulers placed on the throne by conquering Alexander. The world was changing, and the fixed rules of Egyptian architecture were being stretched to accommodate these changes.

An Architecture for Eternity

Egyptian architecture changed only in subtle ways during thirty-one dynasties, over twenty-seven hundred years. The goal of Egyptian culture, and the architecture that housed its institutions, was continuity and order; this unending effort to thwart time, death, and decay bound the architect to the service of tradition. In part, this adherence to tradition arose out of the need for proper management of the Nile waters, which required continual social cooperation and strict discipline. As historian E. B. Smith wrote, the "beneficent tyranny of the Nile" created in Egypt a benign "environmental despotism" rather than a "social tyranny."[19] Ancient Egyptian society was one in which man and nature were bound into a fixed pattern, and the pharaoh became the divine symbol of that absolute and permanent man-nature relationship. In response, Egyptian architecture was one of immovable, massive geometric forms, sharp-edged and crystalline. The Egyptians valued bigness, mass, and solidity as the expression of durability, a guarantee of unending security and indestructibility. The constant repetition of their sacred chants found a parallel in the repetition of pylon after pylon and column after column in their temples. And yet, out of obelisk, pylon, hypostyle hall, and all the other architectural elements, the Egyptians never fashioned an organic architecture; for all their pragmatic science they speculated or theorized very little. The Egyptians never stepped back from the architectural object, never studied it reflectively as an abstract thing, because, as E. B. Smith further observed, "they saw not the stone but the symbol."[20]

11.21. Temple of Athena Nike, Akropolis, Athens, Greece, c. 435–420 BCE. Having gone past the projecting bastion on which this temple sits, the visitor enters the sacred precinct of the Akropolis through the Propylaia gateway. Circling around the entry Propylaia, the visitor is greeted by this jewel of ancient Greek architecture. Photo: A. Frantz.

Chapter 11

Greek Architecture

> The Greek architect . . . dealt with forms both natural and constructed. With them he celebrated his three deathless themes: the sanctity of the earth, the tragic stature of mortal life upon the earth, and the whole natures of those recognitions of the facts of existence which are the gods.
>
> —*Vincent Scully,* The Earth, the Temple, and the Gods, *1962*

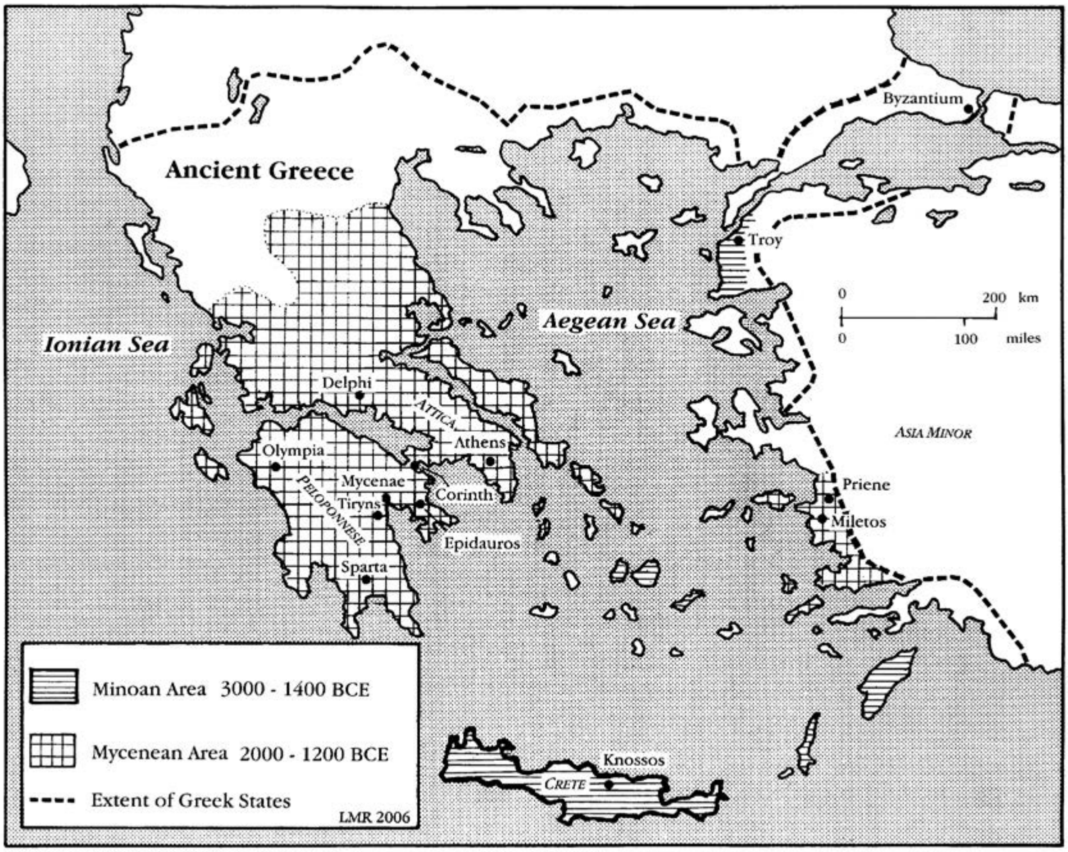
The Greeks were proud of their public and sacred architecture, and even in antiquity, the white marble Parthenon atop the Akropolis hill in Athens was recognized as a special achievement. One writer of the second century BCE, in describing his visit to Athens, wrote admiringly of the "costly, remarkable, and far-seen temple of Athena called the Parthe-non" rising on the Akropolis to greet those coming into the city.[1] In the following millennia, the Parthenon continued to be praised in literary works even though Europeans seldom visited Greece once that country was absorbed into the Ottoman Turkish Empire in the fifteenth century. Only in the mid-eighteenth century did an English expedition, led by James Stuart and Nicholas Revett, venture to Athens to record in a scientific way the actual appearance of the fabled Parthenon. The reputation that the ancients had attributed to the building was confirmed, and the Parthenon became a singular symbol of the clarity and precision of ancient Greek architecture. In the nineteenth century, this led to a revival of Greek architecture in which the form was understood even if the spirit that created the Parthenon was missing. Since the mid-nineteenth century, as study of Greek history and literature has ceased to be the measure of a well-educated person, ignorance of ancient Greek culture has increased. Hence, to better understand the intellectual clarity of ancient Greek architecture, we must know something of the intellectually rigorous civilization that gave rise to it.

The ancient Greeks of the period 750 BCE to 350 BCE learned much from Egypt, apparently adapting their earliest sculpture and post and lintel stone architecture from Egyptian models. They readily admitted this, for as Plato wrote in *Epinomis,* "Whatever the Greeks acquire from foreigners is finally turned by them into something nobler."[2] Quickly, however, the Greeks shaped an art and architecture distinctly their own, creating a system of values celebrating dynamic human capacities that has formed the basis of Western civilization ever since.

The Geography of Greece

Unlike Egypt, where the river and desert encouraged a particularly static culture, Greece's very different geography and climate influenced a more dynamic culture and fostered a much different view of a human's place in the world [11.1]. In ancient times, Greece included more than the broad peninsula, extending from the Balkans at the southeast corner of Europe; from the second millennium BCE onward, Greek territory also included the scores of islands scattered to the south and east, as well as the area along the coast of Anatolia, or Asia Minor, in what is now Turkey. The ancient Greeks, in fact, spoke of the Aegean Sea between the Greek peninsula and Asia Minor as "the pond," since their countrymen were scattered about its edges.

Everywhere, the Greek landscape is rough, a corrugated mass of limestone and marble mountain ridges extending into the sea like fingers, sheltering innumerable bays and coves. The land is divided into three main parts, centered on the principal peninsula. To the southeast of the main peninsula is Attica and the city of Athens. East of the peninsula



11.1. Map of Ancient Greece.

lies the large island of Euboea, close to shore. To the south, like a gigantic hand with its fingers outstretched and pointing the way to Crete and Egypt, is the peninsula of the Peloponnese, attached to the mainland mass by a narrow isthmus at Corinth.

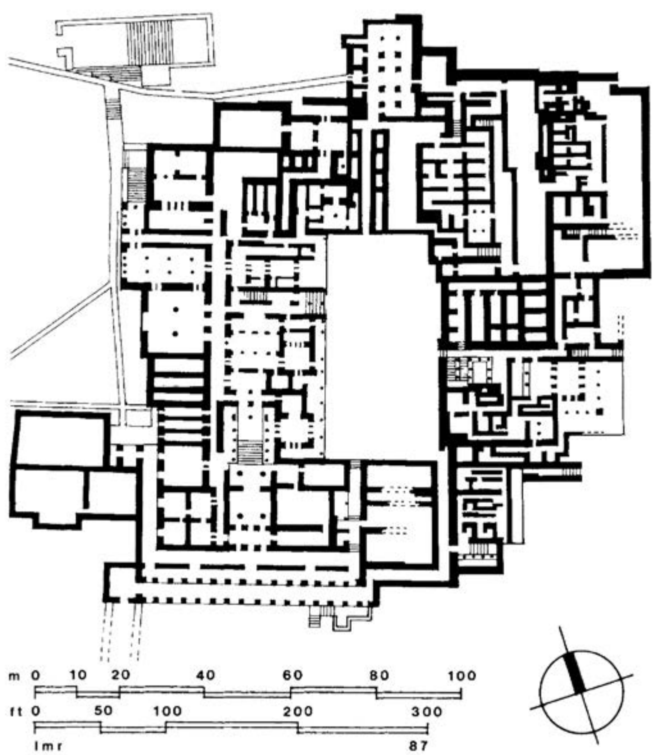
There is little flat soil except in coastal plains and occasional inland valleys. Farming was always difficult and became more so as the forests were cut and the thin upland soil washed into the sea. This erosion was already well advanced even in ancient times, for Plato observed in *Critias* that "the fertile soil has fallen away, leaving only the skeleton of the land."[3] Travel from one valley or plain to the next was always treacherous; hence, the Greeks turned to the sea very early as their major highway, and this risk-taking on the seas, in turn, bred in the Greeks an adventurousness of spirit, a love of action, and a readiness to put their strength to the test. The tough, resilient fiber of the Greeks was formed in response to an environment that could change dramatically in an instant, for besides violent thunderstorms, the region is prone to earthquakes, dangers seldom encountered by the Egyptians. The agricultural economy of the Greeks was based on small farms individually owned and operated, and both this economy and the rugged landscape prevented consolidation of the many separated Greek city-states into a single centralized nation. Nonetheless, the Greeks shared a common religion and a rich subtle language that set them apart from those who spoke what sounded to them like nonsense, "bah-bah"—the *barbaroi,* or barbarians. The Greeks identified themselves as a whole, whatever their individual city-state allegiance, as Hellenes and their land, as Hellas.

Minoan and Mycenaean Greece

The Greeks of what is customarily called the Classic period, roughly 479 BCE to 338 BCE (the period focused on here), had descended in stages from Bronze Age cultures that flourished first on the island of Crete and the islands of the Cyclades in the Aegean Sea, and then on the Peloponneses and in central Greece. The oldest culture was the Minoan, which began as early as 3400 BCE and reached its peak between 1600 BCE and 1400 BCE. It was named after the mythical King Minos by the archaeologist Sir Arthur Evans, who believed the culture had been centered in the immense and sprawling palace and administrative complex at Knossos, which he began to excavate in about 1900 [11.2].

The Knossos palace measured more than 460 feet (140 m) square, centered about an open court running on a roughly north-south axis from the sacred mountains to the sea. Running through the building was a sophisticated plumbing and drainage system. In places, the palace walls were four and five stories high in a series of setbacks around light courts and stairwells [see 4.27]. The principal chambers had walls brilliantly painted with murals depicting religious activities and festive sports, especially contests involving men vaulting over charging bulls. It may well be that the complexity of the Knossos palace plan and the bull cult that flourished there formed the basis of the subsequent legend of Theseus and the Minotaur who lived in a fabled labyrinth. The palatial complexes on Crete were remarkable for the complete absence of defensive walls, suggesting that the Minoans had such complete control of the sea they feared no invasion. This focus on the secular life of the palace sets Minoan culture apart from that of Egypt, with its focus on the tomb, or that of Mesopotamia, with its focus on the towering ziggurat temple.

Just prior to 2000 BCE, the outlying mainland Minoan settlements were taken over by a new group that, presumably, moved down from the north. By 1600 BCE, the newcomers had established their own distinct culture, called Mycenaean after the city of Mycenae on the Peloponnese; this city was apparently the peninsula's new cultural and political center. A particularly vigorous and aggressive people, the Mycenaeans seem originally to have been a client state of the older Minoan culture and were likely dominated by the more prosperous Minoan culture centered on Crete—that is, until 1628 BCE when the volcanic island of Thera (modern-day Santorini) in the middle of Minoan territory exploded violently, sending a tsunami that affected the entire Aegean region and spewing out an ash cloud that enveloped the earth, causing recorded crop failures in China.[4] Minoan cities along the north coast of Crete were almost entirely swept away, and Minoan cultural influence diminished



11.2. Royal Palace, Knossos, Crete, 1600 BCE. Plan of the principal living level. This palace was combination residence, administrative center, and storehouse, open at its edges and without protective walls. Drawing: L. M. Roth, after S. Hood and W. Taylor, The Bronze Age Palace at Knossos *(London, 1981).*

11.3. City walls and Lion Gate, Mycenae, Greece, c. 1300 BCE. The huge size, roughness, and irregularity of the stones in the wall greatly impressed the later Greeks of the Classical age. The Lion Gate still makes a strong impression on approaching visitors. Photo: Manuel Cohen/The Art Archive at Art Resource, NY.

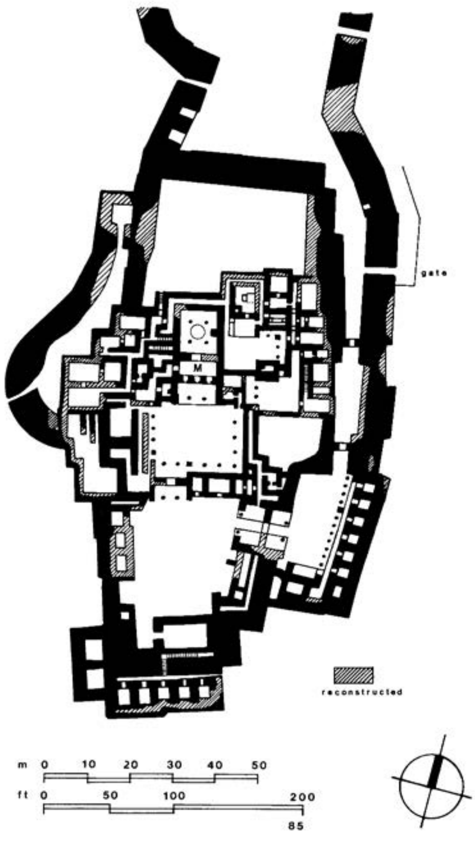
rapidly. Subsequently, until around 1150 BCE, the Mycenaean culture flourished.

With the resulting political vacuum after the explosion, Mycenaean influence expanded. Located in Greece on elevated hilltops, the Mycenaean cities survived the Thera tsunami. These Mycenaean settlements were not only elevated but heavily fortified and built on isolated, defensible rock plateaus. On the highest ground the principal palace was built, behind thick walls of large, irregular, but carefully fitted stones. The Greeks of the later Classic period, on looking upon these ancient ruined walls of massive rough blocks, imagined that the walls could have been built only by the mythical one-eyed giant Cyclops, and hence this type of masonry came to be called ***cyclopean***. All the major settlements, including Mycenae, were of this kind [11.3]. (Mycenae was the seat of King Agamemnon, who led these early Greeks to Troy in Homer's *Iliad,* which may be an embellished and imperfectly remembered account of an actual campaign in northern Asia Minor.) At Pylos, in 1939, archaeologists found what has been called the home of King Nestor, who accompanied Agamemnon in the Trojan War.

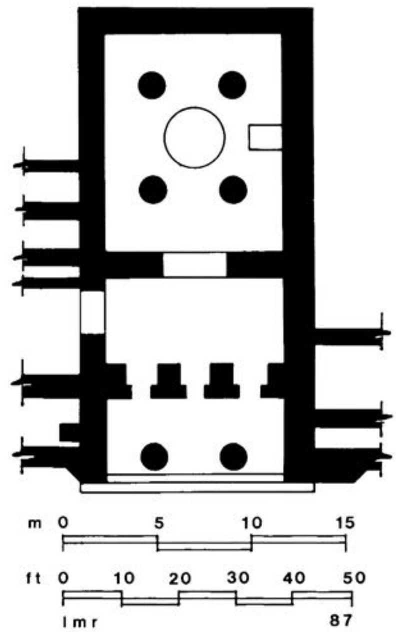
The city of Tiryns (Homer's "Tiryns of the Great Walls"), just south of Mycenae at the base of the thumb of the Peloponnese, illustrates the basic organization [11.4]. Set high on a limestone plateau rising from the plain and surrounded by massive cyclopean walls 20 feet (6 m) thick, the city is approached by a ramp on the east side. Attackers would have been forced to approach along the east wall with their right side—the side not protected by a shield—exposed to bowmen on the parapets. Entry is through a ***propylon*** gate into a court. In contrast to the strong outer walls, the inner structures were built with wooden frames and rubble-stone-infilled walls. Another propylon gate, on the north side of the court, led to a smaller palace court ringed with a sheltering colonnade. This in turn led to the heart of the palace, which the Greeks called the **megaron** [11.5]. The *megaron* consisted of an entry porch formed by projecting walls framing two columns, a vestibule, and the throne room, nearly square, with its roof carried by four columns (virtually the same arrangement found at Mycenae and Pylos). At the center of the principal room was a raised circular hearth, suggesting that the room was open at the center of the ceiling.

The traditional view is that about 1150 BCE, the Mycenaean settlements were swept over by yet another group from the north, the direct ancestors of the Classical Greeks. The Greeks later called them the Dorians. The Mycenaean culture collapsed, although some cultural strongholds, especially Athens, resisted. Some groups fled the Peloponnese and sailed east, setting up colonies in the islands close to Asia Minor and on the Anatolian coast itself. Thus, remnants of the old Minoan-Mycenaean culture continued in the easterly region that became known as Ionia, while the mainland of Greece slipped into a dark age. Architecture in stone and the brilliant mural painting of Minoan and Mycenaean palaces disappeared. The Dorians' major cultural contributions were a richly figurative language and a new group of predominately male sky-gods, who ruled from the heights of Mount Olympus in north Greece. These gradually replaced the maternal earth deities of the Minoans and Mycenaeans or took over some of the old deities' attributes.

Only around 750 BCE did stone architecture reemerge on the mainland, and with it the beginnings of Classical Greek civilization. At Sparta there developed a closed, rigorously militaristic society ruled by a landed aristocracy, with its ordinary inhabitants, the helots, put into slavery. Meanwhile, at Athens, the Dorian culture merged with the surviving Mycenaean elements, creating a far more cosmopolitan city life that was receptive to new ideas, particularly to later democratic rule by free males. To the clarity and grace of the old Minoan and Mycenaean cultures were added in Athens the passion and imagination of the new.



11.4. Akropolis Palace, Tiryns, Greece, c. 1400–1200 BCE. Mycenaean cities were built atop defensive strongholds, as at Tiryns. **M** *= Megaron. Drawing: L. M. Roth.*



11.5. Megaron unit, Akropolis Palace, Tiryns, Greece, c. 1400–1200 BCE. The form of the central ceremonial chamber, the megaron, is believed to have provided the model for the later Greek temple. Drawing: L. M. Roth.

At the same time, Greek colonization of the Mediterranean began, in response to the poor agricultural conditions at home and the need for raw materials. Almost every major Greek city sent out parties. Euboea established such cities as Neopolis (Naples) in central Italy. Megara founded Chersonesus (Sevastopol) at the southern tip of the Crimea in the Black Sea and Selinus in Sicily. Achaea had numerous large settlements in southern Italy, which later the Romans came to call Magna Graecia. These settlements included Poseidonia (which the Romans translated as Paestum) and Messana (Messina in Italian). Corinth had a number of settlements up the coast of what is now Albania and a major colony at Syracuse, Sicily. Phocaea founded cities along the Spanish and French coasts, including Tarraco (Tarragona); Massilia (Marseilles), near the mouth of the Rhone; Antipolis (Antibes); Herakles Monoecus (Monoco); and Nicaea (Nice). Miletos, the major Ionian city commercially and culturally, founded nine colonies around the Black Sea. Other colonies were planted in Cyrene, North Africa, and Naucratis in the delta of Lower Egypt. Only where the rival Phoenicians had set up competing trading bases—in Palestine, Syria, and North Africa—were the Greeks absent.

Although we use the word *colony,* these were not mercantilist sources of raw materials in the sense of eighteenth-century European colonies. Greek colonies were wholly independent adjunct communities; the Greeks called them *poikia,* which means, literally, "away homes." Because of colonization and the resulting far-flung trade, Greek ideas and especially the Greek language were spread the length of the Mediterranean and around the Black Sea. For nearly a thousand years, the Greek language became an international mode of communication.

The Greek Character

The mixing together of aspects of the artistic sophisticated Minoan/Mycenaean cultures with the pragmatism of the Dorians produced a unique Greek character, emphasizing inquisitiveness, a love of action, and the desire to achieve perfection in human intellectual and physical endeavors. The Greeks wanted to know why the gods did what they did, what the nature of humankind was, and how the world was formed and how it operated. And, fortunately for us, they perfected a written language that enabled them to record their speculations. Most of all, the Greeks were supremely confident in their own cultural superiority compared to that of the surrounding barbarians (as they perceived them).

The Greek quest for truth is best exemplified by the natural philosophy developed by Ionian Greeks during the sixth century BCE. The first of these Ionian scientist-philosophers was Thales of Miletos, a merchant who traveled to Egypt and Mesopotamia, learning geometry and astronomy, which enabled him to predict solar eclipses. He also proposed the idea of a few basic components out of which the world was made, an idea that ultimately led to the concept of atoms, the smallest indivisible components of all matter, an idea developed by Leukippos of Miletos and his pupil Demokritos of Abdera.

The Greeks had an innate love of logic (*logos,* a word that can be variously translated as "reason," "idea," "conception," or simply "word"), a natural order whose opposite was irrational *chaos*. In everything, the Greek sought balance and symmetry (*summetria,* "having like measure") as the ideal. Nothing in nature was seen as wholly capricious, for even the gods had reasons for their actions. Hence, Heraclitus wrote, "Measure and logos are firm in a changing world." Heraclitus described the cosmos as a balance of such opposites as hot and cold, night and day, health and disease.

Much of this early philosophy was based on a priori assumptions rather than on observation of how things actually worked, and Plato complained that there was too much variety in natural appearances. Aristotle, on the contrary, devoted himself to observation of the natural world. The Platonists might venture off into pure metaphysical speculation. The Ionian philosopher Pythagoras of Samos, who established a colony of followers at Croton in Italy, took this mystical direction, proposing a natural philosophy based solely on numbers: "all things are number." He and his followers discovered the basis of musical harmony by observing that a taut string one half as long as another produced the same tone an octave higher. From this and other experiments, they determined the mathematical basis of musical harmony. They also conceived of triangular and square numbers, and provided a proof of the concept first used by the Mesopotamians and Egyptians, that the area of a square drawn out on the hypotenuse of a right triangle was the sum of the areas of comparable squares made on the other two sides. Carpenters today still use this principle, quickly measuring out a triangle with sides 3 and 4 feet long and a hypotenuse of 5 feet to create a truly square corner.

Small wonder that the Athenian philosopher Protagoras of Abdera, a friend of Perikles, should write in his essay *Truth:* "Man is the measure of all things, of those which are that they are, and of those which are not that they are not." In the

Greek, this can also be taken to mean that "man is the measurer of all things," that truth is relative to human perception and interpretation. Sokrates was convinced that truth could be found only by constant questioning, refinement, testing. And, as Xenophanes wrote, "The gods did not reveal everything to men at the start; but as time goes on, by searching, they discover more and more."[5]

What the Greeks endeavored to achieve in all things was *arete,* that quality of excellence that results from refinement and testing in all human endeavors—poetry, music, pottery, city government, sculpture, and architecture. *Arete* could be obtained through a contest, *agon* (from which the English word *agony* is derived). Accordingly, the Greeks regularly sponsored contests, at Argolis, Corinth, Delphi, and, of course, Olympia, in search of *arete.* The crown of laurel was awarded not only to athletes but also to musicians and poets. Through contest, *agon,* a human being learned of his capacities and limits, what was meant by the inscription carved at the Temple of Apollo at Delphi: "Know thyself." *Arete* was an all-encompassing physical, moral, and intellectual excellence, requiring a balance in life achieved through rigorous self-discipline.

"Nothing to excess" sums up the Greek view of life, and it was for this reason that Greeks had no time for narrow specialists. A person of *arete* did all things well and kept in balance; he worked his farm outside the city and participated in the town assembly. If he was wealthy, he was expected to pay for the production of public festivals or provide a ship for the city's navy; if not, he accepted his duty to be ready at a moment's notice to march as far as necessary in full armor to defend the honor of his city. To realize a well-ordered life, a person endeavored to exercise strength and power in restraint, to value quality before quantity, noble struggle over mere achievement, and personal honor over opulence. These ideals were upheld by the Stoic philosophers and passed on to their disciples and admirers, of whom the last and best was arguably the Roman emperor Marcus Aurelius; his "Meditations" or "Thoughts to Myself" represent a good summation of Stoic philosophy.

The Greeks ascribed an almost semi-divine nature to humans. Sophokles has the chorus in *Antigone* sing:

> Wonders are many on earth, and the greatest
> of these
> Is man. . . .
> The use of language, the wind-swift motion
> of brain
> He learnt; found out the laws of living together
> In cities, building him shelter against the rain
> And wintry weather.
> There is nothing beyond his power. . . . [6]

This wondrous celebration of the human inquisitive spirit was recaptured during the Renaissance and still underlies Western thought to this day.

The Olympian gods were described in Greek myths in human terms and depicted in perfect human form. But unlike Judeo-Christian scripture, which lays down proscriptive laws as to how humans are to conduct themselves, the Greek myths (the closest things to Greek scripture) describe, through the misadventures of the gods, how *not* to organize and conduct one's life. The Olympian deities combined male sky-gods introduced by the Dorians (such as Zeus, hurler of lightning) with female earth deities of the Bronze Age (such as Hera, Zeus's wife). The result is that many temples built to the Olympian gods combine aspects of both masculine and feminine attributes. The temples are usually Doric in style (that is, built with Doric columns, possessing a male massiveness) but at the same time, they are often aligned on an axis that runs to a distant, double-peaked mountain sacred to the earth deities of the Bronze Age.[7] The twelve Olympian gods were worshipped by all Greeks, although some gods had regions and temples where they received special reverence, such as the Temple of Zeus at Olympia; the Temple of Poseidon at Sounion, at the point of land southeast of Athens; and the Temple of Apollo at Delphi. Particular gods also were associated with individual cities, so that the Athenians worshipped Athena (the founder of their city and patroness) in two temples embodying her manifestations as Athena Polias, the protectress of the city, and as Athena Parthenos, the warrior maiden.[8] Some Greeks found comfort in mystical cults, but for the most part Greek religion was a straightforward affair of making the proper offerings to the gods. There was no generally accepted notion of an afterlife, as had become common among the Egyptians; perhaps everyday Greek life was too arduous for them to wish it to continue forever. Instead, the Greeks sought immortality through the achievement of *arete,* excellence in deeds, so that one's accomplishment would be recorded, spoken of, and remembered forever. The achievements of Plato, Aristotle, and all the other Greek philosophers prove they were right.

The Greek Polis

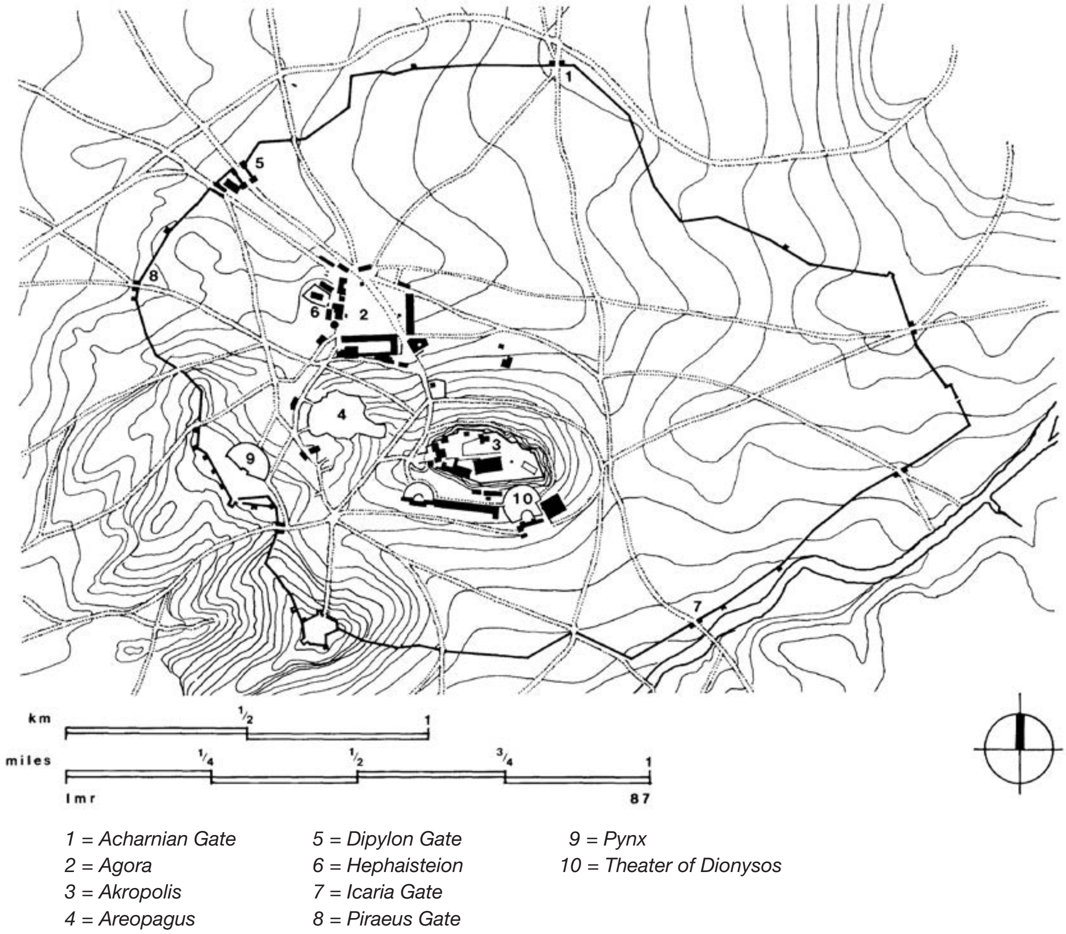
The most important political contribution of Greek civilization was the invention of democracy in the *polis* of Athens, spread with particular fervor by Athenians to the cities over which Athens had influence. As with other Greek words, we have no proper equivalent to *polis* except to render it as "city-state," which says both too much and too little. The polis was a community of families related by common ancestors; a person did not move into or join a city—one was born a member. Those who traveled and lived in cities other than those where they were born were considered resident aliens; only in rare instances were they made full citizens with the right and the responsibility of participating in governing the polis. The fierce pride regarding one's own polis, and the disdain and mistrust of other poleis (the Greek plural of *polis*) prevented the Greeks from forming voluntary and long-lasting alliances; eventually, when they were confronted by the militaristic Romans, it would prove their political undoing. A polis encompassed the city and the farms around it, for Greeks preferred to live in the city in close quarters and walk out to their farms, rather than live in isolated farm villas. As H.D.F. Kitto summed it up, the polis encompassed "the whole communal life of the people, political, cultural, moral, and economic."[9]

To say a polis was a city suggests to us a size that is too large, for Greeks felt a man ought to be able to walk across the entire breadth of the territory of his polis on foot in two days. In *The Republic,* Plato described the ideal polis as having 5,000 male citizens, and Aristotle wrote in *Politics* that a man should be able to recognize all the male citizens of his polis by sight.[10] Most poleis were roughly this size, although Athens, Syracuse, and Akragas eventually had populations of more than 20,000. In 430 BCE, the total population of the region of Attica, including Athens, was roughly 330,000, of which about 15,000 were resident aliens and about 115,000 were slaves in domestic service. Of the remaining 200,000, about 35,000 were male citizens over eighteen, and the remainder were women and children.

In a few places and during times of extreme social disruption, a single individual might be granted temporary authority to impose autocratic rule over the polis, resulting in what the Greeks called *tyranny;* in other places, a few aristocratic families might exercise rule in an *oligarchy,* as was the case in Sparta. Athens originally had such an oligarchy of aristocratic *archons,* but through a series of reforms during the sixth and fifth centuries BCE, the governance of the city shifted to the rule of its *demos*—that is, its "free male citizens," very like the modern concept of *democracy*. The entire community of citizens, not just their representatives, met monthly in an open-air assembly on a hill in Athens called the Pnyx. There, everything having to do with the welfare of Athens was argued and voted on; even the generals and admirals who battled on behalf of the polis were elected to their positions. In this arrangement, the benign climate of Greece aided significantly, for the Greeks had limited means of covering a structure to hold several thousands. Although smaller committees were chosen by lot to deal with daily matters, overall political leadership was conveyed to whoever was most persuasive and commanded respect. From 461 BCE to 429 BCE, that leader in Athens was Perikles; he was elected general for fifteen years in a row, and thirty times in all. It was he who led the polis in erecting the major buildings on the Athenian Akropolis.

Greek City Planning

Most poleis grew gradually, focused on and growing around the remains of a Bronze Age citadel built on an *Akropolis,* a term composed of the Greek *akron* ("high") plus *polis* ("city") meaning "high city." This growth can easily be seen in Athens, whose renowned Akropolis rises dramatically over the plain of Attica [11.6, 11.7]. Over preceding centuries, the household shrines in the ancient Athenian Bronze Age Akropolis palace had become sacred sites dedicated to various Olympian gods, and later, on these same spots, a succession of temples was built. At the base of the Akropolis, paths leading out to the surrounding farms eventually became streets, and along one of these, northwest of the mass of the Akropolis, a roughly triangular, open space was set aside as the *agora,* whose boundaries were defined by surrounding houses and public buildings. The agora was the social, economic, and political communal heart of the Greek city, the open living room where trade was carried on, students were taught, and the business of the polis (politics) was discussed [11.8]. In Athens, the agora was defined first by private houses and shops, but by the third century BCE, *stoas,* long buildings opened by colonnades along one side and providing shelter for artisans selling wares, began to be built. In the stoas that later enclosed the Athenian agora, Zeno and his followers met to observe and discuss human nature; they came to be called Stoics, and their philosophy, Stoicism. On the elevated ground immediately west of the agora stands the Doric temple dedicated to Hephaistos, god of the anvil, fire, and the forge, special to the artisans who traded in the agora. Interspersed about the agora were other, smaller public buildings and the *bouleuterion,* a covered meetinghouse for the *boule,* the council of the polis that met daily. The roofed



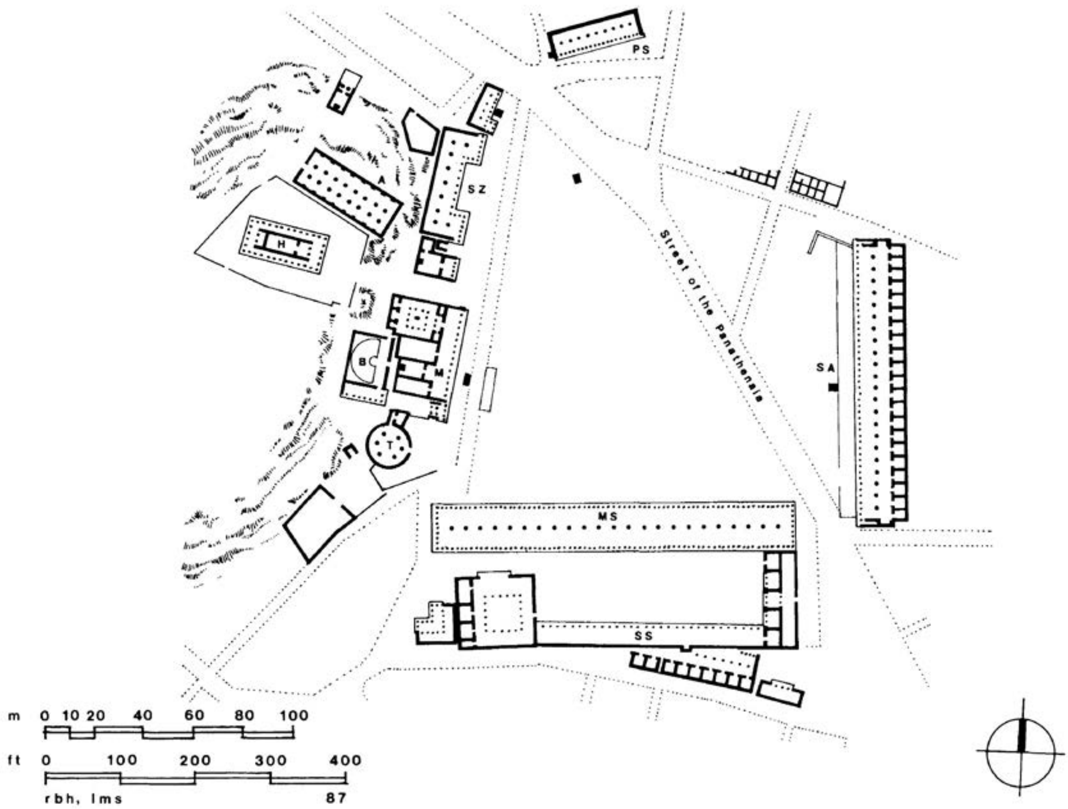
11.6. Topographic Map of Athens, c. 400 BCE. In Greek cities that developed from Bronze Age settlements, the focal point was the elevated and defensible akropolis ("high city") and the agora ("marketplace") below; streets generally radiated out from these two places, following the topography. Drawing: L. M. Roth, after Travlos, Pictorial Dictionary of Ancient Athens *(London, 1971).*

bouleuterion could accommodate up to seven hundred people.

In the Greek colonial cities, typically laid out from scratch on open ground, a more orderly orthogonal grid was often employed, as at Poseidonia (Paestum in Latin). It was not until the Persians later destroyed cities in Ionian Greece from 494 to 479 BCE that this more objective and scientific method was applied in the homeland, and it was fitting that it should have happened first at Miletos, where Greek science had been born a century earlier.

The replanning of Miletos came about as a result of its destruction by the Persians. In 560 BCE, Ionia was controlled by Croesus, king of Lydia in western Anatolia. Croesus considered launching a military campaign against Persian forces, but, curious to get a forecast of the outcome, he went to Delphi to consult the famous oracle there. In answer to his question whether or not to attack, he was given this cryptic answer: "If Croesus goes to war he will destroy a great empire."[11] Imagining that the empire to be destroyed was that of the Persians, Croesus self-assuredly attacked. The more powerful Persians, however, retaliated in force, gradually conquering not only Lydia but all its allies as well, amalgamating the Ionian Greek cities within the Persian Empire by 540 BCE. The oracle had been correct, but the kingdom Croesus destroyed was his own. The captive Ionian cities resisted their overlords, imploring

11.7. Akropolis, Athens, Greece, viewed from the west. Photo: Hirmer Fotoarchiv, Munich.

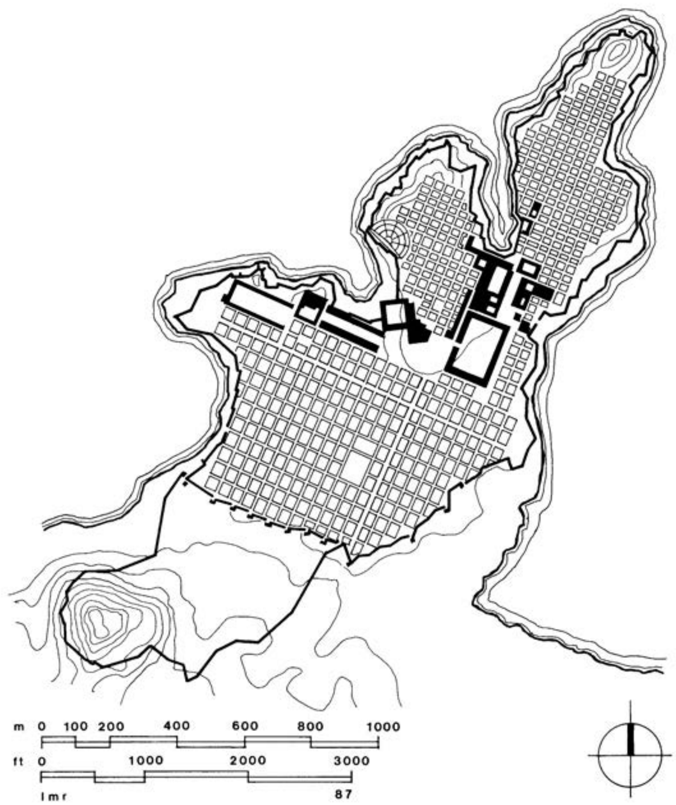


11.8. Agora, Athens, Greece, c. 100 BCE. Running diagonally through the agora was the Dromos, the processional way extending from the Dipylon Gate (off the plan to the upper left) to the foot of the acropolis toward the lower right. The Stoa of Attalos is the long building to the east. **A** *= Armory;* **B** *= Bouleuterion;* **H** *= Hephaisteion (Temple of Hephaistos);* **M** *= Metroon;* **MS** *= Middle Stoa;* **PS** *= Poikile Stoa;* **SA** *= Stoa of Attalos;* **SS** *South Stoa;* **SZ** *= Stoa of Zeus;* **T** *= Tholos. Drawing: B. Huxley and L. M. Roth, after Travlos,* Pictorial Dictionary of Ancient Athens *(London, 1971).*

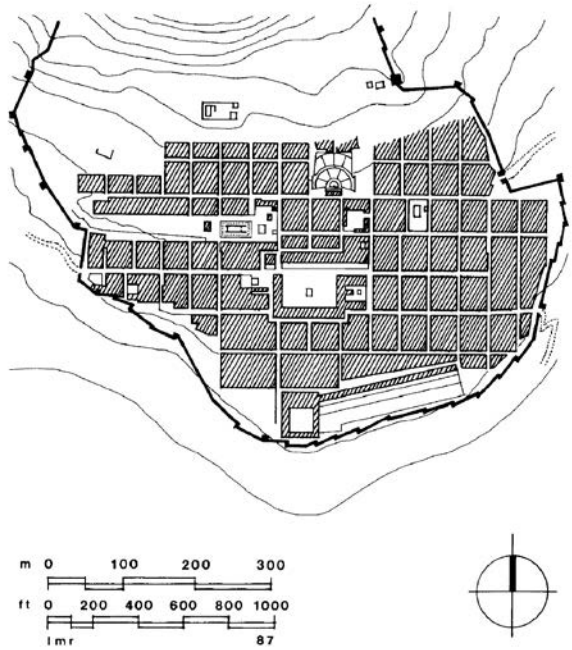
the Spartans, the Athenians, and other mainland Greeks to aid them; in the struggle, many Ionian cities were destroyed by Persian forces, including Miletos in 494 BCE. To discipline the impudent mainland Greeks who had become a serious irritant, the Persian emperor Darius led his army through northern Greece, moving southward, advancing toward Attica. In 490 BCE, the massed Persian armies were confronted at Marathon, twenty-six miles from Athens, by a small army of Greeks. Despite being far outnumbered by the Persians, the Greeks miraculously defeated them.[12] Not to be deterred, in 480 BCE, after Darius's death, his son Xerxes launched a second campaign against Greece. Again greatly outnumbered, the allied Greeks fought bravely but lost; Xerxes' forces then entered Athens and set fire to the Akropolis temples. Meanwhile, a fleet of two hundred Athenian and allied ships surrounded the Persian navy in the Bay of Salamis, within sight of Athens, and crushed the Persian fleet, the first of a series of subsequent military reverses for the Persians. Within a year, defeated, the Persians withdrew and were pushed back into central Turkey. The Greek Ionian cities were finally liberated from Persian "barbarian" domination.

With the Persian threat gone, the destroyed Ionian cities, including Miletos, were rebuilt. The plan of the new Miletos, circa 479 BCE, is usually credited to Hippodamos, a Milesian whom Aristotle describes in *Politics* as the man who "invented the art of planning cities" and who also laid out the Athenian port of Peiraeus as well as the city of Rhodes [11.9].[13] The site at Miletos was a relatively level peninsula jutting into the sea at the mouth of the Meander River, with two deep inlets that formed excellent harbors. Hippodamos adjusted the orthogonal grid to the general direction of the peninsula, rather than orienting it to the points of the compass, and divided the city into three distinct zones. To the north was the residential quarter; at the center, running roughly from one harbor to the other, was the agora, divided into two sections by the bouleuterion in the middle; to the south was another residential area of larger blocks. Missing was a sacred precinct for the major temples, but in this case it was because the extraordinarily important Milesian religious site, the great Apollo sanctuary at Didyma, was just 14 miles (22 km) to the south.

Priene, an Ionian city not far to the north of Miletos, was rebuilt in the latter part of the fourth



11.9. Hippodamos (architect), plan of the city of Miletos, Asia Minor, c. 450 BCE. The regular geometric plan of Miletos was divided into three zones, residential to the north and south, with a commercial heart at the center around the agora and near the two harbors. Drawing: L. M. Roth.



11.10. Plan of Priene, Asia Minor, c. 450 BCE. Priene, built atop Mount Micale, shows how a grid plan could be adapted to a sloping hilltop site. Drawing: L. M. Roth.

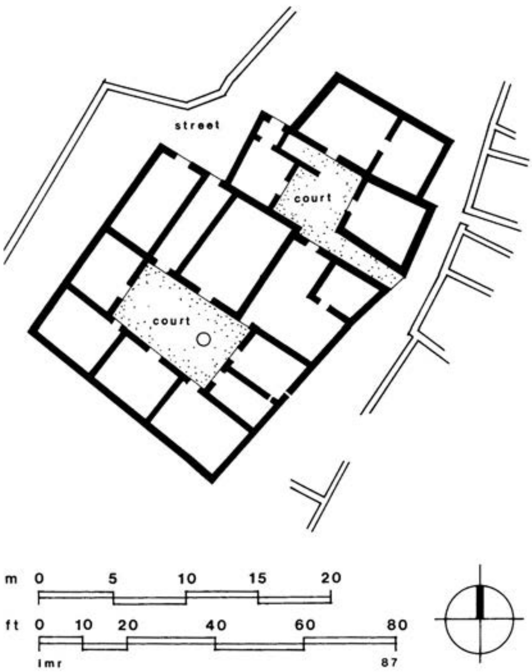
century BCE [11.10]. Here an orthogonal grid was adapted to a steeply sloping hillside site, with houses in regular blocks that measured approximately 120 by 160 feet (36.5 by 48.8 m). Six principal streets, generally level, ran east and west; the fifteen minor streets were stepped and ran north and south. Roughly at the center was the rectangular agora and, looking over it, to the north, was the precinct of the temple of Athena and the theater. At the south edge of the city were the stadium and the palaestra (wrestling gymnasium).

Domestic Architecture

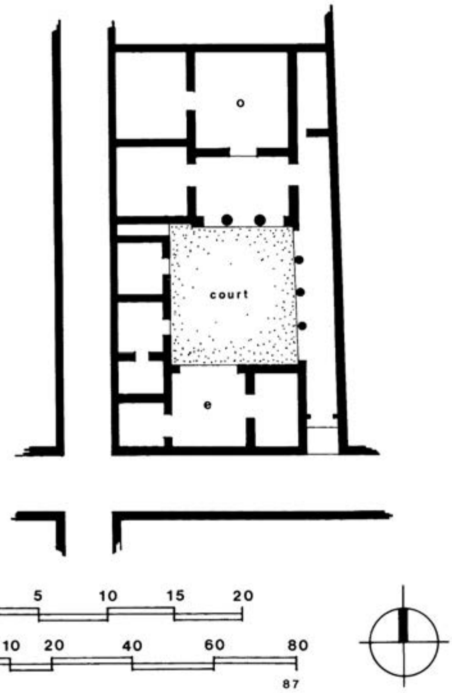
Since most civic and commercial business was transacted in the open air in the agora, the private houses of the Greeks generally were small and unelaborated until the fourth century BCE, when Greek culture entered a new phase, called Hellenistic. Indeed, in Classical Greece, it would have been considered extremely inappropriate for an individual to build an expensive, highly decorated house simply to display personal power and position—the ideal was “nothing to excess.” Artisans’ houses discovered west of the Athenian Akropolis show how, in older cities, the plans were adapted to the irregular street pattern [11.11]. In such artisans’ homes, there might be a room set aside for the production of pottery or metalwork. Aside from this specialized room, the house consisted of a small cobblestone court open to the sky, with a series of rooms opening onto it. Of one story, these houses usually had roofs pitched inward toward the central open court. Because of the regular blocks, the houses in Priene also were rectangles [11.12]. Typically, these Priene houses had an *exedra* (shown as “e” in 11.12) to the south of a central court, sheltered from the sun and winds, and a megaron type of unit, or *oikos* (shown as “o”), the major public room.

Public Buildings

Compared to the number, types, and size of later Roman public buildings, Greek public buildings were more limited. Perhaps most important in impact and function were the *stoas* that lined and came to define the agoras. Long, rectangular buildings open on one side to face the agora, these often had an internal row of columns down the middle to support the roof or the upper floor, with small chambers in a row along the back for storekeepers and offices. Following the Classical period, stoas became quite long, as illustrated by the 117-foot (35.7-m) stoa given to Athens by King Attalos of Pergamum and built around 150 BCE on the east side of the agora [11.13]. Various covered halls were built to accommodate small groups of people. The *bouleuterion* was one type, designed to house the boule, or council, of the polis. The bouleuterion of Athens, on the west side of the agora, was larger than most, but the small bouleuterion at Priene, built about 200 BCE, survives in better condition.

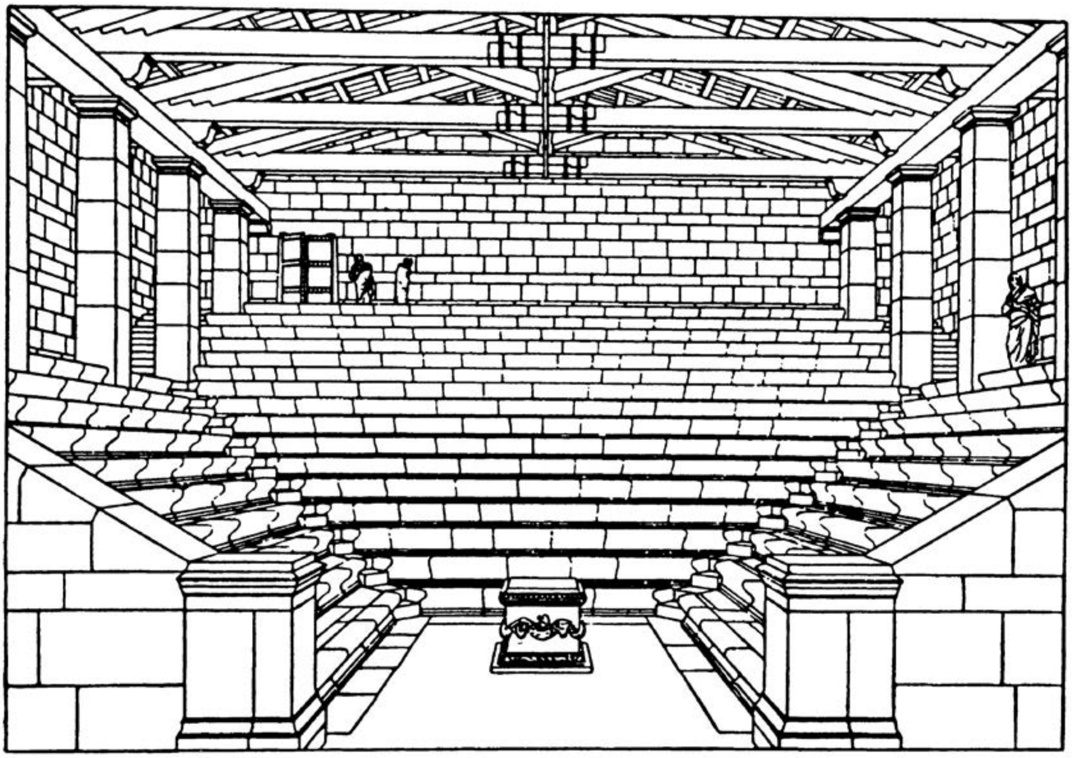


11.11. Artisans' houses near the Agora, Athens, Greece, c. 350 BCE. In Athens private houses were fitted into the irregular street pattern. Drawing: L. M. Roth, after Travlos, Pictorial Dictionary of Ancient Athens *(London, 1971).*



11.12. House, Priene, Asia Minor, c. 450 BCE. In planned cities such as Priene, private houses had more regular plans. At the south edge of the open central court was the exedra ***(e)****, and off the court was the principal public room, the* oikos ***(o)****. Drawing: L. M. Roth.*

11.13. Stoa of Attalos, Athens, Greece, c. 150 BCE. Built by King Attalos of Pergamum as a gift to the city of Athens, this stoa was meticulously reconstructed in the 1950s. It illustrates well the Hellenistic civic buildings that began to line and define Greek agoras. Photo: © Bettmann/Corbis.

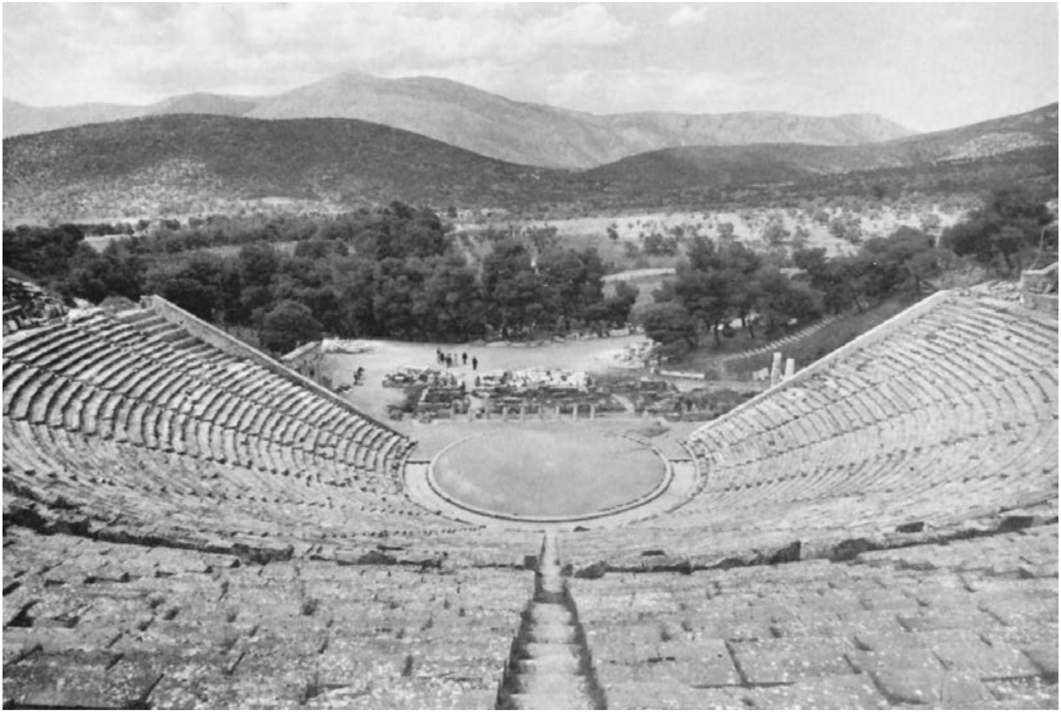


11.14. Bouleuterion, Priene, Asia Minor. 200 BCE. Interior view. Such comparatively small covered buildings were built by the Greeks to house their civic councils. This one measured 60 by 66 feet (18.5 by 20 m) and could seat about seven hundred people. From Lawrence, Greek Architecture *(Harmondsworth, England, 1967).*

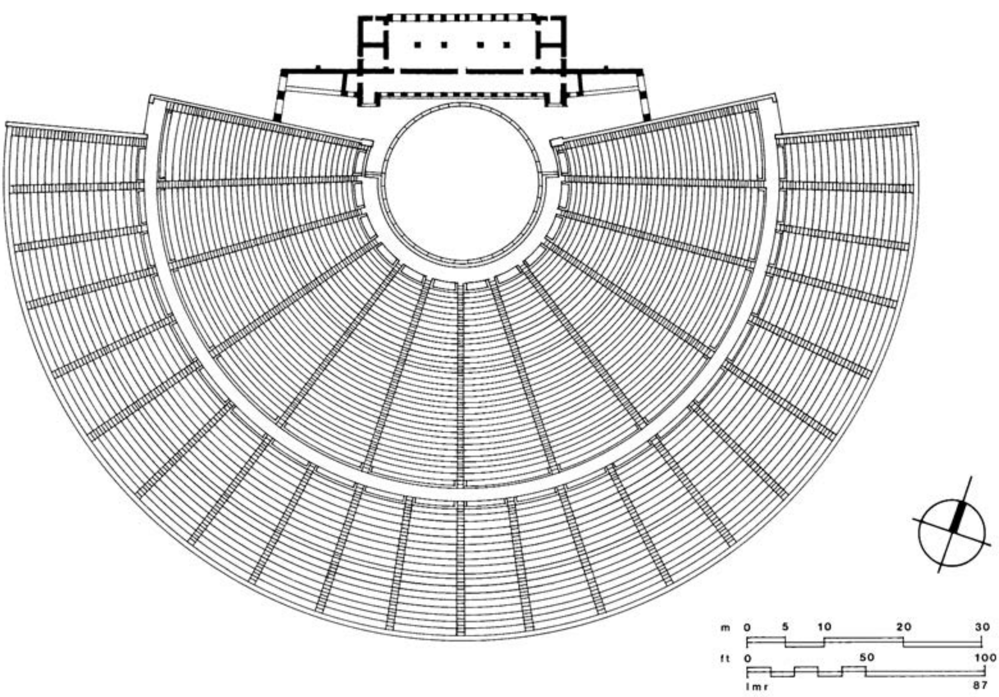
Measuring nearly 60 by 66 feet (18.5 by 20 m), the Priene bouleuterion had tiers of benches on three sides, providing seating for about seven hundred people, and could probably have housed nearly all the voting male citizens of Priene, whose total population must have been about four thousand [11.14]. Around the topmost seats were fourteen supports, reducing the span required of the wooden truss roof to roughly 47.5 feet (14.5 m), a considerable span at that time.

The largest Greek public buildings were open to the air and included theaters and stadia for athletic contests. A *stadion*—the Greek word means both a unit of distance of about 656 feet (200 m) and a stadium structure with tiers of seats—might be used only at certain times of the year, but the theater was nearly as important a part of civic life as was the agora. Drama productions began as religious rituals for the god Dionysos and, by the time of Perikles, had become an important means of defining and elaborating the ideal of civic and moral rectitude, *arete,* as the plays of Aeschylus and Sophokles demonstrate. Even the ribald comedies of Aristophanes played an important part in this civic purpose. Going to the theater was a celebration of community spirit; the plays contributed importantly to political education and were not merely facile entertainment, as they became later in the Roman Empire. The fact that the permanent stage structure, or *skēnē* (origin of modern *scene*), was relatively low is important, for in becoming part of the drama itself, the audience members could raise their eyes to look out from the theater over the landscape of their polis, so that, as Vincent Scully wrote, "the whole visible universe of men and nature came together in a single, quiet order."[14]

Again, it was fortunate that the generally benign Greek climate made it possible to build theaters in the open, for there was no practicable way to cover a building seating 14,000 people, the number accommodated in the theater at Epidauros. In some instances, the theater also was used for the assembly of all the citizens of the polis. The theater at Epidauros, built around c. 350–300 BCE on the thumb of the Peloponneses, perhaps from designs by Polykleitos the Younger, retains nearly all its original features [11.15, 11.16]. There were three basic parts: the *theatron* ("seeing place"), or the



11.15. Polykleitos the Younger, Theater, Epidauros, Greece, c. 350 BCE. Elevated view. Typically, Greek theaters adjoined religious sites and were built into hillsides. The seats here extend around 200° and looked down onto low, temporary skēnē structures. Photo: Hirmer Fotoarchiv, Munich.



11.16. Theater, Epidauros, Greece. Plan. Greek theaters wrapped around an area greater than a semicircle. Drawing: L. M. Roth, after G. C. Izenour, Theater Design *(New York, 1977).*

spectators' seating area built into the side of a hill carved out to form a bowl; an *orchestra* ("dancing place"), the circular floor, 70.5 feet (21.5 m) in diameter, where the actors declaimed and the chorus sang and danced (centered in the orchestra was an altar to Dionysos); and the *skēnē,* a low structure forming a backdrop behind the orchestra. In Greek theaters (as distinct from Roman examples), the seating formed more than a half circle, here about 200°, and the *skēnē* structure was little more than one story high. At Epidauros, there are fifty-five semicircular rows of seats, divided by an ambulatory about two-thirds of the way up. The initial seating area below the ambulatory, or *diazoma,* holds 6,210 people; with the later addition of the upper section, the capacity was increased to about 14,000 people.

The Greek Temple

By far the most important building in the polis was the temple. Although it served a most vital public function and was a symbol of the polis, it was not a public building in the sense that we use the word today, for only priests and selected individuals actually entered it. In contrast to its comparatively plain interior, the exterior of the temple was lavished with artistic attention, for public rituals were celebrated at the altar in front of the temple. Because of this and the fact that the temple's enclosed volume was not a public space, the Greek temple has been described as a monumental sculpture set in the landscape.

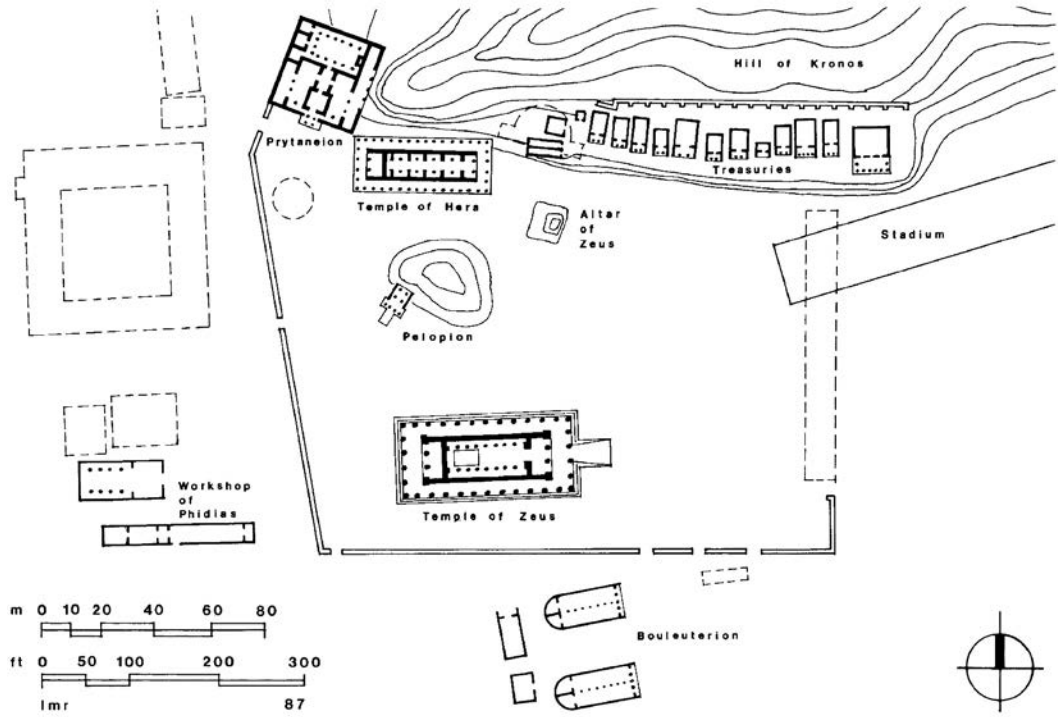
The Greek temple was placed in a sacred precinct, or *temenos,* delineated by a low wall or curb, although as these sites were built on over the centuries, stoas and other structures might define the temenos more clearly. There was no effort to align any of these enclosing buildings according to predefined axes; they were adjusted to the topography of the site. In addition, the temples themselves might be aligned on axes leading out to mountain peaks in the landscape, sacred since dim prehistory.

Perhaps as early as 1050 BCE, the crude form of the Greek temple emerged, a wooden structure with upright columns completely around the central chamber. Earlier ritual offerings to the gods had been made in sacred groves, with the trees decorated with the sacrificial offerings. It is believed that the temple, with its surrounding colonnade, was an attempt to re-create the sacred grove. The columns became those decorated trees, and the many parts of the Doric, Ionic, and later Corinthian orders were named for the actions performed in these rituals. The architecture became the concrete manifestation of the ritual actions, although by the time Vitruvius cataloged this information from his Greek sources in the first century BCE, the original meaning of the Greek architectural terms had already been lost.[15]

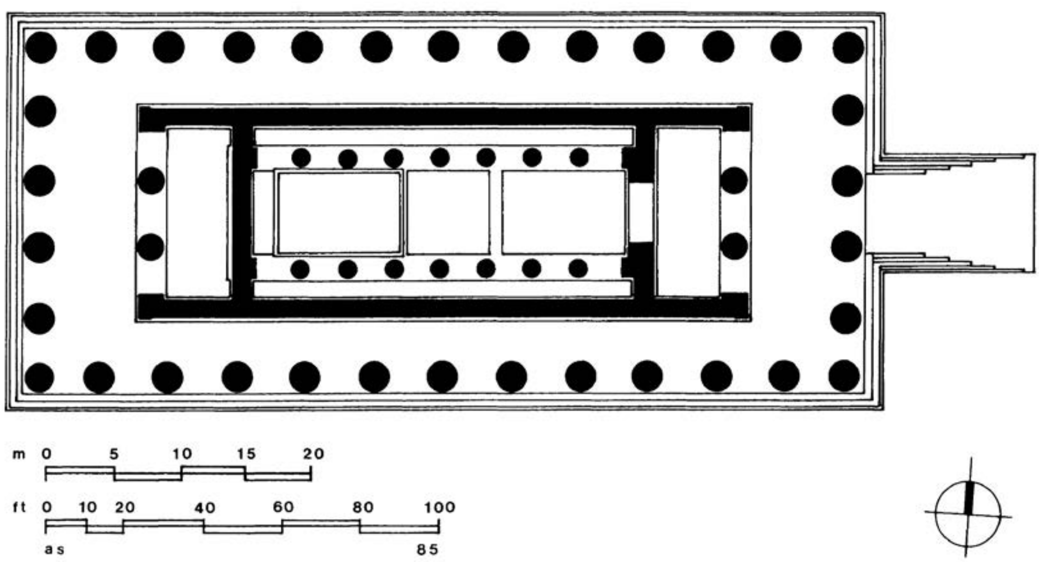
The temenos at Olympia [4.37, 11.17] is a good example of temples in their context. This sacred precinct is framed by the bouleuterion on the south, a stoa to the east, and a range of small city treasuries nestled against the hill of Kronos to the north. At the north edge of the temenos was a temple to Hera, wife of Zeus. The temple was originally built of wood; as time passed, it was replaced, part by part, with elements of stone. The principal building was the large temple to Zeus built by the citizens of Elis in 468–460 BCE and designed by Libon of Elis [11.18]. Measuring 91 by 210 feet (27.7 by 64.1 m), it was a Doric temple, with six massive columns across each end and thirteen columns on the sides (for a discussion of the Greek orders or columns, see Part I, pages 42–44). The Greeks built their temples of local stone, and at Olympia, it was a coarse limestone covered with a plaster made with marble dust. The temple was *peripteral*—that is, it had a single row of columns all around, rising from a three-stepped base (the only unusual feature was the ramped approach from the east). Inside was the *naos,* a rectangular chamber with projecting spur walls, marked by projecting *antae* at each end, with two columns between them. Inside, between rows of smaller Doric columns supporting the roof, was a huge, seated image of Zeus, fashioned by the Athenian sculptor Pheidias and made of gold and ivory fastened to a wooden armature. The sculpture was listed as one of the Seven Wonders of the World.[16]

The temple complex considered to most fully embody the spirit of ancient Greece is found on the Akropolis at Athens. What is seen there today is the result of a remarkable building program initiated by the Athenian polis under the direction of Perikles several decades after the Akropolis was burned and destroyed by the Persians in 480 BCE; the buildings were to be the symbol of the victory of Athens and of Greeks generally over barbarism. To prevent the Persians from ever again posing a threat, Perikles created the Delian League, a confederacy of all the poleis around the Aegean, and a portion of the funds they contributed was used to build the new Akropolis as an emblem of that victory.[17]

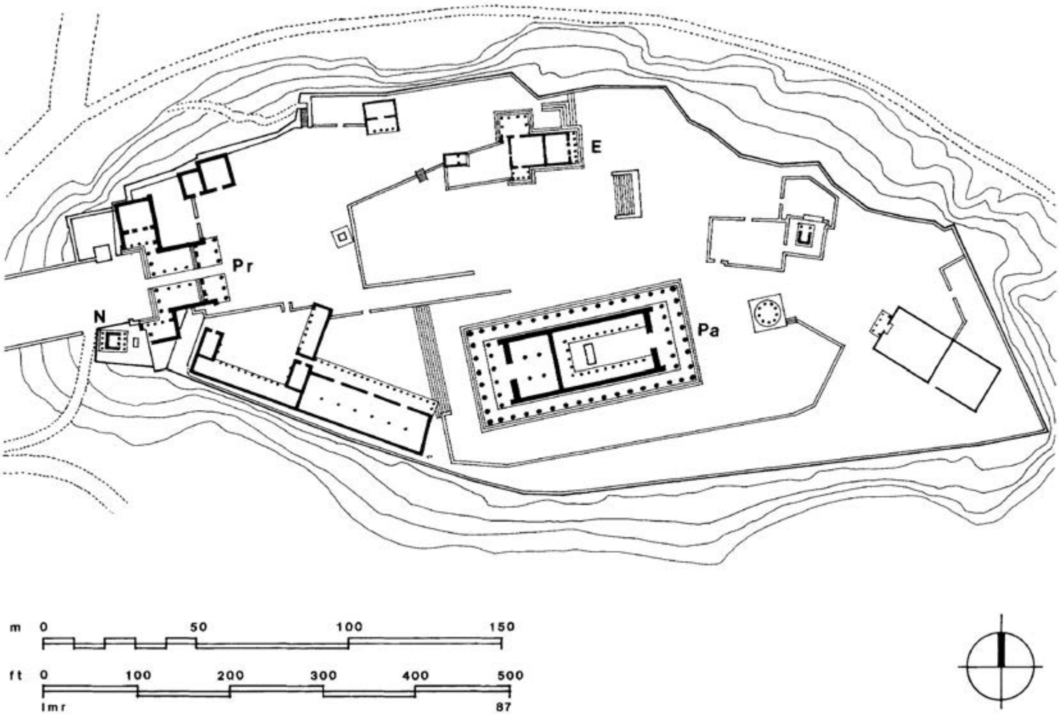
The Akropolis was the ideal spot for these new temples. Rising 300 feet (91.5 m) above the city, it put the gleaming white marble buildings in view of the residents of the entire polis and also made them visible from the harbor at Piraeus and the Bay of Salamis, where the Persian ships had been sunk [11.7, 11.19, Plate 17]. In fact, when the Akropolis



11.17. Temenos, or sacred precinct, Olympia, Greece, fifth century BCE. The temenos encompassed one or more temples, altars, treasury buildings, and other related subsidiary buildings. Here the major temples were dedicated to Hera and Zeus. To the east of the temenos at Olympia was the stadion *(stadium), where the Olympic Games were held. Drawing: L. M. Roth, after Lawrence,* Greek Architecture *(1967).*



11.18. Libon (architect), Temple of Zeus, Olympia, Greece, c. 468–460 BCE. Plan. The Temple of Zeus incorporates the basic features of the Greek temple during the Classical period, having six Doric columns across the front and thirteen along the sides. Sheltered by the columns is the inner naos *chamber containing the image of Zeus. Drawing: A. Stockler.*



11.19. Akropolis, Athens, Greece. General plan, showing buildings completed in the Periklean building campaign, as of about 400 BCE. Drawing: L. M. Roth after Travlos, Pictorial Dictionary of Ancient Athens *(London, 1971).*

temples were being rebuilt, some of the marble column drums spoiled in the fire were used in rebuilding the parapet walls; easily visible from the city below, they stood out as badges of honor—symbols of the victory of the Greeks (especially the Athenians) and perpetual visual evidence of their military spiritual superiority.[18]

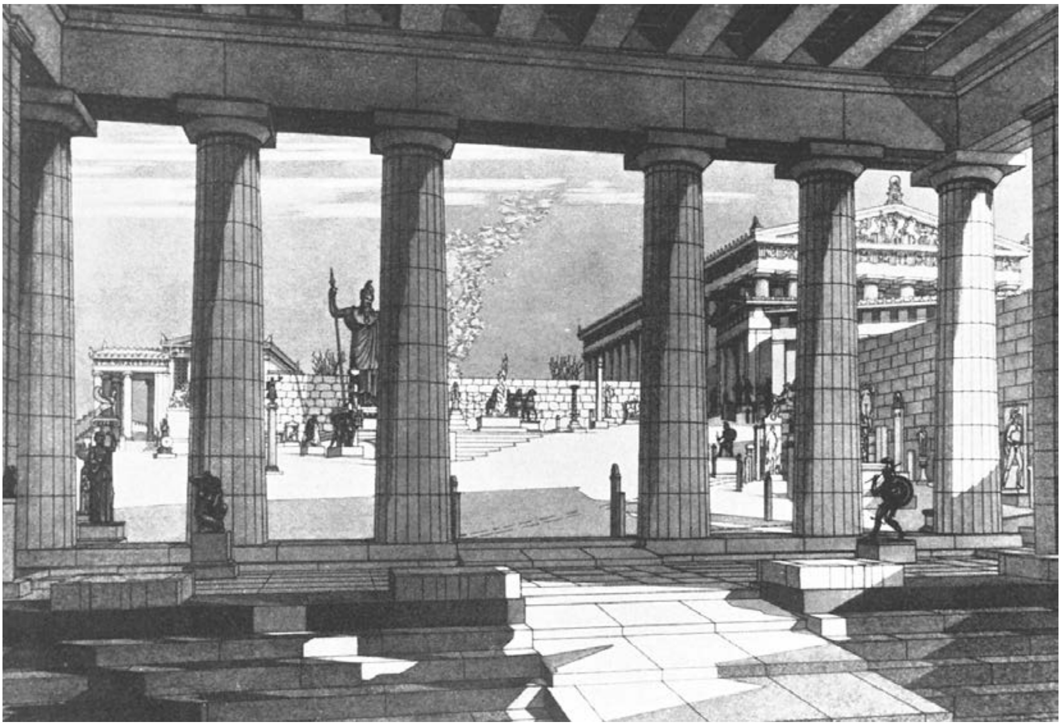
The Akropolis was the focal point of the Panathenaia festival, observed every year on Athena's birthday in late summer but celebrated with special festivities every fourth year. For those quadrennial occasions, pilgrims and celebrants gathered outside the Dipylon gate on the city's northwest side and formed a procession that moved along the street called Dromos, through the agora, and up onto the Akropolis. Gifts for Athena, including a specially woven wool robe for the ancient wooden statue of Athena, and sacrificial cattle were taken up the winding approach to the summit of the Akropolis.[19]

On an ancient bastion projecting from the western extremity of the plateau, a small marble temple dedicated to Athena Nike, goddess of victory, was built by Kallikrates about 460–450 BCE.[20] The bastion was subsequently rebuilt and a new temple, the one currently there, was erected during 435–420 BCE [11.20, 11.21, p. 218]. The Nike Temple is the first element of the Akropolis seen as one approaches the Akropolis. Its delicate Ionic columns, only four at each end, contrast with the massiveness of the Doric columns of the next element to come into view, the entrance gate to the Akropolis, the Propylaia.

The present Propylaia replaced an earlier, smaller gate that had faced more toward the southwest; after that gate was destroyed by the Persian fire in 480 BCE, it was replaced in 437–432 BCE with the present larger, more ceremonial marble entrance, designed by the architect Mnesikles [11.22]. Besides the gate itself, the building included two projecting and flanking chambers for pilgrims. To the left, as one entered, was a gallery designed for resting and lined with paintings; hence the name *pinakotheke* ("painting gallery"). The smaller, unfinished gallery to the right may have been planned as a *glyptotheke* ("sculpture gallery"), but despite its unfinished shape, the front was built in such a way that the sense of balance is preserved as one ascends toward the Propylaia. In rebuilding the Propylaia in 437 BCE, Mnesikles rotated the building, giving it a new alignment with its axis running parallel to

11.20. *Temple of Athena Nike, Akropolis, Athens, Greece, c. 435–420 BCE. This tiny jewel was built to commemorate the Greek victory over the Persians in 449 BCE; it stands over an ancient Bronze Age defensive bastion protecting the gate to the Akropolis. It has Ionic columns only at the front and rear. Photo: NGS Image Collection/The Art Archive at Art Resource, NY.*

11.22. *Mnesikles (architect), Propylaia, Akropolis, Athens, Greece, c. 437–432 BCE. Past the projecting bastion, the visitor enters the sacred precinct of the Akropolis through the Propylaia gateway. Photo: A. Frantz.*



11.23. Propylaia. For this restoration view, artist Gorham Phillips Stevens has eliminated some internal Doric columns to show better the view into the temenos. To the left can be seen the Erechtheion, just left of center is the statue of Athena Promachus, and looming on the right is the Parthenon. Drawing: G. P. Stevens.

that of the largest temple on the plateau, the Parthenon, both pointing toward the Bay of Salamis. So, turning back and looking through the gate, the pilgrim saw framed between its columns the site where the Persians had been repulsed.

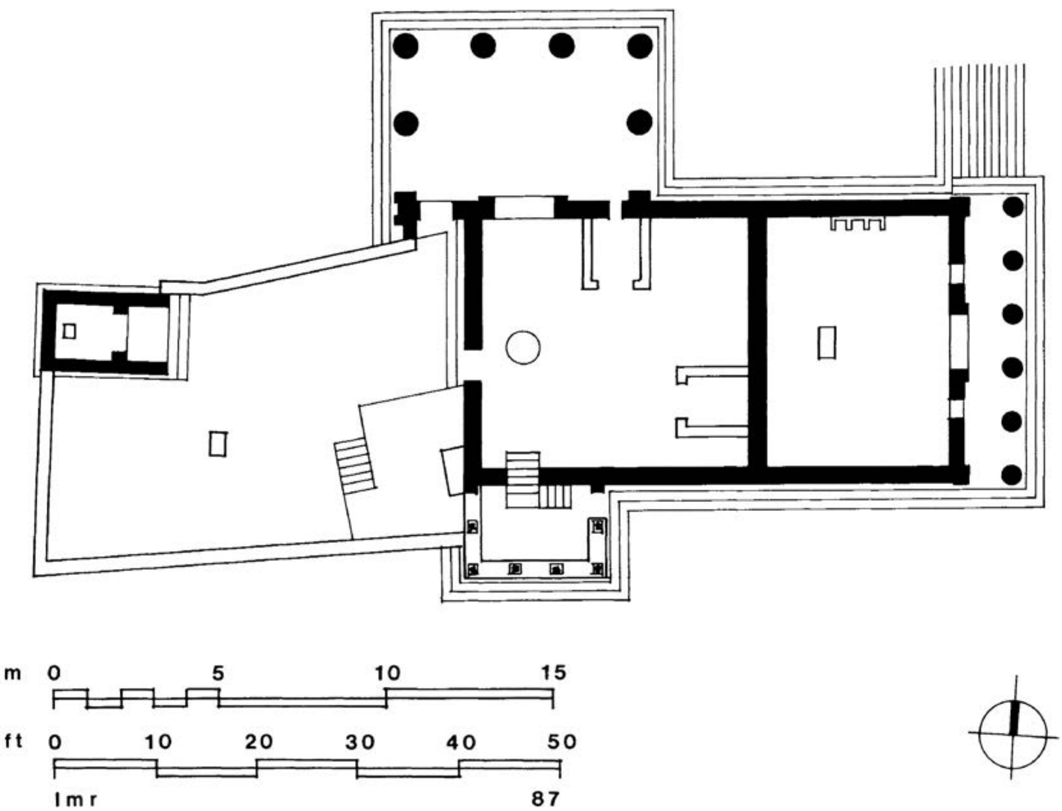
Beyond the gate and inside the sacred precinct were scores of statues and votive slabs erected as thanksgiving offerings, among which rose a gigantic bronze statue of Athena Promachos ("the Champion"), the glint of whose upraised gilded spear tip could be seen from the sea [11.23]. Behind the Athena Promachos statue, running parallel to the rear wall of the Propylaia, were the remains of the cyclopean wall of a terrace of the ancient Bronze Age palace, perhaps the palace of the legendary Erechtheus, king of prehistoric Athens.

To the left could be seen the upper part of the complex form of the temple called the Erechtheion, and to the right, over the roofs of lower treasury buildings, rose the great bulk of the Parthenon. Following a ramp along the south side of the ancient cyclopean terrace, the pilgrim reached the west end of the Parthenon and could turn toward the north to see the asymmetrical Erechtheion.

The last major temple constructed on the Akropolis, the Erechtheion, was also the most unusual [11.24, 11.25]. Built probably from 421 BCE to 405 BCE (the architect is unknown), it housed shrines to a number of gods, local deities, and heroes, and it stood over several sacred spots, including the mark said to have been made when Poseidon's trident spear struck the rock and caused a salt spring to appear. Also beneath the Erechtheion were the graves of the legendary Erechtheus and Kekrops. Most important, however, the temple housed an ancient statue of Athena Polias, protectress of the city and goddess of the hearth.

Originally, there had been a more traditional Doric temple of Athena Polias, which was just to the south of the present Erechtheion, but this had been burned by the Persians in 480. In building the replacement to the north, the architect faced numerous problems accommodating the many sacred spots as well as a steep change in grade; as a result, the Erechtheion has several levels. To the east, from higher ground, is the six-column Ionic porch leading to the *naos* that housed the ancient wooden image of Athena. To the north, at a lower level, is

11.24. Erechtheion temple, Akropolis, Athens, Greece, 421–405 BCE. This complex building houses shrines to a variety of gods, including Athena Polias, protectress of the city. It sits astride a drop in the level of the rock, and hence has a split-level plan. It includes the Porch of the Maidens (Caryatids). Photo: A. Frantz.



11.25. Erechtheion. Plan Drawing: L. M. Roth, after Travlos, Pictorial Dictionary of Ancient Athens *(London, 1971).*

a larger Ionic porch, four columns wide, leading to the chamber of Erechtheus. In an open court immediately west of the temple, there was an olive tree sacred to Athena. That part of the site could not be covered, and so the Erechtheion ends in a blank west wall with engaged Ionic columns. To the south, in the direction of the Parthenon and over the grave of the legendary King Kekrops, is the Porch of the Maidens, or Caryatids, with six supports in the form of maidens with crowns on their heads forming the capitals of the "columns"; it was the most original portion of the many novel aspects of this highly unusual building.

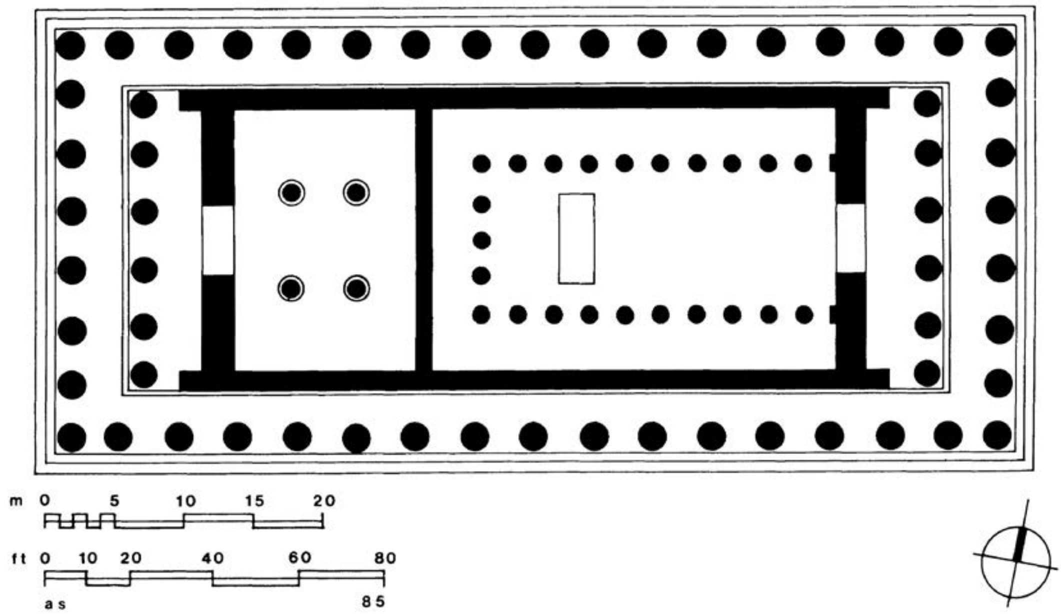
If the Parthenon to the south personifies *logo*—clarity, and precision—the Erechtheion, with its delicate and highly enriched Ionic details, seems to bring order out of a kind of casual disorder. The Erechtheion is the embodiment of an Ionian flexibility and elegant grace in contrast to the Doric Olympian austerity of the Parthenon. Yet the Erechtheion is not the product of an idyllic and peaceful golden age, for the design and construction of the temple occurred during the Peloponnesian War and a concurrent plague that decimated Athens and threatened to destroy the polis. In absolute contrast to the desperation of the times, perhaps in defiance to those troubles, the Erechtheion is a jewel box of delicate refinement, not the embodiment of despair.

The Parthenon

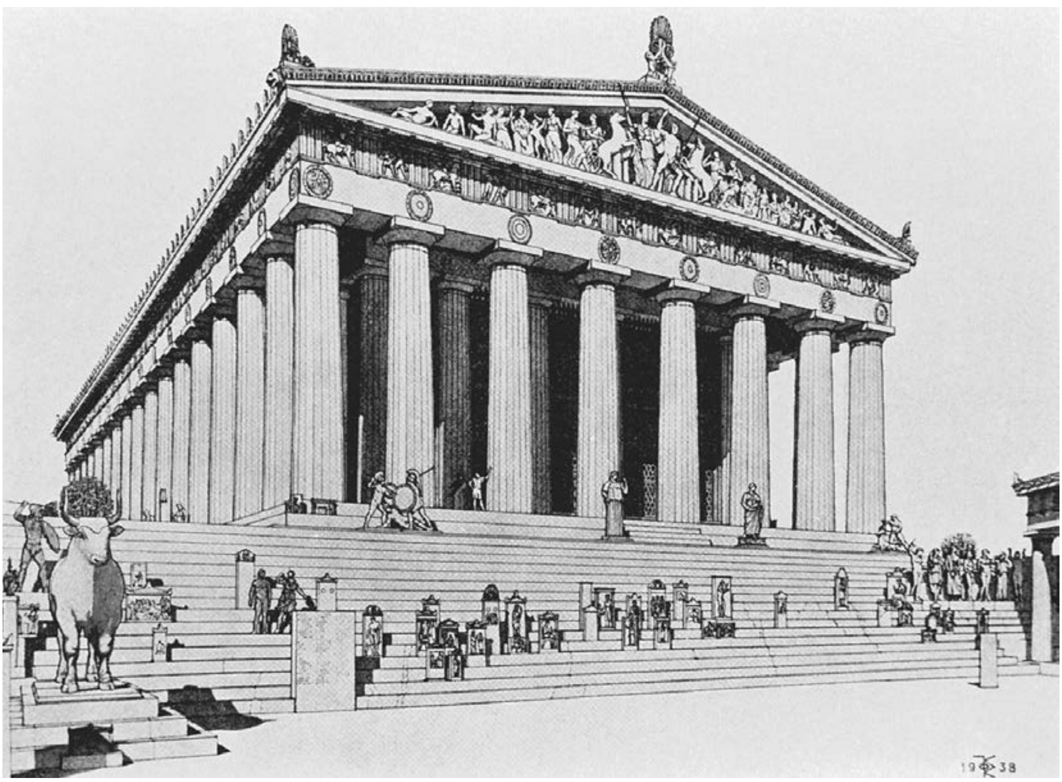
The first building to be rebuilt on the burnt Akropolis was the largest of them all, dominating the hill and the plain of Attica below; this was the temple to Athena Parthenos ("Athena the Maiden"), goddess of war and wisdom. An earlier temple on this spot determined the final alignment toward Mount Hymettos to the west. A replacement, begun in 490 BCE and still in the early stages of construction, was destroyed by the Persians. A number of column drums of white marble, quarried from Mount Pentele, survived the fire and were reused for the columns of the new temple. The Parthenon was built in 447–438 BCE from designs by Iktinos (possibly assisted by Kallikrates). In view of this reuse of material, the complete harmonization of proportioned parts in the finished building is all the more remarkable, for the architects were using elements originally proportioned for a building of different design.

The Parthenon is unusual for several reasons. One is its large size—it measures roughly 101.5 by 228 feet (30.9 by 69.5 m), and the order rises 45 feet (13.7 m) to the top of the cornice (that is, a ratio of 4 to 9, compared with the temple's width—a proportion we will discuss later in this chapter). Other reasons are its eight columns across the ends (when six was more traditional) and its double-chambered *naos* [11.26]. To the east was the larger chamber, housing a huge standing figure of Athena, helmeted and carrying a spear and a shield; like the Zeus at Olympia, this was made of gold and ivory and was created by Pheidias, who it is believed also supervised all the sculpture carved for the temple. To the west was the nearly square chamber called the Parthenon (the term was later extended and applied to the entire building), housing a treasury of offerings to Athena including the silver throne from which Xerxes watched his ships go down to defeat in the Bay of Salamis. Although the temple was built with the Doric order, massive and austere, befitting the goddess of war, the roof of the Parthenon chamber was supported by more delicate Ionic columns inside.

As at Olympia (see Chapter 4), all the sculpture on the Parthenon related to themes associated with the goddess and the Athens site. Since this is the most Panhellenic of temples, commemorating the victory over the Persians, the sculpture illustrates in various ways the struggle between *logos* and *chaos,* between civilization and barbarism. The ninety-two metopes in the Doric entablature illustrated this in four ways. To the east were images of battles between the Olympian gods and earth giants, to the west were scenes of Greeks fighting Amazons (as a substitute for the Persians), to the north were representations of Greeks against Trojans (another adversary from Asia Minor like the Persians), and to the south were pairs of battling Lapiths and Centaurs, the same story depicted in the west pediment at Olympia. The larger pediment figures depicted stories relating more directly to Athens. In the west pediment, facing the Propylaia, was the story of the contest between Athena and Poseidon to determine who should have dominion over the region of Attica. Poseidon attempted to persuade the Athenians by a display of his power in striking the Akropolis with his trident, while Athena caused an olive tree to grow miraculously—the Athenians preferred Athena's offering [11.27]. In the east pediment, over the door to the principal *naos* and Pheidias's cult image, was a depiction of the birth of Athena, springing fully armed, from the brow of her father, Zeus. Most original of all, inside the encircling outer peristyle and around the top of the wall of the *naos* was a continuous frieze of sculpture, 3.5 feet high by 525 feet long (1.07 by 160 m), showing what appears to be the Panathenaic procession. Prior to this, only gods and semi-divine heroes were depicted in temple sculpture; now, for the first time, ordinary mortals, Athenians, appear. Perhaps these figures



11.26. Iktinos and Kallikrates (architects), Parthenon (Temple of Athena Parthenos), Athens, Greece, 447–438 BCE. Plan. This temple has two naos *chambers, one for a treasury and a larger one to house the gold and ivory figure of Athena Parthenos, goddess of war. The plan and ratio of columns contain the proportion* x : 2x + 1. *Drawing: A. Stockler.*



11.27. Parthenon. West front viewed from lower court. Restoration drawing by Gorham Phillips Stevens.

11.28. Parthenon. View of the west end. Photo: A. Franz.

represent the original Panathenaia procession, but it is also likely that the Athenians of the Classical period were looking at idealized images of themselves, confidently portrayed celebrating Athena's protection of their city and the way of life it embodied.

The aspects that have made the Parthenon so special from the time of its creation include the extraordinary precision of its construction and the subtleties and refinements used in its design [11.28]. Shunning the use of mortar between the marble blocks, the builders employed a system of dry masonry called *anathyrosis*. The blocks were cut, squared perfectly, and the surfaces were ground absolutely flat. For vertical joints, the inner surfaces were cut away so that only the edges of adjacent blocks touched in a perfectly tight seam. In this region, prone to earthquakes, the blocks were locked together with iron clamps sealed in molten lead to protect the clamps from oxidation. As an embodiment of logos, the entire design is governed by a proportional system of x to $(2x + 1)$, or 4 to 9. Accordingly, if there had to be eight columns across the ends (using the drums already cut), the length would be seventeen columns $(2x + 1)$. The podium and the *naos* both have dimensions that have the proportion of 4 to 9, or 1 to 2.25. The same proportional relationship was used for the ratio of the height of the order (including the entablature) to the width of the ends, and for the ratio of the diameter of the columns to the spacing between columns, center to center.

More remarkable still were the subtle visual refinements, what Vitruvius said the Greeks called *alexemata,* or "betterments." Greek temples were to be designed, he wrote in Latin, *quod oculus fallit,* or "with regard to that in which the eye deceives us." He explained that if a stylobate platform is built truly flat, "it will appear to the eye to be hollowed out," and that corner columns must be thicker since "they are set off against the open air and appear to be more slender than they are." So, he instructed his reader, the stylobate should be raised in the center, with *temperatione adaugeatur,* or "addition . . . made by calculated modulation."[21] In the Parthenon, the stylobate platform is in fact a segment of a huge sphere and rises toward the center; on the long sides, it rises nearly 4 inches (10.2 cm) in the center and about 2 inches (5.1 cm) across the ends, and every horizontal line parallel to the stylobate is similarly curved. Because of this slight base curvature, the columns—if they had been built with no correction—would all be leaning slightly outward, but just the opposite is true. Not one of the columns is perfectly vertical; they all have an *inward* inclination of about 1:150, which equates to roughly 2.4 inches (6 cm). Moreover, the corner columns incline on the diagonal. If the center lines of the corner columns were extended, they would meet roughly 1.5 miles (2.4 km) above the temple stylobate. In addition, just as Vitruvius wrote, the corner columns are nearly 2 inches (5.1 cm) thicker than all the others, and they are set nearly 2 feet (0.61 m) closer to the other columns.

The Parthenon gives the impression of being a scheme based on absolutely straight lines, a series of perfectly flat horizontals and straight verticals, in perfect equilibrium. Not only are the base and entablature curved, but there are no truly straight lines anywhere in the building; it is all a combination of nearly imperceptible diagonals and curves. Moreover, the columns have what Vitruvius called *entasis,* a subtle curved taper that starts about two-fifths of the way up the shaft [11.29]; the total reduction in the width of the standard column is eleven-sixteenths of an inch, or 1.75 centimeters (this represents a radius of curvature of roughly 1 mile, or 1.6 km). In the Propylaia, the entasis is three-fourths of an inch (1.9 cm). Furthermore, the sculpture of the pediments (those portions that survived) were designed and carved so that they look correct only when viewed from a position 45 feet below (13.7 m), not straight on, as in a museum today: and the figures are carved completely in the round, when only their fronts would be visible. Why was such extraordinary care exercised and such energy expended? One compelling reason was *arete,* for the home of the goddess required the most excellent materials and the most exacting workmanship. It was done because the Greeks *could* do it. And also, in purely practical terms, the inclined columns would help, however slightly, to resist lateral earthquake movement. (The ruined condition of the Parthenon today, incidentally, is due entirely to human calamity. In later centuries, the building was changed from a temple into a Christian church, and then into a mosque, and finally was used as a Turkish gunpowder magazine. In 1687, the Venetians lobbed an artillery shell through the roof, setting off the gunpowder in an explosion that blew

11.29. Parthenon. Detail of corner columns. Photo: © Werner Forman/Corbis.

the stones all over the Akropolis, severely damaging adjacent buildings.) As classicist Jerome J. Pollitt and art historian Jeffrey M. Hurwit have suggested, perhaps the care taken in the *alexemata* was a way of creating a tension between what the mind *expects* to see and the information the eye *actually sends* to the brain—*quod oculus fallit*—so that the two divergent images, real and ideal, can never be brought into complete concordance. The result is a building that seems to shimmer with intellectual excitement and, as Pollitt writes, is "vibrant, alive, and continually interesting."[22]

It is significant, too, that no new building was ever built in the center of the reconstructed Akropolis. There, on the remains of the Bronze Age palace, a broad terrace was made between the Erechtheion and the Parthenon. In that most sacred of spots, man is in the middle, the measure and measurer of all things. In one direction was visible the ancient sacred mountain of Hymettos, and in the other, through the doors of the Propylaia, the Bay of Salamis; myth and human history fused in the experience of the Athenian standing there in the clear light of Attica. As at Olympia, where the pediment figures of Pelops and Hippodameia challenge the athletes in their quest of *arete,* so too atop the Athenian Akropolis the human observer is challenged to contemplate the never-ending struggle between reason and irrationality, civilization and barbarism, *logos* and *chaos*. The Parthenon, in hard white marble, serves as proof that an ideal *can* be realized through exquisite human action.

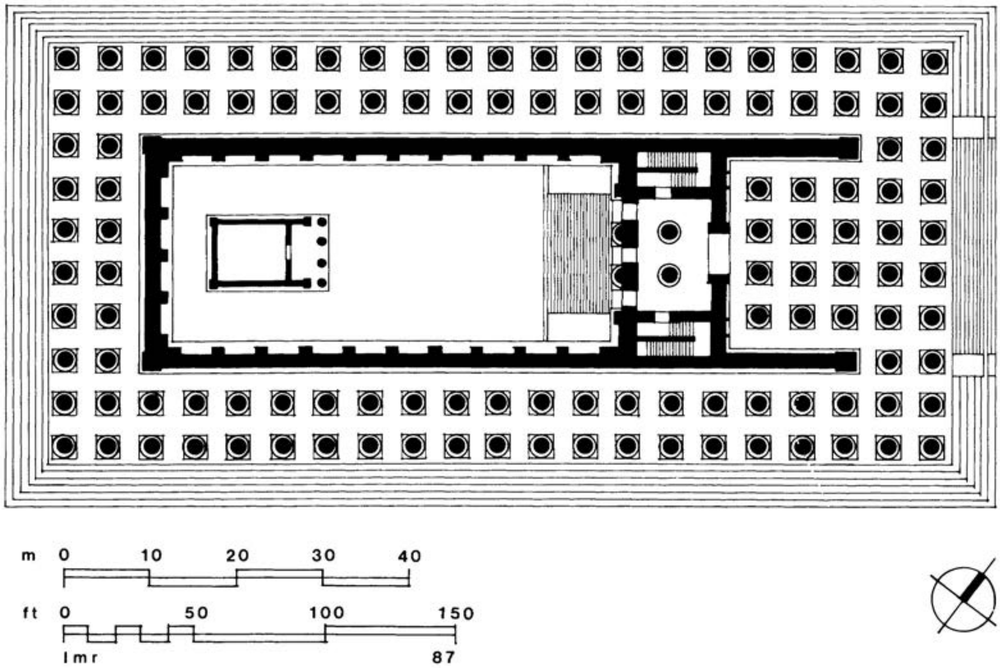
Hellenistic Architecture

The cherished independence of the Greek city-states, compromised by Perikles' confederation, slipped away when the many Greek poleis were amalgamated into a true empire by Philip II of Macedonia and his more famous son, Alexander the Great, during 360–323 BCE. The relative peace this political subjugation brought actually fostered the flowering of Greek philosophy and science, for it was during this period that Aristotle, Zeno, and Epicurus wrote and taught, that Archimedes and Euclid developed their theorems, and that sculptors such as Praxiteles and Lysippos worked.

Alexander, personally taught by Aristotle himself, passionately loved all things Greek and exported Greek art and culture to all the lands he subsequently conquered, including Persia, Egypt, Syria and Palestine, Babylonia, Iran, and even the northern regions of India; he also expanded international trade and the exchange of ideas. The visual arts, no longer restrained by the austere Classical Greek ideal, became more elaborate, ornamental, and passionate, and this more embellished art and architecture we now called Hellenistic. A hint of what was to come is found in the Parthenon, but it would be carried much farther. To admirers of the older standards, the liberties being taken were disturbing; the Roman scholar and writer Pliny the Elder even went so far as to say in his *Natural History* that after the time of Lysippos, "art stopped."

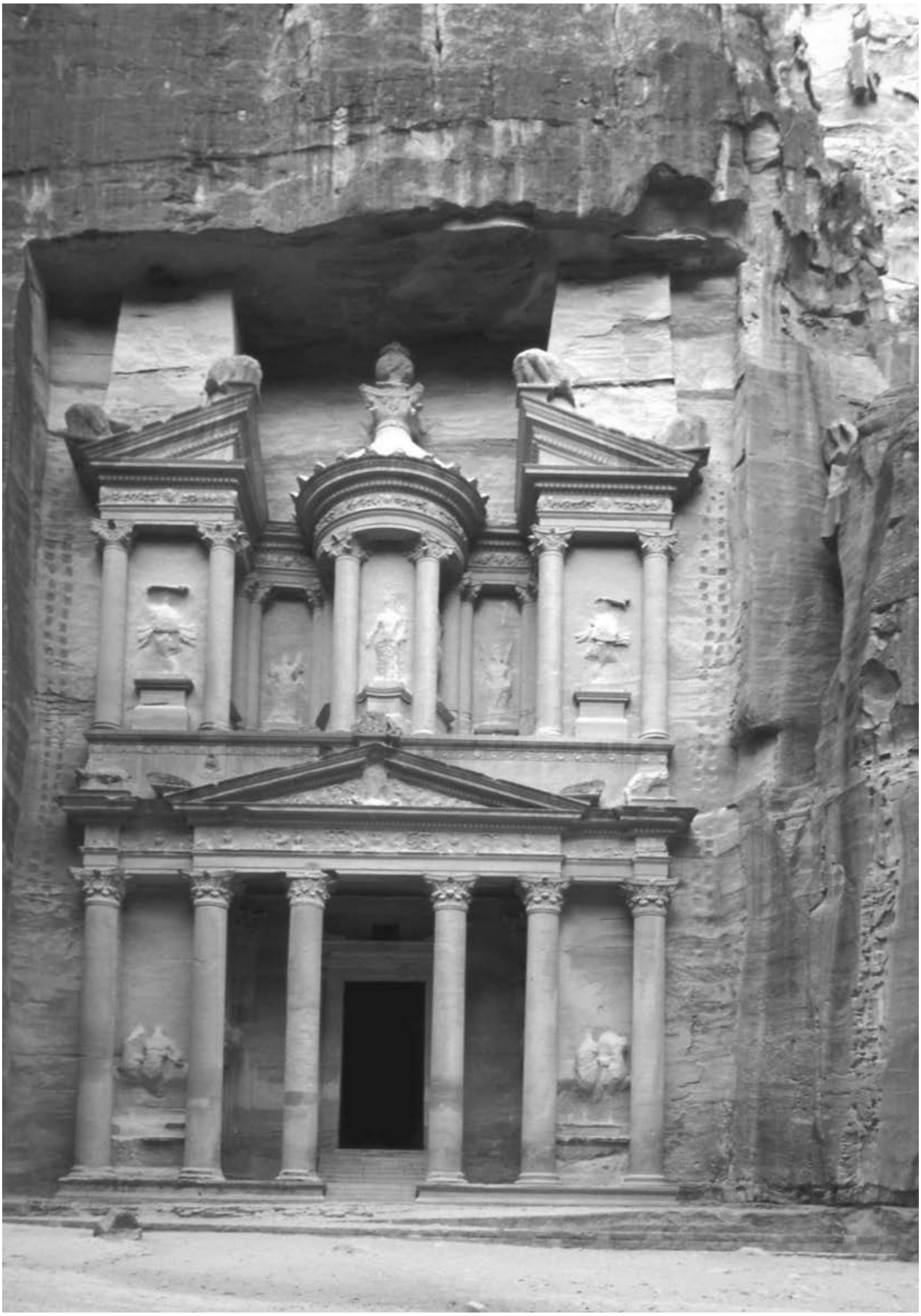
Compared to the models of Classical Greece, Hellenistic architecture underwent changes. The elegant Ionic and Corinthian orders were made increasingly more elaborate, while the more simply austere Doric of mainland Greece gradually fell from favor, not to be rediscovered until the mid-eighteenth century.

The spatial and dimensional elaboration of the Greek temple is well illustrated by the new Temple of Apollo at Didyma, outside Miletos, in Asia Minor, begun about 330 BCE and attributed to the architects Paionios of Ephesos and Daphnis of Miletos [11.30, 11.31]. One of the largest Greek temples ever begun, it rose from a stereobate of seven huge steps measuring nearly 194 by 387 feet (59 by 118 m) at the bottom (this is a double square, 1:2). The *naos* structure was surrounded by a double row of the tallest and slenderest Ionic columns of any Greek temple, 64 feet 8 inches (19.7 m) high. This double peripteral colonnade (two rows of columns all around) was ten columns across the front by twenty-one columns along the sides. The *naos,* 75 feet (22.8 m) across, was too big to be roofed but was left open to the sky, what is called *hypaethral;* the Ionic pilasters along the inside walls, by themselves, were 6 feet wide and 3 feet deep (1.8 by 0.9 m). The visitor, no doubt overwhelmed by the sheer size of this vast enclosure, descended into the open *naos* "court" by a flight of stairs 50 feet (15.2 m) wide. Inside the open *naos,* amid a grove of laurel trees, was an Ionic shrine the size of small Ionic temples of the Classical period (about 28 by 48 feet, or 8.5 by 14.6 m). In truth, the temple was never completed, allowing a most telling detail to come down to modern times. In 1979, fine, barely visible lines were discovered incised on the high interior walls of the inner *adyton* chamber. They are, in fact, the "blueprints" of the temple, rendered in full scale and precisely scratched into the surface of the marble to serve as a guide over the several lifetimes it would have taken to complete construction.[23] These remarkable inscriptions survived at the Didymaion because, since the temple never was finished, the walls of the *naos* court never received their final polishing.



11.30. Paionios of Ephesos and Daphnis of Miletos (architects), Temple of Apollo at Didyma, outside Miletos, Asia Minor, begun c. 330 BCE. Plan. One of the largest Greek temples ever attempted, this had no roof over the naos *but was open to the sky, with a small temple at the end of the open court. Drawing: L. M. Roth, after Lawrence,* Greek Architecture *(1967).*

11.31. Temple of Apollo at Didyma. Interior of the naos. *Photo: Hirmer Verlag, Munich.*



11.32. "The Treasury," Petra, Jordan, c. 100 BCE–200 CE. Cut out of the solid cliff face, this facade shows how Classical design elements were used in a decorative sculptural way during the Hellenistic age. Photo: © 2006 John Hedgecoe/TopFoto/The Image Works.

Every part of the typical Classical temple of the Periklean period was enlarged in scale at Didyma, stretched in length, and more elaborately embellished. The deliberate restraint of the Classical period was giving way to the celebration of worldly wealth, and the balance between civic virtue and public display characterized by Periklean Athens was replaced by a fondness for sumptuous detail.

Today, another well-known example of Hellenistic architecture is the rock-cut building called "The Treasury" (Arabic *Al Khazneh*), in the ancient city perhaps originally called Rekem but today known as Petra [11.32]. Located in the southern Jordanian desert, it was inhabited by the Nabataeans, who developed successful measures to control and store the water released in occasional rains. Situated on once-active caravan trade routes extending to Gaza, Damascus, and Aqaba, the town prospered, resulting in a number of impressive buildings cut into the sandstone cliffs. "The Treasury," sculpted between 100 BCE to 200 CE, demonstrates how Grecian architectural elements were now being used for decorative effect, most notably in the upper half with its pediment cut away in the middle for the introduction of a round mini-temple.

An Architecture of Excellence

Greek architecture, perhaps best represented by the temple, is the embodiment in stone of the striving for the mean, that ideal balance between extremes. In architectural terms, this becomes a balance between the vertical elements of lift (the columns) and the horizontal elements of load (the beams of the entablature), between action and rest. Each component block or column drum, each piece of narrative sculpture, was crafted to perfection, in the best available materials, not as a display of wealth in itself but because it was fitting to honor the gods and one's polis in this way. The goal always was excellence in form, in detail, in workmanship because—as the Greeks believed—this is the only way a human being can achieve his fullest potential. Greek temple architecture represents a unique synthesis of essence and substance, of idealistic form and clearly articulated structure. The Greeks cared little for immortality on a spiritual plane; rather, they sought to ensure their immortality in human memory, through their intellectual and artistic excellence. The Parthenon is proof that they succeeded in living forever.

12.26. Baths of Caracalla. Interior perspective. Restoration drawing. Although now shorn of the marble veneers and embellishments, such baths and other public buildings were richly and colorfully ornamented, as this restoration drawing suggests. Compare to 12.25 as the baths appear today. From R. Phené Spiers, The Architecture of Greece and Rome *(London, 1907).*

Roman Architecture

Roman architecture shapes spaces.

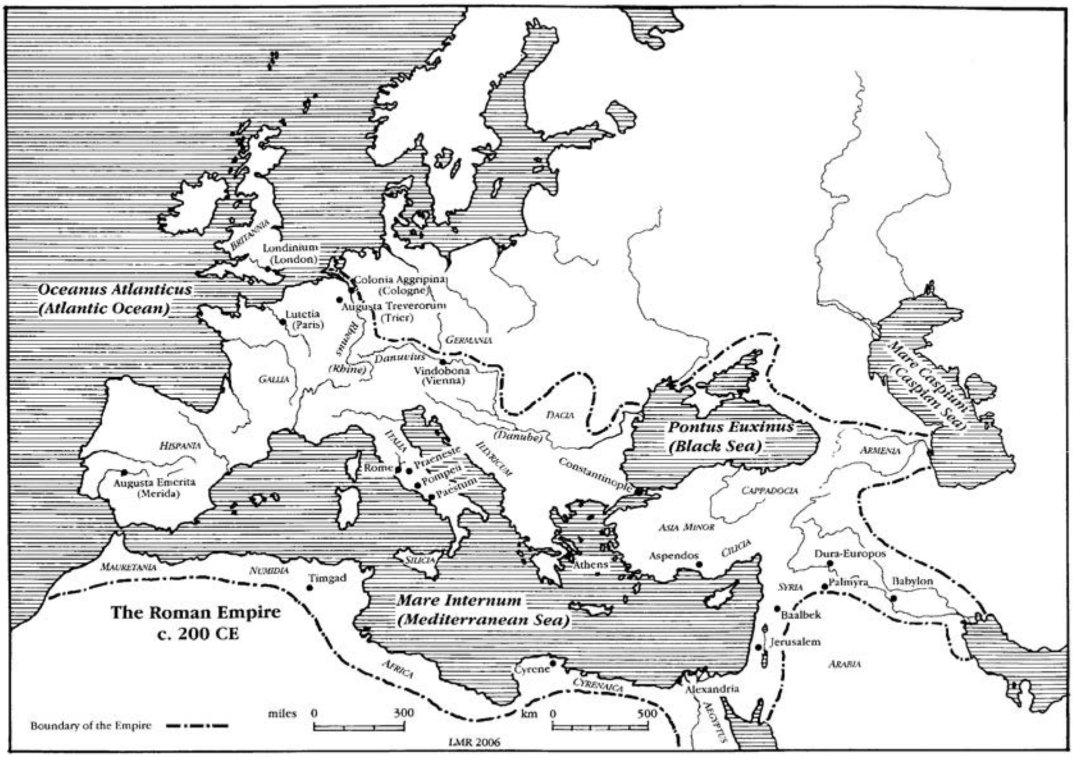
—*H. Kähler,* The Art of Rome and Her Empire

Greek public architecture was made up of sculptural masses set in balanced contrast to the landscape. In comparison, Roman architecture, as Heinz Kähler has observed, is an architecture of space, enclosed internal space and outdoor space, opened on a grand scale. The Egyptians and the Greeks shaped powerfully evocative buildings, but seldom were these structures meant to contain groups of people other than in council chambers and theaters that were open to the sky. Public life was conducted in the out-of-doors, among these sculpted architectural objects. The buildings' constricted interiors were the domain of a priestly and social elite. Only in Hellenistic architecture did public spaces begin to be shaped in a conscious and deliberate way, and this shaping of space became the essence of Roman architecture. No better examples exist of the supremacy of space than in the enormous Roman baths or the vast interior of the Pantheon in Rome, its concrete dome arching over a clear span of 142.5 feet (43.4 m) [3.26, 3.27].

One reason why the Romans attached great importance to public architecture, both enclosed spaces and public spaces, was that from the beginning, Roman civilization focused on the city as its basic constituent element. Indeed, the Romans marked the beginning of their history not from a decisive battle or the action of a particular king but from the founding of the city of Rome by Romulus and Remus in 753 BCE. Official records were dated from the founding, on the Capitoline Hill in Rome, of the principal temple to Jupiter—Jupiter Optimus Maximus (Most Supreme Jupiter), the principal deity of the state religion—dedicated on September 13, 509 BCE, one year after the republic was instituted. For the next five centuries, Romans took great pride in the fact that they were free and self-governing, and even during the subsequent empire, the emperors who governed most successfully were those who maintained the appearance of the cherished old republic and made themselves appear to be merely agents of the Roman people through their Senate. Romans were particularly "political animals," to use Aristotle's phrase, but in the case of the Romans, their "polis" came to include the whole of the Mediterranean basin and beyond [12.1].

Roman History

Like the Egyptians and the Greeks, the Romans were significantly shaped by the geography in which they happened to arise and by the impact of the almost incessant warfare that this geography seemed to make almost usual. Roman history is divided into three distinct phases: the rule of the early kings, the republic, and the empire. About 1000 BCE, groups of Balkan settlers moved into the Italian peninsula; among them were the Latins, who settled in the area around the Tiber River in the center of the peninsula. The site the Latins picked was auspicious, on seven hills at a point on the river far enough from the sea to prevent easy attack but on water still navigable from the sea. Roughly three hundred years later, it is believed, the Etruscans moved into the area north of Rome in what is now Tuscany.[1] Possessing a more advanced culture, the Etruscans gradually came to dominate the neighboring tribes, including the Latins, over whom they imposed a king. In 509 BCE, the inhabitants of the city of Rome rebelled, deposing the king and instituting the republic, governed by a senate of patricians with executive power vested in two consuls, who served only for a year. Over the next several centuries, this system of government was expanded to include an assembly of plebes, or lower classes.



12.1. Map of Roman Empire. Drawing: L. M. Roth.

Except for the spine of the Appenine Mountains running the length of the peninsula, there are no truly major barriers to movement in Italy as there are in Greece, nor are there insulating deserts as in Egypt. The citizens of the city of Rome first had to secure their liberty by removing the threat of the Etruscans, and then to the south, they secured their borders in stages until they encountered the established Greek colonies. The Greeks then appealed to the mainland mother cities for help. After a series of rigorous battles, the Romans acquired control over the Greek colonies, so that by 265 BCE, Rome was in control of the entire Italian peninsula. The Romans then found themselves in trade rivalry with the Carthaginians of North Africa. Carthage, on the Mediterranean coast of modern-day Tunisia, was a former Phoenician colony that had made itself the center of bustling Mediterranean-wide commerce and began to view Rome as a possible competitor. This struggle for power resulted in what the Romans called the three Punic Wars (the Latin *Punicus* means "Phoenician"), 265–146 BCE, which eventually led to a conclusive Roman victory, the obliteration of the city of Carthage, and the absorption of Carthage's colonies into the Roman state. Meanwhile, the Roman armies and navy encountered challenges from Macedonia and Syria and defeated them as well. These victories added to Rome's expanding domain much of Alexander's former empire. As peripheral territories were conquered, they were admitted to the empire as participants so that the conquered people soon (in most cases) saw themselves as Romans. This embrace of new citizens meant that most dissention and rebellion was avoided. So long as the new citizens observed official state religious rites, they were largely free to continue practicing whatever local religion they favored. The consequence of these political policies was that by the end of the first century BCE, Rome was no longer a single city, or the peninsula of Italy, but a series of annexed colonies and federated cities stretching from Gibraltar and Gaul (modern France) in the east to Armenia, Palestine, and Egypt in the west. The Romans began to refer to the Mediterranean Sea as *mare nostrum,* "our sea."

Rome had become an empire, struggling to govern itself as though it was still a republic, with resultant political upheavals. In 46 BCE, the Senate named Julius Caesar *dictator* (the Latin and modern meanings are nearly identical) for ten years in the hope of ending the recurrent civil wars. The position of *dictator* was intended to be temporary, but two years later, as Caesar appeared to be making himself *de facto* king, he was assassinated by those who were offended by his concentration of power. The Senators hoped to reestablish the old republic, but civil war again broke out. Then in 31 BCE, Julius Caesar's nephew, Octavian, set out to establish order. After Octavian defeated Mark Antony and Cleopatra, extending Roman rule into Egypt, he was appointed *princeps* ("first citizen") by the Senate and given the *imperium* command (that is, appointed emperor), which made him *dictator* and head of the army. Octavian then assumed the title Augustus ("venerable," "majestic"). Even though Augustus was in fact emperor, he carefully retained all the apparatus of republican rule, thereby avoiding a clash with the ardent republicans in the Senate. His reign of forty-one years was marked by peace and the establishment of an imperial bureaucracy that functioned smoothly even after his death, despite the depredations of the Julio-Claudian emperors who followed him, including the depraved Caligula and the wanton Nero.[2]

Several years after Nero's death, Vespasian was declared emperor by the army, and he began the Flavian dynasty (his family name was Flavius), which ruled successfully from 69 to 81 CE, followed by fifteen years of terror under Domitian. Upon Domitian's death, the Senate appointed Nerva as emperor. With his appointment, there began the era of the so-called Five Good Emperors, who included the well-known Trajan, Hadrian, and Marcus Aurelius; their reigns, from 96 to 180 CE, marked the longest period of peace and prosperity of the empire and were coincident with its maximum expansion and the reach of Roman law under Trajan. These years of efficient administration were the golden years of civil order and peace—*Lex Romana* and *Pax Romana* (Roman Law and Roman Peace). Much of the best Roman architecture was built during these periods of peace and expansive economic development, that is, during the reigns of Augustus, the Flavians, and the Five Good Emperors.

After Marcus Aurelius, the empire began to suffer growing internal rigidity as well as pressure from invaders who were pushing against the imperial boundaries. In response to this, in 285 CE, the emperor Diocletian divided the empire into two sections to be administered by two coequal emperors. Having taken these steps, Diocletian retired to his fortified palace on the Adriatic Coast at Spalatro, Yugoslavia. This system soon fell apart, but the empire was pulled together once more in 324 CE by Constantine, who moved the imperial capital away from Rome to a new city that he founded at the entrance to the Black Sea on the old Greek city of Byzantium; it was called the New Rome but soon acquired the name Constantine's City, or Constantinople.

The Roman Character

During the early republican years of struggle, when the constant threat from neighboring tribes required that Roman farmers be ready to take up arms at any moment, the Roman character was formed. Current popular literature and media may lead us to think of ancient Romans, throughout their long history, as irredeemably debauched and consumed with pursuing every physical pleasure, when in fact that description applied only to some Romans, particularly those of the imperial period during the reigns of Caligula and Nero. The rigors of the start of Rome, during the centuries of republican self-governance, bred a character defined by ingrained discipline, patriotic responsibility, and serious purpose that is best described by the Latin term *gravitas,* a sense of the importance of matters at hand, a propensity for austerity, conservatism, and a deep respect for duty and tradition. A good Roman practiced a strict morality, served the state, maintained unimpeachable honor, and strove for physical and spiritual asceticism—traits that Augustus himself later exemplified.

From the early days of the republic, Romans felt an extreme pride in their system of laws and governance. As the city of Rome extended its control over the Italian peninsula, there developed a driving impulse to spread the benefits of Roman law and republican governance to the rest of the world. This imperative had been issued by Jupiter himself, as expressed by Virgil in the *Aeneid:* "To Romans I set no boundary in space or time. I have granted them dominion, and it has no end."[3] It is a great irony that the Romans who later thirsted for blood sports involving human and animal slaughter were also the very people who created a universal system of law that sustained the rights of all citizens along the length of the Mediterranean for five centuries. The Romans endeavored to achieve universality and a clearly perceivable order in all of life, and their unique achievement was to give form to this civic order in the urban spaces they shaped—a form framed by clearly ordered ranks of axially disposed and colonnaded buildings.

The Romans were inherently pragmatic and realistic, unlike the speculative and idealistic Greeks. Although technological advances continued as Rome gained control of the Mediterranean basin, there were no great Roman theoretical scientists.

What the Romans produced in abundance were engineers and builders who developed architectural forms on a scale that the earlier Greeks could never have conceived, as Strabo boasted in his *Geography.* Roman engineers built a network of roads linking all parts of the empire, from the Portuguese coast to the ends of Turkey and Syria; if a stony mountain outcrop loomed in the way of a road, they simply cut through it. They captured streams and conducted the water more than 30 miles (48.3 km) to the cities, tunneling through hills and lifting the aqueducts over valleys on bounding arcades. Rome itself had fourteen aqueducts, over 265 miles (426.5 km) in total length, carrying 200 million gallons of water into the city daily. In many parts of Europe, the water supply and the sewer systems were far better under the Romans than they were from the Middle Ages until the start of the twentieth century, and in Segovia, Spain, the city's water is still carried in the Roman aqueduct.

Roman Religion and the Roman Temple

Religion in Rome was centered in the home, the *domus.* The Roman belief system was originally an animistic religion in which gifts were rendered to impersonal spirits that governed every aspect of nature—trees, rocks, water, and the fire of the domestic hearth. Each house had small shrines where offerings were made. The Etruscans had introduced a pantheon of Greek-like gods and began the construction of columnar temples raised on high platforms with columnar front porticoes. After contact with the Greeks, the Romans invested their civic, or state, gods with much of the character of the Olympian gods, so that Jupiter became nearly the same as Zeus. Jupiter, in particular, became viewed by the Romans as protector of the state.

Always fond of clearly specified procedure, the Romans developed detailed prescribed ceremonies in worshipping the gods, rituals carried out by priests (usually prominent members of the upper senatorial class) who had little contact with the ordinary artisan, merchant, or slave. Ordinary private Romans, for their part, still made offerings to the *numina,* the spirits worshipped in their home shrines, but state priests took care of the intricate rituals of state religion. Hence, religious observation in the Roman world became split between the state religion supported by state funds, on the one hand, and private activities conducted in the home, on the other—everyone seeking the blessings of a multitude of gods but also offering public vows requesting that the state gods ensure the security of the state. As the empire expanded, local gods worshipped in added territories were simply absorbed into the overall pantheon: Cybele, Isis, Mithras, and Sol Invictus among many others. With the end of the republic and the rise of imperial rule, the public vows shifted to requesting the health of the emperor. Once the emperor died, he was elevated to the position of a god, an outgrowth of ancient veneration of the dead. Only in the eastern part of the Mediterranean, among the monotheistic Jews, and then the Christian followers who split off from them, did the insistence among these groups on the acceptance of dogma and total allegiance to one god raise the threat of treason on the part of those who refused to make prayers to the deified dead emperors. If the Christians refused to recognize the deified emperors as gods, then they were, by that repudiation, enemies of the state. Official suppression of Christianity and then persecution of them as criminals followed in the early centuries of the common era.

The Roman temple, *templum,* based on Etruscan prototypes, was similar to the Greek temple and eventually was embellished with Greek orders and architectural details.[4] The underlying difference in the Roman temple had to do with how the sacred precinct around the temple was consecrated through human actions. The first step was to set up an ***axis*** that dominated the orientation of the temple, as well as the space in front of it (a *forum*); the axis and the *forum* shaped how a person approached the temple. At the dedication of a temple site, the priest, or *augur,* would survey the intended plot and name the boundary lines. He would draw a circle in the earth, dividing it with two perpendicular lines to mark the quadrants of the temple enclosure, laying out an axis in front of him, and a cross axis determining front and back, left and right. Whereas the Greek temple was set down in an open area and approached from all sides, the Roman temple was placed at the end of this clearly defined open space, aligned on the axis of that forum. It was set back against the rear of this forum space, high on a podium—unlike the Greek temple, with its three equal steps all around—and could be approached only from the front, up a long flight of stairs. Like the Greek temple, however, the Roman temple had columns, but these were primarily at the front, supporting the gable roof over the entrance to the ***cella***, the enclosed sacred chamber (essentially the same as the Greek *naos*).To the sides and rear, the *cella* wall was dominant, with the columns merged into the wall to form engaged columns integral with the wall of the *cella*.

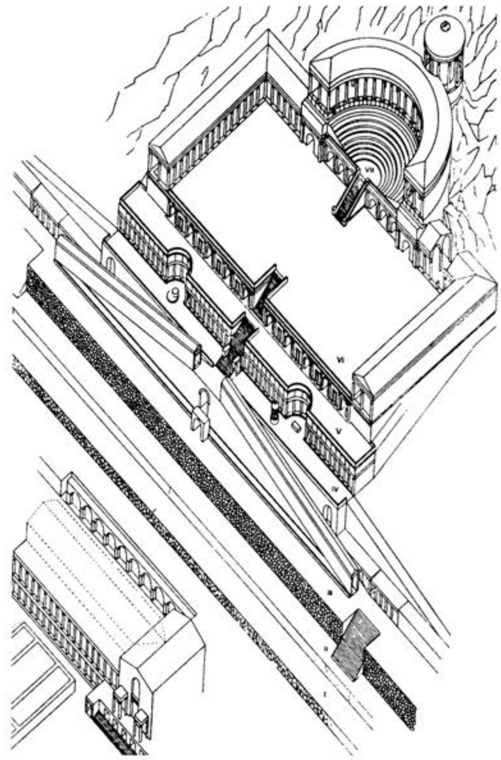
Among the best preserved of such Roman temples is the one built about 19 BCE in the provincial town of Nemausus in Gaul (Nîmes, France). Today,

12.2. Maison Carrée, Nîmes, France (the Roman city of Nemausus, Gaul), begun c. 19 BCE. One of the best preserved of all Roman temples, this shows the high base, emphatic front, and engaged columns in the side walls typical of Roman temples. Photo: © Wayne Andrews/Esto. All rights reserved.

the temple is called the Maison Carrée, the "square house," because of its clear, rectangular geometry [12.2]. Although built during the reign of Augustus, and therefore technically an imperial building, it duplicates the form of traditional temples of the earlier republic—for example, the smaller Temple of Fortuna Virilis in the forum in Rome. The rectangular enclosed forum in front of the Maison Carrée, however, has long since been built over.

A particularly dramatic example of the rule of the axis in controlling external space was for centuries covered up; this is the Sanctuary of Fortuna Primigenia at Praeneste (Palestrina), Italy [12.3]. Probably built under the direction of Sulla, who conquered Praeneste for Rome in 82 BCE, the site accommodated several ancient sacred spots and was part of Sulla's reestablishment of the ancient local cults. Although the site, on a steep hillside, was known through later written descriptions such as Cicero's *De divinatione,* it had been built over during the Middle Ages.

As it happened, Palestrina was heavily bombed in World War II, and when the rubble was cleared away, beneath the debris lay the remains of the ancient Sanctuary of Fortuna. This discovery enabled scholars to reconstruct its elaborate plan and to study the details of the terraces and colonnades that survived. At the bottom were barrel-vaulted shops leading to three shallow terraces. From there, long, covered ramps converged on a central axial stair at the fourth level. Here, graceful colonnades provided sheltered walks. Above was another terrace and an axial stair leading to the sixth and largest terrace, which was framed on three sides by colonnaded loggias. Another stair then led up to a small, theater-like series of concentric steps, culminating in a semicircular colonnade. Behind and rising over this was a circular temple, the focus of the entire composition; from the temple and the semicircular loggia just below it, visitors could look out over the valley to the sea. Recalling the terraces of Queen Hatshepsut's mortuary temple west of Thebes, the Romans here transformed an entire hillside, reshaping nature according to their unique vision of the earth's yielding to the geometric and axially disposed design of human invention. Built of concrete and tufa masonry, the Sanctuary of Fortuna Primigenia was a hint of the even larger and more complex concrete structures to follow during the empire.



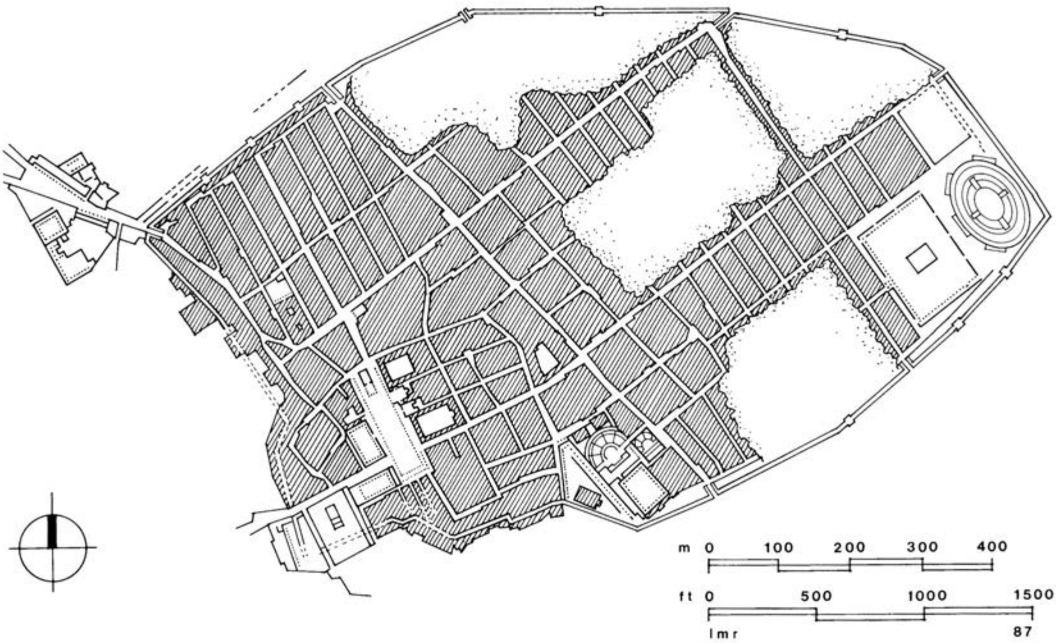
12.3. Sanctuary of Fortuna Primigenia at Praeneste (Palestrina), Italy, c. 80 BCE. This complex of ramps and terraces, leading up to the temple of Fortuna, shows clearly the organization of Roman space around a dominant axis. From Brown, Roman Architecture *(New York, 1961).*

Roman Urban Planning

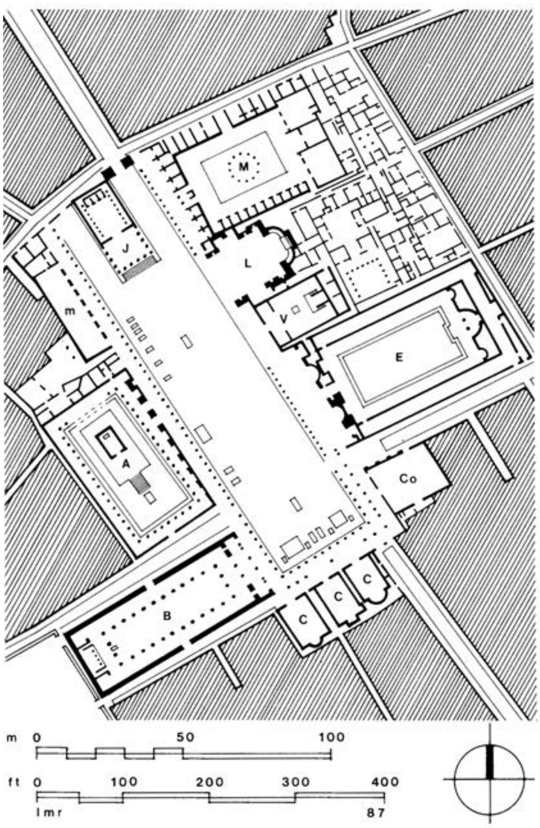
Like Greek life, Roman life was focused on the city, but as the Roman Empire grew, the far-flung cities became part of a federation of communities with participants exercising self-rule rather than acting as subject peoples. The annexed cities were the prime agents in spreading *Romanitas,* the encompassing sum of Roman privileges, values, and culture. By the second century CE, early urban Christian converts described rustic country folk not living in cities (and therefore not converted to Christianity) as pagans, from *paganus,* meaning a country person.

Early Roman cities, as well as cities that had started as Greek colonial settlements, such as the commercial and resort town of Pompeii, south of Neopolis (Naples), had networks of streets forming irregular rectangles [12.4]. As these cities expanded, the new blocks might become more regular, but at these ancient sites, there was no urgency to align the streets with the points of the compass. At the heart of these old cities, culturally if not always topographically, was the *forum,* the civic open space, the setting of the principal temple dedicated to Jupiter, lined with loggias and civil buildings. The forum thus served much the same function as the Greek agora. In his treatise, Vitruvius suggested that the ideal proportions of a rectangular forum are 2 to 3, width to length.[5] What distinguished the Roman forum, however, was its clear architectural definition and its generally rectangular shape dominated by the Temple of Jupiter at one end on the axis of the forum (the north end at Pompeii). Around the forum, enclosing it and giving it shape, would be found several buildings housing the *curia,* or city offices, and a *basilica,* a large, roofed building where legal cases were heard, as well as various lesser temples and public buildings. The forum of Pompeii illustrates these elements well [12.5].

From the Hellenistic Greeks, the Romans absorbed the technique of orthogonal planning, and they soon made this the basis of laying out army camps during the second century BCE.[6] Just as in dedicating a temple site, the ground for the camp, the *castrum,* was surveyed and the basic governing lines, or *limites,* were established at the center of the camp with an instrument called the *groma*. The principal street running north and south from this point was the *cardo,* and the principal east-west street perpendicular to it, the *decumanus*. Beyond the walls of the camp, this system would be extended on a larger scale (sometimes reoriented

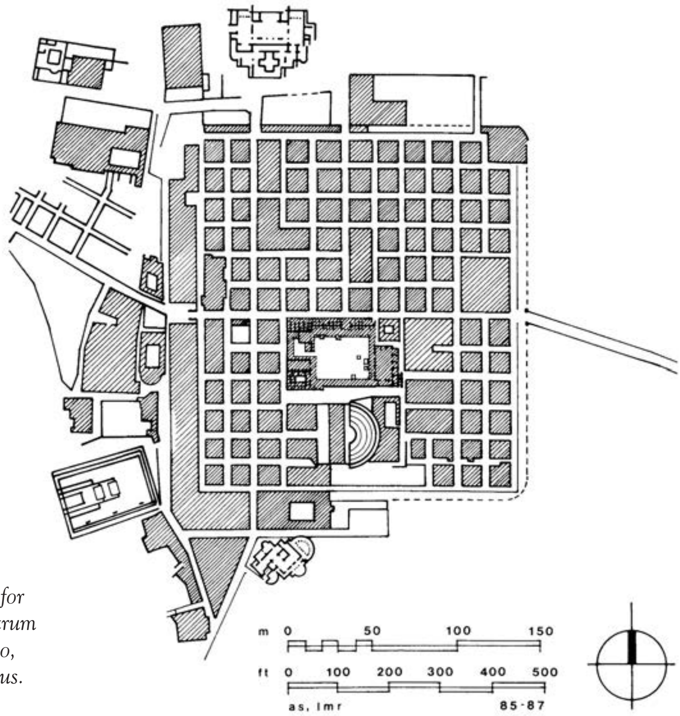


12.4. Pompeii, Italy. Plan of the city. The ancient heart of the city, founded in the sixth century BCE, is to the southeast. Later extensions have a more regular grid-like system of streets. The stippling indicates areas not yet excavated. Drawing: L. M. Roth, after Boethius and Ward-Perkins, Etruscan and Roman Architecture *(Harmondsworth, England, 1970).*



A = *Temple of Apollo*
B = *basilica*
C = *curia (city offices)*
Co = *Comitium*
E = *Eumachia Building*
J = *Temple of Jupiter*
L = *Lararium*
M = *Macellum*
m = *market*
V = *Temple of Vespasian*

12.5. Plan of the Forum, Pompeii, Italy. The principal public space in Roman cities was enclosed by the curia (city offices) and one or more basilicas (legal chambers), was ringed with colonnades, and focused on the Temple of Jupiter. Drawing: L. M. Roth, after Boethius and Ward-Perkins, Etruscan and Roman Architecture *(Harmondsworth, England, 1970).*



12.6. Plan. Thamugadi (Timgad), Algeria, founded in 100 CE. Established as a colony for military veterans, this city had a military castrum plan. The main north-south street is the cardo, and the main east-west street is the decumanus. Drawing: A. Stockler and L. M. Roth.

in deference to the slope of the land), in blocks called *centuriae,* measuring 2,400 Roman feet to a side.[7] These large squares were equivalent to a hundred small farms—hence their name, centuries, in English.

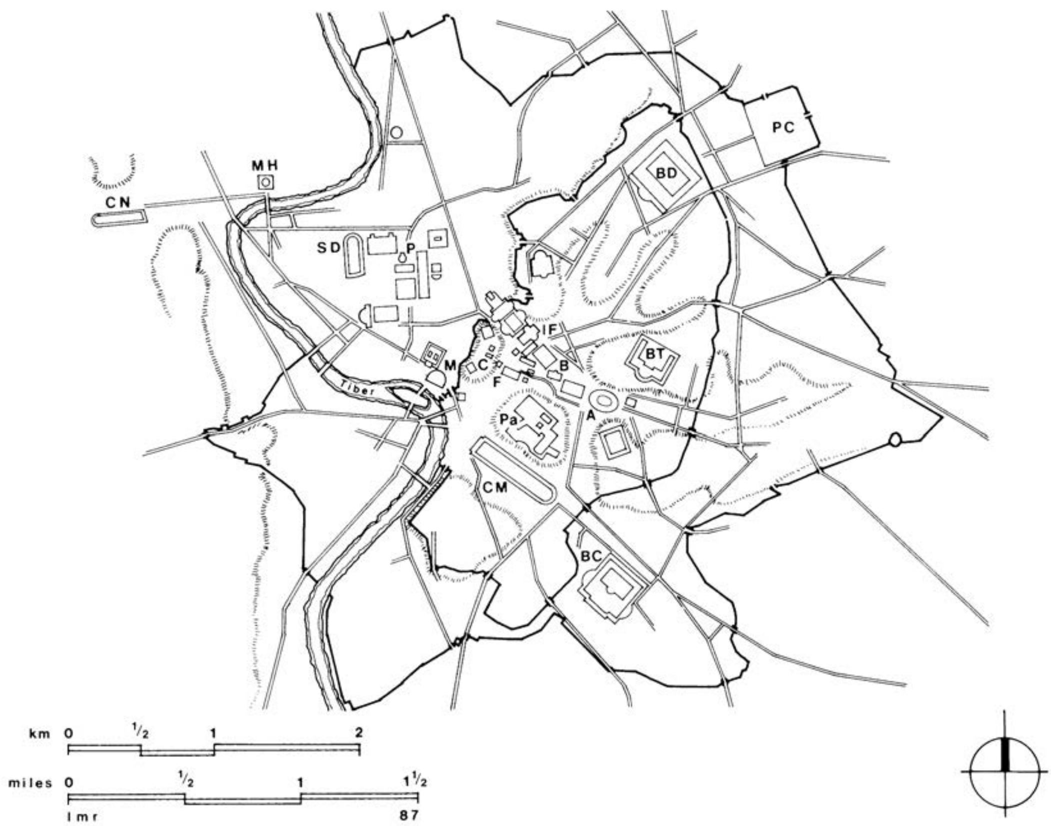
Military encampments in turn became the basis of countless town plans throughout the empire. In numerous European cities today, these grid plans survive in varying degrees in the medieval street patterns. In England, especially, the legacy of the Roman camp survives in the names of scores of towns, for "chester" is derived from the Latin *castrum:* Leicester, Chichester, Silchester, Worchester, and Chester are but a few examples. One military outpost that has survived in remarkable detail is Thamugadi (Timgad), in the Roman province of Numidia, now eastern Algeria [12.6]. Founded in 100 CE as a colony of military veterans guarding a strategic outpost, the camp was laid out with a rigid orthogonal grid, but as it expanded outside the original walls, the rigid rectilinear order was gradually eased. Immediately south of the decumanus is the forum, with the curia to the west and a large basilica on the east side. Just south of the forum was the city's principal theater. Outside the walls, on the north and south, were the largest of the public baths.

Of all the forums, the most celebrated were those in the city of Rome itself, beginning with the original city square, the Forum Romanum, considered the *caput mundi,* or "head of the world" [12.7, 12.8, Plate 18]. Because this original forum had grown bit by bit over several hundred years, it was not rigorously orthogonal, as were those in cities laid out from scratch, but beginning with Julius Caesar, additional forums were built north and east of the original forum in a more regular way. Julius Caesar's forum, the Forum Iulium, begun around 56 BCE, provided the model—strictly rectangular, lined with loggias, and focused on a Temple of Venus Genetrix. Augustus then added his Forum Augustum (dedicated in 2 BCE), on an axis perpendicular to the Venus Genetrix temple. Focused on a large Temple of Mars Ultor ("Mars the Avenger"), the forum was backed up against an old city wall. Additional forums (or *fora*) were added by succeeding emperors, each forum commemorating a significant military achievement and dedicated to a god whose attributes were admired by the patron emperor. By means of interlocking and interwoven perpendicular axes, these spaces are linked together to form a complex but relatively coherent system.

The imperial forums culminated in the vast Forum of Trajan, north of the Forum Augustum. This large forum was designed by Apollodorus of Damascus and built at the direction of the emperor in 98–117 BCE to commemorate his victories in Dacia, north of the Danube. More complex spatially than the earlier forums, this had a broad loggia-lined forecourt measuring 660 by 390 feet (200 by 120 m), further enlarged by the semicircular exedrae on each side screened by the loggias. On the hillside overlooking the northern exedra were public markets constructed by Trajan as part of the forum-building project. At the far north end of the forum complex was a temple to the deified Trajan, built by his successor, Hadrian. In front of the temple were two libraries, one for Greek and one for Latin manuscripts. Between the libraries stood the great stone column of Trajan, 125 feet (38 m) high, covered with a spiraling relief depicting the Dacian campaign. The temple to Trajan could not be seen from the great open space, however, for between the temple and the broad court was a huge basilica (the Basilica Ulpia), the largest in all Rome.

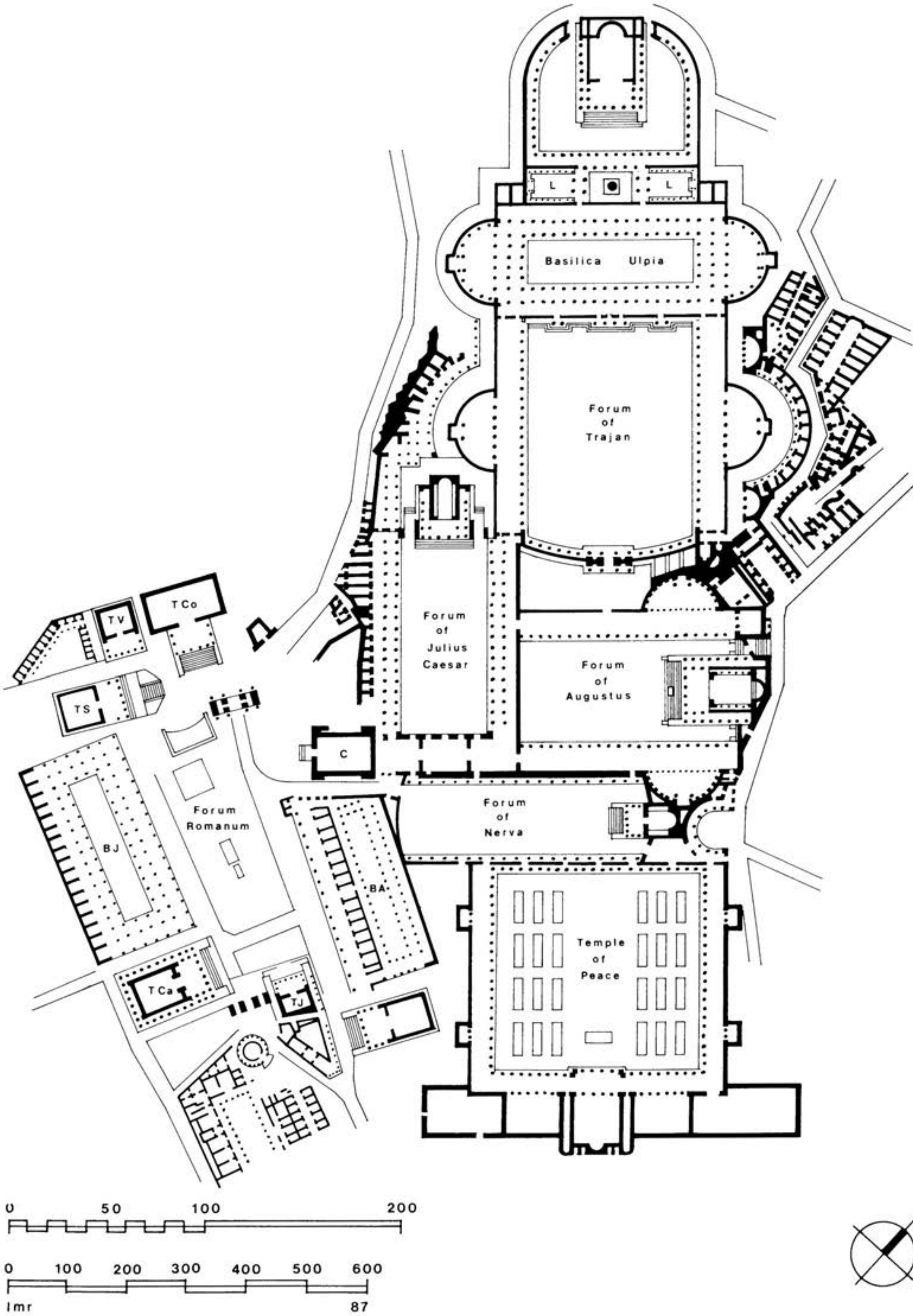
The Enclosure and Manipulation of Space

The focus on urban life and civic activities required the development of new building types in Roman architecture, buildings that enclosed space for the use of the public. Although the *cellas* of Roman temples had several chambers to house the image of the god and a treasury, only priests entered these rooms. Other civic activities, however, such as legal proceedings, required a large, covered space where judges could hear cases, where litigants could wait their turn, and where the public could listen. The ***basilica*** was designed to accommodate this need.[8]



A = Amphitheater	*BT = Baths of Trajan*	*IF = Imperial Forums*	*PC = Praetorian Camp*
B = Basilica of Maxentius (Constantine)	*C = Capitoline Hill*	*M = Theater of Marcellus*	*SD = Stadium of Domitian*
	CM = Circus Maximus	*MH = Mausoleum of Hadrian*	
BC = Baths of Caracalla	*CN = Circus of Nero*	*P = Pantheon*	
BD = Baths of Diocletian	*F = Forum Romanum*	*Pa = Palatine Hill*	

12.7. Schematic map of the City of Rome, third century CE, showing major buildings and forums. Drawing: L. M. Roth.



12.8. The Forum Romanum and the Imperial Forums, Rome, c. 54 BCE–117 CE. The interconnected Imperial Forums were built by successive emperors on interlaced axes next to the ancient Forum Romanum, the center of Roman civic and political life. Drawing: L. M. Roth, after Sear, Roman Architecture *(London, 1982).*

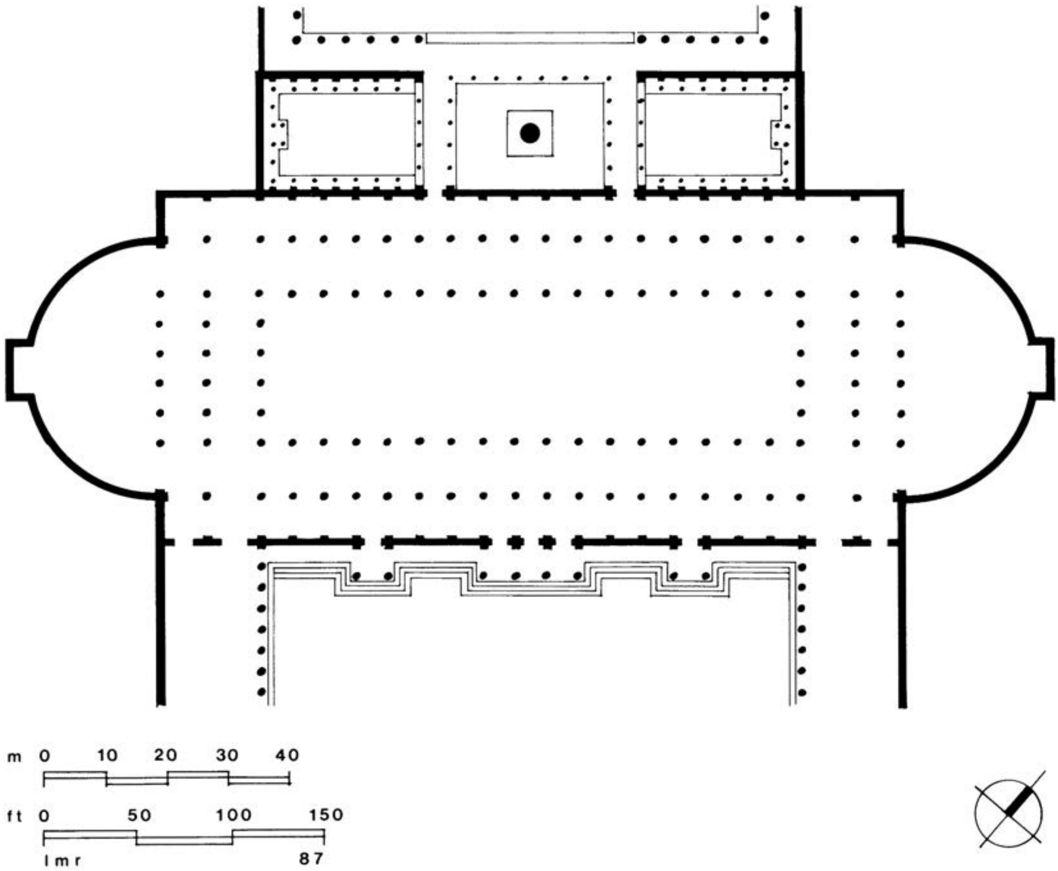
Normally a long, rectangular building placed adjacent to a forum, a basilica typically had an internal encircling colonnade, with an apse or a cylindrical projection at one end (or sometimes both ends), where the judges would sit. At the geometric center of the semicircular apse would be an altar acknowledging the spiritual presence of the emperor, for only in his symbolic presence could cases be heard. The Basilica Ulpia (Trajan's family name was Ulpius) illustrates this building type on a grand scale [12.9, 12.10]. Not including the apses, the building measured 385 by 182 feet (117.4 by 55.5 m) wall to wall, with two concentric internal colonnades opening onto a central vertical space, which by itself was 260 feet (80 m) long. The vast center space was covered by a timber truss roof spanning 80 feet (25 m).[9]

Increasingly during the second century CE, Roman builders used a form of concrete, *opus caementicum,* for the walls and vaults of these public buildings. Their concrete was a thick mortar (not a pourable liquid like modern concrete) laid with bands of brick. Having learned that their exposed concrete did not weather well, Roman builders incorporated brick or stone as an outer facing. From about 200 to 100 BCE this facing had consisted of random masonry blocks, *opus incertum,* but during the next two centuries, regular square bricks were used, set on the diagonal, *opus reticulatum.* After about 100 CE, flat bricks or tiles were used as the facing, *opus testaceum.* Concrete construction reached its height in the public baths of the late empire, as illustrated in the surviving three-bay Basilica of Maxentius, which was inspired by Roman baths. Begun by Emperor Maxentius in 307 CE, the basilica was finished by Constantine in c. 325 [3.26, 12.11]. The central circulation space measured 265 by 83 feet (80.8 by 25.3 m) and was covered by three huge groin vaults, with a semicircular exedra at the northwest end; three large chambers on each side provided buttressing for the concrete groin vault of the center "nave." Each of these side chambers, measuring 76 by 56 feet (23.2 by 17.1 m) and covered by a barrel vault, could accommodate additional court proceedings. Unfortunately, of the entire building, only three of these side chambers survive today.

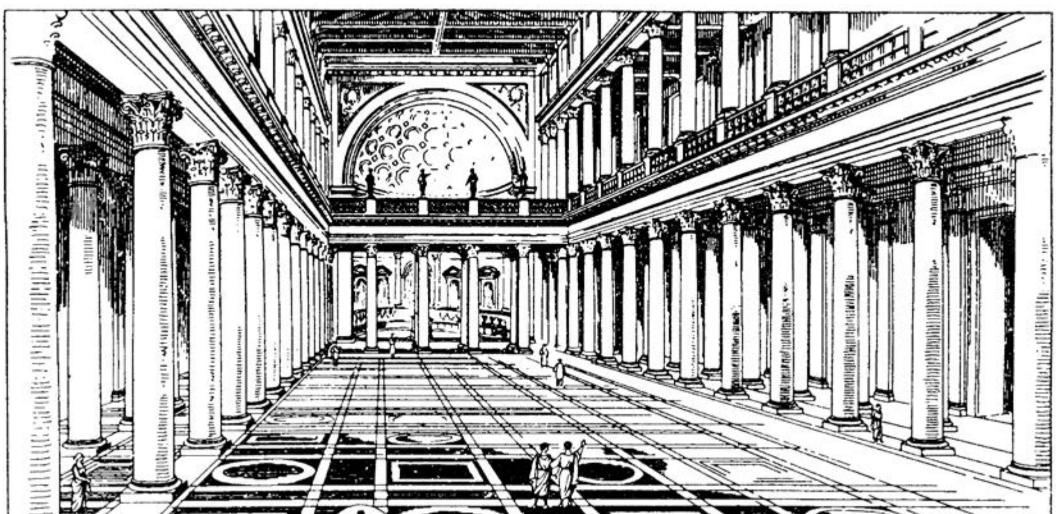
The building that best symbolizes the Roman enclosure of space and the powerful effect of such defined space is the Pantheon—no doubt because it survives nearly intact [3.27, 12.12, 12.13]. Built by Hadrian between c. 118 and c. 128 CE, the Pantheon was a temple to all the gods—its name comes from the Greek *pans,* "all," plus *theos,* "god"—including the deified emperor Augustus. Since the Romans imagined the earth as a disk covered by a heavenly dome, the new building undertaken by Hadrian was to symbolize that universe of earth and the gods. Who designed it is not known, although Hadrian himself may have played a part in devising the conceptual scheme.[10] Built of concrete of varying density from bottom to top, it is a model of the heavenly dome, the realm of all the gods, measuring 142.5 feet (43.4 m) in diameter. This hemisphere rests on a drum of equal height, so that the distance from the top of the dome to the floor is the same as the width of the dome; in other words, one could inscribe a perfect sphere within the enclosed volume. The only source of light (aside from what comes through the sheltered door) is the *oculus,* or eye, at the top, 30 feet across (9.1 m). Its beam of light slowly creeps across the marble floor and inches up the wall, marking out the cycles of the sun like a gigantic timepiece. As noted in Chapter 3 in the discussion of domes, the concrete of the Pantheon dome exerts tremendous downward thrust, which is diverted by eight radial barrel vaults in the thickness of the drum wall (20 feet; 6.1 m) to eight major piers. Between these piers are eight deep niches (where the statues of the gods were once placed), whose interiors are obscured from view by screens of slender Corinthian columns. Thus, the enormous weight seems to come down to a wall broken up into shadowy recesses. One reason the building survives in such good condition is that in 609 CE, it was consecrated by Pope Boniface IV as the church of Santa Maria Rotunda.

From the outside, a person approaching would have had little suggestion of the ballooning space within the building, for originally a long, colonnaded, rectangular forum in front of the Pantheon prevented clear views of the cylindrical side walls of the building [12.14]. Facing onto this forum is a broad octastyle (eight-column) Corinthian portico of monolithic gray Egyptian granite columns with white marble bases and capitals. The portico is backed against a tall, square attic block that also prevents full view of the cylinder and dome. The exterior seems always to have been rather plain, but the interior is resplendent with colored marble revetment. The walls and floor are covered with a veneer of marble, granite, and porphyry brought from the corners of the Roman world, evidence of the far-flung trade network made possible by the *Pax Romana,* the Peace of Rome.[11]

Perhaps no other single building so sums up Roman building achievement as does the Pantheon. It exploits concrete building technology to its fullest; it defines simply yet powerfully a clear geometry that assumes universal and cosmic significance,



12.9. Apollodorus of Damascus, Basilica Ulpia, Forum of Trajan, Rome, Italy, 98–117 CE. Plan. Largest of all the basilicas in Rome, this provided for two legal hearing chambers at each end, with an immense covered volume for public assembly. Drawing: L. M. Roth, after MacDonald, Architecture of the Roman Empire *(New Haven, 1965).*



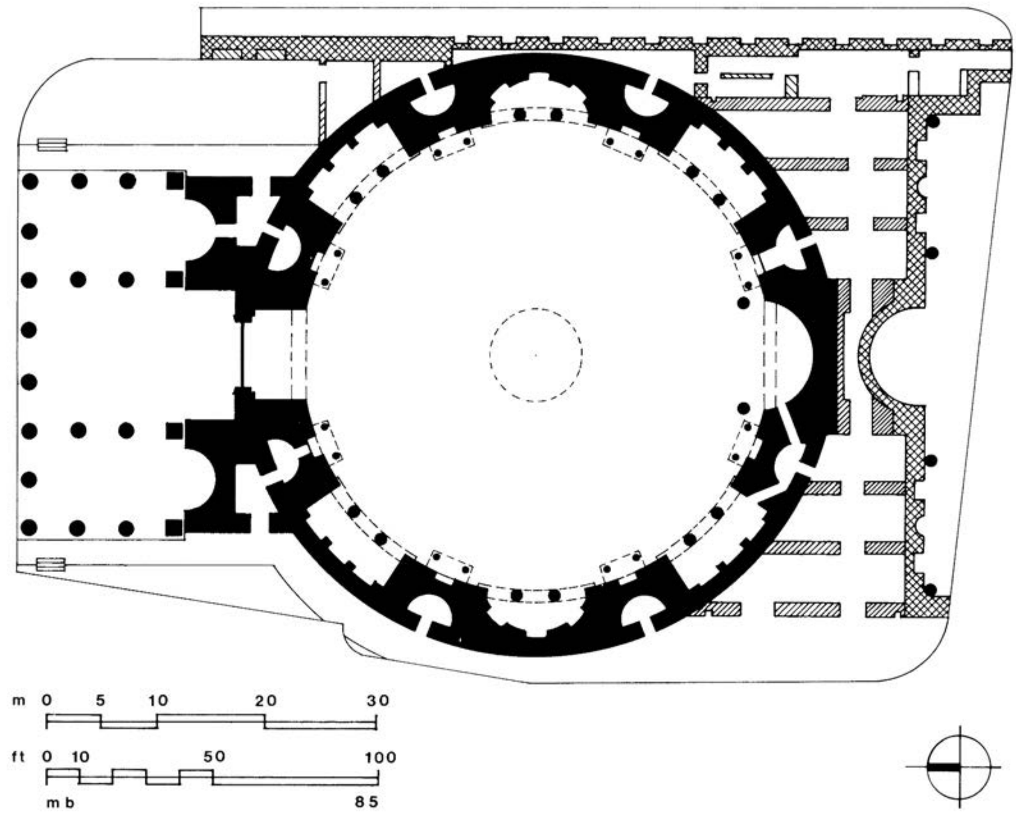
12.10. Basilica Ulpia. Interior view. From B. Fletcher, A History of Architecture *(New York, 1931).*

12.11. Basilica of Maxentius, Rome, Italy, 307–325 CE. View of the surviving three side chambers. Photo: Scala/Art Resource, NY.

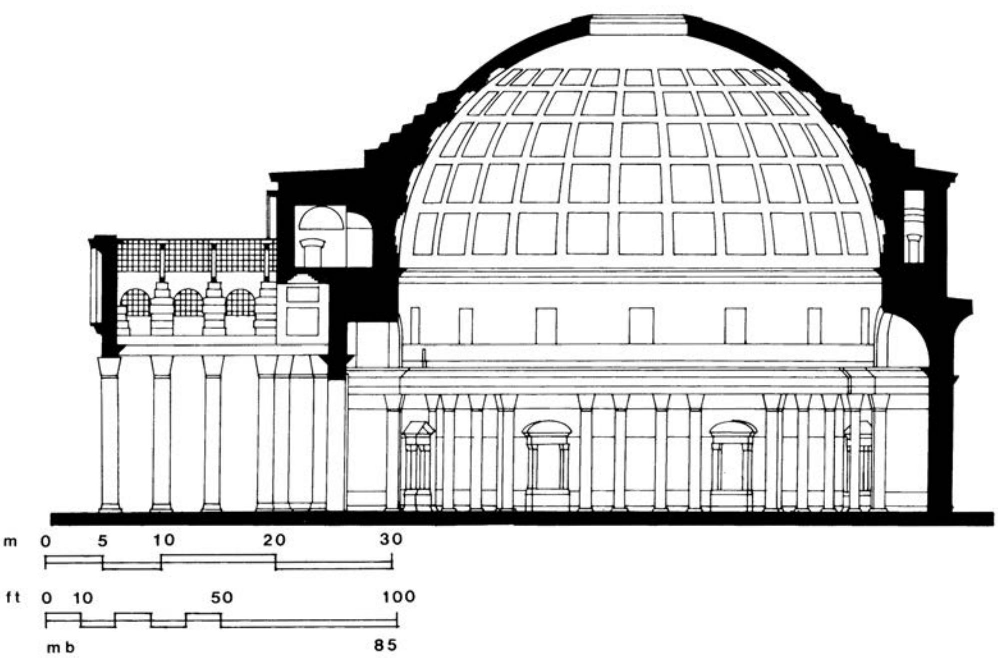
at a scale that never fails to evoke awe. It illustrates highly organized building operations in constructing formwork, in coordinating the arrival of building materials, and in timing the placement of the thick concrete mixture. It is evidence of the potential of human ingenuity and aspiration. But most important, it is evidence that building can transcend utilitarian construction, for the Pantheon is the embodiment, as David Watkin has put it, of "the symbol and the consequence of an immutable union between the gods, nature, man, and the state."[12]

The Pantheon was the culmination of important experiments that had been pursued for more than two centuries. Its particular distinction was its vast scale, but equally important architecturally were the earlier experiments in manipulating more intimate spaces carried out in building the Domus Aurea ("Golden House") for Nero in 64–68 CE. In 64, a disastrous fire had erupted near the Circus Maximus, spreading rapidly and consuming the heart of old Rome. Nero conveniently blamed the fire on a new religious sect, the Christians, and commenced the first of successive waves of persecution. Of Rome's fourteen administrative districts, three had been obliterated in the fire and ten more were severely damaged. Nero promptly claimed the destroyed districts, appropriating for himself the area around the Esquiline Hill. Here he and his architects, Severus and Celer, set about building a luxurious "country" estate on 350 acres (41.7 hectares) in the center of the city, filling it with fountains and a palace that looked out over an artificial lake. The entrance was built against the Forum Romanum, opening onto a court dominated by a gilded bronze statue that Nero had made of himself. At 120 feet (36.6 m) high, the statue was called the Colossus.

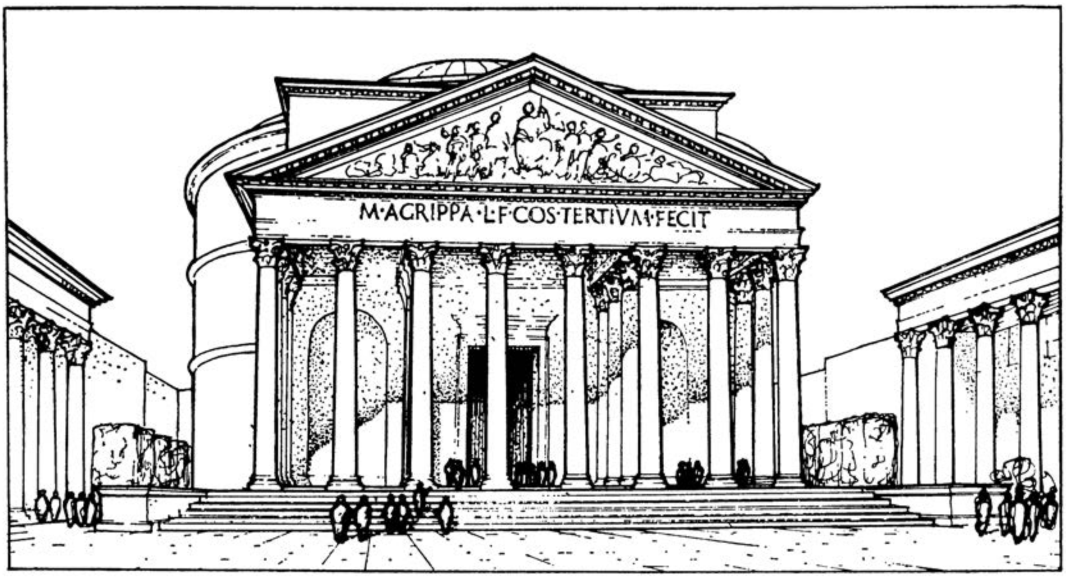
The Domus Aurea was a complex of interconnected geometric volumes, its rooms covered by nearly every known type of vault and dome [12.15, 12.16]. In the north wing was a low, octagonal room covered by an octagonal vault that became hemispherical toward the top and opened in a large oculus. Around this were taller, barrel-vaulted chambers whose open ends looked inward toward the curve of the dome, so that these surrounding vaulted chambers were lit from unseen sources with light bounced from the outer surface of the central dome.



12.12. Pantheon, Rome, Italy, 118–28 CE. Plan Drawing: M. Burgess.



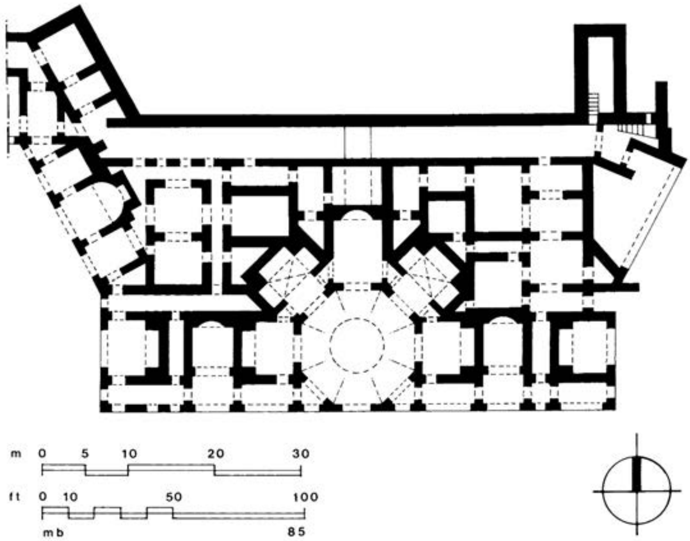
12.13. Pantheon. Section. Drawing: M. Burgess.



12.14. Forum of the Pantheon, Rome, Italy. Originally the Pantheon, like other Roman temples, faced an open forum whose enclosing colonnades may have partially obscured the drum of the dome, heightening the sense of surprise one experienced upon entering. From Axel Böethius and John B. Ward-Perkins, Etruscan and Roman Architecture *(Baltimore, 1970).*

Domestic Architecture

Nero's Domus Aurea was an elaborate evocation of an ex-urban villa, a retreat in the countryside. Roman writers, such as Virgil in his *Georgics,* developed an aesthetic appreciation of the natural landscape for its own sake. This sensitivity, essentially unknown before, was an interest also reflected in the letters of Cicero and Pliny the Younger, who affectionately describe their country villas. Despite this new appreciation of the landscape, Roman civilization was nonetheless essentially urban. Cities were the building blocks of the empire, the centers of trade and commerce. Rome itself was huge, having about a million inhabitants during the reign of Augustus. Complaints—about the shortage of housing, exorbitant rents, pollution, crime in the streets, and the general high cost of living—were



12.15. Severus and Celer (architects), House of Nero, the Domus Aurea (House of Gold), Rome, 64–68 CE. Partial plan. Overlooking a lush landscape created in the heart of the city, this villa consisted of concrete-vaulted rooms in a wide variety of shapes. Many rooms were illuminated by ingenious oculus windows and reflecting walls. Drawing: M. Burgess, after MacDonald, Architecture of the Roman Empire *(New Haven, 1965).*

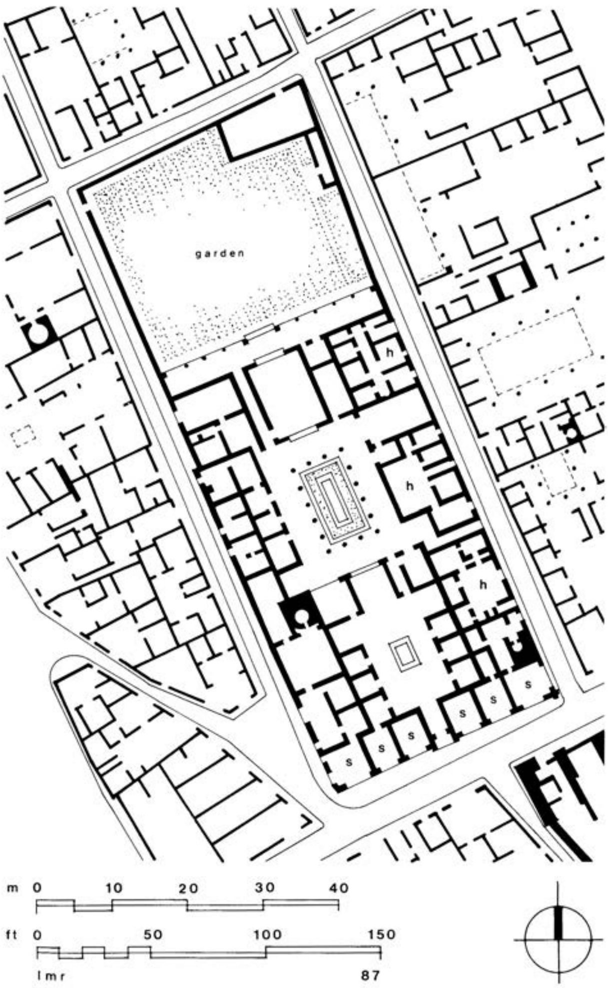
12.16. Domus Aurea. Interior view of the octagon. Photo: Fototeca Unione, American Academy in Rome.

common. Because of increasing congestion, chariots and other vehicles were excluded from the city during daylight, with the result that much of the commercial traffic was conducted at night.

Most urban citizens lived in apartment houses, large blocks of three or four floors that opened onto landscaped internal courts. These *insulae* ("islands") filled entire blocks. Often hastily and shoddily built as speculative real-estate ventures, they were known to collapse; in a letter to his friend Atticus, Cicero wrote that two of his shops had fallen down, but that he had a rebuilding scheme that would recover his losses.[13] Augustus had decreed that no *insulae* could be built more than 70 feet high (21.3 m), and after the fire in 64 CE, Nero declared numerous additional building regulations, specifically requiring the use of nonflammable materials. The *insulae* in Rome itself have long since been replaced, but in Rome's port city, Ostia, many have survived, some up to the third floor [12.17]. Built of brick and concrete, they had balconies running around the entire block; many of these were connected by bridges over the narrow streets to neighboring *insulae,* enabling residents to move about the city without descending to the congested streets.

The destruction of Pompeii on August 24, 79 CE, when Mount Vesuvius erupted, in fact preserved a range of different house types, from small artisans' residences to large patrician residences and expansive country villas just outside the city.[14] At the northwestern end of Pompeii are a number of blocks in the later, more orthogonal extension of the city; these blocks contain several houses, ranging from small to very large. One block is nearly filled by the expansive house of Pansa [12.18]. Except for its large garden to the north, it typifies the arrangement of a single-story Roman town house, with its closed face to the street and inward focus. For the most part, private houses had symmetrical floor plans where possible. The entrance connected with a large public room, the *atrium,* open to the sky through an opening in the roof and ringed with cubicles. The roof of the atrium pitched inward, so that rainwater dripped into a pool, the *impluvium,* at the center of the room. On the axis beyond the atrium was the *tablinium,* the principal public room, which was screened by draperies. Beyond the tablinium was an

12.17. Apartment blocks (insulae), Ostia, Italy, late first and second centuries. Model. This model shows the galleries and balconies that ran around some of the apartment blocks. In places, these galleries bridged across the street to allow movement from building to building without having to descend to the congested streets. Photo: From Brown, Roman Architecture *(1961).*



*12.18. House of Pansa, Pompeii, Italy, second century BCE. Plan. Somewhat larger than other houses in Pompeii, this structure nonetheless has the same component elements (the major addition here is the large garden to the north). Like other Roman urban houses, it was surrounded by contiguous smaller houses and shops open to the street (**h** = rental houses, **s** = rental shops). Drawing: L. M. Roth, after W. F. Jashemski.*

open court, or *peristyle,* ringed with a colonnade. Around the peristyle were more cubicles and the *triclinium,* the dining room just large enough to accommodate three broad reclining dining couches. In some houses, the peristyle was large enough to be a garden, with another impluvium at the center. Beyond the peristyle, on the axis, was the *oecus,* or reception room. Surrounding the house of Pansa and filling out the block were several small, individual residences on the east side, six small shops opening to the street on the south side, and a bakery and two more shops on the west side. Such enclosing apartments and shops provided income to the owner, whose house was in the center of the block.

The various houses, villas, and public buildings of Pompeii have acquired special importance, for the entire city and the neighboring towns of Herculaneum and Stabiae were buried under as much as 30 feet (9.1 m) of volcanic ash in the eruption of Mount Vesuvius. Because the ash deposits fell relatively slowly at first, the courts and houses became filled with the ash material. Later, when the explosive pyroclastic blast came, many of the houses and buildings were already mostly buried and were thus spared serious destruction, although some roofs had already collapsed from the weight of the ash. Initially, many people had sufficient time to escape, but others went to the upper levels above the accumulating ash, expecting it to cease at some point.[15] Household articles were left where they were dropped and the bread on the bakers' counters was abandoned, but the residents who refused to flee suffocated and were buried by the ash wherever they collapsed. Gradually, the streets and houses were filled with the falling ash, which covered wood furniture and wall paintings. When the site was uncovered in the eighteenth century and excavation began in 1748, the first detailed evidence of everyday Roman life came to light. Early excavators discovered voids filled with skeletal bones and eventually devised a method of injecting these voids with liquid plaster to reveal the ghost-like forms of the people who were overcome where they fell and were buried.

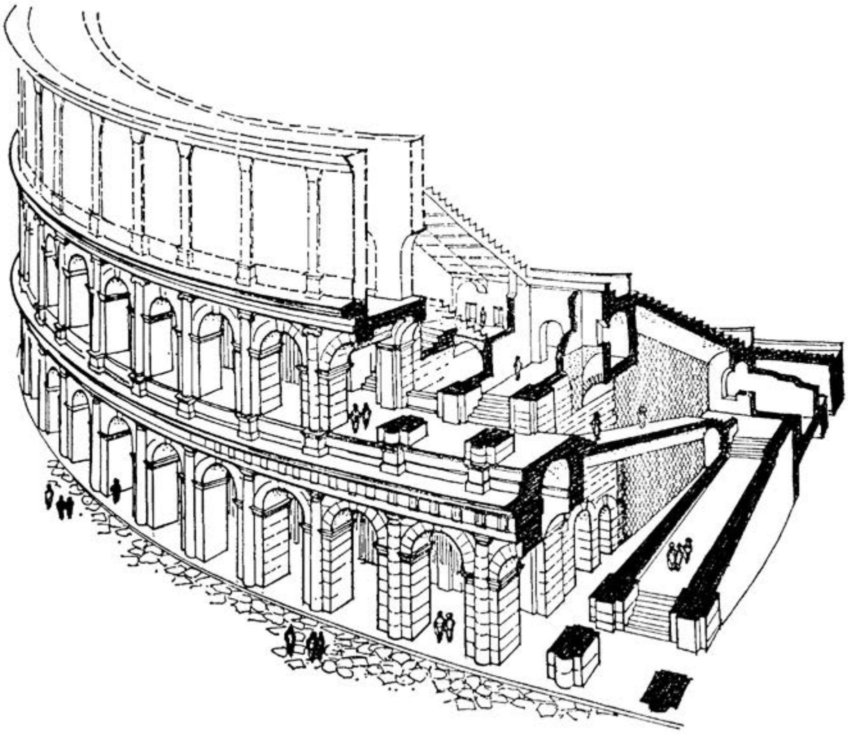
Public Buildings

Because of their intensive urban life, the Romans developed a range of varied public building types. The largest of these, meant to accommodate public amusements, were not roofed, but others had large interior volumes covered with concrete vaults of various shapes.

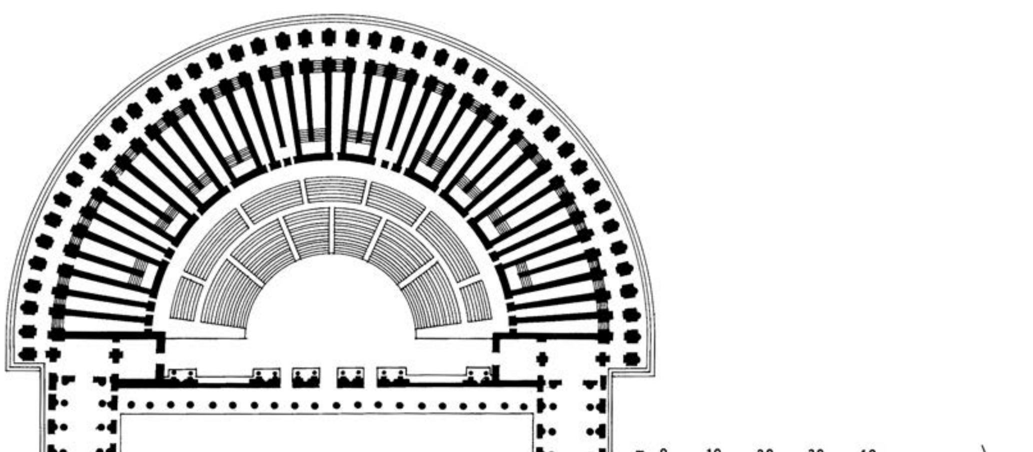
Roman theaters, derived from Greek models, were the scene for revivals of Greek plays as well as the production of newer Roman works, but they never served the quasi-politico-religious function of the Greek theater. Accordingly, Roman theaters were not located near temples, but close to the business center of the city; and since they were not built on natural hillsides like Greek theaters, Roman theaters had their seats ramped up on tilted concrete vaults raised on stone piers. The basic form of the Roman theater was crystallized in the Theater of Marcellus, Rome, projected by Augustus himself and built under the direction of Marcus Agrippa. The theater was dedicated about 12 BCE [12.19].[16] The seats were inclined on a system of radiating and tilted concrete barrel vaults supported by radiating stone piers, between which threaded the stairs and ramps leading to the sections of seating. The outer curved wall was opened up by superimposed arcades of travertine faced with engaged orders—unfluted Doric at the lower level and Ionic on the second level (the treatment of the third level is not known with certainty since the structure was heavily modified during the Middle Ages). Unlike Greek theaters, Roman theaters were exactly semicircular, with a half-circle orchestra where senators were often seated; the Theater of Marcellus measured 365 feet (111 m) in diameter [12.20]. As was typical of Roman theaters, the seats faced a permanent *scaenae frons,* a wall as high as the rear wall of the semicircular seating. On its three tiers of seats, each one pitched somewhat more steeply than the one below, the Theater of Marcellus could accommodate eleven thousand spectators.

Every Roman city had one or more theaters, but the one that has survived best is the theater in Aspendos, in the Roman province of Pamphylia, near the coast of south-central Turkey [12.21].[17] Designed about 155 CE by Zeno of Theodorus, this example was built against a convenient hillside, although the sides of the semicircular seating that extended out laterally from the hillside are carried by vaults and arcades. The theater is 315 feet (96 m) in diameter and can accommodate up to seven thousand spectators. The stage and *scaenae frons* still stand, but missing is the sloped, reflecting wooden ceiling that was originally cantilevered 27 feet (8.1 m) out over the stage. The *scaenae frons* was once richly embellished, with two superimposed colonnades of paired columns carrying alternated segmental and triangular pediments. To shield theatergoers from the sun, a *velarium* awning, supported by fifty-eight masts planted in sockets at the rear of the seating, could be pulled over the audience.

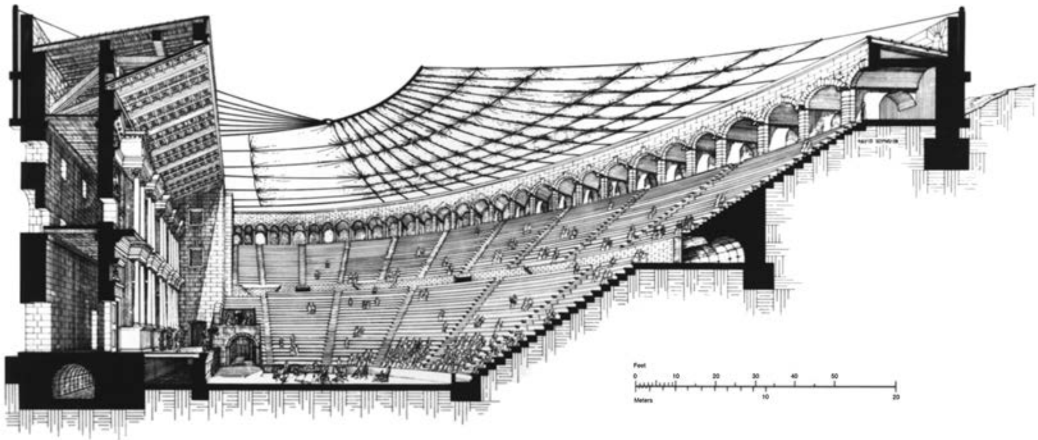
The principal Roman innovation in "theater" design was to combine two theaters to form the oval amphitheater devoted to gladiatorial contests and



12.19. Theater of Marcellus, Rome, Italy, finished 12 BCE. Perspective. This cutaway drawing shows the system of circulation used to admit viewers to the ramped seats. The uppermost floor was removed in the Middle Ages, but the superimposed engaged columns (Ionic over Doric) survive in the lower stories. From Axel Boëthius and John B. Ward-Perkins, Etruscan and Roman Architecture *(Harmondsworth, England, 1970).*



12.20. Theater of Marcellus. Plan. Drawing: L. M. Roth, after Kähler, The Art of Rome and Her Empire *(New York, 1963).*

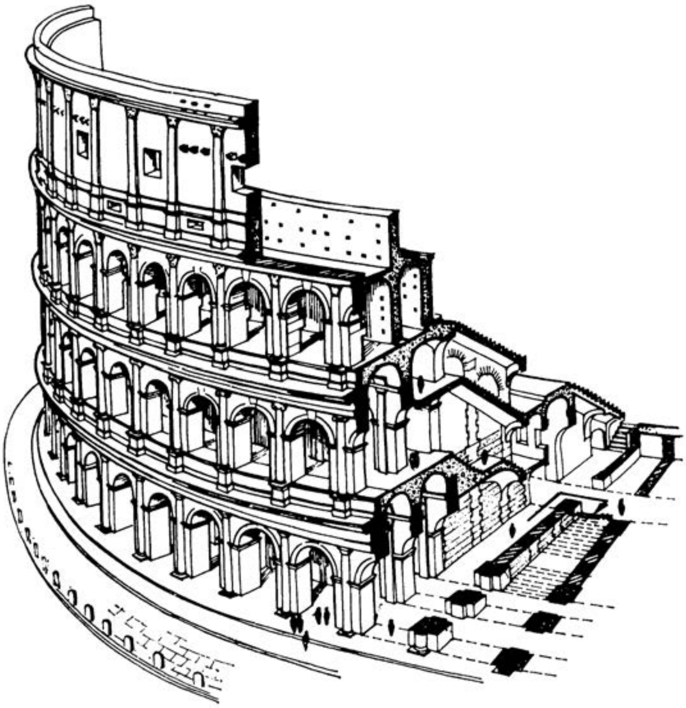


12.21. Zeno of Theodorus, Theater, Aspendos, Pamphylia (Turkey), c. 155 CE. Section perspective. The Roman theater focused on a tall, permanent stone scaenae frons, or backdrop scene, that rose as high as the back, uppermost seats. From G. C. Izenour, Theater Design *(New York, 1977).*

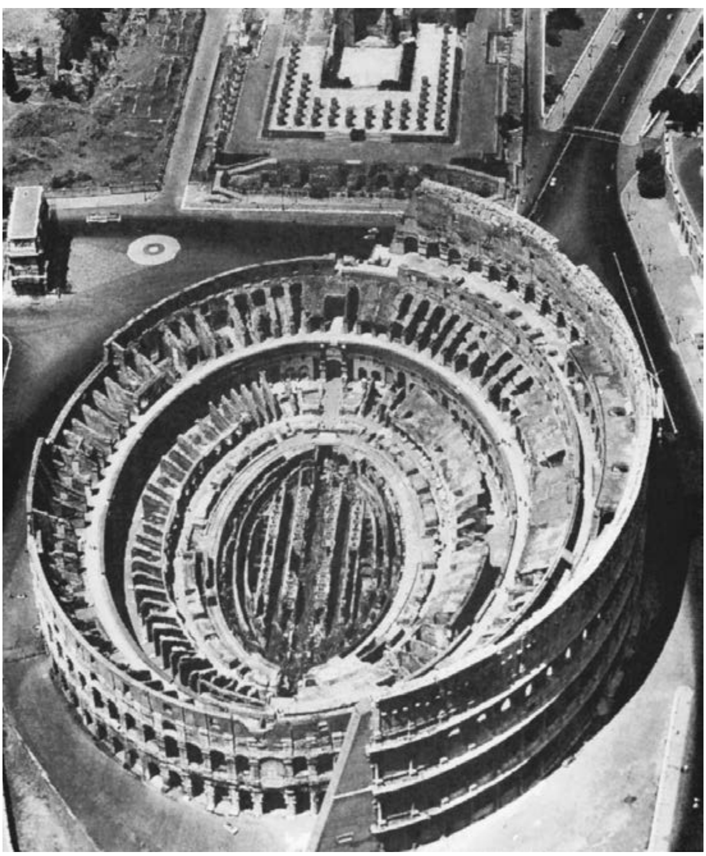
other large-scale amusements. The oldest surviving example is that at Pompeii, built about 80 BCE. It measures 500 by 350 feet (150 by 105 m) and could hold twenty thousand spectators. The word *amphitheater,* however, has become nearly synonymous with the huge Flavian amphitheater in Rome, popularly called the Colosseum [12.22, 12.23]. This was begun by Emperor Vespasian in 80 CE, after the end of Nero's unpopular reign, when the grounds of Nero's Domus Aurea were appropriated for new public building. Vespasian's amphitheater was in fact built in the basin where Nero's artificial lake had been and stood next to Nero's colossal statue—hence the name Colosseum. (Nero's Domus Aurea was later covered in part by the Baths of Trajan.) The unknown architect/engineer of the Flavian amphitheater was a master of logistics and construction deployment, for the building was under construction in several areas at once by different work crews. On a foundation ring of concrete, piers of tufa and travertine were placed to carry the concrete vaults forming the shell for the tiers of seating. Overall, the amphitheater measured 615 by 510 feet (188 by 156 m), with a clear arena floor of 280 by 175 feet (86 by 54 m). The floor was laid with wood planks over a series of subterranean chambers and passageways through which lions and other animals could be admitted to the arena floor; the floor could be removed and the entire lower level flooded for mock naval battles using miniature ships. The seats rose in tiers to 159 feet (48.5 m), with a curved outer wall of four superimposed arcades. As in the Theater of Marcellus, the stone arcades incorporated engaged columns—unfluted Doric on the ground floor, then Ionic, Corinthian, and finally Corinthian pilasters on the uppermost, fourth story. At the fourth level, too, were sockets holding masts for the velarium cover that could be stretched over the audience. The individual wedge sections of seats were divided into seventy-six separate blocks, each with its own entrance, exit stairs, and ramps incorporated into the vaulted passages under the seats, a system nearly identical to that used in many modern sports arenas. Between forty-five thousand and fifty-five thousand people could be seated in the Flavian amphitheater at one time, a number comparable to many football stadiums today.

Even larger were the stadiums, or circuses, used for chariot races. The biggest of them all in Rome was the Circus Maximus, in the valley between the Palatine and Aventine hills and begun in 329 BCE [12.7]. Shaped rather like a modern football stadium, but much longer, the Circus Maximus was about 1,820 feet (555 m) from the stables at one end to the curve at the other. It was approximately 380 feet (115.8 m) wide. The Circus Maximus has disappeared, but the smaller Circus of Domitian survives as a ghost negative image in the open space of the Piazza Navona, for the enclosing walls of the circus's seating were reused in medieval buildings that were themselves replaced with new buildings in the Renaissance [visible in 16.20].

The unique Roman structural achievement was covering large spaces for public use, as in the creation of the basilica as a legal court. Another special Roman creation was the public bath, examples of which were built in profusion throughout the empire during the second century CE. In Rome itself,



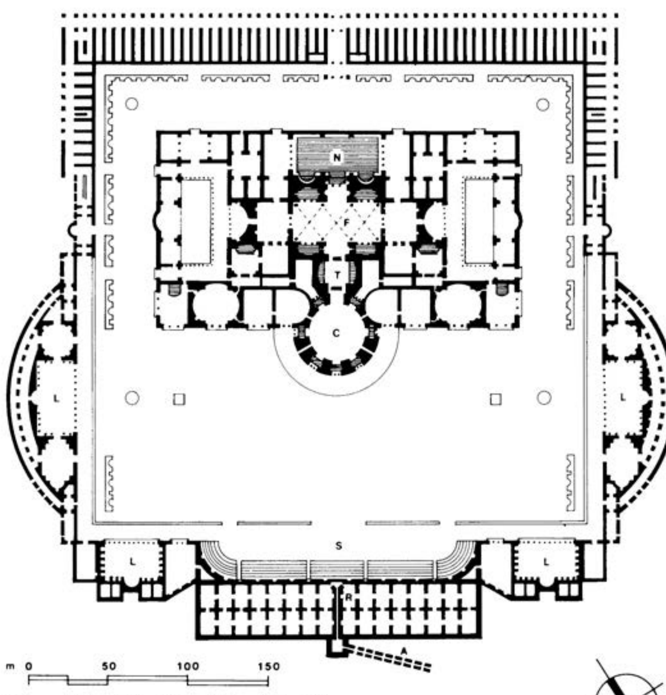
12.22. Flavian Amphitheater (the Colosseum), Rome, Italy, begun, c. 80 CE. Perspective. Roman amphitheaters were designed for popular amusements and sports events. This, the largest of them all, could seat up to 55,000 people, admitted through seventy-six separate gates. From Axel Böethius and John B. Ward-Perkins, Etruscan and Roman Architecture *(Harmondsworth, England, 1970).*



12.23. Flavian Amphitheater (the Colosseum). Interior of arena. Originally the floor was overlaid with heavy wooden planks covered with sand for gladiatorial contests. Below were the animal cages. For special occasions the floor was removed and the arena flooded for mock naval battles. Photo: Fotocielo.

according to a catalog of buildings drawn up in 354 CE, there were then 952 baths of varying size.[18] Roman baths, *thermae,* were used for much more than simply washing. They combined aspects of a modern health club with that of a public library and school, for the biggest baths (such as the Baths of Caracalla in Rome [12.24]) contained shops, restaurants, exercise yards or *palaestrae,* libraries, and lecture halls and reading rooms (*gymnasia*), arranged around spacious gardens filled with sculpture (in fact, many of the surviving Roman copies of Greek sculpture were found during archaeological excavations of the gardens of these baths). In the Baths of Caracalla, the largest in Rome, more than 1,600 bathers of one gender could be accommodated at one time in its sprawling 33 acres. The entire complex was 1,152 feet wide (351 m), excluding the curved exedrae, and 1,240 feet (378 m) in depth, including the water reservoirs at the south end fed by the Marcian aqueduct. Along the north side were shops, and in the exedrae on the sides were libraries and lecture halls; flanking the reservoirs were additional libraries. The remaining space within the walls was shaded by groves of trees. In the northerly half of the enclosure was the principal bath building, 750 by 380 feet (228 by 116 m). On the central axis, on the south side, was the large domed hot room, the *calidarium,* 115 feet (35 m) in diameter, with hot pools in niches in the wall of the drum. Immediately north of this was the warm room, the *tepidarium,* with two pools at the sides of this hall. The tepidarium led to the large three-bay cold room, the *frigidarium,* 183 feet by 79 feet (55.7 by 24 m). At the heart of the building, the frigidarium had three groin vaults rising 108 feet (32.9 m) above the roof, with light pouring through the eight semicircular lunette windows [12.25; 12.26, p. 248]. To the north of the frigidarium was the swimming pool, the *natatio,* open to the sky but apparently additionally illuminated by bronze mirrors attached to metal fixtures overhead. The entire complex, including gardens and enclosing facilities, was built on a 20-foot-high (6 m) platform, which provided for vaulted storage rooms and the furnaces that heated the tepidarium and calidarium by means of flues in the floors and walls through which hot air circulated.

Every Roman city of any significance had at least one theater and one bath. Provincial Timgad had fourteen baths in all, with two large establishments



A = Marcian Aqueduct
C = Calidarium (hot bath)
F = Frigidarium (cold baths)
L = Libraries
T = Tepidarium (warm baths)
N = Natatio (swimming pool)
R = Water reservoir
S = Stadium

12.24. Baths of Caracalla. Rome, Italy, 212–216 CE. Plan of the bath complex, showing surrounding gardens and reading rooms. Drawing: L. M. Roth, after B. Fletcher, A History of Architecture *(New York, 1931).*

12.25. Baths of Caracalla. View along axis of the frigidarium. Photo: Album/Art Resource, NY.

on the north and south edges of the city [12.6], built in the third and mid-second centuries CE, respectively. In the northern outpost of Augusta Treverorum (Trier, Germany) on the Moselle River, the spacious heated baths built in the fourth century CE must have been especially welcome. Trier had a number of other large public buildings; the basilica still stands nearly intact. A bath was built in the provincial city of Lutetia (Paris); the ruins today are part of the Musée National du Moyen Age. In Britain, the Romans took advantage of natural mineral hot springs that bubbled up next to the Avon River, building there *thermae* and a city they called Aquae Sulis (today Bath, England).

Roman theaters, circuses, and baths were built and operated with imperial funds and were available at no charge to the public. The purpose of these expensive enterprises was to keep the unruly populace occupied, for tens of thousands in the city of Rome were unemployed. The construction of such buildings itself provided work for those in the building trades, and the continual games and the pleasures of the baths served to divert the populace. Grain was dispersed as well; free "bread and circuses" in the cities soon became imperial policy. There was, of course, a price to be paid for such state largess, in the form of increasingly burdensome taxes throughout the empire. By the time of

Diocletian's reign, 284 to 305 CE, restrictions bound sons to the trade of their fathers and farmers to the land, and thus the basis of medieval serfdom was created.

Later Roman "Baroque" Architecture

During the later Roman Empire, architectural forms became larger, more extensively embellished, and formally complex. This move toward elaboration and complexity was especially pronounced in the provinces, removed as they were from the influence of the austere models in Rome. In the eastern Mediterranean areas such as Syria, Roman administrators accepted local religions and gods, so long as official ceremonies embraced prayers and oaths supporting the state religion and the deified former emperors. The difficulty arose in the province of Judea, where the Jews (and soon the Christians branching from them) tolerated no other gods in the ardent monotheism they practiced. Accommodations were made with the local Jewish authorities.

The official toleration of the worship of local deities in the provinces (so long as official temples were built and dedicated to Jupiter) resulted in the construction of other temple buildings and complexes that differed significantly from those in Rome. Several striking examples are found in the city of Balabakk (Baalbek), southern Syria (now Lebanon), a Roman colony established about 16 BCE.[19] The principal temple there was dedicated to Baal, the great god of storms who had become equated with Jupiter; next to it was a temple to Tammuz (synonymous with the Roman god Bacchus). Begun soon after the establishment of the colony, the vast temple complex was under construction for nearly 250 years. The large Temple of Jupiter was raised on an immense podium 40 feet (12.2 m) high; it faced a square forum court 380 feet square (115.8 m), which in turn opened onto a hexagonal forecourt 192 feet (58.5 m) across. The adjoining Temple of Bacchus had richly ornamented interior *cella* walls, the spaces between its engaged Corinthian columns filled with heavily ornamented architectural detail.

Centuries later, such spatially complex architecture came to be described as "baroque," the term developed to describe the richly modeled architecture of the seventeenth century in Italy. One such late imperial Roman building is the small temple or shrine of Venus in Baalbek, built in the third century CE. The shrine is a combination of a round temple fronted by a rectangular portico carrying a pediment [12.27]. The entablature of the enclosing Corinthian colonnade is pushed back in deep concave curves, as is the podium of the temple, so that the building reads more like a molded sculptural mass than as a structural arrangement of stone posts and beams.

An Architecture of Universality

Just as Hellenistic architecture moved away from the earlier formal clarity of Periklean architecture, so too did late Roman architecture move away from the austerity of the republican age toward what later historians would call a Baroque complexity in the Imperial period. Moreover, as the empire expanded into what was viewed even then as the "exotic East," the transported Roman architecture became yet more complex. In the later years of the empire, the emphasis increasingly was on experimentation and on pushing stone and concrete to their structural and plastic limits. While the *Pax Romana,* the Peace of Rome, endured during the peaceful and prosperous reigns of Augustus, the Flavians, and the so-called Five Good Emperors in the second century CE, the Romans perfected an architecture unlike that ever seen before and spread it the length of the Mediterranean world. A Greco-Roman architecture, it combined the elegance of detail and refinement of form of Greece with the pragmatic functionalism, civic scale, and sense of power of Rome. It was also a universal architecture, embodying the essence of *Romanitas,* that sense of the wholeness of Roman culture, wherever it was built—whether in Rome itself, Palmyra in Syria, Alexandria in Egypt, Timgad in Africa, Trier in Germany, Olisipo (Lisbon) in Portugal, or Londinium (London) in distant Britain. Whereas the outland Greeks held their allegiance to their respective mother cities, Roman citizenship conveyed rights that were uniform anywhere in the empire, and the presence of dispersed Roman architecture symbolized this unity.

Unlike Egyptian architecture, which focused on the next world, Roman architecture focused on the here and now. Roman buildings, like the more elemental Greek buildings that influenced them, addressed not the mysteries of the hereafter but the problems and civic needs of the present. Roman structures were visually and intellectually comprehensible, composed of parts that had recognizable proportional relationships and clear connections. Having found a new and pliable material in concrete, Roman architects discovered ways of shaping and playing with space, of molding light and shadow—discoveries that have repeatedly inspired architects ever since.

12.27. Temple of Venus, Baalbek, Lebanon, third century CE. Seen from the rear, the components of the Corinthian order are bent and curved in total contradiction to their origins as a linear post and beam system; here they have been transformed into sculptural forms, an example of Roman "Baroque" architecture. Photo: From T. Wiegand, Baalbek*, vol. 2 (Berlin, 1923–1925).*

After the second century CE the *Pax Romana* gradually disintegrated before the pressure of barbarian tribes at the borders of the empire, eager to be accepted and granted citizenship either willingly or by force. Diocletian attempted to facilitate administration by dividing the empire into two halves in 285, but his short-lived success relied on political ruthlessness. After his death, the disintegration continued and central authority virtually collapsed, with multiple rival emperors until Constantine gradually defeated them and restored order in 312. But when Constantine then relocated his imperial capital to the New Rome (Constantinople) far to the east, the light of Classical learning slowly dimmed and was nearly snuffed out in Western Europe. The glory that had been pagan imperial Rome was transported to Constantine's new Christian Rome being built at Byzantium.

IN-1. Angkor Wat, Angkor, Siem Reap Province, Cambodia, begun c. 1120 CE. At the very center of this vast temple complex rises this tall stone tower, an allegory of the mythical Mount Mehru, the home of the gods. Photo: SEF/Art Resource, NY.

ESSAY 1

Indian Architecture

Exactly when interactions first began between early cultures, in what we now call the West and those described as being in the East, is difficult to say. Evidence shows that, four thousand years ago (2000 BCE), nephrite jade was being carried east from deep in central Asia to what would become China, and by 500 BCE Chinese silks were being taken west by Persian caravans along what would later be called the Silk Road. That overland caravan trade route was certainly busily in operation by the first century BCE; one bit of intriguing evidence in the biblical Book of Esther is mention of dispatches being sent and received by the Persians from India and the Kingdom of Kush.

India was perhaps the first of the great Asian cultures to have interactions with the West, beginning in 530 BCE when the forces of Darius, emperor of the Achaemenoid (Persian) Empire, expanded his realm over the Hindu-Kush mountains into what is now Pakistan and then pushed further east to the Indus River. Two centuries later, Alexander the Great conquered the Persians and added that empire to his own, maintaining the boundary at the Indus and Beas Rivers. Subsequent interactions brought Hellenic sculpture to India, where it influenced Gandaran art. But how much influence may have moved in the opposite direction to Alexandrian Greece is not clear, though Chinese silks were being transported west. The Roman historian Strabo records that the Greco-Bactrian kings in what is now Afghanistan and Pakistan had made contact by 200 BCE with the Chinese in the region of what is now called Chinese Turkestan, thus establishing the first recorded direct contact between West and East.

By the time Augustus had added Egypt to the Roman Empire in 30 BCE, Chinese silks were regularly being shipped from India to Egypt and then on to Rome. In fact, by the first century CE, the fad for silk had grown so intense, and the outflow of Roman gold and silver in payment so large, that the Roman Senate passed laws forbidding the wearing of silk. Throughout the lifetime of the Roman Empire, regular trade in silks, spices, and other goods continued, transported in Arab and Roman ships around Arabia to Indian ports and by land over the Silk Road. Although knowledge of Indian culture and architecture itself may not have extended to the Roman world, the existence of its luxury goods did.

By the time of the maximum extent of the Roman Empire (the first and second centuries in the common era), Indian culture was already as ancient as those of Mesopotamia or Egypt. Early hominid tools extending back 2 million years have been found in the northwestern part of the Indian subcontinent, and evidence of what appear to be the earliest semi-permanent human shelters, dating back to nine thousand years ago, have been found in Madhya Pradesh. During the Bronze Age, an agricultural society began to emerge in about 5000 BCE on the Indus River, producing large urban settlements that flourished from around 3300 to 1500 BCE at such locations as Harappa and Mohenjo-daro. Eventually more than a thousand settlements were created in the Indus Valley, producing remarkable artwork and forms of writing whose translation is still debated.

About thirty-five hundred years ago, groups of Indo-Aryan invaders moved in from the north, bringing with them ascetic religious practices. From before 1700 to 500 BCE, an Indo-Aryan culture was established across northern India. A native Dravidian religion developed in this area, with emphasis on male and female fertility imagery. These ancient belief systems underlie Indian temple architecture today, combining abstract diagrammatic and symbolic plan arrangements overlaid with a profusion of luxuriant carvings portraying the numerous gods shown in episodes from their many stories, including depictions of rapturous transcendental male and female union.

Around twenty-six hundred years ago, three major religions developed in greater India—Hinduism, Jainism, and Buddhism—each with a variant belief in the transmigration of souls, reborn in new bodily form after death. The Hindu pantheon of numerous deities is associated with natural elements and events, symbolizing an ancient dual emphasis on the individual and the universal, so that both male and female attributes, the phallic *lingam* form and the corresponding female *yoni* imagery, were strongly developed. Hinduism, with its many elaborate rituals carried out by Brahmin priests, was rejected by both Jainism and Buddhism.

Starting with Siddhartha Gautama (c. 563–483 BCE), Buddhism seeks through meditation to quell and even eliminate human desire, thus offering release from pain and rebirth. Through intense and prolonged meditation, Siddhartha Gautama reached the state of being the "enlightened one," or Buddha. Spread throughout India and beyond by disciples and monks who emulated the Buddha's example, Buddhism rejected the elaborate Hindu rituals in favor of seeking release from the self with the extinction of desire, leading ultimately to a state of *nirvana.*

In Hindu belief the primordial world floated in a vast ocean, with the sacred Mount Mehru at its center consisting of five or six ascending levels or terraces. From this idea developed the concept of the gods residing in the mountains or in sacred caves; this led to the creation of temples as caves carved into the solid rock of cliff sides, the carved elements of the resulting shaped space inside recalling more ancient forms once built in wood. A good example is the Vishnu cave-temple carved out in the sixth century at Badami in Karnataka, southern India, a hall with many square columnar piers, oriented on a north-facing axis. Another is the cave-temple at Karli dating from roughly 100 BCE (discussed in Chapter 1, Figure 1.13).

Two axes typically govern Hindu temple architecture: a horizontal ground-plane axial system oriented to the cardinal directions, most often facing east; and a towering mass marking a vertical axis. This dominant vertical mass, the *shikhara,* represents the sacred mountain; it rises in progressively higher masses that are gently rounded at the top. The enormously thick masonry walls of the base enclose a small internal chamber, the sacred cave-womb space, *garbhagriha.* Leading up to the *garbhagriha* are several chambers, aligned on the principal east-facing axis, surrounded by columnar porches, the entire complex set on a tall plinth or base, the *mandapa.* This type of northern Indian temple is well represented by the Kandariya Mahadeva temple at Khajuraho, built in about 1025–1050 in the Madhya Pradesh region of north-central India, whose rising, slightly parabolically curved *shikhara,* in the quintessential mountain profile, appears as bundled layers [IN-2].

Hinduism was carried north, east, and south from India, so that temples are found in Nepal, Bhutan, Suriname, Sri Lanka, and Indonesia. The largest religious complex ever built in Asia is the famous Hindu temple, Angkor Wat, Cambodia (the modern name means "City Temple"). Begun around 1120 CE as a temple to Vishnu by Suryavarman II, the Khmer ruler, the complex—built entirely of sandstone—is also a shrine to its creator. Angkor Wat was about .93 mile (1.5 km) south of the ancient Khmer capitol city of Angkor Thom, which was set inside a square protective moat and wall nearly 1.86 miles (3 km) on each side. Virtually all the enclosures and walls in the entire district including Angkor Thom and Angkor Wat are perfectly aligned to solar east-west and true north. The enormous Angkor Wat temple complex is, in essence, a series of nested rectangular areas all set inside a broad encircling moat measuring 1.2 miles (1.9 km) in length, east to west, and just over a mile (1.7 km) in width, north to south; the moat itself is nearly 656 feet (200 m) wide. Inside the moat is a broad platform measuring roughly 4,920 feet (1,500 m) long east to west and 4,265 feet (1300 m) wide north to south. The principal entrance to the temple is from the west side through a *gopura* or gate lodge that echoes the form of the distant main temple at the center. From this *gopura* gate stretches a broad elevated causeway extending nearly 1,150 feet (350 m) to the entrance to the lowest platform of the central temple. This first temple platform measures 660 by 540 feet (200 by 167 m) and is encircled by a roofed gallery. The middle terrace measures about 376 by 314 feet (115 by 96 m). In the center is the upper-most third terrace measuring roughly 174 feet (53 m) square. Four tall towers mark the four corners of the temple, with central axial colonnaded links connecting to the soaring center-most tower, the focus of the

IN-2. Kandariya Mahadeva Temple, Khajuraho, Madhya Pradesh, India, c. 1025–1050 CE. The highest tower, at the rear of the temple, the shikhara, *represents the mythical Mount Mehru. Photo: © DeA Picture Library/Art Resource, NY.*

entire complex, rising 215 feet (65.5 m). This commanding central tower represents the home of the Hindu gods, Mount Meru [IN-1]. The dimension numbers given here in approximate modern units suggest that a local Khmer cubit module was used (measuring roughly 43.55 cm), yielding groups of multiple dimension measurements rich in Khmer symbolism. The precise solar alignment thus enriches the significance of the measurement dimensions, incorporating important numbers in the ancient Khmer solar and lunar time cycles [IN-3].

Jainism, like Buddhism, turned away from the elaborate rituals of Hinduism, substituting extreme personal asceticism and a profound respect for all animal life. Because of this religious emphasis, no notable unique architectural forms were created for this faith. Jain temples appear remarkably like Hindu models.

As for Buddhism, there are no significant remaining Buddhist temples in India, since the Buddha himself established no formal organized worship nor any official organization to spread his teaching. Any physical structures of Buddhist worship in India disappeared when Buddhism was later rigorously suppressed. The elements of Indian Buddhist architecture survive better in examples based on Indian prototypes but are built in places to which Buddhism was carried, such as Sri Lanka and Cambodia. Once carried over the Himalayas, perhaps as early as 265 BCE, Buddhism flourished in China, alongside the older Daoism and Confucianism. From China, Buddhism was later carried to Japan—perhaps as early as 250 BCE but officially in 552 CE—where it thrived and coexisted with the native Shinto religious practices. It is in these last two countries that Buddhist temples particularly developed, though built in ways that drew on local traditions (they are discussed in other essays).

IN-3. Angkor Wat, Angkor, Siem Reap Province, Cambodia, begun c. 1120 CE. With the spread of Hinduism beyond India, temples and temple compounds were built elsewhere; this large symmetrical complex (overall, the largest religious complex in the world, measuring nearly 4,921 by 4,265 feet [1500 by 1300 m]) was both a temple and a shrine to its builder. SEF/Art Resource, NY.

IN-4. The Great Stupa, Sanchi, Madhya Pradesh, India, 273–236 BCE. Built as a shrine where a portion of the Buddha's remains were believed to have been deposited, such a stupa would be a pilgrimage site. Photo: © Robert Harding Picture Library Ltd/Alamy.

One building type that developed under Buddhism, the *stupa,* remains well represented by a surviving example in India, however. Following the Buddha's death, his ashes were divided into ten parts, which were carried to places associated with his life and teaching. There portions of his ashes were buried in mounds inspired by the small mounded village memorials or *chaityas* traditionally built over the remains of deceased revered leaders. The Buddhist stupa, however, is typically a large domed mound covered with stone that represents the dome of heaven; it is enclosed by circular walkways for circumambulation and defined by encircling stone fences (revealing their original inspiration from wooden fences), punctuated by large gates positioned in the cardinal directions representing the winds. The finest Buddhist example remaining in India is the Great Stupa at Sanchi in the Madhya Pradesh, begun by the Indian ruler Ashoka (sometimes spelled Asoka) between 273 and 236 BCE [IN-4]. This stupa was part of a larger precinct that over time came to include fifty-one temples, numerous smaller stupas, and freestanding columns. The size of the great stupa dome is 120 feet (36.6 m) in diameter, rising 54 feet (1.5 m). Atop the dome is a square platform with railing (*harmika*) symbolizing an altar, and a spire-like form (*chattra*), an *axis mundi* that resembles superimposed parasols. These layered elements represent the stages of enlightenment achieved by Buddha as well as symbolizing the *bodhi* tree under which the Buddha achieved his final enlightenment. As Buddhism spread eastward, this crowning *chattra* form is believed to have been the inspiration for the development of the Chinese pagoda tower (the name for which derives from the Indian Sanskrit *dagoba* for stupa), as well as the Japanese pagoda counterpart.

While Buddhism expanded across southeast Asia in the following centuries, its long decline in India began with invasions from the north, the loss of support from rival Hindu political leaders, and finally the series of Muslim invasions from the northwest, beginning in the seventh century CE and culminating in the establishment in Delhi of the political center of the Mughal

Empire (also spelled Mogul and Moghul) in northern India under Babur and his grandson, Shah Jahan. The arrival of Islam significantly changed the architecture of northern India and is superbly represented by the tomb that Shah Jahan built for his third wife—the Taj Mahal, 1632–1648 (discussed in the essay on Islamic architecture). Ironically, by the nineteenth century, Buddhism was essentially extinct in India, the land of its birth.

Like Africa, India was colonized by the British. Most ironically, with the local disappearance of Buddhism, the Indians themselves had allowed the Sanchi Stupa to become seriously deteriorated; it was the British who undertook its restoration. Operated from 1757 by the British East India Company as a kind of private colony, greater India (including today's Pakistan, Bangladesh, and Burma/Myanmar) became an official crown colony in 1858, governed by a viceroy from the capital of New Delhi through a bureaucratic system staffed by educated Indians that came to be called the British Raj. India occupied a special position in the British Empire; it was metaphorically called the jewel in Queen Victoria's crown. With the British came the full impact of Victorian industrialization. A railroad network was built throughout the country, dotted with new British-built railway stations. One city significantly affected by this industrialization is Mumbai (called Bombay during the colonial period); it is filled with British-designed public and governmental buildings, nearly all of which are still in service.

Britain was greatly influenced by contact with India. Many businessmen sent to India by the British East India Company did well there, returning to England after their active business careers and bringing with them Indian servants and a taste for things Indian, including its spiced cuisine. One notable example was Sir Charles Cockerell, who had made a fortune in India and hired his brother, architect Samuel Pepys Cockerell, to build a large country house called Sezencote, Gloustershire (1805–1820). It was a romantic blend of late Georgian English forms embellished with an onion dome and *chattras* atop the corners, set in a gently rolling English Garden Park. This building in turned inspired the young Prince of Wales (George IV) to build the even more fantastical Royal Pavilion at Brighton, on the sea (1811–1822), a Mughal-inspired confection of multi-lobed arches and onion domes small and large, built under architect John Nash. Seldom has a colony so influenced the architecture of its governing people, much less buildings done for a future king.

Of the various building undertakings of the British in their many far-flung imperial possessions, none reached the level of imposing architectural solemnity, combined with references to local indigenous architecture, as in their creation of the new center of the British Raj in New Delhi, built adjacent to ancient Delhi. Designed by the preeminent British architect of the day, Edwin Lutyens, New Delhi was to replace Calcutta as the political center of British Indian government. The New Delhi project (initiated in 1912, completed in 1931) was a model of axial organization; during this extended building process, Lutyens was knighted. How Sir Edwin brought together modified Western classical design methods and forms with native Indian elements is discussed in Chapter 19 [pp. 562–563].

The doctrinal and political friction between Muslims and Hindus, strenuously controlled under British colonial rule, so threatened to turn into brutal civil war once the British turned over control in 1947 that India was partitioned, creating the new Muslim nations of Pakistan, Bangladesh, and Burma (later Myanmar), separate from Hindu India. Now independent, many of the new countries turned to European and American architects for their new capitol buildings, including the Indian state of Punjab, which engaged architect Le Corbusier; his Secretariat and High Court buildings are discussed in Chapters 4 and 6[1] [420, 6.1, 6.11]. Bengal (first called East Pakistan and then Bangladesh) selected American architect Louis I. Kahn to design its new National Parliament in Dacca (Dhaka) (1964–1982).[2] Officially titled the Jatiyo Sangsad Bhaban at Sher-e-Bangla Nagar, the massive monumental building of cast concrete with inset marble strips is a study of arranged and linked geometric forms—circles and squares—positioned on crossed perpendicular and diagonal axes, all reflexively symmetrical, except on the west side of the building where a planned mosque was aligned to point to Mecca.

Many younger architects in India were strongly influenced by Kahn's powerfully evocative work, including Balkrishna Doshi, who worked closely with Kahn on his Indian Institute of Management, Ahmedabad (1962). Like many perceptive architects from colonized areas, Doshi melded the best ideas of Western architects with whom they studied or worked with what they learned from the building traditions and forms of their native lands. One example of this fusion is Doshi's Gandhi Labour Institute, Ahmedabad (1980–1984), discussed in Chapter 20.

Arguably, of the many regions around the world brought together in the British Empire, India benefited most and best from this intercultural experience, retaining and using aspects of language, governmental structure, and the architectural legacy left by their former colonial governors.

13.20. Hagia Sophia, Istanbul, 532–537. Interior view. Photo: Erich Lessing/Art Resource, NY.

Chapter 13

Early Christian and Byzantine Architecture

The dome of Hagia Sophia was not there to mark an object of veneration, as domes did in martyria; . . . the thought of crowning Hagia Sophia with a dome related to the sanctity of the whole building as an earthly analogue to heaven. The visible universe was concretized in the Byzantine mind as a cube surmounted by a dome.

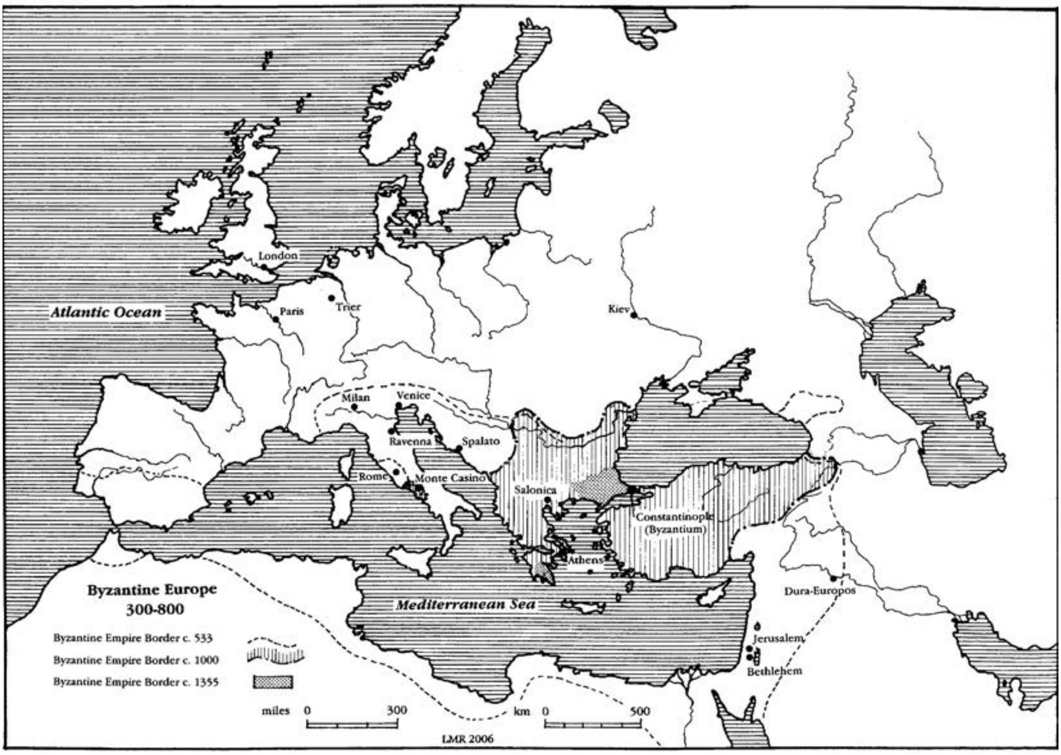
—*Spiro Kostof,* A History of Architecture*, 1985*

Roman life focused on temporal comforts and pleasures, as the Roman bath well illustrates. The bath was designed to serve the needs of the body in its pools and exercise gardens, to feed the mind in its libraries, and to reward the eyes in its vast molded spaces lined in multicolored marble brought from the far corners of the Roman Empire. After Constantine, however, this emphasis of Roman life on the here and now was gradually replaced with a very different concern for the hereafter through the influence of a new religion that reshaped the way Romans began to think about the world and themselves. Even as the Roman Empire began to come apart politically, it was being reshaped from within, so that the primary emphasis was no longer on secular concerns but on religious concerns. As a result, new building needs arose, necessitating new building types. Courts, administration buildings, and houses continued to be built as required, but real architectural innovation shifted to solving the problem of how to house communal groups of worshippers. This new church building, however, was at first not elaborate in form or detail, as the baths had been. Those external qualities of architecture that had appealed to a cultivated visual sensibility gradually were replaced by an architecture of simpler elements, fostering a sense of mysticism.

The Transformation of the Roman Empire

We sometimes speak of "the fall of the Roman Empire," as though, on a particular day, there was a sudden collapse. In fact, it was more a gradual transformation, occurring over more than a century, marking the change from a pagan empire to a Christian empire. Constantine's relocation of the entire imperial bureaucracy of the old Rome on the Tiber to the New Rome at the mouth of the Black Sea in 330 was symbolic of a number of sweeping changes in the Roman world. It was no longer the old Rome, as that term had been used before. The empire fashioned by Augustus and enlarged by Trajan had come apart, as the social cooperation and mutual trust that had enabled the empire to function were disappearing by the third century. Although numerically there were now more Roman citizens, they were no longer free but tied by law to the land or to their occupations. Along the length of the northern borders, Germanic tribes were pressing for admission into the empire, and they in turn were being pressed from behind by other tribes being driven west from deep in central Asia by the Huns. One by one, Germanic tribes were allowed across the borders, and although they provided excellent soldiers for the Roman army, the character of Rome and of its legions was meanwhile gradually changing [13.1].

The other change, and the one that had the most far-reaching effect, was the impact of the new religion that had sprung up in a backwater of the empire, in the rebellious and troublesome province of Palestine. At first a sect among the Jews, the new faith was quickly embraced by adherents in Asia Minor, Egypt, Greece, and the city of Rome itself. In roughly a century the religion spread from twelve disciples in Galilee to a tenth of the population in the Roman Empire, dramatically transforming the



13.1. Map of Europe, 300–850.

empire from within. This change in the hearts of the believers was so all-embracing that, when they went to carve the date of building on the walls of their new houses of worship, they used not the year of reign of the current emperor, as was typical for most Roman buildings, but the year of the lord to whom they owed a far deeper, more personal spiritual allegiance. They scratched "A.D." for *anno domini,* the year of the lord, reckoned from the date of birth of the son of a Judean Jewish carpenter. The force that was transforming the new Roman Empire was Christianity.

In 284, Diocletian found himself head of a splintering empire. Rent by a half-century of civil war, the empire was too big and too complex for one person to rule. He had divided the empire into east and west portions, setting up two co-equal emperors, each titled Augustus and each assisted by a subordinate Caesar designated as successor. Diocletian himself ruled the Eastern, Greek-speaking half of the empire, which consisted of Greece, Asia Minor, and Egypt; his co-emperor, Maximian, ruled the Latin-speaking half, which comprised Italy, Gaul, Africa, and Spain. The city of Rome ceased to be the western center of imperial rule, as the imperial seat was alternately at Trier, Germany, or in Milan; in the east, it was at Nicomedia, in northwest Turkey.

In 305, Diocletian abdicated and retired to the fortress-palace he had built for himself at Spalato (Split), on the Yugoslavian coast, forcing Maximian to step down as well. The two remaining Caesars soon faced other aspirants to the imperial throne, and civil war again erupted. In the West, the contest was now between Constantine in Trier and Maxentius in Rome. When Constantine marched on Rome in 312, Maxentius inexplicably left the safety of the city walls and confronted Constantine's army where the Via Flaminia crosses the Tiber on the Mulvian Bridge. Constantine's biographer, Eusebius, recorded that in a dream on the eve of battle, Constantine had a vision in which he saw a cross in the sky with the inscription *in hoc signo vince,* "in this sign conquer." He thereupon had the letters *chi* and *rho,* the first letters of the name *christos,* emblazoned on his soldiers' standards, and marched out to defeat Maxentius, becoming emperor in the West. From that date, Constantine embraced the Christian faith, becoming its champion and defender, and in 313, he issued the Edict of Milan, in which Christianity was given full equality with other religions in the empire (significantly, he himself was not a confirmed communicant and was not baptized until just before his death). He continued his struggle with the Eastern Caesars and, by 324, was sole ruler of a once-more-united Roman Empire.

The religion that Constantine now proclaimed had at first been given little notice in Rome, for there were so many mystery religions then being practiced in the empire. To understand the appeal of Christianity for first-century Romans, one needs to understand the life and teaching of Jesus of Nazareth.[1] The son of a carpenter, he was born in Bethlehem in Judea, in southern Palestine. Jesus studied Jewish scripture and, at about the age of thirty, began a career as an itinerant rabbi, or teacher. He preached brotherly love, charity, humility, and adherence to the spirit of Jewish law, but he enraged Jewish religious authorities by forgiving sins in the name of God, whom he called his Father. He strongly criticized hypocritical religious practices that outwardly adhered to the letter of Jewish law but promoted insensitivity to true human needs. Religious authorities were also infuriated that Jesus' followers believed him to be the *christos,* Greek for "the anointed," the promised Messiah, the son of God, who would deliver Israel from Roman rule. Instead of armed political revolt, Jesus preached personal spiritual renewal. Eventually, Jewish religious authorities forced the Roman governor, Pontius Pilate, to have Jesus crucified, a degrading form of execution usually reserved for state criminals. But on the third day after his death, Jesus' disciples believed, he rose from the dead and later ascended to heaven.

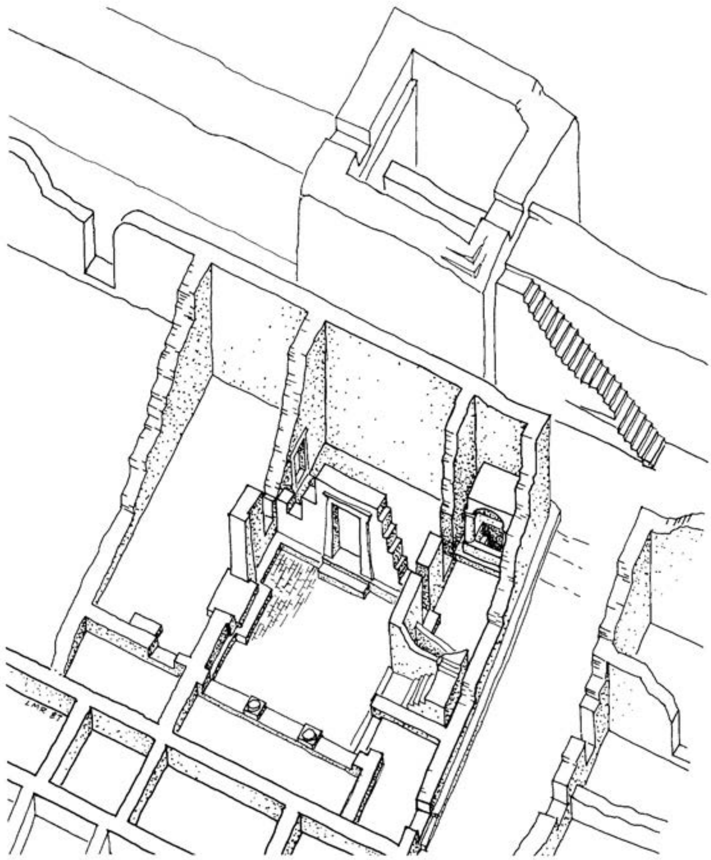
Initially, the followers of Jesus were Jews in Palestine. As Hellenized Jews from around the eastern Mediterranean came to Jerusalem for religious festivals, converts were made, since the teachings of Jesus fit well with late Classical Greek philosophy, particularly in his emphasis on a renewal of spirit and the nurturing of the soul rather than an endless search for purely physical gratification; Jesus' emphasis on personal moral rectitude fit nicely with the ideals of the Stoics. Soon, groups of these converted Hellenized Jews were found in Alexandria, in Egypt, and in most of the major cities of Asia Minor. The most important factor in spreading Christian teaching was the work and travels of Paul of Tarsus, a native of the city in Cilicia, in southwestern Turkey. A well-educated Jew, he was also a Roman citizen and thus able to travel freely to the early Christian communities in Asia Minor and Greece. The letters he wrote in Greek to these early churches quickly became sacred scripture for the early Christians. When Paul was arrested and about to be scourged, he reminded the centurion that it was unlawful to whip an uncharged Roman citizen; subsequently, when Paul was brought before the Roman governor, Felix, Paul claimed his right as a citizen to have his case heard by the emperor Nero. Accordingly, Paul was sent to Rome, where he joined Peter, one of the original apostles who had journeyed there. Both were later executed as criminals against the state when Nero began persecution of the Christians after the fire in 64.

At first, the teachings of Jesus appealed to slaves and artisans, those for whom the hardships of earthly life held little appeal and for whom a heavenly paradise was far more appealing, but gradually Roman patricians embraced the faith as well. By 200, numerous Christian communities had sprung up throughout Palestine, in Syria, over half of Asia Minor, in Greece, and in central Italy and Rome. Scattered groups also were located in Gaul and North Africa. By 400, parts of Spain were Christian, as was nearly all of Gaul, Italy, and Egypt. In another two centuries, Ireland was staunchly Christian, as was all of Spain, a large part of England, portions of North Africa, most of Yugoslavia and the Balkans, and all of Turkey and Armenia, stretching to the Caspian Sea.

As the early Christian churches proliferated, despite periodic suppression by Roman authorities, an early form of church organization developed, with volunteer *episkopoi,* overseers or bishops, supervising the congregations in a single city. There might also be *presbyters,* councils of elders. Eventually, the bishop of Rome was accorded primacy among the bishops in the Latin West, since it was believed that Peter had been the first bishop of Rome and had received his authority directly from Jesus. As Christ had said, "You are Peter [*petros* in Greek], and upon this rock [*petra* in Greek], I shall found my church."[2] The metropolitan bishop of Constantinople, who described himself as the Universal Patriarch, was accorded first rank among the Eastern, Greek-speaking Christians. This division between the two heads of the church, coupled with the difference in language, would in time also split the church itself.

Early Christian Architecture

During the early periods of persecution, Christians tried not to direct attention to themselves. They gathered quietly in the homes of fellow Christians, collecting donations to help those in their group who needed aid and sharing a communal meal of bread and wine to commemorate the supper that



13.2. Christian church, Dura-Europus, Syrian-Iraqi border, c. 230–232. In this Roman outpost city, a small Roman house was converted for the use of an early Christian congregation. Drawing: L. M. Roth, after M. Rostovtzeff.

Christ had shared with his disciples on the eve of his death. During this communion, the faithful believed that the spirit of the resurrected Christ was in their midst.

At first, there was no need for specialized architecture, for the small Christian groups adapted their worship to the available spaces in private homes. The church, or *ecclesia* (which in Greek means "the assembly"), was not a physical structure but the people themselves. Those who desired to become Christians could watch the first part of worship, but then had to withdraw to another room or to the peristyle of larger houses, while the confirmed celebrated the *agape,* "love feast," and the *eucharist,* "thanksgiving"; only those who had been ritually baptized could participate in the Mass of the Faithful. When the occasion demanded, as when Paul visited Ephesus, a hall might be rented.[3]

In the city of Dura-Europus, established by Alexander's army on the Euphrates River (now on the Syrian-Iraqi border), there was discovered one of oldest known Christian church buildings [13.2]. This house, built in about 230 adjacent to the town wall, was soon converted for the use of the congregation in about 231–232. As it happened, both this building and a nearby Jewish synagogue were preserved when the buildings were subsequently filled with earth to strengthen the wall during an attack by the Persians in 257. In modifying the house for church use, two rooms were merged by the removal of a wall, and another chamber was made into a baptistery with the construction of a small pool covered by a canopy on four columns.

As Christianity spread beyond the Jews along the length of the Mediterranean, variations in religious interpretation inevitably sprang up and the problem of heresy emerged. By 385, Christian leaders, only recently themselves the subject of imperial persecutions, began to order the death of Christian heretics. Such was the growing power of church authorities that in 390, Ambrose, Bishop of Milan, was able to excommunicate Emperor Theodosius and force him to rescind an imperial decree. Four years later, Theodosius banned pagan religions altogether, making Christianity the sole religion of the empire.

Constantine's Churches

Faced with the deteriorating political situation in the west and desiring to be closer to the threatened Danube frontier, Constantine had shifted the capital of the empire eastward. He selected the old Greek city of Byzantium, on a peninsula jutting into the Bosporus, the narrow neck of water that connects the Black Sea with the Sea of Marmara and the Aegean Sea—at the juncture of Asia and Europe. There, he built a new Christian capital city, free of the entrenched pagan traditions of old Rome, and filled it with new administrative buildings and churches. In 330, the entire mechanism of government was moved to this New Rome, which was now called Constantinople ("Constantine's City"). Constantine took an active role in church administration, personally determining church doctrine and policy. He saw himself as the earthly vicar of Christ the Eternal King, as is evident in the letter addressed to his bishops. In it, he admonished them to inform him promptly of divisions within the church, for "by them God may be moved not only against the human race, but also against me myself to whose care by His heavenly will He has entrusted the guidance of the affairs of earth."[4] He soon learned just how extensive those differences of interpretation were. In 325, only a year after he reunited the empire and made Christianity the favored imperial religion, he was obliged to call an ecumenical, or universal, Council at Nicaea to settle the question of the Arian heresy. The result of this council was the Nicene Creed, which all Christians thereafter were obliged to embrace.

With Christianity's shift from being a clandestinely practiced faith of comparatively few to the official state religion, from private, secreted worship to large congregational gatherings, there arose the problem of devising a building type appropriate both functionally and symbolically for public worship. Unlike older religions, in which individuals made private offerings, Christianity was a congregational religion, with a liturgy (from the Greek *leitourgia,* "public service") in which the faithful gathered together as a communal body to offer gifts and share a common meal. The Christians required not only buildings that would accommodate large numbers of converts but also enclosed spaces that would facilitate hearing the spoken word and chanted psalms. Clearly, the ancient Roman temple form could not be used, for it was doubly unsuitable: first, it did not have broad internal spaces suitable for housing scores or hundreds of people, and second, it so thoroughly symbolized pagan gods and Roman emperor worship.

Constantine and church officials looked to secular public buildings, and the type they selected was the basilica [see 12.9, 12.10]. The basilica had originally been devised for public gatherings, and its symbolic connotation, having to do with the equitable administration of earthly justice, was positive. It was a simple matter to replace the small altar devoted to the emperor with one at which the Eucharist, or ritual communal meal, could be celebrated. Since the basilica was axial in spatial organization, that axis served to focus attention on the altar. The only real substantive change was shifting the entrance from the middle of the long sides to the end opposite the apse and altar.

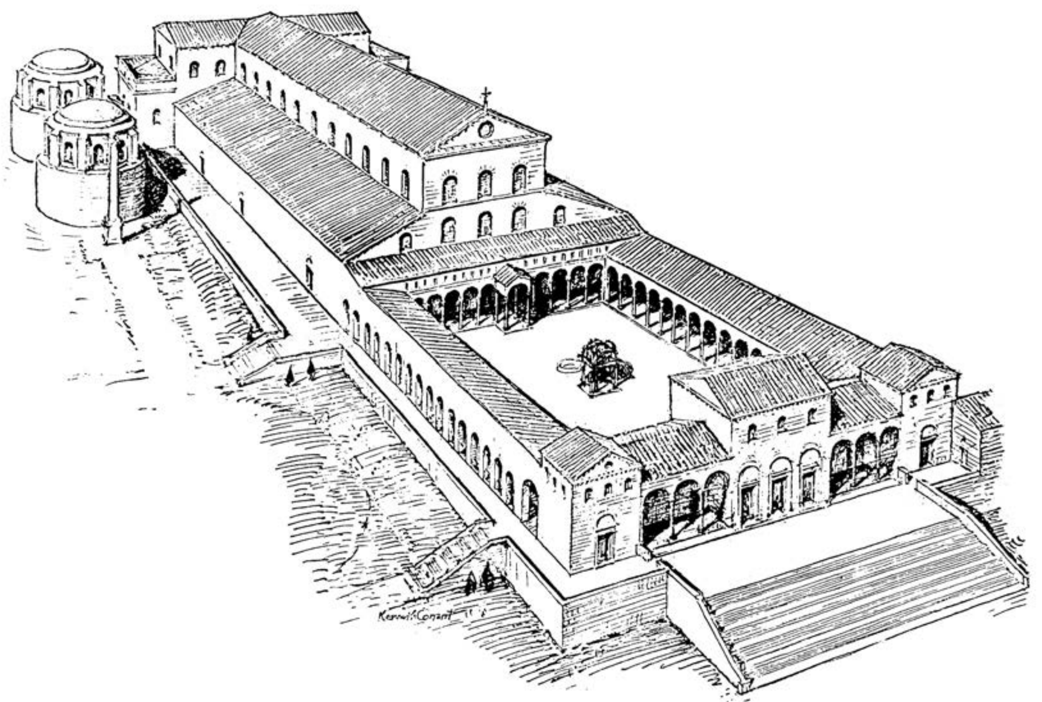
The other building type favored by the early Christians had a centralized plan, whether round, octagonal, or square, and was derived from royal tombs; the octagonal tomb Diocletian built for himself in his palace compound at Spalato is an example. The centralized plan was also derived from the pagan *heroa,* a building commemorating the deeds of a divinity or the deceased member of a prominent family. Early Christians began to employ this form for *martyria,* structures marking the place of suffering or execution of a martyr, and also for burial mausoleums of prominent Christians. A passage from Revelation provided the basis for this practice: "And when he had opened the fifth seal, I saw under the altar the souls of them that were slain for the word of God, and for the testimony which they held."[5] Centralized buildings also came to be used for baptisteries, where believers symbolically died to their old life and rose renewed, reborn from the water; an octagon was the form used for the baptistery of the Lateran Basilica in Rome, the first baptistery in the city, built circa 315.

Constantine put the imperial treasury at the disposal of church officials in building numerous churches, particularly at the sites held most sacred by the Christians. In building major churches in Rome as well as in Palestine, he and his bishops gave direction to the later development of church architecture at both ends of the empire during the next thousand years. In Italy, basilican axial churches were favored, while in the East, centralized plans were favored. Almost immediately after officially recognizing Christianity, in 313, Constantine donated the imperial palace he had inherited, the former palatial residence of the Laterani family in Rome, for the residence of the bishop of Rome. Soon thereafter, construction on the cathedral began next to the palace. The new building would be dedicated to Saint John, or San Giovanni in Laterano. The term *basilica* refers first to a public gathering place and only second to a particular form of public building. *Cathedral,* however, means specifically a church containing the official chair of the bishop, the *cathedra,* from which official pronouncements are made "from the chair," *ex cathedra;* hence, a basilica may be a cathedral but that is not always the case.

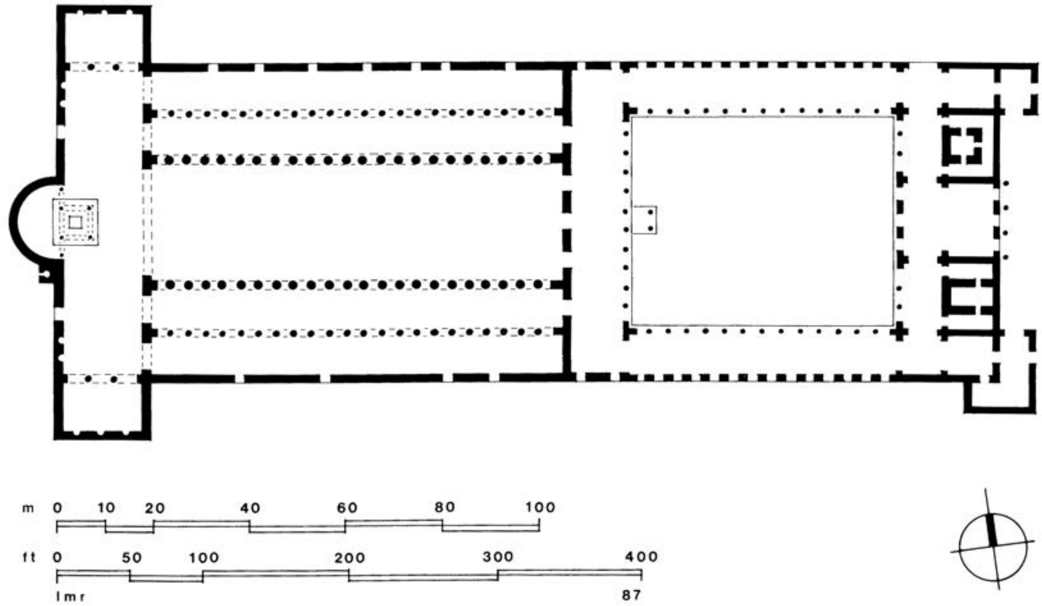
The Lateran cathedral, as the principal parish church of Rome, was large, measuring about 245 feet (75 m) in length and 180 feet (55 m) in width. It could hold several thousand worshippers. Unfortunately, it was extensively rebuilt in the seventeenth and nineteenth centuries, and little of the Constantinian building remains.

The other major Constantinian church in Rome was the Basilica of Saint Peter, built outside the walls of the city on the Vatican Hill, in an area that had formerly been a cemetery, next to the remains of the Circus of Nero. It was in this circus, according to tradition, that Peter had been crucified and then hastily buried nearby. The place of his interment was soon venerated, and it was over this martyrium that the Constantinian church was built, begun about 319–322 and finished about 329 (the forecourt atrium probably not until 390). It was an immense basilica, rivaling the Basilica Ulpia in size [13.3, 13.4]. The principal portion, the nave of the basilica, was 301 feet (92 m) long; along the sides ran two aisles, making the total width 216 feet (65.9 m).[6] The nave rose in a clerestory pierced with many tall windows to a ceiling height of 104.5 feet (31.8 m); thus, the ceiling was almost exactly half as high as the building was wide. Attached to the nave at the west end was a cross arm, or transept, 297 feet (90.7 m) long and 69 feet (21 m) wide, giving the plan of the basilica the form of a T. (The resemblance of such a basilican form to that of a cross became deeply symbolic for these early Christians.) From the center of the transept extended a semicircular apse capped by a half-dome; the apse was centered directly over the tomb of Peter and thus served as a martyrium. Unlike the Lateran basilica, Saint Peter's was a pilgrimage church, and although not used for services every day, it needed to be extremely large to accommodate crowds on special festival days.

Saint Peter's and other early churches were clearly derived from the great imperial basilicas, but additional modifications were necessitated by the special needs of Christian worship. The secular basilicas for hearing litigation had been entered



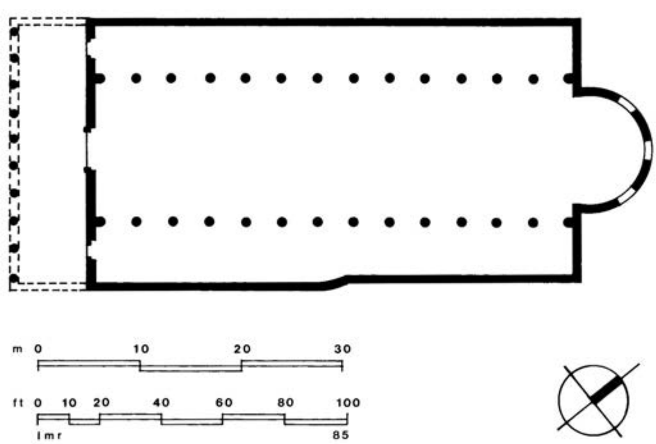
13.3. Basilica of Saint Peter (Old Saint Peter's), Rome, Italy, 319–329. Aerial perspective. One of the largest basilicas in Rome, this was built by Constantine over the spot where Saint Peter was believed to have been buried after his martyrdom. Drawing: Kenneth J. Conant; courtesy, Loeb Library, Harvard University.



13.4. Old Saint Peter's. Plan. Drawing: L. M. Roth.

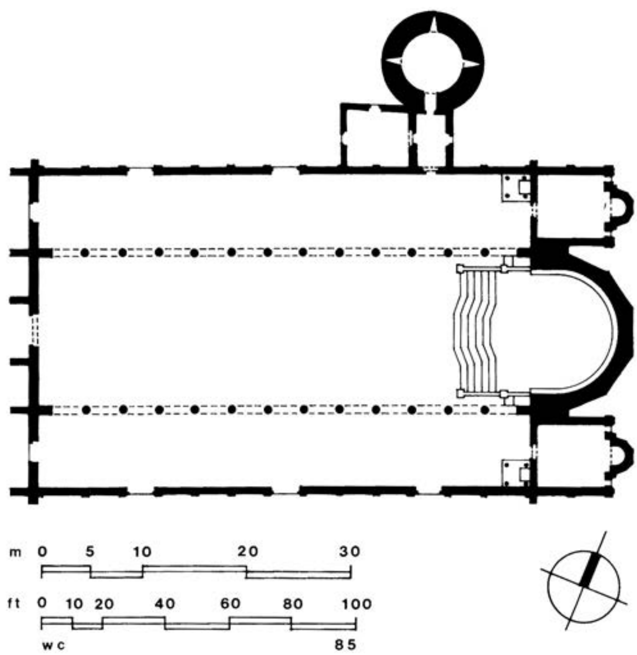
from the middle of the long sides. In the new church basilicas, entry was from one end, where a vestibule, or narthex, was created, with the altar placed at the far end in the semicircular apse. Outside, preceding the narthex, a large atrium forecourt ringed with colonnades was added where the unbaptized withdrew during the Mass of the Faithful. At Saint Peter's, entrance to the atrium was through an imposing propylon or gate. Including the narthex and atrium, the total length of Saint Peter's was 669 feet (203.9 m) from transept to propylon.

Subsequent churches in Italy and other parts of the West tended to follow the pattern provided by the Constantinian basilicas. An example is Santa Sabina on the Aventine Hill, Rome, built 422–432 [13.5]. Another well-preserved example is San Apollinare, in Classe, the harbor town of Ravenna; this church was built around 532–549 and was paid for largely by the financier Julianus Argentarius (the freestanding *campanile,* or bell tower, is of a later date) [13.6, 13.7, 13.8, Plate 7]. The church has seen some changes over time; the floor of the apse was raised to allow for a crypt below, and some of the marble veneer of the interior has been removed. Nevertheless, the Corinthian arcade of veined Hymettos marble from Greece and the



13.5. Santa Sabina, Rome, Italy, 422–432. Plan. This is a good example of the small, basilica-plan Christian churches built throughout the city once Christianity became established as the state religion. Drawing: L. M. Roth.

13.6. San Apollinare in Classe, outside Ravenna, Italy, c. 531–549. Aerial view. The freestanding bell tower (campanile) is of a later date. Photo: Alinari/Art Resource, New York.



13.7. San Apollinare in Classe. Plan. Drawing: W. Chin.

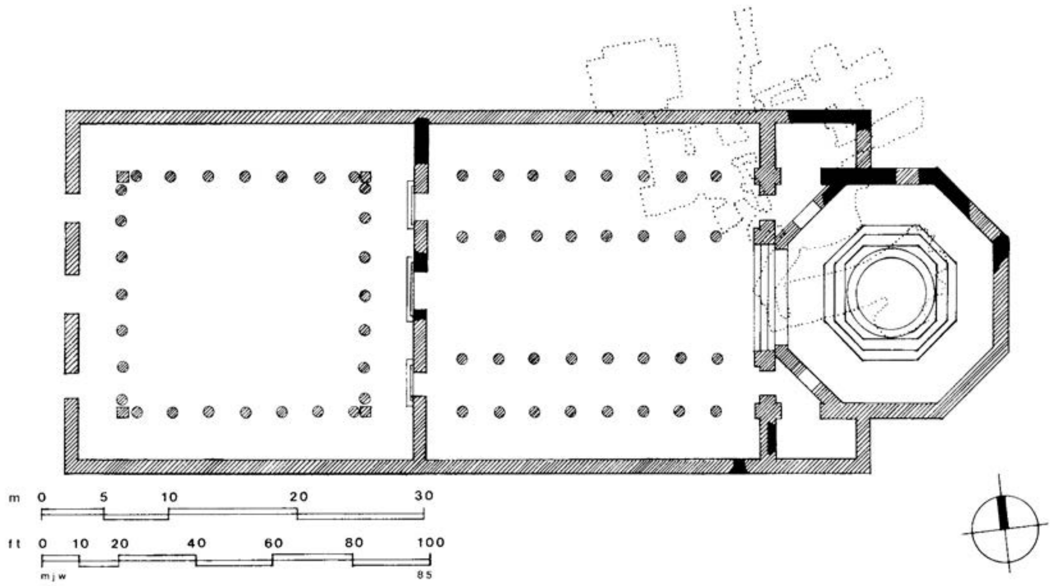
13.8. San Apollinare in Classe. Interior, looking toward the altar. Photo: Scala/Art Resource, NY.

sparkling mosaics in the apse illustrate the reach of Byzantine influence when the church was built and when Ravenna was the capital of the emperor's Western governor, or *exarch*.

In the Eastern part of Constantine's empire, new churches took a slightly different form, representing centralized martyria, the buildings erected on the spots associated with the life and death of Christ. Constantine's mother, Helena, a devout Christian long before her son's conversion, had made a pilgrimage to Palestine to retrace Christ's steps. She discovered what were believed to be the stable cave in Bethlehem, where he had been born, and the hill of Golgotha in Jerusalem, where he had been crucified.

In 326, Constantine resolved to build a church over the Bethlehem grotto, the Church of the Nativity, and although that building was replaced by another in the sixth century, enough remains to suggest the general outline of Constantine's church, finished in 333 [13.9]. Like the early churches in the West, it had an atrium (roughly 148 by 92 feet, or 45 by 28 m) for the reception of the unbaptized and a basilica with side aisles (in all, 95 by 93 feet, or 29 by 28.3 m) for the assembly of the faithful. Instead of having a transept and a small apse, however, the church terminated in a large, domed octagon, with an opening in the floor through which pilgrims could look down into the cave believed to be Christ's birthplace.

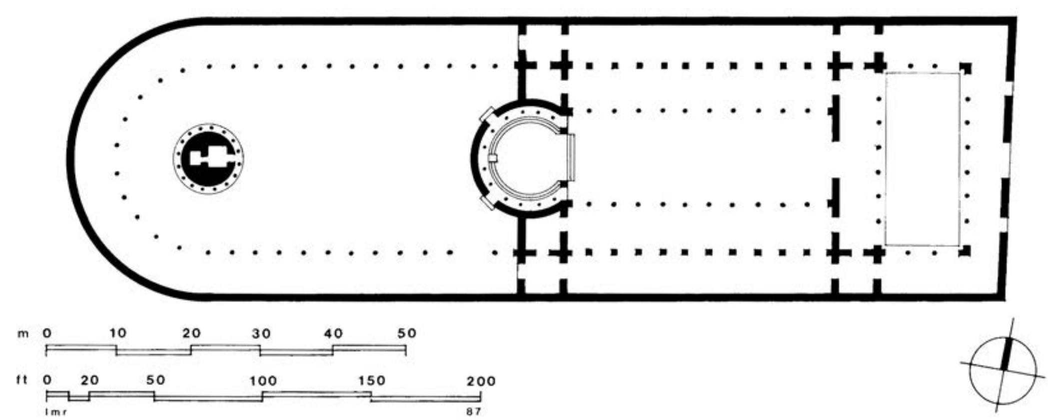
Even more imperial attention was given to the church complex covering the sites of Christ's death, burial, and resurrection in Jerusalem. In an official imperial decree of 325, Constantine ordered that there be built in Jerusalem "a basilica more beautiful than any on earth."[7] The architect appears to have been Zenobius, working from general plans possibly sent from Constantinople; construction began about 326 and led to dedication in 384 [13.10]. The church had a compact atrium court, nave, and two side aisles, but ended in a unique "apse" consisting of an almost completely circular structure lined by twelve columns, symbolic of the twelve apostles, supporting a dome. The focal point of this centralized feature was directly over where the remains of the cross had been unearthed by Constantine's mother, Helena. A short distance west of the apse of the basilica was a rock cube—the cut-down remains of the hill of Golgotha—surrounded by a large, atrium-like court ending in a hemicycle. At



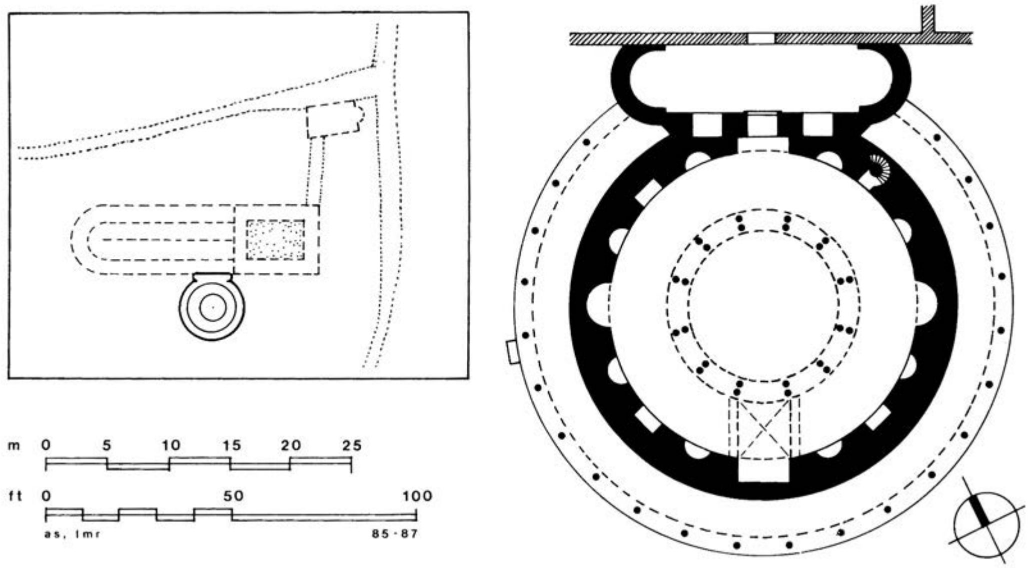
13.9. Church of the Nativity, Bethlehem, Israel, c. 326–333. Plan. Although it was completely rebuilt in the sixth century, sufficient traces of the original church survive to enable reconstruction of the approximate Constantinian plan, with an octagon over the cave where Christ was believed to have been born. Drawing: M. Waterman.

the center of the hemicycle, wrapped around the remains of the tomb, were twelve encircling columns. During 350–380, this martyrium over the tomb was replaced by the much larger Anastasis Dome, a rotunda 55 feet (16.8 m) in diameter and three stories high.

Centralized structures were used for Christian mausoleums in the West as well. One example in Rome, the mausoleum of Constantine's daughter Constantina, survives in excellent condition [13.11, 13.12, 13.13]. It had become the practice for the faithful to build their tombs as close as possible to spots associated with the early martyrs; the mausoleum of Constantine himself was attached to the side of the basilica of Saints Marcellinus and Peter in Rome. Constantina's tomb was built about 350



13.10. Zenobius (architect), Church of the Holy Sepulcher, Jerusalem, Israel, 325–336. Plan. This complex building covered the sites where Christ was believed to have died and been buried. The circular apse of the basilica was centered over where remains of the cross were believed to have been found, and the round structure surrounded the tomb. Drawing: M. Waterman.



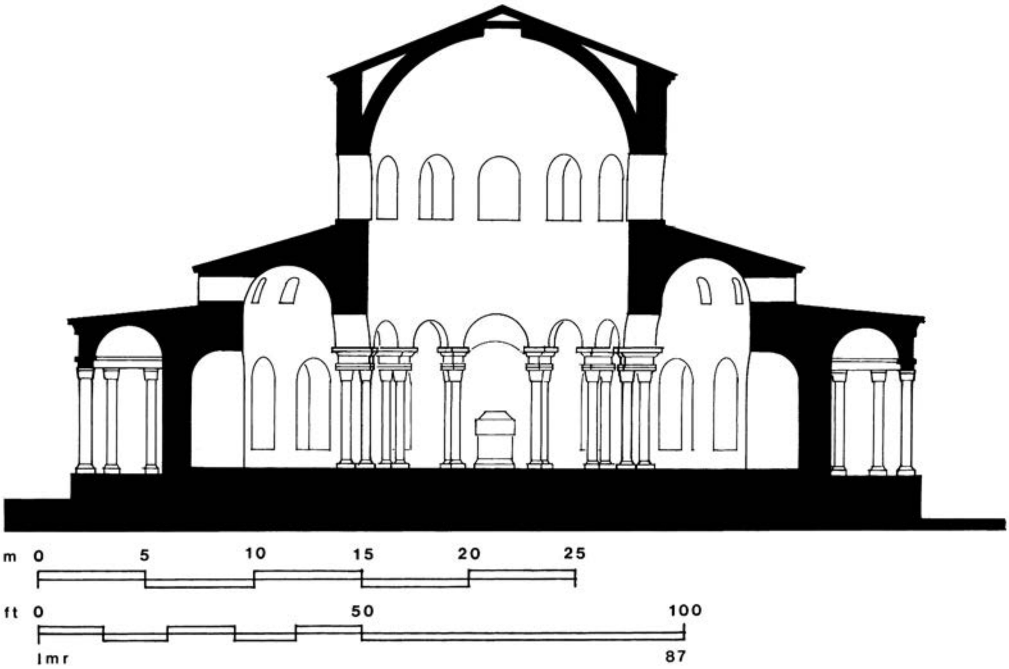
13.11. Mausoleum of Constantina (Santa Costanza), Rome, Italy, 350. Plan. The inset shows the location of the mausoleum adjoining the Church of Sant' Agnese. The large square niche opposite the entrance originally held the sarcophagus of Constantina. Drawing: L. M. Roth.

against the side aisle of the Church of Sant' Agnese (Saint Agnes), outside the walls of Rome, a typical basilican church after the pattern of the Lateran and Saint Peter's. The Church of Sant' Agnese itself is now gone, so that the tomb, later dedicated as the Church of Santa Costanza, now stands isolated. At its center, the building is a tall cylinder, 40 feet (12.2 m) in diameter, pierced at the top by twelve large windows and capped by a dome. This cylinder is raised on twelve pairs of columns reused from a pagan building. Around this is an ambulatory covered by a circular, or annular, barrel vault decorated with mosaics. The thick outer wall is hollowed out by niches, larger ones on the cross axes and a deep, square niche opposite the entrance to contain the sarcophagus of Constantina. Around the exterior is a circular colonnaded porch and a vestibule that once connected the mausoleum to the side wall of Sant' Agnese. The exterior, then as now, was exceedingly plain, whereas the interior was ablaze with mosaics and colored marble, characteristic of Constantinian buildings. External appearances of these early Christian buildings were of little consequence; the interior, like the soul, was the focus of concern.

The Movement of Peoples

By the time San Apollinare in Classe was built at Ravenna, the West had been overrun several times by Germanic peoples from the north, causing repeated political and economic upheavals. The first to arrive, in 376, were the Visigoths, who came from what is now Hungary, and after them, wave after wave of invaders pushed into Italy and across the Western empire. Having long lived next to the imperial borders, however, most of these groups were already converted to Christianity. So, although the invaders brought no change in religion, the political, social, and economic effects of these successive invasions were devastating. The city of Rome was besieged but never actually entered until the Visigoths, under Alaric, sacked Rome in 410; Virgil's inviolate "Eternal Rome" was no more.

The Visigoths eventually moved out of Italy and into what is now southern France and Spain. They were followed by the Vandals, who moved down from Poland through Italy, destroying nearly everything in their path (and lending to posterity their name for those who likewise engage in senseless destruction). They pillaged Rome in 455 and then pushed into Spain and across the Strait of Gibraltar into North Africa. After that the Ostrogoths, from southern Russia, moved into Italy, where they remained. In 476, the last Western Roman emperor was deposed by Odoacer, who set himself up as king of the Romans, a specious claim recognized nonetheless by the Eastern emperor. Finally, in 493, Theodoric established the kingdom of the Ostrogoths in Italy. Roman Gaul (what is now France), in the meantime, had become the new home of the



13.12. Mausoleum of Constantina (Santa Costanza). Section. Drawing: L. M. Roth.

13.13. Mausoleum of Constantina (Santa Costanza). Photo from Henry A. Millon, ed., Key Monuments of the History of Architecture *(New York, 1964).*

Franks, who moved in from the east and occupied northern Gaul, with the Burgundians in the south. Britain was overrun by the Angles and Saxons from Denmark. Only in the East, closer to the protection of the emperors in Constantinople, did the borders remain relatively firm. In the West, where there was no longer a central imperial administration, the glories of the Roman Empire became only a memory.

Yet, except for the Vandals, the invaders were far more affected by the people they ruled than the other way around. The invaders adopted Roman law, Roman civil administrative institutions, and the Christian religion. They attempted to speak a crude form of Latin, thereby gradually transforming their own languages into early medieval Italian, French, Spanish, and Romanian.

Monasticism

Classical literature did survive the invasions, in a fashion, first being used as texts in Christian schools and universities and then nurtured and protected by monastic copyists in a new institution that arose in the east, in Egypt. Toward the end of the third century, a Christian named Anthony retreated into the desert as a way of subduing evil spirits, thereby beginning the monastic movement. Groups of monks began to organize themselves into ordered communities in southern Egypt. During the mid-fourth century, Basil the Great established monasteries in the East, and an early form of monasticism was introduced in France by Martin of Tours. Finally, in the early sixth century, the basis of Western monastic communal life was provided by Benedict of Nursia in his *Rule for Monasteries*. In 529, Benedict established the mother of Western monasteries atop the hill at Monte Cassino in central Italy. In the monasteries that soon began to dot the European landscape, ancient manuscripts were stored, copied, and thus saved from the turmoil around them, to be rediscovered, recopied, and studied five hundred years later, when a new light of human reason began to challenge the orthodoxy of the Middle Ages.[8]

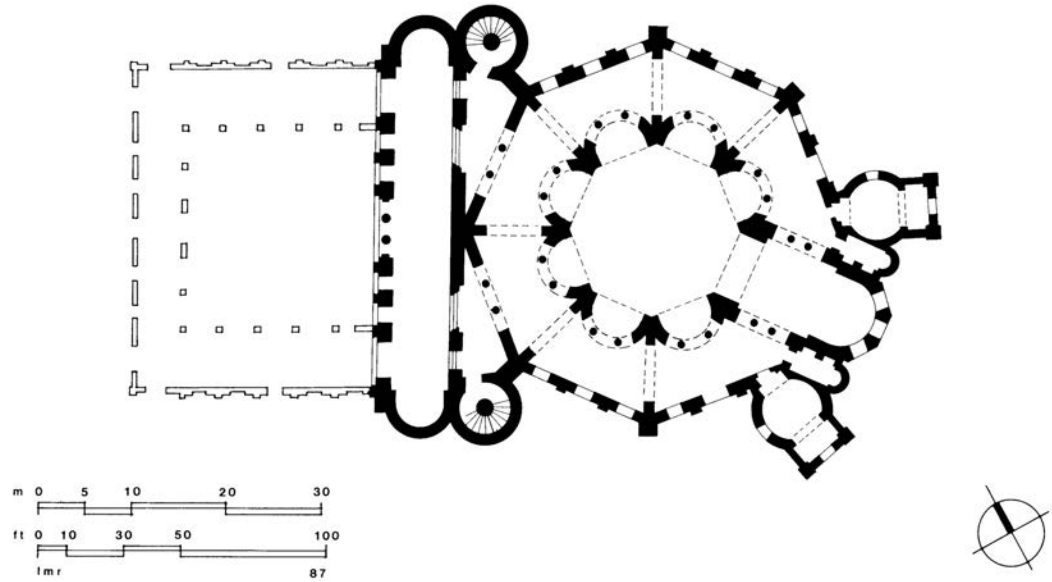
Byzantine Architecture

Once Constantine moved the political capital of the Roman Empire to Constantinople, state and church administration there tended to merge, resulting in what has been termed Caesaropapism, in which the imperial civil authority and control over the church became thoroughly intertwined. Meanwhile, in the West, political and church affairs were increasingly left to take care of themselves in the face of barbarian intrusion.

Justinian's Churches

The Roman Empire, in its new form in the East, achieved a new pinnacle of cultural and political importance during the reign of Justinian (483–565), who ascended to the throne in 527. Justinian came from peasant stock in Illyrium (Yugoslavia) and even late in life was said to speak poor Greek. His uncle, Justin, however, had become emperor in 518 following a military career, and it was he who brought Justinian to Constantinople and educated him. Justinian was given the title Caesar by his uncle, then was made co-emperor, and upon Justin's death, he became sole emperor. Justinian waged successful military campaigns against the Persians and also regained control of Italy and the coasts of North Africa and Spain, establishing an exarch (viceroy) at Ravenna in Italy, although the peninsula was taken over by the Lombards after Justinian's death. It was during the period of Byzantine expansion that some major churches in Italy were built, such as San Vitale and San Apollinare at Ravenna. Built in 532–548, San Vitale also has a double shell of two octagons, with an adjacent atrium, now destroyed [13.14, 13.15]. In San Vitale, the openings of the inner octagon push out in arcaded exedrae; over the octagonal clerestory in the center is a dome, 54.7 feet (16.7 m) in diameter.

Justinian's two most lasting achievements were the codification of Roman law and church building—the latter, in Constantinople at least, partly the result of the former. In 528, Justinian had set up a commission of legal scholars to draw up a new code of imperial enactments (published in 529), and then he turned to a codification of the entire body of Roman law. In 533, this codification produced the *Codex Justinianus,* which eventually became the basis of nearly all legal systems in Europe except in Britain. This legal codification was accompanied by attempts to root out corruption and abuses in the government, measures that were unpopular with some factions of the populace. Even before the completion of the Codex, as reforms were under way in 532, groups of citizens, disgruntled with the reforms and high taxes, rioted. Shouting "*Nika!*" (meaning "conqueror" or "win"), the mobs attacked and burned city offices, public buildings, part of the imperial palace, and the old church of Hagia Sophia (Holy Wisdom) adjacent to it. There was a momentary collapse of civil authority, and a rival emperor was elevated by the people. Bolstered by his wife, Theodora, Justinian stood firm, mustering what imperial troops were available and crushing the insurrection. When the struggle was over, thirty thousand people were dead in the streets.



13.14. San Vitale, Ravenna, Italy, 532–548. Plan. For this western provincial capital of the Byzantine Empire, Justinian built a variant on the octagon-dome scheme. Drawing: L. M. Roth, after Mango, Byzantine Architecture *(New York, 1977).*

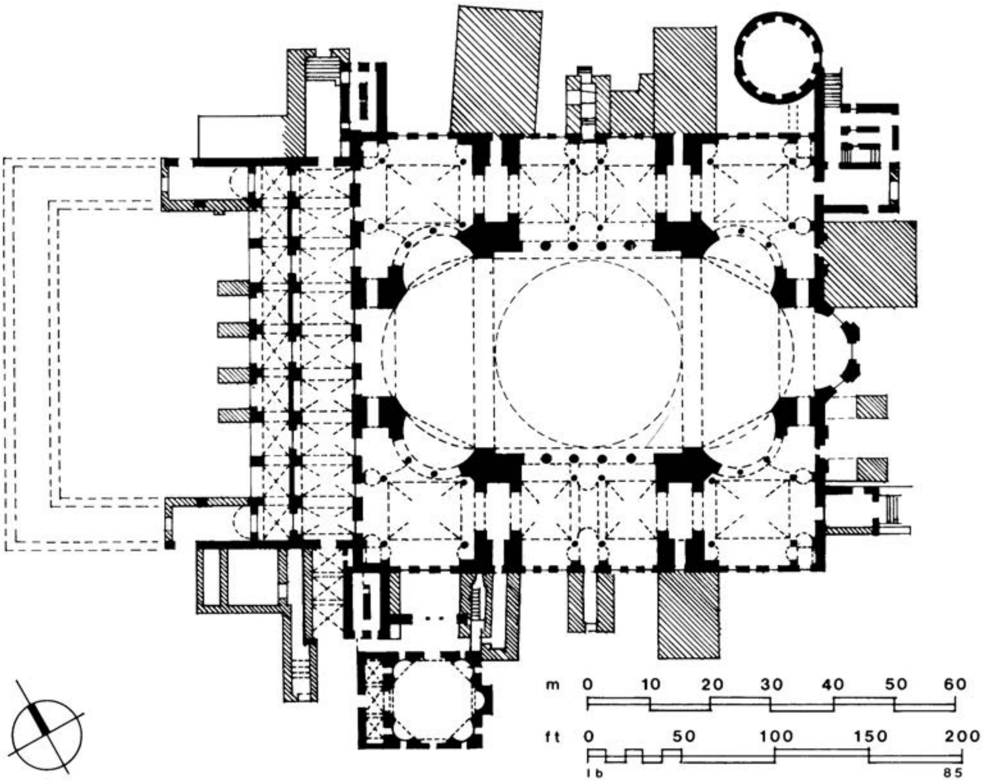
13.15. San Vitale. Interior. Photo: Cameraphoto Arte, Venice/Art Resource, NY.

Justinian then faced the task of restoring order and concord, as well as the challenge of rebuilding large parts of the city. He resolved immediately to rebuild Hagia Sophia as a monument to his rule and as a celebration of his victory. It was to be a centralized building on a vast scale. He had already built the Church of Saints Sergios and Bakchos, 527–532, on a constricted site near his former residence in Constantinople, the architects employing a double-shell plan arrangement, with piers forming an octagon inside an irregular square. A similar scheme had been used for the Church of San Vitale in Ravenna.

For the new Hagia Sophia, however, Justinian had in mind something much larger and more imposing than San Vitale. Instead of employing the usual master builder for the new Hagia Sophia, Justinian engaged two philosophers known for their studies in theoretical geometry. It is a testimonial to the lingering tradition of Classical Greek science that Anthemios should come from Tralles and Isidoros from Miletos, as both cities were centers of ancient Greek scientific investigation. Experts in theoretical physics and statics, only they could design the kind of ethereal, dematerialized building that Justinian wanted.

The new church filled a rectangle measuring 225 by 240 Byzantine feet (230 by 250 feet, or 71 by 77 m). This, too, was to be a double-shell building, for at the center was a square marked by four massive piers, 110 Byzantine feet (102 feet, or 31.1 m) to a side, capped by a dome carried on pendentives [13.16]. The plan was centralized but axial as well, for along the principal axis, the inner square was extended in deep semicircular apses rising to half-dome vaults below the main dome, and these apses were further extended by barrel-vaulted extensions on the axis and arcaded exedrae on the diagonals [13.17]. On the cross axis, the walls were flat and pierced with many windows [13.18, 13.19]. In fact, all the wall surfaces of the vast church were extensively pierced, with windows in the exterior walls and screens of arcades on all sides of the interior volume. Even the base of the dome was pierced, with forty windows between radiating ribs, so that Justinian's historian, Procopius, wrote that the dome "seems not to rest upon solid masonry, but to cover the space with its golden dome suspended from Heaven."[9] The remaining solid surfaces, such as the huge pendentives of the dome, measuring 60 feet across (18.3 m), were covered with mosaics with a gold-leaf background, and the lower interior was sheathed with white, green, blue, black, and other marbles from throughout the Byzantine Empire; dark-green marble columns in the aisles came from the Temple of Artemis at Ephesos, and the dark-red

13.16. Anthemios of Tralles and Isidoros of Miletos, Hagia Sophia (Church of Divine Wisdom), Istanbul, Turkey, 532–537. The minaret towers were added later when the church was converted into a mosque by the Turks who captured Constantinople. Photo: G. E. Kidder Smith, New York.



13.17. Hagia Sophia. Plan. This combines the central focus of domed Roman buildings with the directional focus of the Roman basilica. Drawing: L. Bier and L. M. Roth.

porphyry columns in each of the four exedrae had been removed from the Temple of Zeus at Baalbek. The reuse of materials from ancient temple buildings illustrates several points, one being the great ambition of Justinian but his comparative lack of resources once available to the ancients. Another is the powerful appeal of reconsecrating materials removed from pagan temples for new Christian churches. The conquest of the old pagan world was now complete.

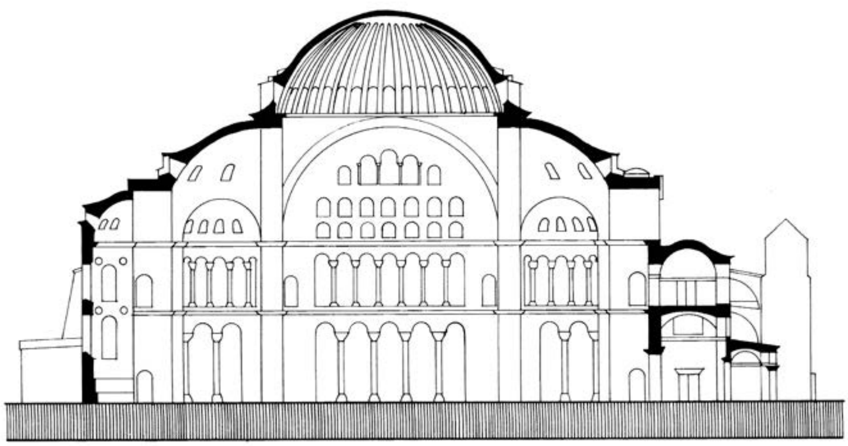
Hagia Sophia was a stupendous achievement—perilously balanced masses and shells of brickwork laced with stone reinforcement, lifted into the air. The central dome, although not as broad as that of the Pantheon in Rome, rises from a ring already elevated 120 feet (36.6 m) in the air, resulting in a total height of 180 feet (54.9 m), some 40 feet (12.2m) higher than the Pantheon [13.20, p. 282]. Hagia Sophia was a physical representation of the fusion of empire and church, for to the Byzantine mind, the cube surmounted by a dome was a model of the universe, the earth covered with the dome of heaven. Unlike the static and rationally perceivable forms and spaces of Classical architecture, here all seems in motion, surfaces curving and intersecting, bathed in a mystical, suffused light issuing from the hundreds of windows and reflecting from marbled walls and mosaics. The importance of Anthemios's and Isidoros's achievement was clearly understood by Procopius:

> The interior abounds exceedingly in sunlight and in the reflection of the sun's rays from the marble. Indeed, one might say that its interior is not illuminated from without by the sun, but that the radiance comes into being within it, such an abundance of light bathes this shrine. . . . All these details, fitted together with incredible skill in midair and floating off from each other and resting only on the parts next to them, produce a single and most extraordinary harmony in the work, and yet do not permit the spectator to linger much over the study of any one of them, but each detail attracts the eye and draws it on irresistibly to itself. So the vision constantly shifts suddenly, for the beholder is

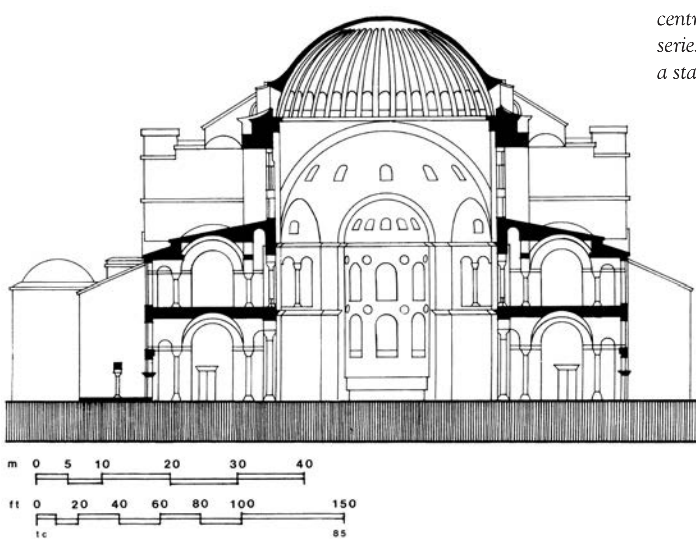
> utterly unable to select which particular detail he should admire more than all the others.[10]

After Hagia Sophia was finished, on December 27, 537, Justinian reputedly entered the new church with the Patriarch of Constantinople, rushed alone to the center, and exclaimed: "Glory be to God, Who has deemed me worthy of this task. O, Solomon, I have surpassed thee."[11] In Hagia Sophia, Justinian gave definitive form to Byzantine architecture, fusing Roman constructive practice with Greek science in the service of theological speculation, with an oriental luxuriousness celebrating the mystery of Divine Wisdom.

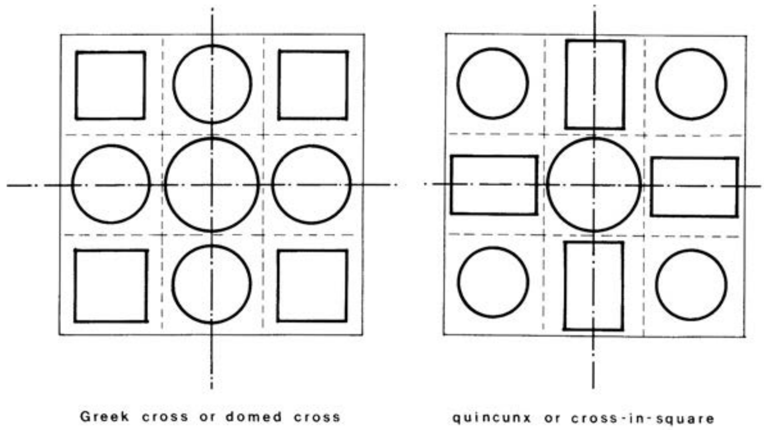
Even as the dome was rising, it appeared that the structure below was insufficient to resist the outward thrust [13.19]. Consequently, towers were added over the buttress piers in the northeast and southwest aisles to increase the downward component of the dome's lateral thrust [see 13.17]. Following earthquakes in 553 and 557, the original low saucer dome collapsed and was rebuilt by Isidoros's son with a steeper hemispherical profile. The original weakness had been the result, in part, of the speed of construction, for the slow-setting lime mortar allowed the arches, pendentives, and buttressing half-domes to deform and spread out as they rose. In 989, a portion of the 557 dome fell, and in 1346, the remaining portion fell. In the successive repairs and rebuilding, additional massive buttresses were added to the exterior of the church, principally on the northeast and southwest sides, where the original design had left the dome inadequately counterbuttressed.



13.18. Hagia Sophia. Longitudinal section. Along the main axis the outward thrust of the central dome is transmitted downward by a series of half-domes and barrel vaults, forming a stable triangular profile. Drawing: T. Cheun.



13.19. Hagia Sophia. Cross section. In comparison with the longitudinal section, the cross section shows relatively little lateral support for the dome, requiring the later addition of bulky buttresses at the corners. Drawing: T Cheun.

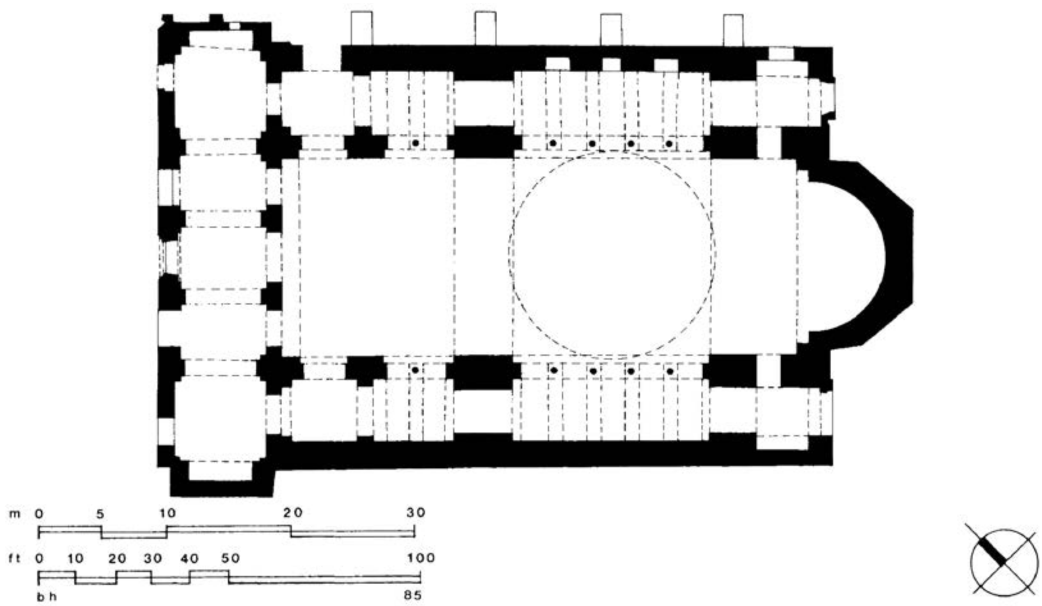


13.21. Diagram of Byzantine church types, showing arrangement of domes. Drawing: L. M. Roth.

Once the Byzantine pendentive had been developed, allowing round domes to be placed over square volumes, Byzantine architects evolved numerous plan variations in which large squares were divided into nine component squares, with domes at the center and the corners (the ***quincunx*** plan), or at the center and on the cross axes [13.21]. Hagia Eirene (Saint Irene, or Holy Peace), another church that Justinian rebuilt in Constantinople after the 532 Nika riot, illustrates one architectural type from which later Byzantine and Russian Orthodox churches derived over the next thousand years [13.22, 13.23]. Although Byzantine churches customarily had centralized plans, Hagia Eirene is axial, but the basic component elements of dome-topped square bays connected by short barrel vaults are present.

Later Byzantine Churches

The later development of Orthodox churches in northern Greece can be seen in the Church of the Holy Apostles, Salonica, 1312–1315 [13.24, 13.25]. A basically square plan contains another square

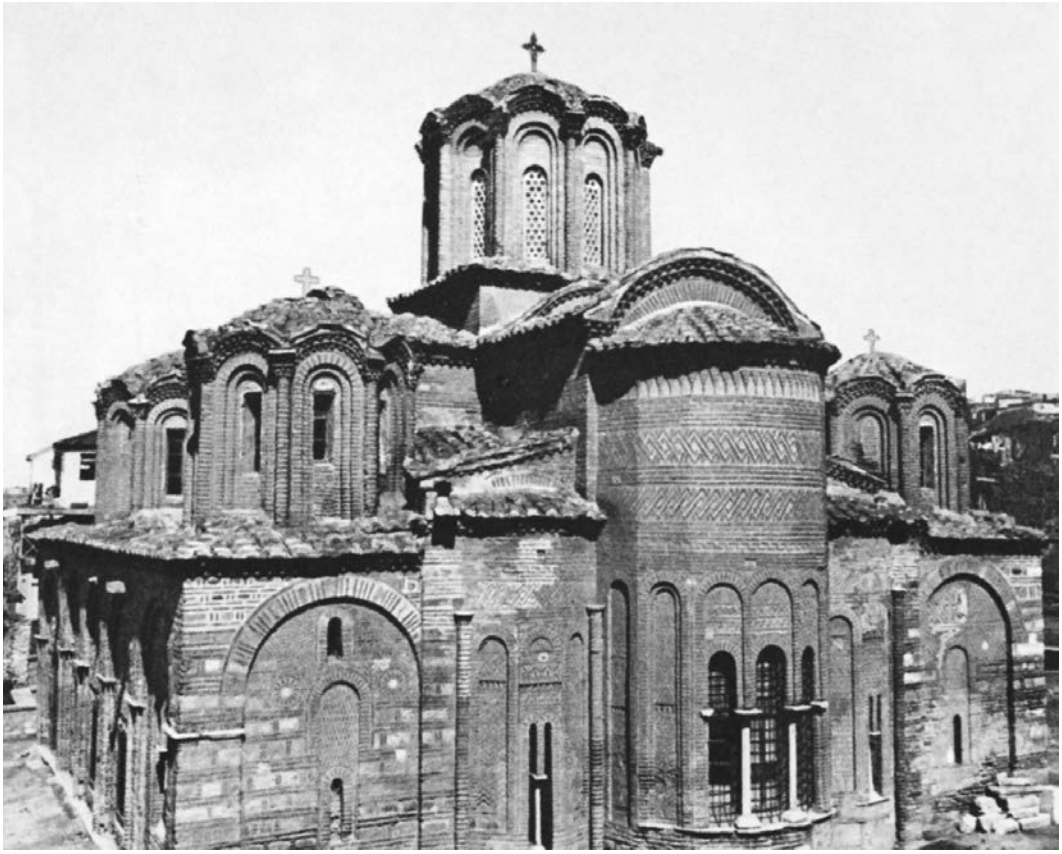


13.22. Hagia Eirene (Church of the Holy Peace), Istanbul, Turkey, begun 532. Plan. This shows perhaps more clearly than the larger Hagia Sophia how a dome could be placed over a square or slightly rectangular plan. Drawing: L. M. Roth, after Mango, Byzantine Architecture *(New York, 1977).*

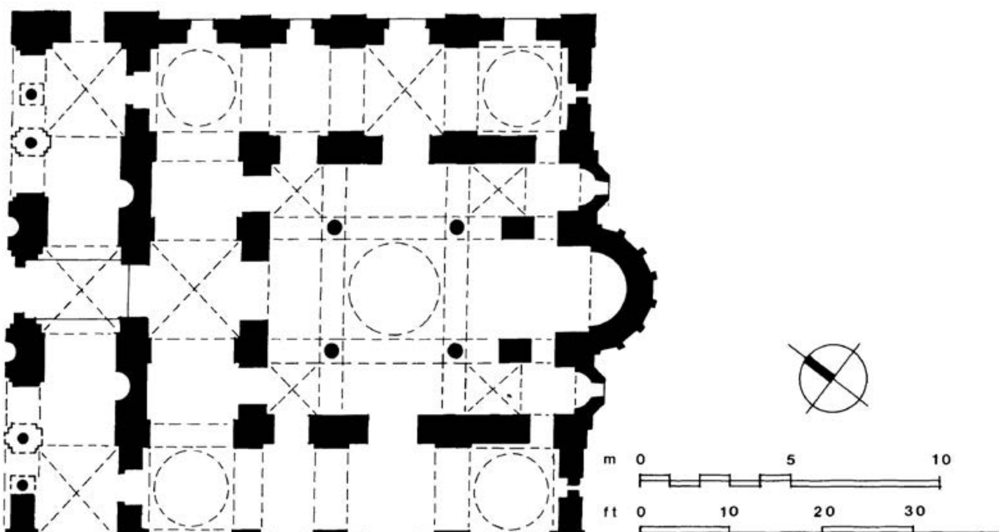
13.23. Hagia Eirene, Istanbul. Interior. Photo: Josephine Powell, from Krautheimer, Early Christian and Byzantine Architecture *(New York, 1986).*

divided into a Greek cross, with a tall dome rising over the center. In each corner of the outer square are smaller domes. Eastern Orthodox Christianity was carried northward into Russia, and with it, the modular, domed church. Just as Russian Christianity gradually assumed its own unique identity, liturgy, and self-governance, so too did the Russian people modify the Byzantine church architectural form and make it something uniquely Russian. Kiev, in the Ukraine in southern Russia, was then the cultural center and capital of Kiev-Rus; in 988, its ruler, Prince Vladimir, embraced Byzantine Orthodoxy. Through Kiev, Russia adopted the spiritual, artistic, and cultural heritage of Byzantine civilization. The character of Russian churches was determined by examples such as Saint Sophia in Kiev, begun about 1037, which stressed the vertical character in narrow, soaring, domed chambers; the exterior of this church, however, has been greatly modified over the centuries.

The Byzantine tradition even had an impact in the West, especially in Venice, which carried on extensive trade with Constantinople and the eastern Mediterranean. It is possible that Byzantine architects and workmen were employed in building the new Church of San Marco (Saint Mark), Venice, begun in 830 and rebuilt in 1063–1095 [13.26, 13.27, 13.28]. San Marco, the chapel of the doges, or dukes, of Venice (rather than the bishop's seat), was built to house Saint Mark's remains, which had been removed from Alexandria when the city became Islamic territory. San Marco is a good example of the Greek cross, five-dome church, in which four square arms project from a central, slightly larger square, each square covered by a dome (the vestibule to the west was added later). Here, the walls were covered entirely in gold-backed mosaic, presenting figures of the apostles, saints, and angels. San Marco, however, had limited influence in the West, for it was a transplanted form. In eleventh-century



13.24. *Church of the Holy Apostles, Salonika, Greece, 1312–1315. View from the east. Photo: Alison Frantz.*

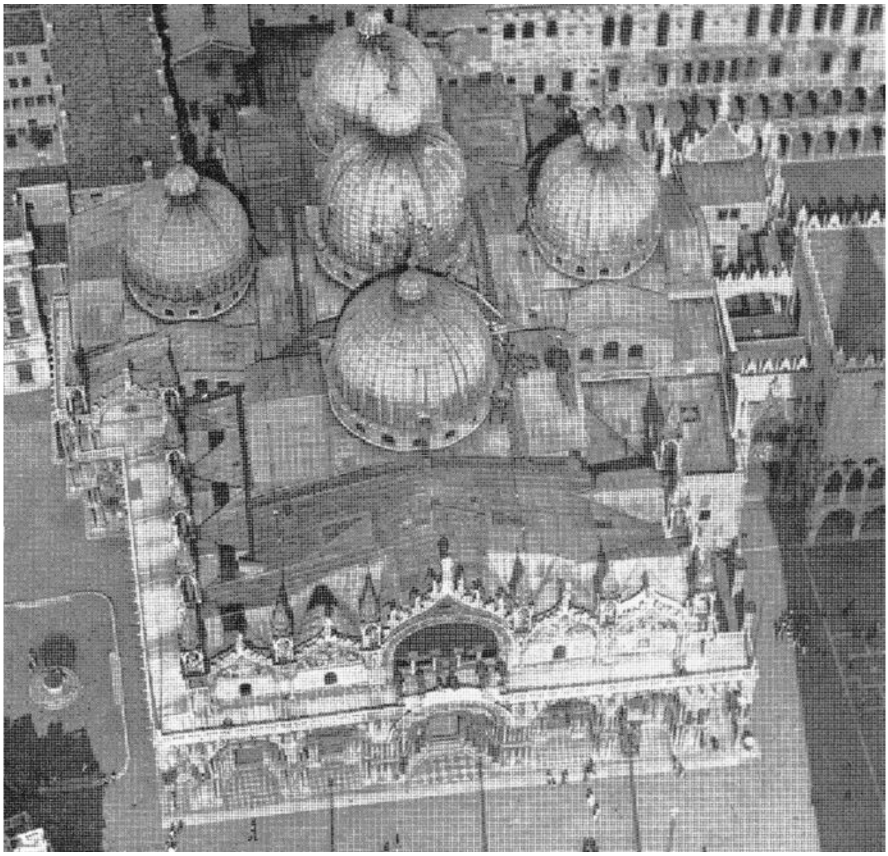


13.25. *Church of the Holy Apostles, Salonika. Plan. Drawing: L. M. Roth, after Mango,* Byzantine Architecture *(New York, 1977).*

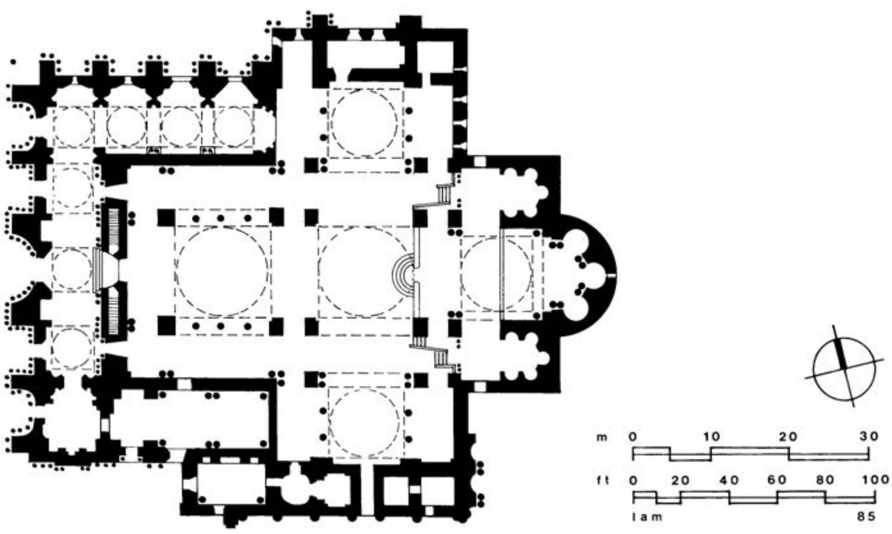
13.26. Church of San Marco (Saint Mark's), Venice, Italy, 1063–1095. Interior. Photo: Erich Lessing/Art Resource, NY.

Europe, a very different tradition in church architecture, evolved from the Western Constantinian basilica, was just then beginning to reach its peak.

The Byzantine Empire survived for nine hundred years after Justinian's reign, gradually shrinking in influence; its outlying territories were lost piecemeal to the advance of an especially fervent new religion spreading out from Arabia. About 610, in the city of Mecca, the prophet Muhammad began preaching the new faith of Islam; by 632, Islam had swept the Arabian peninsula, and in another thirty years, soldiers of Islam had conquered Persia, Syria, Palestine, Egypt, and North Africa as far as Algeria. In 673, Constantinople itself had come under siege by



13.27. Church of San Marco, Venice. Aerial view. This shows clearly the five domes, somewhat obscured by the Late Gothic embellishment added to the facade of the church. Photo: From Henry A. Millon, ed., Key Monuments in the History of Architecture *(New York, 1964).*



13.28. Church of San Marco, Venice. Plan. Built perhaps by Byzantine architects, the church was based on Justinian's Church of the Holy Apostles, Constantinople (now destroyed). Drawing: L. Mack and L. M. Roth, after Mango, Byzantine Architecture *(New York, 1977).*

Islamic armies, but successfully withstood it; this was but the first of many such sieges, however, and the city finally fell to the Seljuk Turks in 1453, to be renamed Istanbul. Yet Justinian's extended architectural influence continued to shape Islamic buildings, particularly in the domed mosques of Suleyman and the Sultan Ahmed in Istanbul, all the way to the white marble dome of the tomb of the Taj Mahal, all built from 1550 to 1650. (See the separate essay on Islamic architecture.)

An Architecture of Heaven

As the Roman Empire was transformed into a Christian empire, churches and other religious buildings emerged as the preeminent architecture. Other public buildings and residences faded into relative obscurity. Churches were internalized, their exteriors deliberately restrained in spatial modeling, detail, and color. The artistic focus shifted to the building's interior, on creating a mystic image of heaven that was the very opposite of the architecture of the workday world outside. Byzantine art and architecture were devoted to reinforcing religious experience, in which the familiar physical world of human sensation is transformed into a suggestion of the transcendental world. Images of stylized reality, captured in the glittering mosaics, evoke a spiritual presence in an otherworldly atmosphere of resplendent grandeur. In the ambience of shimmering light from countless windows, reflected from high, mosaic-lined domes, and the flickering of innumerable lamps and candles filtered through the rising haze of pungent incense, the early Christian and, later, the Byzantine Church celebrated the fusion of secular and religious rule and the endeavor to create an earthly simulacrum pointing to heavenly perfection.

Plate 42. Jeanne Gang, Aqua (apartment tower), Chicago, Illinois, 2007–2010. Here the sheer vertical plane of glass, recalling Mies van der Rohe, is transected by the undulating floor slabs that suggest the rippling waves of Lake Michigan. Photo: UIG/Getty Images.

Plate 44. Renzo Piano, Tjibaou Cultural Center, New Caledonia, 1992–1998. Piano's complex of low exhibition rooms and ten soaring "great houses" merges with a landscape carefully designed to highlight indigenous plants. Photo: © John Golling, courtesy of Renzo Piano Building Workshop.

Plate 45. Daniel Libeskind, Hamilton Building addition, Denver Art Museum, Denver, CO, 2002–2006. Capitalizing on the sharply angular aggressiveness of Postmodernism, Libeskind has created a building that presents itself as a forceful work of art. Photo: © Prisma Bildagentur AG/Alamy.

Plate 46. Zaha Hadid, Heydar Aliyev Cultural Center, Baku, Azerbaijan, 2007–2012. The smoothly undulating exterior can be aptly described as "biomorphic." Photo: Ferid Xayruli, courtesy of Zaha Hadid Architects.

Plate 47. Paul Andreu, Beijing National Center for the Performing Arts, Beijing, China, 2000–2007. With many people arriving by subway and entering from below the Center, the traditional sense of approach and the transition from exterior to interior is erased. Photo: Imaginechina via AP Images.

Plate 48. The Kubala Washatko Architects (TKWA), Aldo Leopold Legacy Center, Baraboo, Wisconsin, 2006–2007. The connection to the earth is maintained through exposed wood structure and rough stone, while the roof is almost entirely covered with photo-voltaic panels providing all needed energy. Photo: © The Kubala Washatko Architects, Inc./Mark F. Heffronc.

Plate 49. Glenn Murcutt, Simpson-Lee House, Mount Wilson, New South Wales, Australia, 1989–1994. Using straightforward industrial materials and structural methods, Murcutt nonetheless creates poetic connections to the landscape. Photo: Anthony Browell, courtesy Architecture Foundation Australia.

Plate 50. Samuel Mockbee with the Rural Studio, Yancey Chapel, Sawyerville, Hale County, Alabama, 1995. Using found materials such as discarded tires and salvaged wood, Mockbee and his architecture students provided needed buildings for rural people with extremely limited means. Photo: Timothy Hursley.

Plate 51. Conservation Design Forum, Inc., City Hall Building Roof Garden, Chicago, Illinois, 2001. Positioned in a very prominent political location is this dramatic demonstration of making a useful place while significantly reducing ongoing building energy demands. Photo: Chicago Department of Environment/Mark Farina/AP.

Plate 52. Adrian Smith of SOM, Thomas Beeby, Frank Gehry, and other designers, Millennium Park, Chicago, Illinois. At Mayor Richard M. Daley's urging and with generous corporate support, this long-standing urban eyesore—an abandoned, sprawling rail yard—was converted into a festive public playground built over a garage. Photo: Adam Jones/Getty Images.

Plate 53. Ken Yeang, Solaris Building, Fusionopolis research and development complex, Singapore, 2008–2010. Using a continuous wrap-around landscaped balcony ramp, Yeang provides oxygen-generating plantings as well as shielding from the sun, creating more area for landscaping than existed on the original building site. Photo: Copyright T.R. Hamzah & Yeang Sdn. Bhd. (2013), courtesy of Ken Yeang.

Plate 1. Geppa-rō teahouse, Katsura Detached Villa, Kyōto, Japan, c. 1616–1660. Space in a traditional Japanese house, including a large teahouse such as this, is made infinitely variable by the sliding internal and external wall screens, allowing direct visual connection to the external gardens. Photo: Vanni/Art Resource, NY.

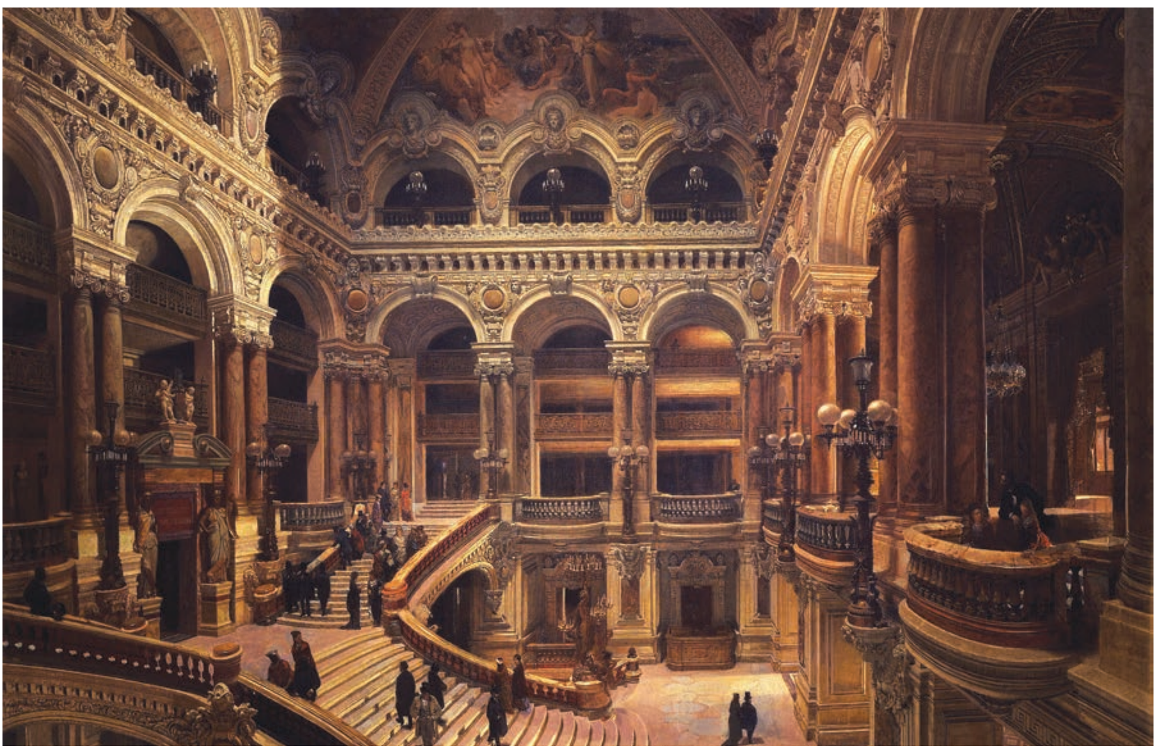


Plate 2. Charles Garnier, Paris Opéra, stair hall, Paris, France, 1861–1875. Because circulation—people being able to see and greet each other—was such an important function, Garnier made the stair hall one of the biggest rooms in the opera house. Photo: Gianni Dagli Orti/The Art Archive at Art Resource, NY.

Plate 3. Hagia Sophia, Istanbul, Turkey. Shown here after being converted to a mosque, the interior, as portrayed by the artist, indicates how the pendentives function in making the transition from a circular to a square plan. Lithography after Gaspare Fossati, 1850. Photo: bpk, Berlin/Kunstbibliothek, Staatliche Museen, Berlin, Germany/Art Resource, NY.

Plate 4. Color wheel. In this circular arrangement, colors can blend with each other seamlessly.

Plate 5. Palace at Knossos, Crete, c. 1600 BCE. When the palace was excavated in 1900–1905, its colors were still relatively bright, as seen on the inverted red columns and numerous wall murals. Photo: Vanni/Art Resource, NY.

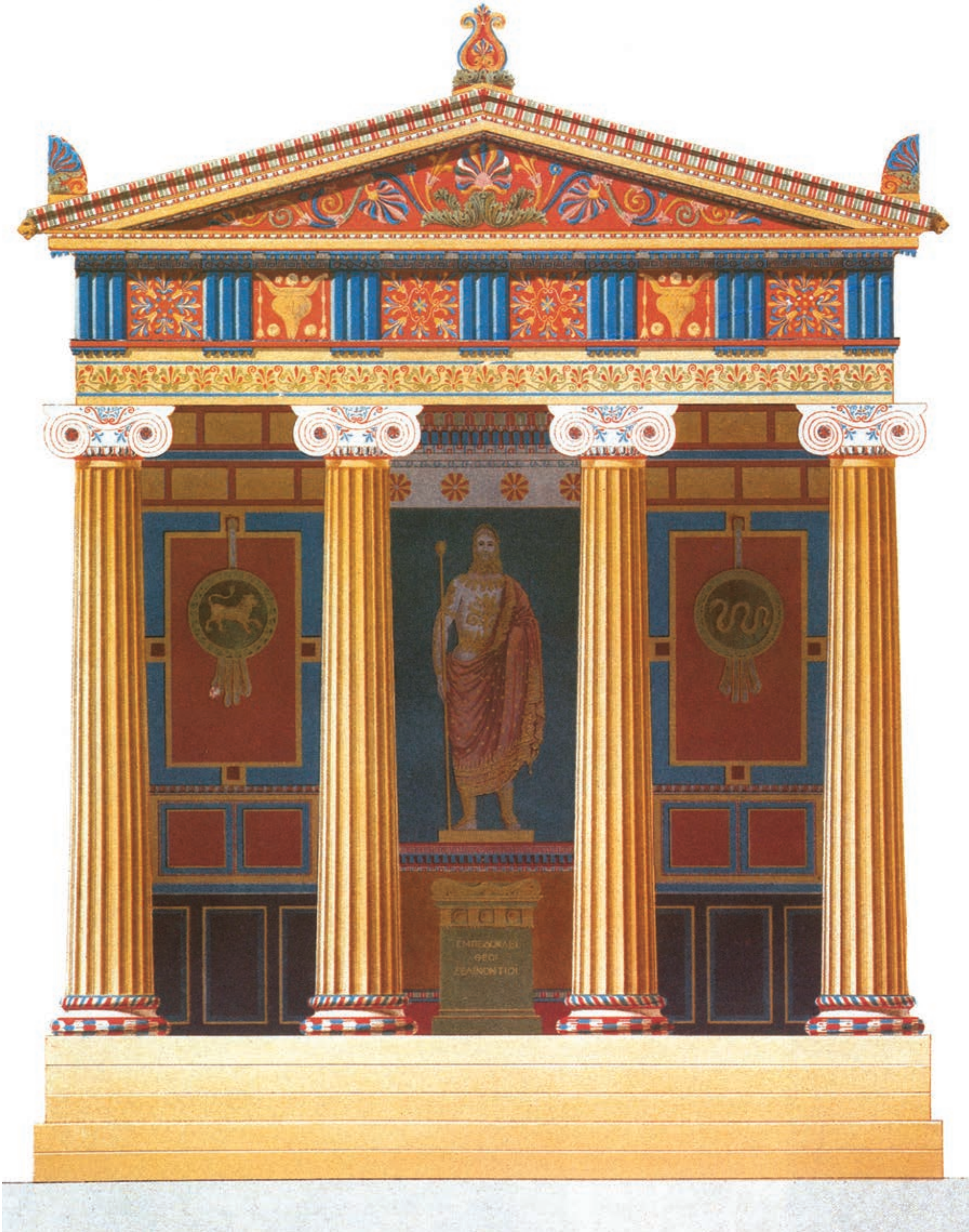


Plate 6. Jacques-Ignace Hittorff, Temple of Empedocles. From Hittorff's Restitution du Temple d'Empédocle à Sélinonte, ou l'architecture polychrome chez les Grecs (Paris 1851). Hittorff's restoration drawings of brightly colored Greek temples caused outrage in the mid-nineteenth century among those accustomed to the sun-bleached whiteness of ancient ruins. Photo: Courtesy, the Avery Library Collection, Columbia University, New York.

Plate 7. San Apollinare in Classe, Ravenna, Italy, 532–549. In the apse, particularly colorful mosaics portray Christ as the Good Shepherd. Photo: Alfredo Dagli Orti/The Art Archive at Art Resource, NY.

Plate 8. Masjid-i-Shah Mosque, Isfahan, Iran, 1611–1638. The glistening glazed tiles that cover the softer, structural material bring a note of vivid color to Islamic architecture. Photo: SEF/Art Resource, NY.

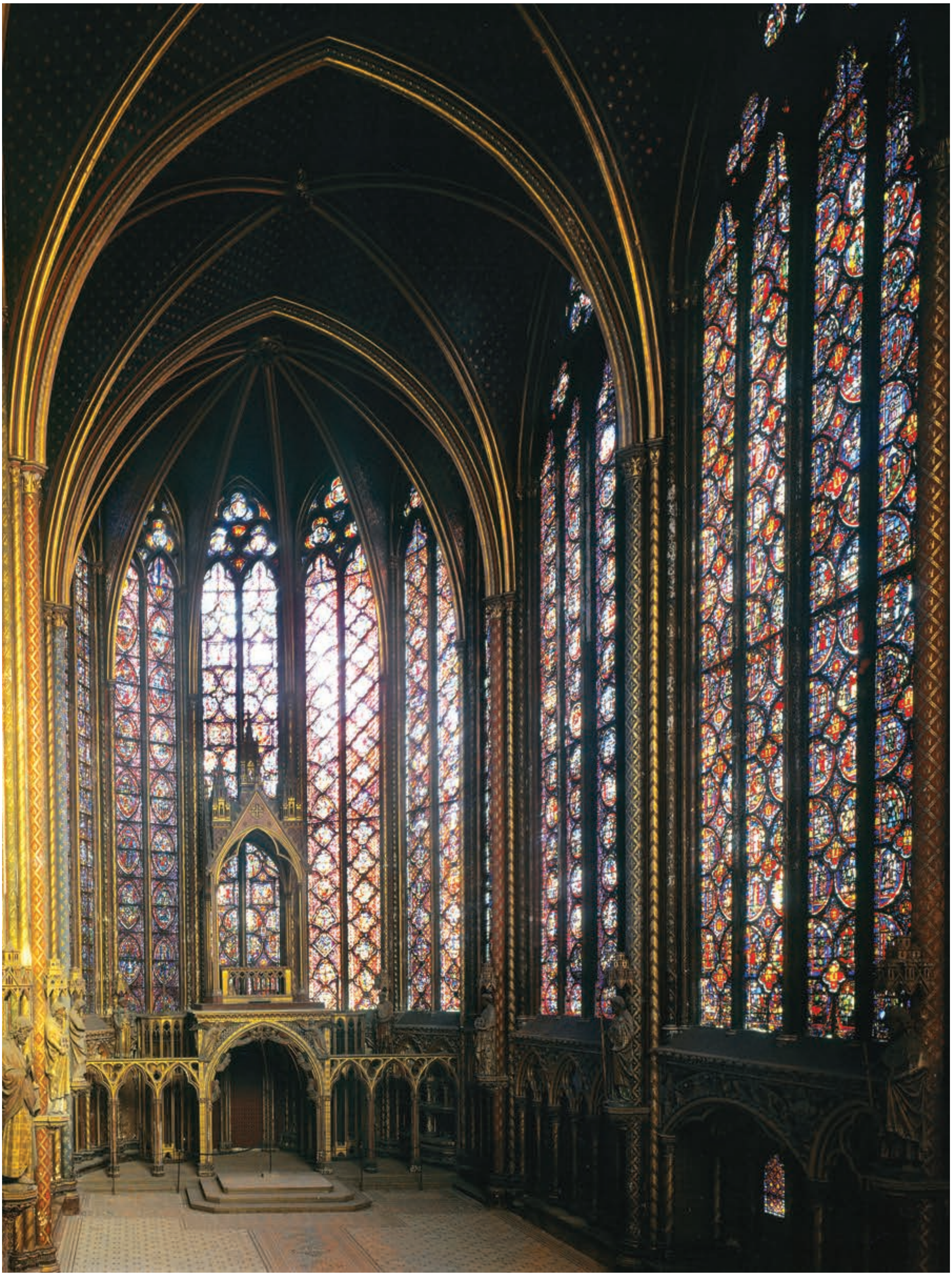


Plate 9. Thomas de Cormont, Royal Chapel of Sainte-Chapelle, Paris, France, 1242–1248. Interior of upper royal chapel as restored by Eugène Emmanuel Viollet-le-Duc, 1845–1860, showing the high levels of color originally painted on the stone, complementing the intense colors in the stained-glass windows. Photo: Scala/Art Resource, NY.

Plate 10. Balthasar Neumann, Vierzehnheiligen (Pilgrimage Church of the Fourteen Saints), Franconia, Germany, 1742–1772. Against a background of cream and white, color is used in painted mural panels and opulent faux finishes. Photo: Erich Lessing/ Art Resource, NY.

Plate 11. Sir George Gilbert Scott, Midland Grand Hotel (part of St. Pancras Railroad Station), London, 1868–1874. High Victorian Gothic architects reveled in the dramatic contrast of strongly colored natural building materials of stone, brick, and slate. Photo: © VIEW Pictures Ltd/Alamy.

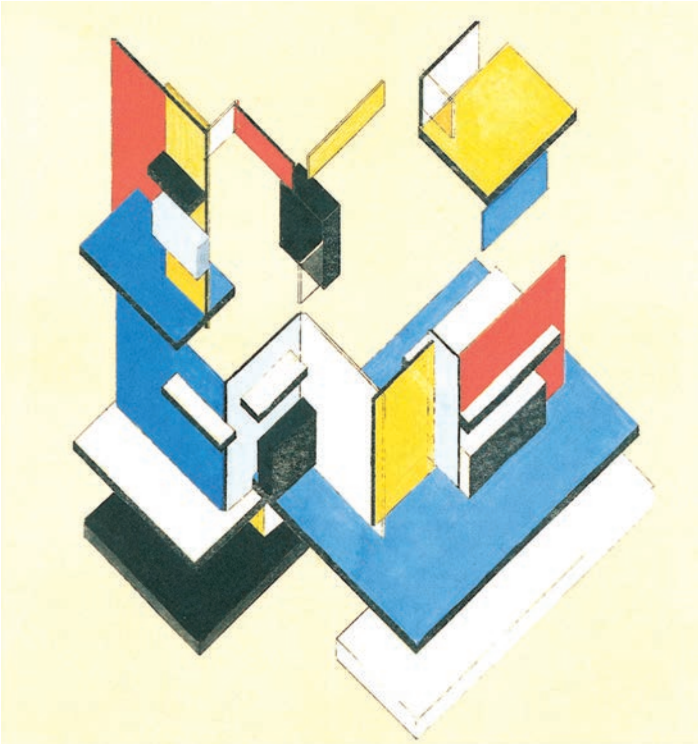


Plate 12. Theo van Doesburg and Cornelis van Eesteren, Color Construction: Project for a Private House. Drawing, gouache on paper, 22½ × 22½ inches, 1922. In De Stjl design, colors possess associated numerical values, creating a "balanced" abstract composition. Photo: The Museum of Modern Art, New York, Edgar Kaufman, Jr., Fund.

Plate 13. Charles Moore, Piazza d'Italia, New Orleans, Louisiana, 1975–1980. In Ironic Postmodernism, dramatic color combinations and contrasts reappeared after having been suppressed for half a century. Photo: Norman McGrath.

Plate 14. Musikverein (Symphony Hall), Vienna, Austria, 1867–1870. The large performance space, called the Golden Hall because of its abundant gilding, has a basic rectangular shape and many planes of ornament that result in the good acoustic properties in this acclaimed chamber. Photo: © epa european pressphoto agency b.v./Alamy.

Plate 15. House of the Vettii, Pompeii, Italy, prior to 79 CE. Wall paintings in the corner of the house show the skill in linear perspective drawing practiced by Roman artists and architects. Photo: Gianni Dagli Orti/The Art Archive at Art Resource, NY.

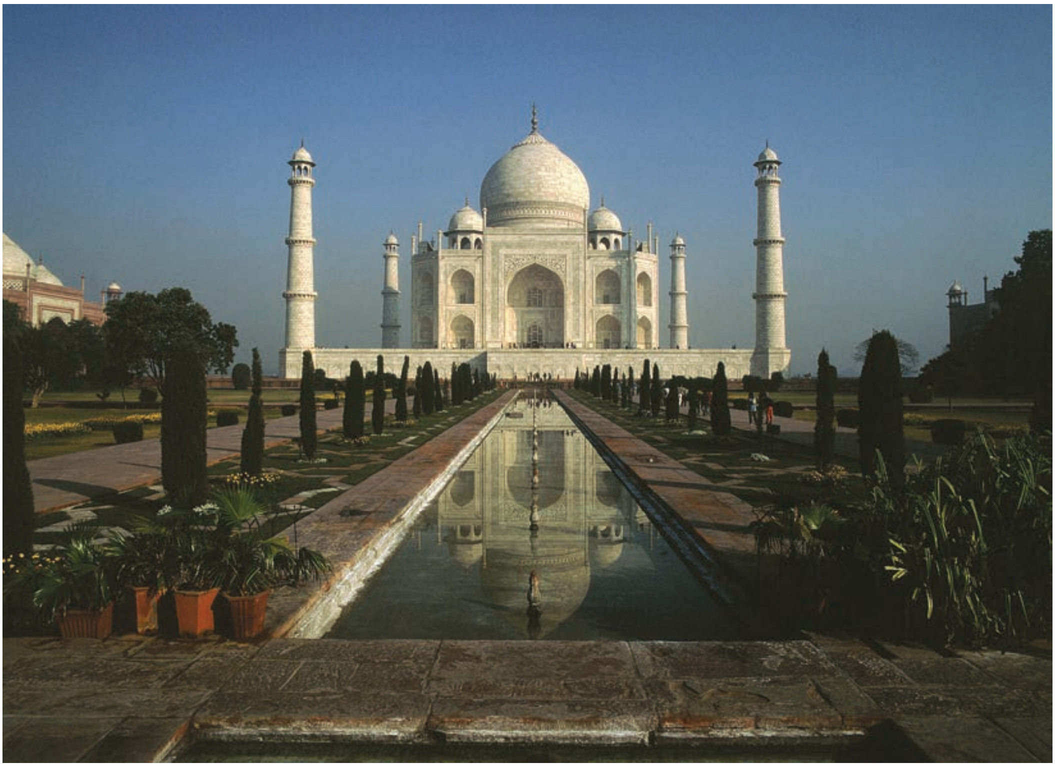


Plate 16. Taj Mahal, Agra, India, 1630–1653. Color abounds in the garden plantings, as well as in the many semi-precious stones inlaid to form decorative patterns in the white marble tomb building. Photo: The Art Archive at Art Resource, NY.

Plate 17. Idealized View of the Acropolis and Areopagos in Athens, 1846. Oil on canvas, 102.8 x 147.7 cm. Inv. 9463. Bayerische Staatsgemaeldesammlungen, Munich, Germany. This mid-nineteenth-century painting presents an artist's rendering of how the Athenian Akropolis might have appeared about 450 BCE. Photo: Vanni/Art Resource, NY.

Plate 18. Roman Forum, Rome, Italy. The Roman Forum, the caput mundi ("head of the world"), was the focal point of Roman religious, political, and commercial life. The scattered surviving fragments suggest the great size and complexity of the Forum of the ancient city of Rome. Photo: Vanni/Art Resource, NY.

Plate 20. Palenque, southern Mexico, flourished in seventh century CE. As excavation and analysis continues, it has become clear that virtually the entire city was painted red, enhanced with highly colored sculptural panels. Photo: Christopher Evans/ National Geographic Stock.

Plate 19. Mosque at Cordobá, Cordobá, Spain, 961–987 and later. The form of the Islamic hypostyle hall for the haram prayer hall was greatly extended in this instance, creating through the hidden sources of light a near-mystical atmosphere. Photo: Werner Forman/Art Resource, NY.

Plate 21. Aerial view of Tenochtitlan, on Lake Texcoco, Mexico, fifteenth century. This reconstructed view depicts the Aztec capitol as it might have first appeared to Spanish conquistadors. Mid-twentieth-century painting by Miguel Covarrubias. Photo: Schalkwijk/Art Resource, NY/María Elena Rico Covarrubias.

Plate 22. François Cuvilliés, Amalienburg Pavilion, on the grounds of the Nymphenburg Palace, outside Munich, Bavaria, Germany, 1734–1739. The fullest expressions of Rococo were made by French artists working in Germany, as in this hunting pavilion. The central round salon is completely lined with glass, in the form of either mirrors or French doors opening to the exterior. Photo: Erich Lessing/Art Resource, NY.

Plate 23. Garden of the Humble Administrator, Suzhou, southern China, begun 1510. Artfully crafted to combine water, a variety of plants, and covered walkways in zigzag paths, and dotted with strategically placed pavilions, such gardens provided places for court officials to contemplate beauty in its manifold forms. Photo: © IMAGEMORE Co., Ltd./Alamy.

Plate 24. The Amida Hall (Hōōdō) or Phoenix Hall, Byōdōin, Uji, near Kyōtō, Japan, 1053. The outstretched arms extending from the central hall are thought to symbolize the wings of the phoenix. Here the extended cantilevered beams, creating the lifting roofs, are evident. Photo: Vanni/Art Resource, NY.

Plate 25. Katsura Detached Palace, Katsura, near Kyōto, c. 1616–1660. Though perhaps a bit mannered in the extreme exquisiteness of its details, the Katsura villa, set in the midst of a carefully tended garden, is nonetheless considered to express the essence of traditional Japanese house and garden design. Photo: Vanni/Art Resource, NY.

Plate 27. Church of St. George, Lalibela, Ethiopia, thirteenth century. One of the relatively rare examples of a building that was created by cutting away the surrounding rock, much as a sculptor cuts away a block of marble to reveal the figure residing "inside" the stone. Photo: © Robert Harding Picture Library Ltd/Alamy.

Plate 26. A. W. N. Pugin, designer, House of Lords chamber, Houses of Parliament, London, England, 1936–1947. With rich detailing designed by Pugin, this room elegantly accommodates the robed members of the aristocracy. Photo: © Robert Harding Picture Library Ltd/Alamy.

Plate 28. Warren & Wetmore with Wilbur Wilgus, Grand Central Terminal, New York, NY, 1902–1913. One of the great public rooms in the United States. Photo: © D. Hurst/Alamy.

Plate 29. Ragnar Östberg Stockholm City Hall, Stockholm, Sweden, 1911–1923. With stylized references to Sweden's version of Renaissance architecture, Östberg created a modern regional landmark. Photo: © F1 online digitale Bildagentur GmbH/Alamy.

Plate 30. Ludwig Mies van der Rohe, German Pavilion, Barcelona, Spain, 1929 (as rebuilt, 1983–1986). In re-creating the demolished original Barcelona Pavilion in the late twentieth century, the Spanish reconstruction architects returned to the original onyx and marble materials in which the color and vein pattern provided important decorative elements. Photo: © YAY Media AS/Alamy.

Plate 31. Allan Greenberg, The News Building, Athens, Georgia, 1992. The intense color of ancient Greek architecture, as seen in the Ionic order on the upper level of the formal entry stair, is brought to life again in Greenberg's work. Photo: Tim Buchman, courtesy of Allan Greenberg.

Plate 32. Duncan G. Stroik, Saint Thomas Aquinas Chapel, Thomas Aquinas College, Santa Paula, California, 2003–2009. Using an architectural language long associated with California coastal churches, Stroik builds on this regional tradition. Photo by Stephen Schaffer, courtesy of Duncan Stroik.

Plate 33. Rafael Moneo, Museum of Roman Art, Merida, Spain, 1980–1986. Glazed brick, especially when hit by raking shafts of sunlight, brings a warm glow to the Merida museum interiors. Photo: Lluís Casals, March 1987.

Plate 34. James Stirling, Neue Staatsgalerie, Stuttgart, Germany, 1977–1983. In a fusion of traditional forms and new technologies, brightly painted metal surfaces contrast with the warm hues of the travertine and sandstone walls. Photo: © Richard Bryant/arcaid.co.uk.

Plate 35. Richard Meier, Jubilee Church (La Chiesa del Dio Misericordioso), Rome, Italy, 1996–2003. Perhaps because this was such an important politically visible church, being constructed for the Great Jubilee Year of 2000, Meier turned from his previous crisp cubic planes to softer, rounded, evocative forms. Photo: © Art on File/Corbis.

Plate 36. Peter Eisenman, Galicia Cultural Center, Santiago de Compostela, Spain, 1999–2012. Once an advocate of cubic forms derived from Canonical Modernism, Eisenman shifted to using more organically inspired forms. Photo: © Duccio Malagamba, Barcelona.

Plate 37. Santiago Calatrava, Infinity Tower, Dubai, United Arab Emirates, 2005–2012. By gently turning the square plan by increments, floor by floor, Calatrava creates a dynamic architectural form. Photo courtesy of Laticrete, www.laticrete.com.

Plate 38. Norman Foster, 30 St. Mary Axe ("The Gherkin"), London, England, 1996–2004. Employing whimsy in both form and color, Foster created a distinctive building incorporating positive energy-saving attributes. Photo: UIG/Getty Images.

Plate 39. C. Y. Lee, Taipei 101, Taipei, Taiwan, 1997–2003. Taiwanese architect Lee achieved a form suggestive of a gigantic pagoda, with its upper portion divided in eight sections of eight floors each, a most auspicious number in Chinese culture. Photo: AP Images/Wally Santana.

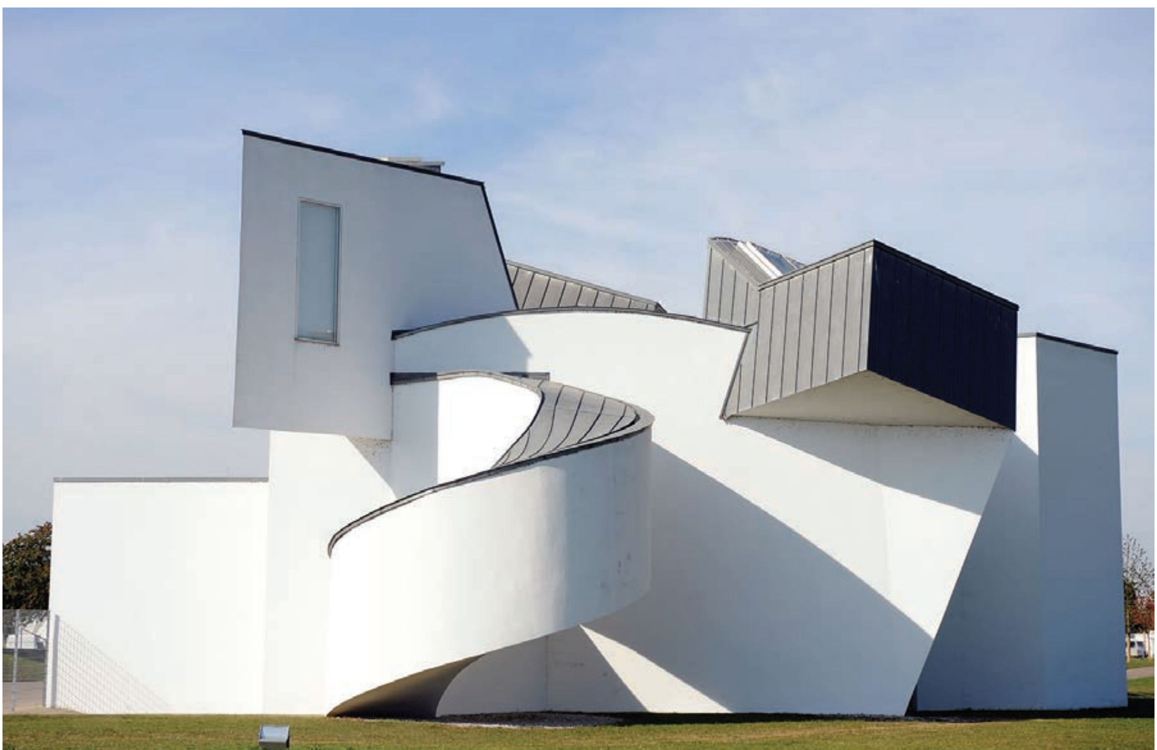
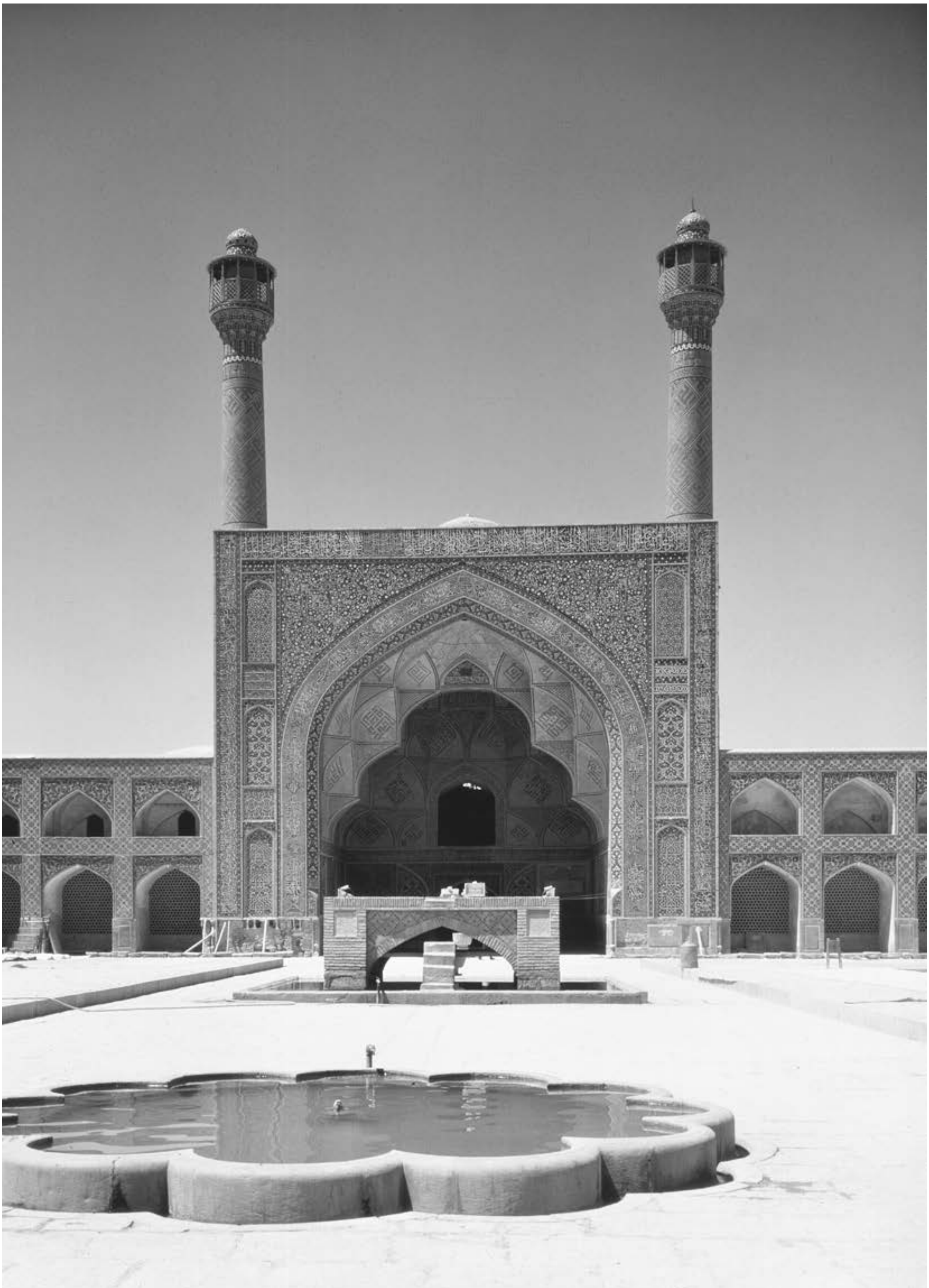


Plate 40. Frank Gehry, Vitra Design Museum, Weil am Rhein, Germany, 1987–1989. Beginning to create elaborately sculpted building forms in the 1980s revealed to Gehry the complicated issues involved in producing working drawings for such complex nonlinear forms. Photo: © Caro/Alamy.

Plate 41. Frank Gehry, Guggenheim Museum, Bilbao, Spain, 1987–1997. The shimmer of the thin titanium sheets almost instantly established a new worldwide standard of prestige in turn-of-the-twentieth-century public architecture. Photo: © Art Kowalsky/Alamy.

Plate 43. Rem Koolhaas and associated architects, CCTV (Chinese Central Television), Beijing, China, 2002–2008. A good example of a building form revealing little about its human scale, this structure certainly makes a dramatic impact, as it was intended to do, in an opening timed to coincide with the Beijing Olympic Games in 2008. Photo: REUTERS/Jason Lee.



IS-1. Jameh (Friday) Mosque of Isfahan, Isfahan, Iran, eighth to twelfth centuries. This iwan *pavilion, enriched inside the arch with curved and scalloped* muqarnas *vaults, is the* qibla *orienting the worshipper toward Mecca. Photo: Gianni Dagli Orti/The Art Archive at Art Resource, NY.*

Islamic Architecture

Islamic Architecture and the West

The influence of Islamic architecture on Europe is part of a long history of interactions that significantly enriched the West in architecture, science, and mathematics. As Islam quickly spread across the Middle East and Africa in the sixth century, Muslim architects and builders embraced and absorbed late Classical and Christian architectural forms and structural techniques, adapting them for their own unique building needs. But to appreciate those distinctive building needs, it may be helpful to understand how Islam arose and expanded.

Islam Develops

Prior to about 600 CE, the Arabian peninsula was divided into many feuding tribes. Then, within about forty years, politics and religion across the entire Arabian peninsula changed dramatically because of the influence of one man, the Prophet Muhammad (c. 560 to 632). When Muhammad began preaching in the courtyard of his home in Mecca, he met with hostility from neighbors, so in 622, he and his followers withdrew to the city of Medina, the year from which the Islamic calendar is measured. He united the local surrounding tribes, and in 628, his followers, now numbering perhaps ten thousand, overtook the city of Mecca. By the time of his death in 632, nearly the entire Arabian peninsula had been converted to the new religion and united in a single Muslim political body, with Muhammad the religious, political, and military leader.

Because the religion established by Muhammad was so different from the practices of others nearby, new architectural spaces were needed, especially a place for obligatory ritual worship.[1] Additionally, Islam has a prohibition against images, not just of Allah and Mohammad but also of humans and animals, so no images of birds, animals, or fish are permitted as embellishment of Islamic architecture. What typically replaced such figurative imagery were elaborate geometric decorative patterns as well as inscriptions of passages from their holy book, the Qur'an, presented in elaborate Arabic calligraphy.

The new faith and political protection was quickly embraced by the Arab people, so that by the time of Muhammad's death in 632, the religion and rule of Islam had spread across the entire Arabian peninsula, northward into Jordan and then eastward through modern-day Iraq, and as far as the western part of Iran. Within the next thirty years, the extent of Islamic control expanded west into Egypt and Libya, in the north from eastern Turkey to Turkmenistan, and east from Syria to the western edge of Afghanistan. Subsequently, Islam spread further across the remainder of North Africa all the way to the Atlantic, and to the east from Uzbekistan through what is now Pakistan.[2] In the East, the spread of Islam continued for several additional centuries into northern India, Bangladesh, western China, and southeast Asia, sweeping over Indonesia. Far to the west, Muslim armies crossed the Strait of Gibraltar into Spain and continued into Europe until they were stopped at the Battle of Tours (also called Battle of Poitiers), in 732.[3]

During the rapid spread of Islam stretching from Spain to central Asia, many regional architectural traditions had been absorbed and integrated into the development of Islamic architecture, but one characteristic remained relatively constant—the dry climate.[4] Thus the arid conditions of everyday life encouraged a dream-image of lush gardens, embellished by dancing fountains, shaded by trees, and scented by flowers—a vision of paradise.

The wonder of Islamic architecture is how rapidly it established the essential character for its religious, public, educational, and governmental buildings. Unlike the long periods of gestation in the development of Egyptian, Greek, or Roman architecture, within two generations, the shepherds and traders of northern Arabia mastered the architecture they encountered outside their homeland, learning both brick and stone construction and the use of arches and vaulting, none of which formerly existed in northern Arabia. Once established, this architectural character was carried to the far ends of the Islamic world, even as it incorporated regional architectural elements.

The Mosque

Essential to Muslim worship is the mosque. The first mosque, providing the conceptual pattern for later mosques, was created by Muhammad in his house in Medina; it was regrettably removed to make way for a new mosque in 1986. The oldest surviving mosque, an architectural model for nearly all later mosques, is the Great (or Umayyad) Mosque of Damascus, Syria, which began as a Roman temple to Jupiter and was then partially rebuilt as an early Christian church. Built directly on the earlier temple site after the city was conquered in 634, the Great Mosque (706–715) is a large rectangle with an enclosed structure on its long southern half, made up of three parallel rooms divided by two rows of repeated classical round arches springing from column to column. (This arrangement conveniently provided a large space without the necessity of building a long-span roof.) The faithful gather in rows in this large covered hall (*haram*) to prostrate themselves in prayer (*salah*). The great scale of the Umayyad Mosque was said to accommodate the entire Muslim population of Damascus at that time. Here, as in a number of early mosques, the need to cover a large space for prayer resulted in rows of parallel arches on columns supporting comparatively narrow parallel roofs. Because of the many columns, they are often called *hypostyle* halls. Along the south wall are three *mihrab* niches (normally just one is set in the prayer wall or *qibla*) to orient the worshiper toward Mecca, the most holy city in Islam. This sacred orientation toward Mecca is required of all mosques; hence, there is no relationship in any mosque to the points of the compass. North of the enclosed prayer hall in Damascus is a broad open court, the *sahn,* ringed with classical round arched arcades on columns. Set at the western side of this court is the fountain used for ritual ablutions before prayer.

Another building type that established a strong model for later Islamic architecture is the Dome of the Rock, Jerusalem (689–691), begun just one year after the city surrendered to the Muslim army of the Rashidun Caliphate [IS-2]. The Arab sweep into Judea in the late eighth century first exposed the Arab conquerors to late Roman architecture as well as the early Christian architecture of the Constantinian churches built there in the fourth and fifth centuries, particularly to the use of domes in religious buildings. The immediate evidence of this impact can be seen in the Dome of the Rock, built to shelter an exposed portion of the bedrock on which the second Jewish temple had stood. The rock is sacred to Muslims as the site from which Muhammad ascended to Heaven to speak with Allah before returning to earth.[5]

The design of the Dome of the Rock drew from both the Church of the Nativity in Bethlehem and the Church of the Holy Sepulcher in Jerusalem (for information on these churches, see Chapter 13). Designing engineers Yazid Ibn Salam and Raja Ibn Haywah incorporated an octagon enclosing an internal ambulatory (as used in Bethlehem), as well as a dome seen in both the Church of the Nativity and the Church of the Holy Sepulcher, but modified so the dome is carried internally by a ring of columns to allow full view of the rock.[6] The wood dome (today covered with gilded metal sheets) is supported below by a ring of internal arcades interspersed with four broad piers, the arches introducing the use of alternating contrasting voussoir blocks—a design feature seen frequently in Islamic architecture, even in distant Spain. While both exterior and interior are brilliant with colored stone inlay, tiles, and other highly colored materials, including bands of Quranic passages, frequent refurbishments over the centuries obliterated the original surfaces. The dome motif introduced here would reappear in various forms across the Muslim world over the next millennium and more.

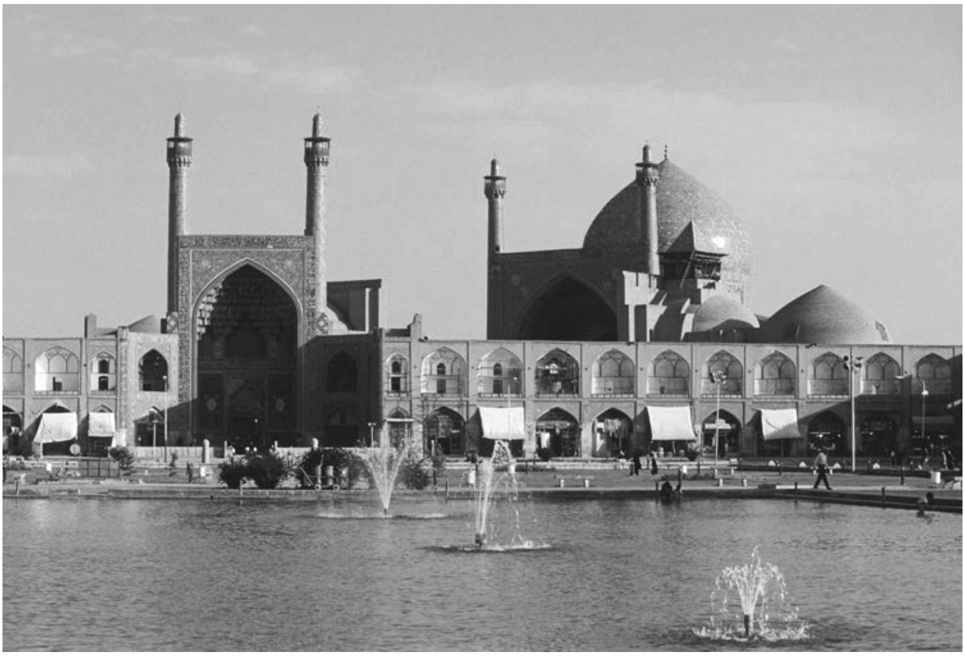
IS-2. Dome of the Rock, Jerusalem, Israel, 689–691. Begun just one year after the city was taken by Muslim forces, this building shows the extraordinarily rapid assimilation of Roman and Early Christian architectural forms. Photo: SEF/Art Resource, NY.

Secular Islamic Buildings

With the establishment of the Abbasid Caliphate, the administrative center shifted to Baghdad (now in Iraq) in 762. During the period of the Abbasid Caliphate, sometimes called the Golden Age of Islamic culture, Baghdad became the focal point of literary, mathematical, and scientific inquiry, marked by the accumulation of large libraries. Schools and universities became essential to Islam, and Mustansiriya Madrasah University, still operating today, was established in Baghdad in 1227.[7]

Another emerging Islamic building type was the palace; one surviving (restored) example is the Qasr-al-Khalifa, or Abbasid Palace, built just outside Baghdad in 836. Among the notable features of its construction was the use of elongated vertical arches whose tops are made up of two circular arcs—that is, pointed arches. Also used were geometric infill patterns in the spandrel panels of the arches, and diagonal linear meander patterns laid up of darker brick in a lighter brick wall.

Because of the size and complexity of the extended Muslim world, the Abbasids had difficulty maintaining control, and various outlying areas, such as the former Persia, became semi-autonomous.[8]



IS-3. Masjid-i shah Mosque, Isfahan, Iran, 1611–c. 1630. This overall view shows, in the distance, the larger tile-covered dome over the sahn *prayer hall, while the foreground shows the entry court. Photo: Mondadori Portfolio/Electa/Art Resource, NY.*

Nevertheless the Persians (present-day Iranians) eagerly embraced the Islamic faith and created splendid mosques. Already a well-established city, Isfahan had been captured by the Arabs in 642 and then, in 1050, was occupied by the Seljuk Turks, who also made the city the center of their vast empire.

Subsequently, the region was conquered by Timur (Tamerlane) and made a part of his empire. Important developments in mosque architecture occurred in central Asia in those areas that Timur conquered and controlled, including mosque types such as the Bibi Kanun Mosque (begun in 1399) in Samarkand (in modern Uzbekistan), which he made his principal administrative and cultural capitol.[9] Similar to other mosques across Muslim territory, these Samarkand mosques had large prayer halls and an open external court, but where the cross axes of the court met with the court walls, large squared blocks or pavilions opened up with soaring recesses further opened by multistory pointed arches called *iwans.* Increasing the splendor of the Bibi Kanun Mosque is its uniform sheathing of brightly colored glazed tiles.

By the start of the sixteenth century in Iran, the ruler Shah Abbas chose Isfahan to be the seat of the Safavid dynasty and initiated a number of building enterprises, including the completion of the resplendent Masjid-i shah Mosque (1611–c. 1630), which suggests influence coming southward from Samarkand [IS-3, Plate 9]. The original building was begun in the eighth century, perhaps a rectangular enclosure having the multicolumned prayer hall to the south and an open *sahn* court on the north, angled to point toward Mecca. Over the centuries various additions and modifications were made to the Masjid-i shah Mosque, and by about 1611 the enlarged *sahn* court was marked by four large *iwan* pavilions on the cross axes, with the two-story arcade enclosing the *sahn* court opened with tall pointed arches that mirror the larger arches that open to the recesses of the *iwans.* The southerly *iwan* leads directly into the large domed prayer hall. This dome, covered with bright turquoise-blue tiles and the tallest feature in the mosque complex, not only has a profile that matches the pointed *iwan* arches but bulges out slightly at the base, creating the prototype of the onion-like dome associated with later Islamic architecture of central Asia and India.

Islamic Architecture in Spain

Far to the west on the isolated peninsula of Iberia (Spain), the Córdoba Caliphate became a center of scientific and literary achievement. An important mosque was built there, replacing an earlier Visigothic church. Begun under Caliph Abd ar-Rahman in 794, the mosque was expanded in 961 and 987, with the addition of several minarets and sections added to the prayer hall.[10] The mosque has a magnificent hypostyle hall, with 856 columns of granite, jasper, onyx, and marble supporting arches of alternated voussoir blocks of red and cream-colored stone [Plate 19]. The horseshoe-shaped arches seem to extend on all sides to infinity, with light wells raised above the parallel ridged roofs to admit light in a seemingly miraculous way. When the Al-Andalus region of Spain was recaptured by Christian forces in 1236, a new cathedral was built on the site, inserted into the very middle of the prayer hall.

Following the recapture of Córdoba, the cultural and artistic focus of Islamic Spain shifted well to the south, to Granada and the court of the Nasrids, the last ruling emirs in Spain. The Alhambra palace complex on an elevated plateau in Granada began as a citadel in the ninth century and later became a fortified residence, but had no systematic geometric planning. After conflicts between branches of the Spanish caliphate brought its political control over Moorish Spain to an end in the early thirteenth century, the Nasrid family emerged as emirs of Granada and made the Alhambra their base, building and enlarging the complex, particularly after Yusuf I became emir in 1333. The architects and skilled artisans employed by Yusuf I and subsequent emirs drew on the full breadth of Islamic design as it had been perfected in Córdoba and elsewhere.

As the Alhambra palace grew, it became the last refuge of Islamic artists and intellectuals fleeing the advancing Christian armies to the north. The new courts and rooms incorporated elements such as the horseshoe arch raised up on tall extensions above the string line (called stilted arches), included a wealth of linear geometric ornamental details in the interiors, and used *muqarnas,* a form of ceiling ornament that resembles nested diminishing stalactites (like sculpted and carved squinches) as they rise to the top of the ceiling. The palace became more organized in rectilinear lines, with passageways leading axially from court to court, each court filled with fountains that added the cooling sound of splashing water to the wealth of visual stimulation. The artistic culmination of the open spaces is the Court of the Lions, measuring 116 by 66 feet (35 by 20 m), with open arcaded side walls of 124 paired marble columns lifting up tall narrow stilted arches [IS-4].[11] Here, as in many other Muslim palaces, the garden is an interpretation of Persian gardens, which themselves are interpretations of the garden of paradise.

IS-4. Court of the Lions, Alhambra Palace, Granada, Spain, c. 1362–1391. A miniaturization of a garden in paradise, this court illustrates the refinement of the Nasrid Emirate in Granada. Photo: Gianni Dagli Orti/ The Art Archive at Art Resource, NY.

Islamic Architecture in India

The religious landscape of India and large portions of southeast Asia were dramatically changed with the spread of Islam from Persia to the south and east. Islamic armies of the Turks and Afghans conquered northern India in the late twelfth century, and an independent Islamic state was declared there in 1206. Mosque building now took the place of Hindu temple building, revealing a fundamental difference in the concept of religious building in northern India. Where the Hindu temple was a vertical mass, a point marker in space, its interior densely enclosed, dark and mysteriously introverted, the newly introduced Islamic mosque had a light-filled court open to the sky and a large covered public place for prayer. The introduction of Islam in Hindu India set up a fundamental conflict that continued into the mid-twentieth century and which, when the British colonial government of the Raj left in 1947, resulted in the confrontational partitioning of greater British India into modern India (Hindu), and Pakistan and Bangladesh (Muslim).

Because the northern region had been invaded by Timur's armies in 1398, there was strong Persian influence in the introduced architecture, including what later became distinctly onion-shaped domes and the pointed "ogee" arch openings. The Delhi Sultanate ruled this Islamic state from 1206 until 1526, when Babur, founder of the Mughal Empire, conquered northern India; his domain extended from Afghanistan to Bengal. By this time a distinctive north Indian Muslim culture had emerged, with Islam established as the official religion, though later Mughal emperors such as Akbar and Shah Jahan encouraged a broad cultural tolerance. Where the traditional teachings of Islam held absolutely firm, however, was in the elimination of figural sculpture from sacred buildings (recall that Hindu and Jain temples had been abundantly coated in layers of sculpted human and divine figures) [p. 276]. Figural painting, however, was permitted in historical and literary manuscripts. In addition, gardens, mirroring the Koranic descriptions of paradise, became a design specialty of the Mughals.

Akbar (full name: Jalal-ud-Din Muhammad Akbar), grandson of Babur, expanded the Mughal Empire and enjoyed a period of relative calm and prosperity, manifested in a series of building projects. Favoring the region of Agra, he relocated his capitol there and undertook construction of a suitable walled community, renaming the city Fatehpur Sikri. Using the red sandstone of the region, Akbar had numerous courts and pavilions constructed between 1571 and 1586. Significant is the Jama Mosque with its large central entrance pavilion and deep *iwan* recess, recalling the mosques of Isfahan, Persia. The wide King's Gate [IS-5] has similar features with notable decorative elements: perched at intervals above the roofs are small, largely ornamental pavilions made up of four corner columns carrying a flat roof slab surmounted by a small dome. Reappearing frequently in Mughal architecture, these small pavilions are called *chattras.*[12]

Shah Jahan, subsequent ruler and grandson of Akbar, was also a prodigious builder, taking advantage of the empire's period of extended prosperity. He particularly favored the ancient settlement of Delhi, which he made his capitol, and where he built the imposing Jama Mosque ("World-reflecting Mosque," 1650–1656).[13] The huge square *sahn* entrance court, lined with an encircling arcade, measures about 377 feet (115 m) to a side, with an ablution tank positioned in the center. The mosque prayer hall proper, along the west side of this court, is about 229 feet (c. 70 m) wide and around 82 feet (c. 25 m) deep. Minarets 130 feet (c. 40 m) tall emphasize its forward corners. Behind the high central *iwan* block rise three marble onion domes.

The last of Shah Jahan's architectural projects, and for many observers the most beautiful building group in northern India, is the striking white marble tomb, the Taj Mahal [8.3]. Built by the bereft Shah Jahan on the banks of the Jumna River near Agra, the building honored his beloved third wife, Mumtaz Mahal, who had died in childbirth. Begun in 1632, the principal building itself was finished in six years, while the garden and adjoining buildings were completed in 1648[14] [8.3]. Bounded by a wall and entered by a large entry gate on the southern edge, the complex contains a broad square garden laid out in a 984 feet (300 m) square, with channels of water on the axes (symbolic of the rivers of paradise) extending out from a slightly elevated pool in the center. Lawns and planted beds fill the four quadrangles. Trees frame flowerbeds, which were originally intended to have various plants producing flowers continuously during the cycle of the seasons. No literate Mughal person entering the garden could have failed to appreciate

IS-5. King's Gate, Palace of Fatehpur Sikri, India, 1571–1586. The palace gate is dotted along its skyline with repeated chattra pavilions*, a building form that became a signature feature of Mughal architecture. Photo: © imagebroker/Alamy.*

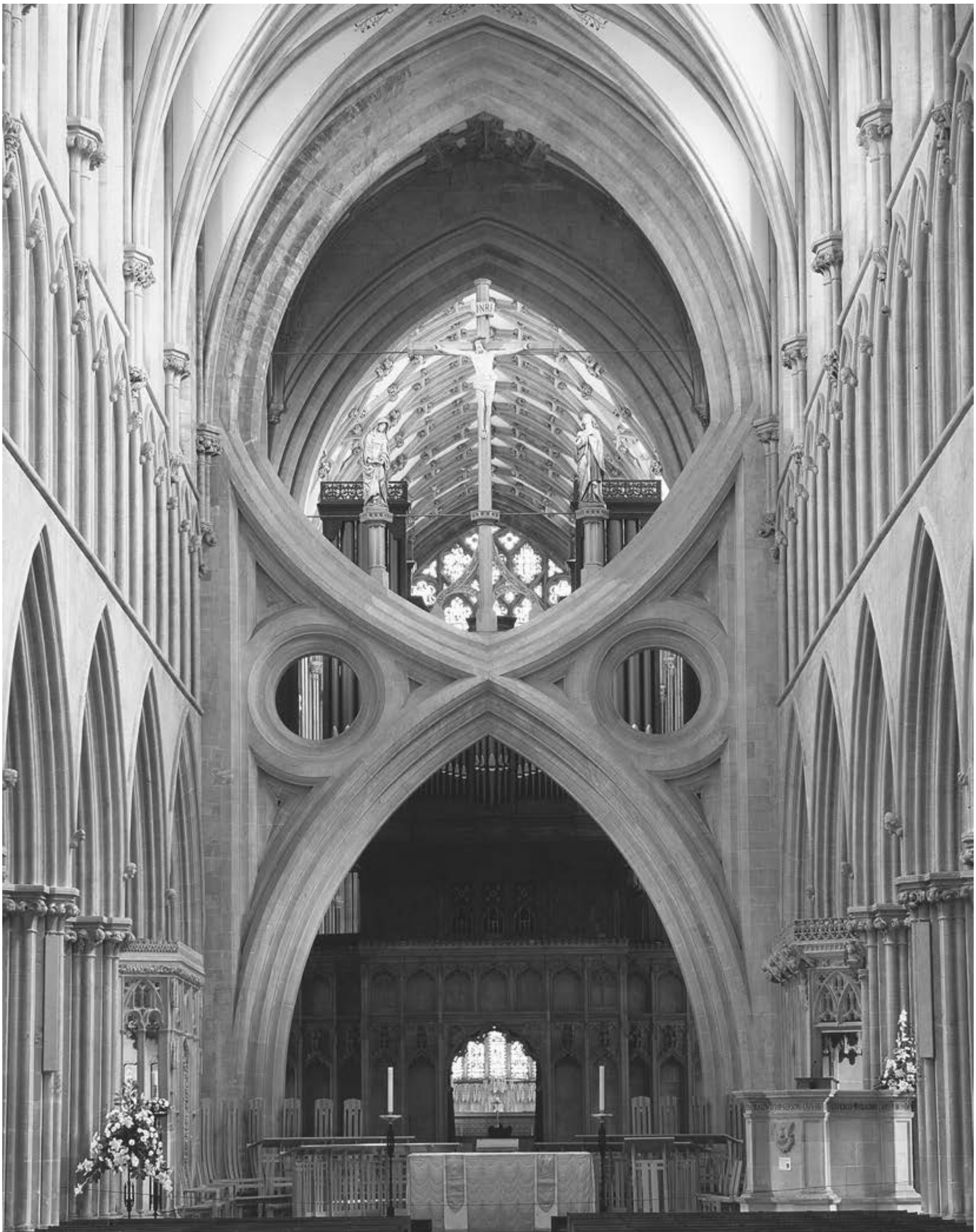
the images of paradise that informed every aspect of the design, for over the entry gate, written out in black marble inlay in a white marble panel, is this passage from the Qur'an:

> But, Oh, thou soul at peace,
> Return thou unto thy Lord, well-pleased, and well-pleasing unto Him,
> Enter thou among thy servants,
> And enter thou My paradise.

At the northern edge of the complex is a raised marble platform, flanked on the west by a mosque and on the east by a meetinghouse, both constructed of red brick with white marble details. Rising between them is the white domed tomb, a masterwork conceived by the shah's architects, Ustad Ahmad Lahauri working with Ahb al-Karim Ma mur Kahn, aided by court calligrapher Amanat Khan. The square mass of the central mausoleum is a symbol of calm and harmony, for it is as high as it is wide, and the height of the dome is the same as that of the arched *iwan* entry block below. The balanced proportions throughout arise from the use of a standard measurement unit called the *gaz* (32 inches, or 81.28 cm); the entire complex measures 374 *gaz* wide and 1,122 *gaz* in length, and everything else is determined by subdivisions of those measurements.

The white marble exterior of the building was embellished everywhere with representations of the flowers of paradise, crafted of inlays of jade, lapis, amber, carnelian, jasper, amethyst, agate, heliotrope, and green beryl. In addition to the ornamental floral and geometrical designs, black marble inlay presents passages from the Qur'an that relate to paradise on the Day of Judgment. In its purity of material and balance of proportions, the Taj Mahal serves as a fitting representation of paradise.

It is said that Shah Jahan perhaps intended to build a similar black marble complex for his own tomb across the river from that of his queen, but he was deposed by his son, Aurangzeb, before this could be carried out. Eventually two white marble sarcophagi were placed side by side within the marble Taj Mahal, and there Emperor Shah Jahan has rested by the side of his beloved Mumtaz Mahal ever since.



14.0. Elias of Dereham, Wells Cathedral, Wells, England, 1174–1490. Wells is unique for its incorporation of inverted arches in the crossing area, countering any tendency for the massive crossing piers to bulge inward. Photo: Gianni Dagli Orti/ The Art Archive at Art Resource, NY.

Chapter 14

Medieval Architecture

The most conspicuous property of Carolingian and Romanesque buildings is their combination of massive enclosure and manifest verticality. . . . So the Romanesque church is simultaneously stronghold and gate to heaven, and the two main building types of the period, the church and castle, are profoundly related.

—*Christian Norberg-Schulz,* Meaning in Western Architecture, *1975*

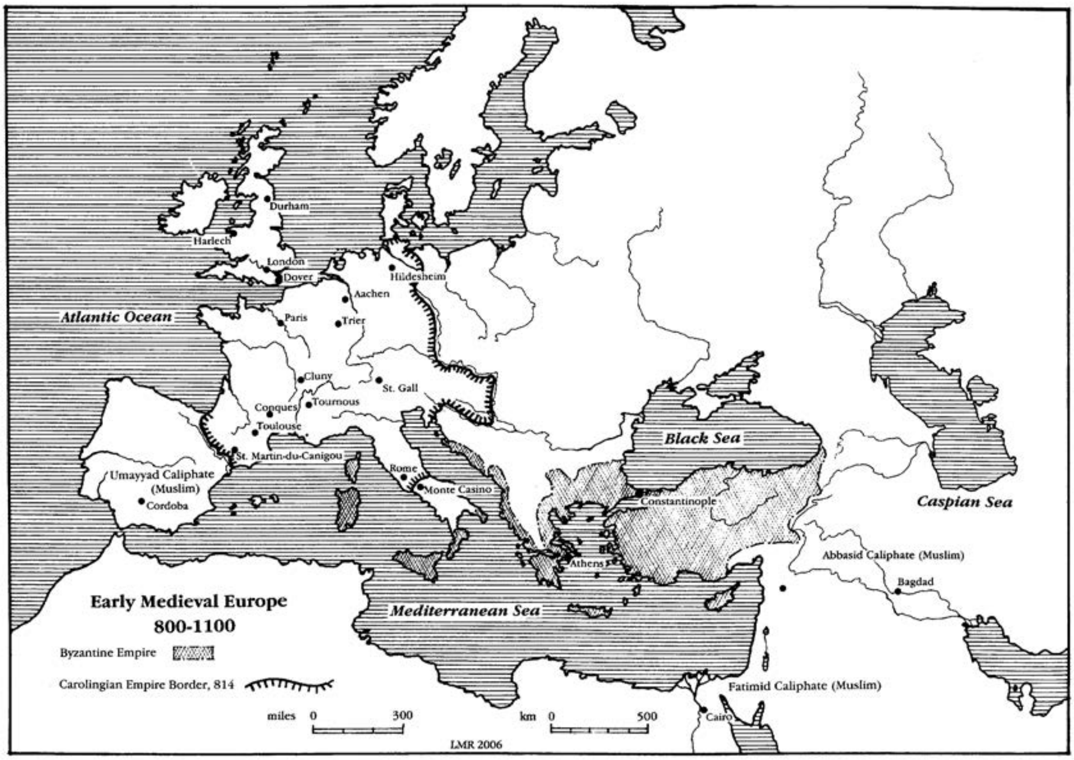
The Gothic church . . . stood for the Heavenly City of Jerusalem . . . [and] was a monument that seems to dwarf the man who enters it, for space, light, structure, and the plastic effects of masonry are organized to produce a visionary scale. There is no fixed set of proportions in the parts, . . . and no standard relationship between solid and void.

—*Robert Branner,* Gothic Architecture, *1961*

Once the Roman Empire ceased to function administratively in the West, there was no central government to commission buildings. Public building nearly stopped during the fifth century and did not resume in any significant way until about 800, with the appearance of Charlemagne. This Carolingian architecture, although consciously built to resemble Roman models, was rather crude compared to the Roman ruins scattered about the old empire. How to carve a true Corinthian capital had been largely forgotten. In the unsettled centuries that followed the end of the Roman Empire, internal divisions and external invasions repeatedly disrupted civil life; civil and religious building forms therefore became both massive defensive refuges from the uncertainties of everyday life and impressive gateways to a promised better afterlife.

The Western church survived the disintegration of the Roman Empire by embracing the hierarchical structure of the Roman political bureaucracy. The bishop of Rome assumed the imperial title *pontifex maximus,* or chief priest, shortened to pontiff or pope, gradually asserting his primacy not only over the other bishops in the West but over kings as well. Charlemagne later was to take crucial advantage of the pope's blessing in creating a new empire in Western Europe. But central international political authority disappeared, and the complex Roman network of public institutions and utilities broke down. Roads fell into disrepair and aqueducts were broken, spilling water over the low country around Rome and causing it to revert to swamp.

The period known as the Middle Ages—as Renaissance scholars would later characterize the long centuries between what they perceived as the enlightened ancient civilization and their own period of renewed humanism during the Renaissance—is now generally divided into three periods: the Early Middle Ages (450 to 1000), the High Middle Ages (1000 to 1150), and the Late Middle Ages (1150 to 1500). The first includes the end of the Roman Empire and the subsequent Dark Age that occurred between 500 and 800 but which ended with the rise of Charlemagne and the Frankish Empire in the ninth century. The next period, the High Middle Ages, was characterized by the development of a more stable feudal system, the gradual resumption of travel and trade across Europe (a resumption that coincided with the eight Crusades against the Muslims in the East), the gradual reemergence of cities as major cultural and economic forces, and the revival of building on a large scale, especially of churches, with an emerging Gothic style in the twelfth century. Despite these positive developments, the High Middle Ages witnessed continued onslaughts by invaders from the north and east.



14.1. Map of Europe, c. 814.

From Hungary came the Magyar horsemen, while from Scandinavia came the Norsemen in their longboats, pillaging coastal and riverbank settlements. The concluding Late Middle Ages were characterized by the maturation of a light and graceful Gothic architecture for church, educational, and private buildings, but this period also experienced the devastation of the Black Death (bubonic plague) and the political turmoil of the Hundred Years' War.

The Early Middle Ages

When the history of the West began to be written in the fifteenth century, Renaissance humanists wrote of the "dark age" that intervened between the glory of Greece and Rome and what they perceived as their own enlightened age. But in actuality, the ten centuries following Constantine's death were not quite the cultural wasteland that Renaissance writers imagined. During those long years, there had been recurrent attempts to recapture something of the accomplishment of the Romans, so that there was a series of rebirths of Classical learning accompanied by efforts to reunite parts of what had once been the Roman Empire.[1]

The Carolingian "Renaissance"

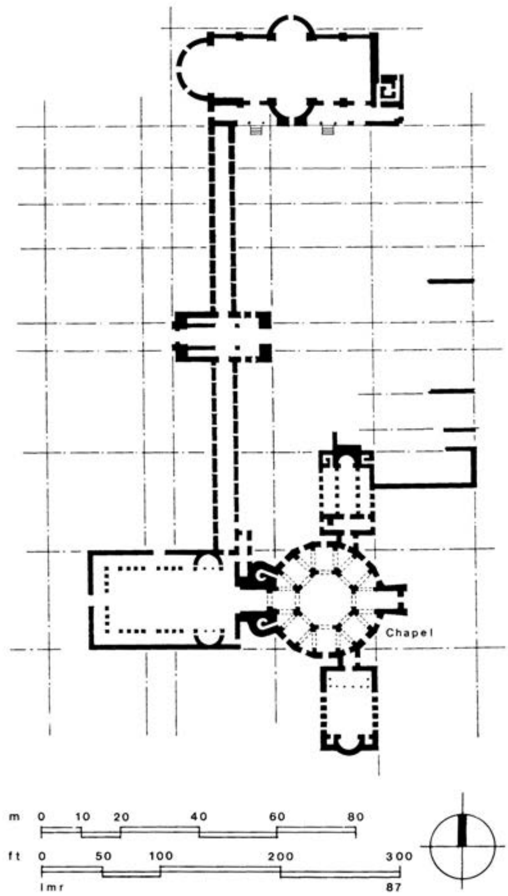
The first of these attempts to recapture the achievements of Classical antiquity was the remarkable Carolingian renaissance in the ninth century. Initiated by Charlemagne, this movement reestablished centers of learning in his Frankish kingdom, which included what is now France and part of Germany and extended down into northern Italy [14.1].

As the Roman Empire crumbled, Europe was divided into individual kingdoms by whichever group was strong enough to take and hold territory. The Visigoths and then the Ostrogoths descended into Italy and ruled for a time until replaced by the Lombards. Central Italy was also controlled for a time by the Byzantine emperor through his deputy or exarch at Ravenna. But meanwhile, the Germanic Franks were pushing westward into northern Gaul, and the Burgundians moved into central Gaul. The Franks gradually emerged as the most powerful of the groups in Gaul under their Christian king, Clovis. In 732, the Franks, under the leader Charles Martel, successfully repelled Islamic invaders at Poitiers, limiting Arabic expansion in

Europe to Spain. Charlemagne (768–814) then consolidated the Frankish areas and extended the borders, absorbing northeastern Spain, central Germany, and the northern Italian kingdom of Lombardy, which extended down to the monastery of Benedict at Monte Cassino. In the annexed territories, entire populations were forcibly converted to Christianity, new churches established, and monasteries founded. Finally, in recognition of his military protection of the pope, Charlemagne was crowned a new emperor by Leo III in 800 at a Christmas Eve ceremony in the Basilica of Saint Peter, Rome.

Charlemagne truly hoped to recapture something of the intellectual achievement of Rome before it could vanish altogether. Although he himself read and wrote Latin imperfectly, he initiated intensive programs to revive Classical arts and letters, setting up schools and putting teams of scholars and scribes to work copying old manuscripts. In copying these works, the Carolingian scholars and scribes developed a clear, rounded form of calligraphy that was later revived by fifteenth-century Renaissance printers and formed the basis of our modern lowercase letters added to the Latin uppercase (capital) characters.

Charlemagne and his court traveled from one royal residence to another in the area of northern France, Belgium, and northwest Germany, and hence there was no single fixed capital; but the principal city of residence was Aachen (Aix-la-Chapelle), west of Cologne and the Rhine. Aachen quickly became the cultural center of Europe. In this city, the revival of Roman architecture resulted in the construction of an octagonal palace chapel modeled closely on the imperial Byzantine Church of San Vitale in Ravenna. Designed by Odo of Metz, it was built of cut stone in 792–805, and its central vertical space was covered with a stone vault, a building tradition that by then had almost been lost [14.2, 14.3].

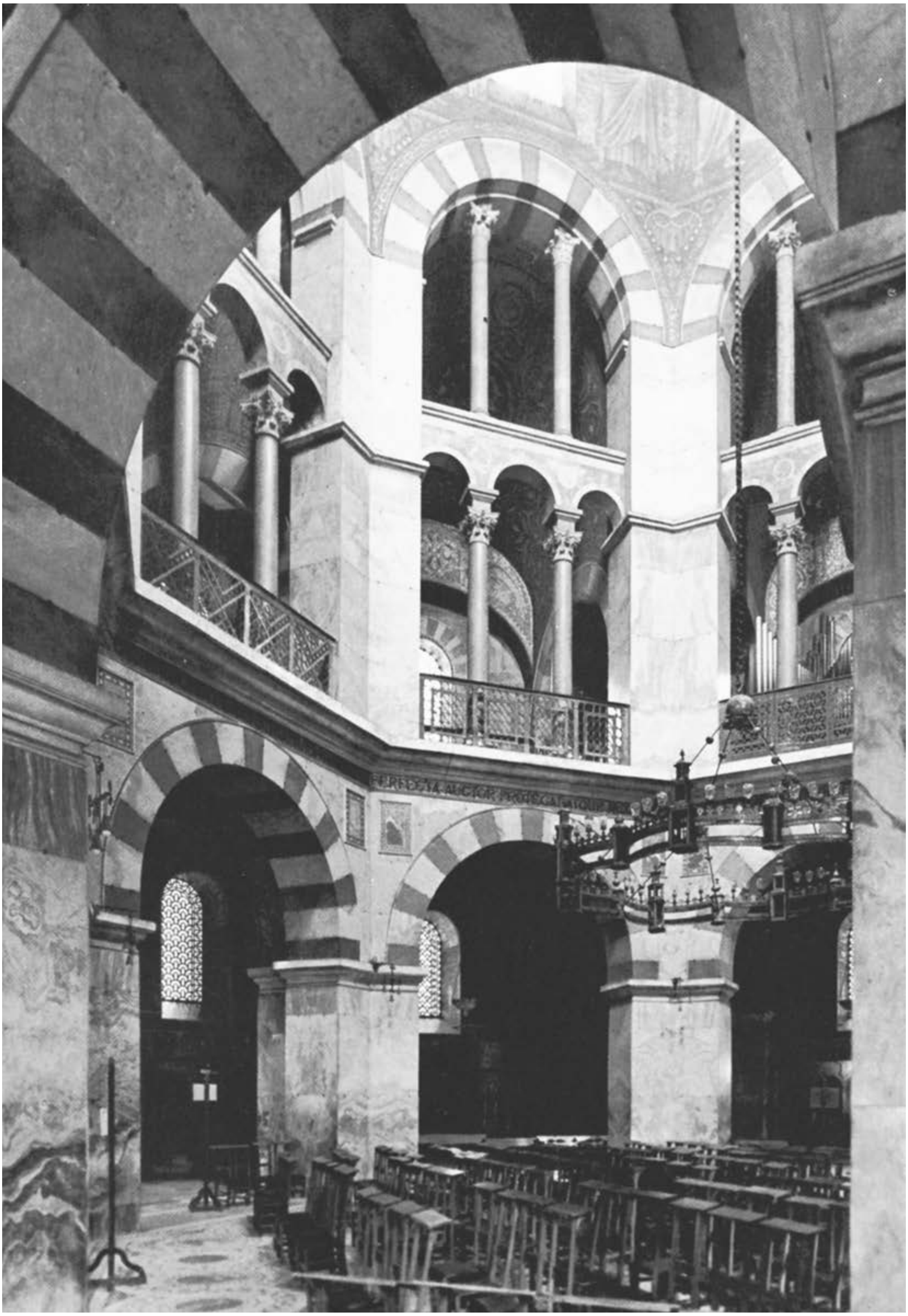


14.2. Palace of Charlemagne, Aachen, Germany, c. 790–810. Plan. Although new buildings replaced this during the Gothic period, fragments of the Audience Hall and connecting hall survive, and the interior of the palace chapel remains nearly intact. The dotted lines indicate probable locations of original walls of Charlemagne's palace. Drawing: L. M. Roth.

Early Medieval Domestic Architecture and Castles

During the period of Charlemagne's Frankish Empire, the basis was laid for the feudal system and rural manorial life that came to characterize the rest of the Middle Ages. The allegiance to a distant central government and a single emperor—a system that had prevailed during the Roman Empire—was replaced by a more regional pyramidal system of direct personal contracts, in which a vassal pledged service to a lord, and farmers pledged their farm production to their vassal ruler, and so on down to the lowest peasant. Cities shrank in upon themselves as productivity shifted to the manors and fortified villas in the countryside; these manor houses, in turn, became the focus of small, rural villages. The minting of coins for an urban money economy ceased, replaced by an agrarian barter economy.

Along with the wood-framed manor house, the other major form of domestic construction was the castle. At first, the castle took the form of a *motte* ("mound" in Old French) and then a *motte and bailey* ("walled enclosure"), beginning about 750 during the time of Charlemagne [14.4]. Atop the motte—either a natural hillock or purposely heaped-up earth—a wooden tower structure was built, serving as both a place of refuge and a residence of the local



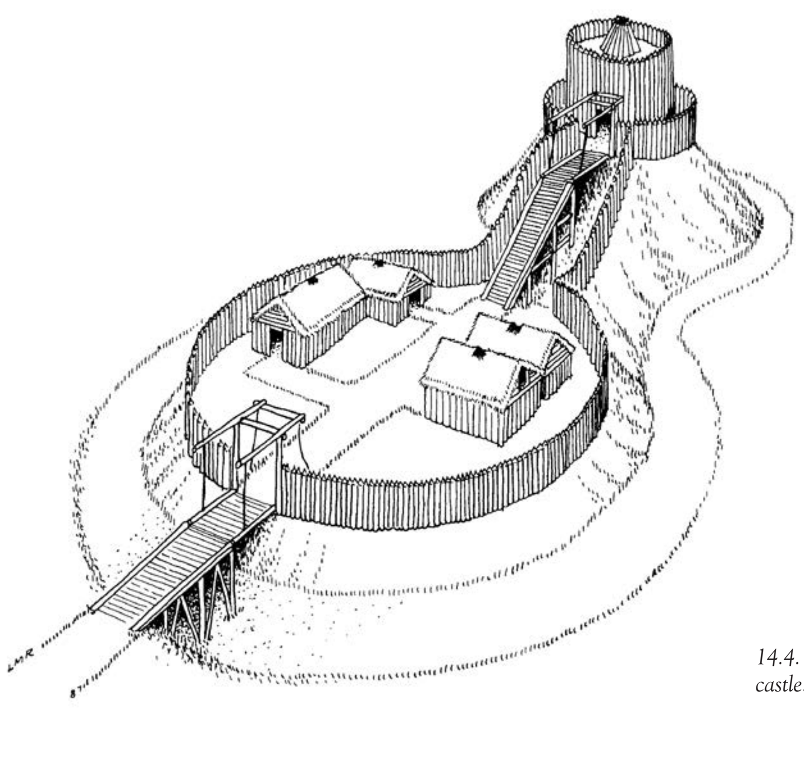
14.3. Odo of Metz, Palace Chapel of Charlemagne, Aachen, Germany, 792–805. Interior. The interior, little touched since Charlemagne's time, shows the clear debt to the Church of San Vitale in Ravenna. Photo: Dr. Harald Busch, Frankfurt am Main.

lord. Attached to the base of the motte, in time, would be a *bailey* containing storage buildings, workshops, and assorted houses, all of wood, and protected by a wooden palisade. The bailey and palisade might be further protected by a surrounding ditch, either dry or water-filled. Although the remains of many of these mounds survive, the wooden structures long ago disappeared. With a view to increasing security, the wooden towers of such castles were later rebuilt as stone *keeps* beginning about 1000. Sometimes the stone keeps were built directly on the ground and not on an elevated mound. These keeps were usually square, or nearly so, although there were also numerous cylindrical keeps, with four or more floors of storage cellars and living quarters stacked atop each other. The walls were up to 15 feet (4.6 m) thick at the base. The keeps were entered by means of a wooden ramp or stair up to the second level (perhaps this accounts for the European practice of calling this the first floor, distinguishing it from the lower, ground floor). The keep of Dover Castle, built by Henry II in the 1180s, is a later, similar example [14.5].

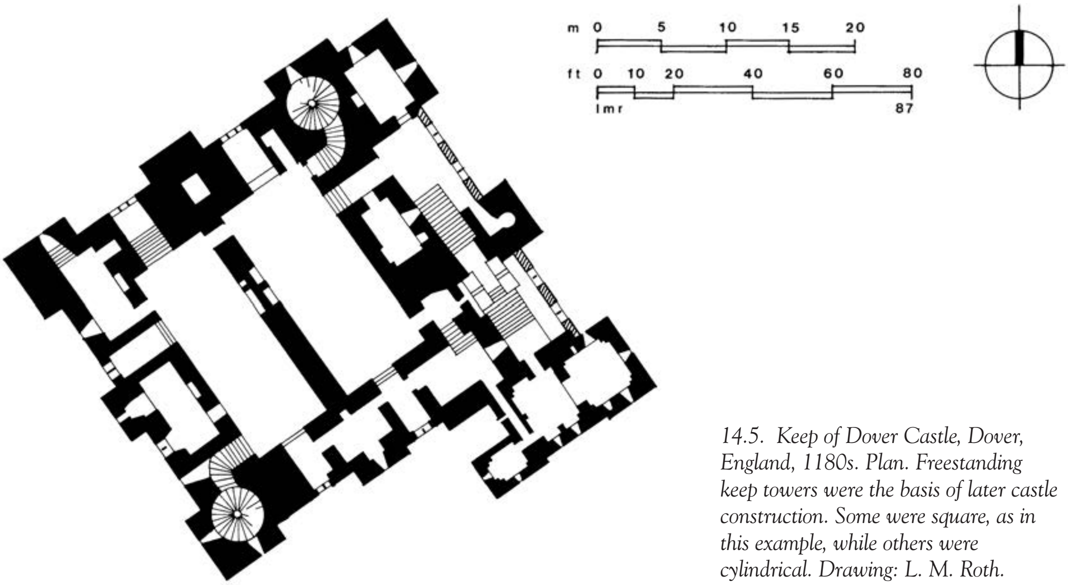
As improving economic conditions permitted more elaborate construction, the baileys adjacent to the keeps also were ringed with stone walls, and eventually the keep was pulled entirely inside the fortified perimeter, becoming the *donjon,* resulting in the walled, or *mural,* castle typical of the twelfth century. Then the outer walls became punctuated by projecting towers spaced at regular intervals determined by the range of bowshot, so that through raking fire from the towers, attackers could be kept from scaling the walls. The keep at Dover Castle came to be surrounded by two such fortified concentric walls, resulting in an inner bailey and an outer bailey [14.6]. Around the outer bailey wall would be a dry or wet moat if the castle sat on a natural prominence or next to a body of water. Immediately next to the principal gate into the inner bailey would be a smaller enclosure, the *barbican,* which forced attackers to expose their unshielded right sides to archers on the battlements atop the bailey wall.

Castle Architecture in Later Periods and the Impact of the Crusades

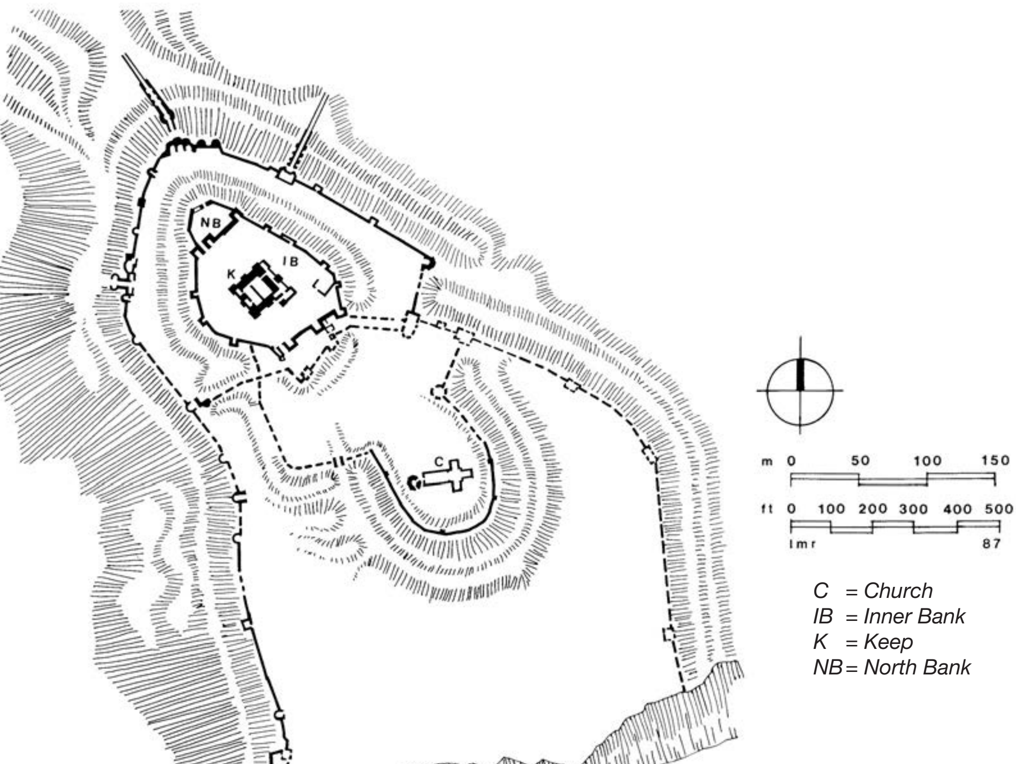
Many later innovations in European castle design were inspired in part by what the Crusaders saw of the fortifications around Constantinople (their stopover on the way to the Holy Land) and also from what they learned of fortifications built by the Muslims, today in Turkey, Syria, and Israel.[2] The efforts by various impromptu European armies to recapture and hold the Holy Land—the Crusades—and forcing the Muslim conquerors to withdraw, were militarily unsuccessful in the long run: no surprise



14.4. View of a motte and bailey castle. Drawing: L. M. Roth.



14.5. Keep of Dover Castle, Dover, England, 1180s. Plan. Freestanding keep towers were the basis of later castle construction. Some were square, as in this example, while others were cylindrical. Drawing: L. M. Roth.



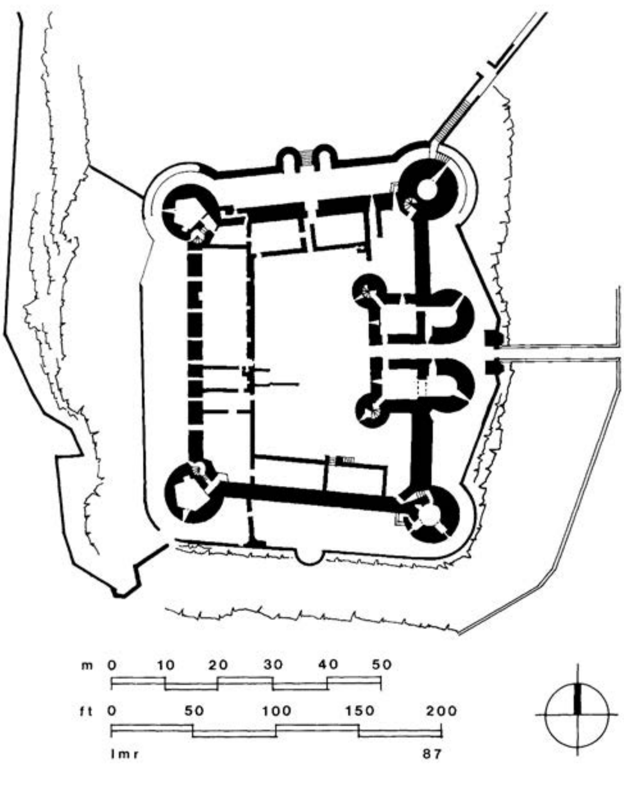
14.6. Dover Castle. Plan of castle complex, showing inner and outer baileys. Drawing: L. M. Roth, after Brown, The Architecture of Castles *(New York, 1984).*

14.7. Krak des Chevaliers, near Tartus, Syria, 1142–1170. This fortress, built by the Knights Templar, was held by them with a garrison of perhaps two thousand men until being taken by Sultan Baibars's army in 1271, though reportedly through deception and not by siege or breaching. Photo: Gianni Dagli Orti/The Art Archive at Art Resource, NY.

considering the distance of Palestine from the European German states, or France, much less England. The First Crusade, 1095–1099, was the most militarily successful, resulting in the conquest of some limited territory in Palestine and Syria. This advance was followed in 1147–1149 by the Second Crusade, when the previously won eastern territories were further fortified. The repeated appearance of these European armies of knights and peasants (there were nine separate waves of crusaders over the two centuries from 1095 to 1272), together with the recurrent atrocities carried out on both sides as Catholic and Muslim armies clashed, created a mutual distrust and hatred between the feuding cultures that has had ramifications even into the twenty-first century. The Crusaders were impressed and influenced, however, by both the Byzantine and the Muslim fortifications they encountered, such as at Kaisariyya (now Kayseri), Tarsus, 'Ayn Zarbā (now Anavarza), Tall Bāshir (now Tilbaşar Kalesi), Edessa (now Şanlı Urfa), Antioch, Ma'arrat al-Nu'mān, Ṭarṭūs, 'Arqā, Tyre, and Acre. This had an immediate impact on the construction of new fortifications by the Crusaders themselves, such as those at Belvoir (*Ar.* Kaukab) in Israel and Chastel Pèlerin (*Ar.* 'Athlīt), Saphet (*Ar.* Ṣafad), Margat (*Ar.* Qal'at Marqab), as well as the best preserved of all, the famous Krac des Chevaliers (*Ar.* Qal'at al-Ḥiṣn) in Syria [14.7]. These examples rapidly accelerated the perfection of castle construction back in Europe.

The European masons building castles in the Holy Land adopted Muslim improvements that, soon after, they incorporated in the castles they built upon returning to their homelands. One castle of this type, so clear and functional in form that it can serve as the symbol of them all, is Harlech Castle, built in 1283–1290, on the west coast of Wales, on a promontory overlooking the Irish Sea [14.8, 14.9]. Its pentagonal plan bears a striking similarity to the layout of the Crusader castle called Belvoir in northern Israel begun in 1168 by the Knights Hospitaller. One of the many castles built by Edward I in his conquest of Wales, Harlech Castle was designed by James of Saint George, who also had charge of the

14.8. *James of Saint George, Harlech Castle, Merionethshire, Wales, 1283–1290. Aerial view. This shows the typical configuration of medieval mural, or walled, castles, with towers (spaced at bow-shot intervals along the walls), double-tower gate, and a central keep, or donjon. Photo: Aerofilms, London.*



14.9. *Harlech Castle. Plan. Drawing: L. M. Roth, after Brown,* The Architecture of Castles *(New York, 1984).*

king's other Welsh castles. James had at least four major works in progress at all times between 1277 and 1300, and up to twenty-five hundred workmen toiling at each site. With a trapezoidal plan adjusted to the rock outcrop on which it sits, Harlech Castle has enormous drum towers at the corners and a twin-towered gatehouse. Inside, there was a granary against the south wall, a kitchen in the southwest corner, with the main hall north of it, and a chapel built against the north wall. Within another century, however, such castle building came to an end, as the introduction of gunpowder made these exposed artillery targets obsolete. Yet the basic castle shape—a rectangular solid or a hollow, marked by corner towers and a prominent central gate tower—was to remain a model of ideal residential form, particularly in France, well into the Renaissance and Baroque periods.

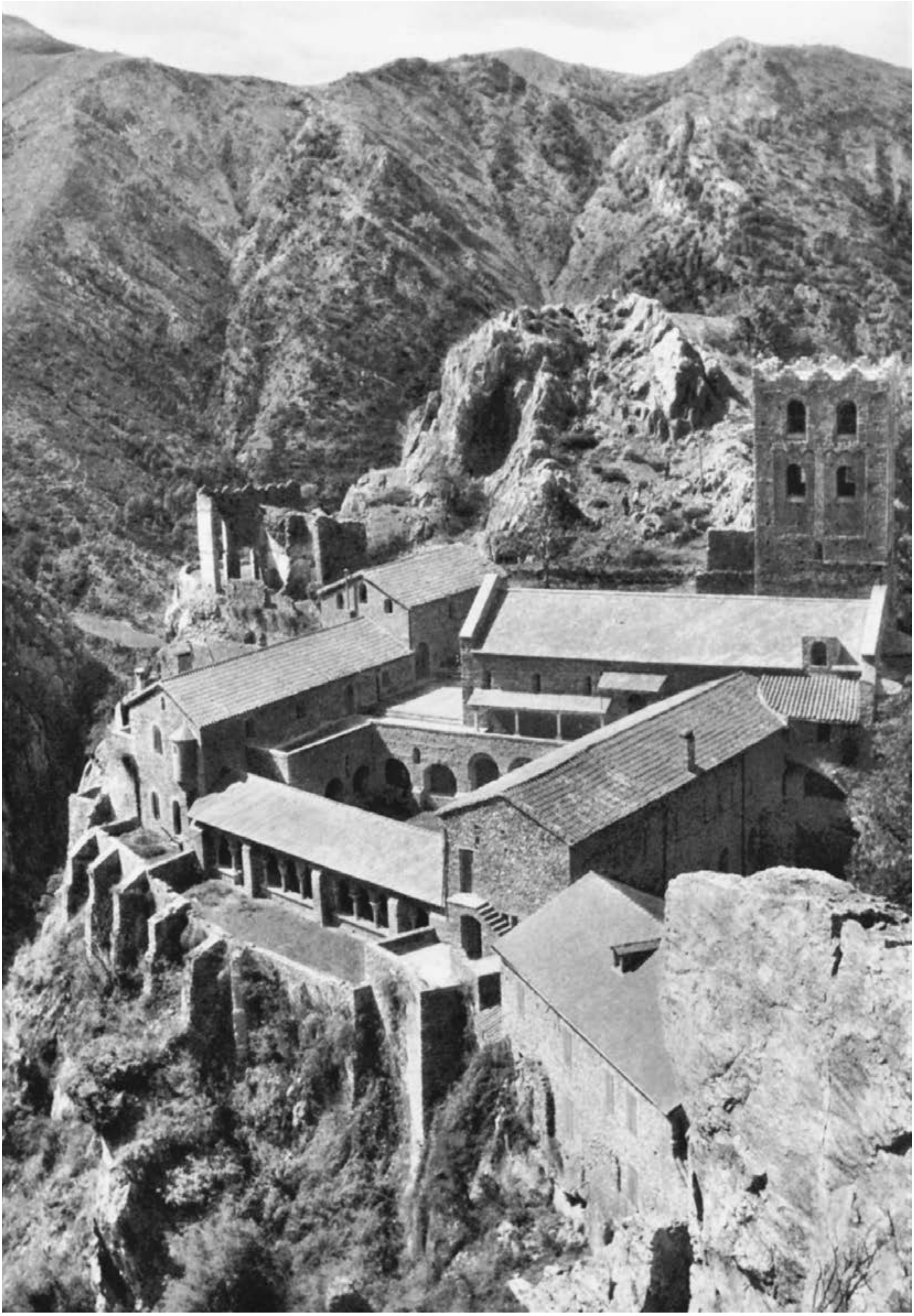
Medieval Monasteries from 800 to 1100

Aside from military construction and the residential facilities associated with it, nearly all other major building activity during the Early Middle Ages involved religious structures. Monastic communities flourished, requiring the development of new building complexes. Although some monastic communities appeared spontaneously, most adopted the *Rule for Monasteries,* written by Benedict of Nursia, and patterned themselves on the monastery he had founded atop Monte Cassino in central Italy in 529. These monasteries provided throughout the West the stabilizing international influence that had formerly been exercised by the Roman government bureaucracy. To the monasteries came men and women who sought to serve God; pledging celibacy, poverty, and obedience, the monks and nuns spent their days reciting the prescribed sequence of prayers, studying and copying manuscripts, guided by their abbot or abbess in a life of piety and manual labor. Gradually, the monasteries became the repositories of sacred, ancient pagan, and even Arabic texts. They became places of refuge from uncertainty in the outer world and the recipients of gifts of land and buildings from local lords seeking absolution from sin or the assurance of heaven. As a result, monasteries came to function as the political, cultural, and agricultural centers of their surrounding regions.

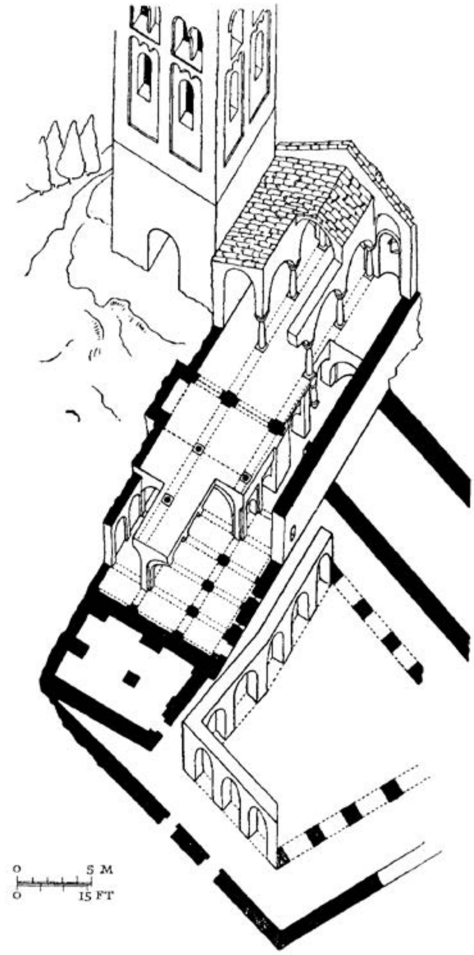
Saint-Martin-du-Canigou. The monastery of Saint-Martin-du-Canigou illustrates well the quality of isolation that monks sought [14.10, 14.11, 14.12]. Built at the top of a steeply sloped, rocky knob in the lower slopes of the French Pyrenees above Prades, it is reached only after an arduous forty-five-minute climb on foot. A small monastery, its irregular plan was adjusted to the site. It was built from 1001 to 1026, under the direction of a monk, Sclua, who became its first abbot. It was paid for by Guilfred, Count of Cerdagne, who eventually left his family and lived in seclusion in the monastery during the last years of his life. It has two church sanctuaries, one atop the other, with the upper church covered by three narrow parallel barrel vaults over both aisles and the nave; the center, or nave, vault is not quite 10 by 40 feet (3 by 12 m). Lighting is dim, for the only windows are at the ends of the barrel vault, illustrating clearly the low levels of illumination that customarily resulted from using barrel vaults.

The Saint Gall Monastery Plan. Lacking an established, far-flung administrative bureaucracy such as the Romans had employed, Charlemagne relied on a network of Benedictine monasteries to run his Frankish Empire and to provide a stabilizing influence across his extended domains. This accounts for the importance of a meeting of monastic officials in about 814, just prior to his death. Summing up the discussions at the conference, Abbot Haito of the monastery at Reichenau (on the German-Swiss border) prepared a diagrammatic plan of a model monastery. He sent the plan to his friend, Abbot Gozbertus of the monastery at Saint Gallen, or Saint Gall, Switzerland (then part of the Carolingian province of Alemanni), for Gozbertus had been unable to attend.[3] The drawing is a most remarkable document, for it is the oldest such architectural plan to survive from the Middle Ages. On several sheets of parchment, stitched together to form a rectangle roughly 44 by 30 inches (112 by 77 cm), was drawn a comprehensive plan of the ideal monastery scheme [7.6, 14.13].

The principal building was a large church, filled with altars for the use of seventy-seven monks and oriented west to east, facing toward the Holy Land and the rising sun. On the sunny southerly side were to be (clockwise) a dormitory for the monks so arranged that they could easily pass into the church for the first prayers of the day at 4:00 a.m.; next to that the refectory for meals; and to the west a cellar for food and beverages, with offices above. These three buildings, together with the church, enclosed a cloister court, ringed with a portico for easy circulation whatever the weather. Clockwise around this central cluster were service buildings for the religious and for visitors, since monasteries served as "hotels" during the Middle Ages for the



14.10. Monastery of Saint-Martin-du-Canigou in the French Pyrenees, 1001–1026. Aerial view. Secluded in the rugged mountains of southwestern France, this monastery illustrates well the isolation from worldly distractions that early medieval monks sought. Photo: From Gustav Künstler, ed., Romanesque Art in Europe *(Greenwich, CT, 1968).*



14.11. Saint-Martin-du-Canigou. Cutaway perspective, showing the organization of the monastery church. Photo: From Kenneth J. Conant, Carolingian and Romanesque Architecture, 800 to 1200 *(Harmondsworth, England, 1966).*

few travelers there were. Opposite the west end of the church was the principal public entrance. Along the north perimeter were dining and sleeping buildings for guests, a school, and the abbot's private residence. Along the east side were the physician's residence and a large infirmary for both monks and novices, bisected at its center by two chapels back to back. Next to this was the cemetery, which also served as an orchard, and gardens that supplied the kitchen with vegetables and the infirmary with herbs and medicinal plants. Along the south edge were the kitchen facilities, including a threshing barn, a granary, a bake house, a brew house, shops, and a cooperage. To the west of this, farming operations were housed, including stables for sheep, pigs, goats, horses, and cattle, along with housing for farm workers. This plan would remain the conceptual blueprint for monasteries thereafter.

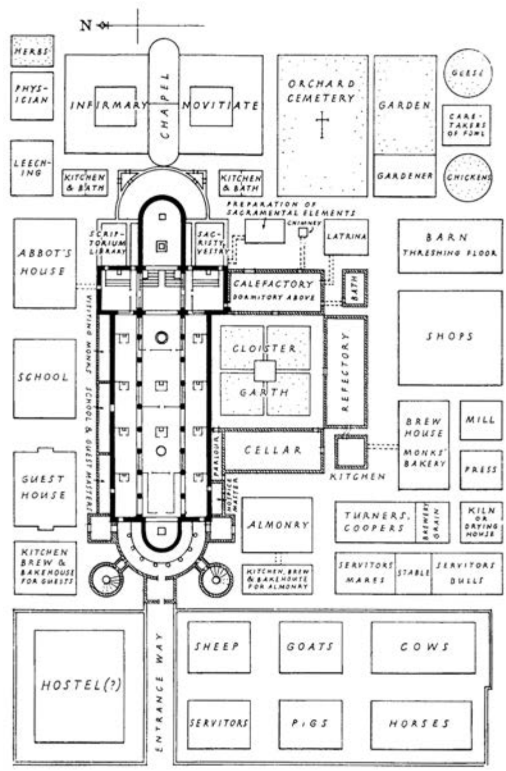
The Monastery at Cluny. How this ideal scheme came to be realized in an actual monastery is well illustrated by the example of Cluny. The monastery at Cluny, in southern Burgundy near the Saône River, was founded in 910 by William the Pious, Duke of Aquitaine. A Benedictine community, Cluny early focused its energies on restoring liturgical purity and effecting church reform, advocating papal authority over all priests and bishops, denouncing the practice of clergy keeping concubines, and attacking simony, or the sale of church offices. Soon, Cluny became the center of a strong reform movement, and eventually, more than fifteen hundred daughter Cluniac monasteries devoted to extending monastic and church reform were founded throughout Europe. Within a century, the measures advocated by the Cluniac reformers were embraced and promulgated by the papacy. For these reasons, the mother abbey at Cluny came to be seen as the most important in the West, and its influence was international. It also grew rapidly and prospered handsomely through gifts of land.

In 915–927, the first church at Cluny was built, but by 955 this was replaced by a larger building. At that time, there were seventy permanent monks, but by 1080, only forty years after the completion of the second church, there were two hundred professed monks and another new building was required. Thus, in 1088–1130, the last and largest complex, Cluny III, was built under the direction of Abbot Hugh and designed by Gunzo, a cleric who was also a mathematician and a musician [14.14, 14.15]. Much of the initial cost of this last building campaign was paid by the king and queen of Castile and León in Spain as a thanks offering for the Christian recapture of Toledo in 1086 from the Muslims.[4] Regrettably, in the anticlerical frenzy following the French Revolution, the great monastic community at Cluny and its vast church were almost utterly demolished, but the prolonged research of Kenneth Conant has yielded a picture of Cluny as clear as if the monastery still operated.

Here, too, the church was oriented west to east; in front of it were the principal gate and an approach court. The church itself had large western towers and a narthex of five bays (nearly as long as many entire churches). Beyond this, through the great portal, was the long nave with two side aisles, ending with a curved *chevet* with five radiating

14.12. Saint-Martin-du-Canigou. Interior of upper church. Although perhaps conducive to meditation, the darkness of the interior shows the problem in creating openings in barrel vaults. Photo: Foto Mas.

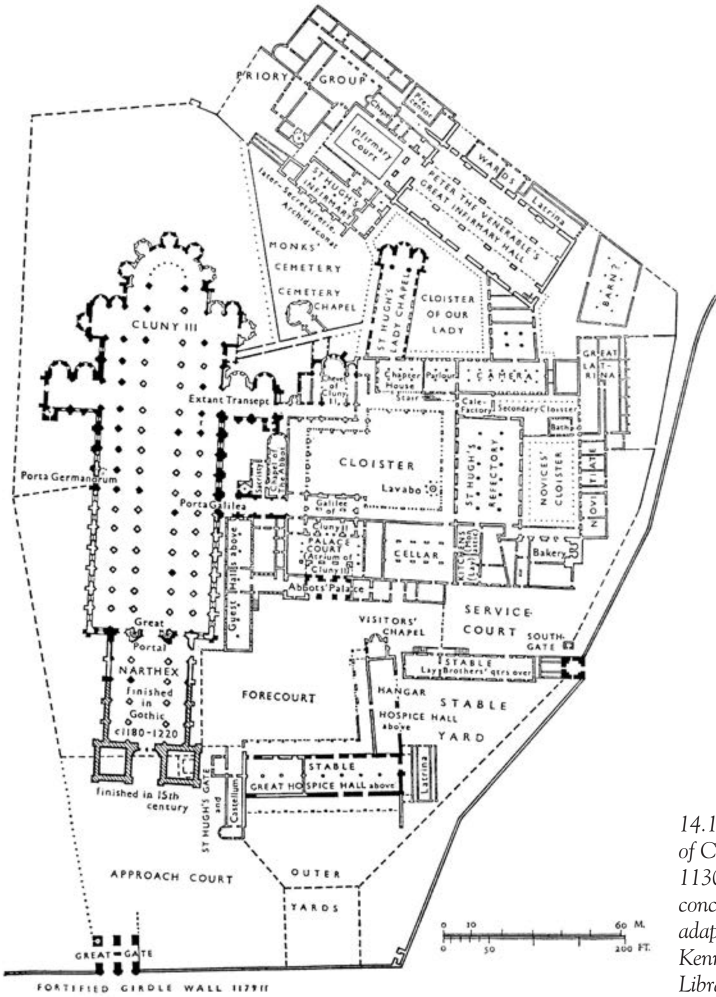
chapels. Altogether the huge church complex was almost 614 feet long (187.1 m) from its west towers to the radiating chapels, comparable in scale to the enormous Constantinian basilicas in Rome. South of the west towers was a stable, with a hospice above for visitors, and south of the narthex was a forecourt ringed with other facilities for visitors and lay brothers. South of the main body of the nave was the cloister enclosed by storage cellars and the abbot's residence to the west, the monks' refectory and kitchen to the south, and chapels and chapter house to the east. Running at an angle to the east of the cloister and church was a large infirmary complex. Hence, with the exception of specialized chapels and other buildings specific to this monastery, the general layout corresponds in the disposition of its main parts to the Carolingian diagram preserved at Saint Gall.



14.13. Plan at Saint Gall Monastery Library, Saint Gall, Switzerland, c. 814. Diagrammatic plan of layout of the various buildings. From Kenneth J. Conant, Carolingian and Romanesque Architecture, 800 to 1200 *(1966).*

Romanesque Churches

As political conditions became marginally more settled across Europe after 1000, building activity flourished, particularly the construction of churches. Yet the memory of invasions in more uncertain times was fresh enough to encourage buildings in which structural masses dominated over void and in which windows were kept small. The memory of Rome lingered as well, especially in southern France, where many Roman ruins served as models, so that the sturdy piers and round arches of the newly emerging

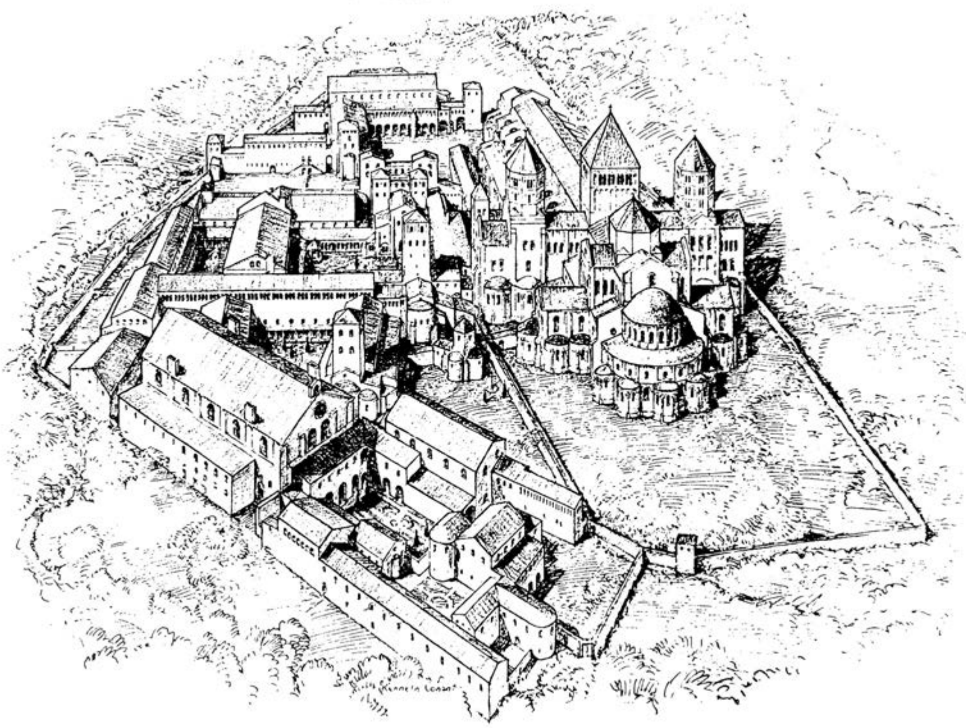


14.14. Gunzo (architect), Monastery of Cluny III, Cluny, France, 1088–1130. Plan. The plan shows how the concept of the Saint Gall plan could be adapted to a specific setting. Drawing: Kenneth J. Conant; courtesy of Loeb Library, Harvard University.

architecture attempted to recall the substantial presence and clear circular geometries of Roman construction. This is one reason why the massive, round-arched architecture of the period 1000 to 1150 came to be called Romanesque.

Saint Michael's, Hildesheim. The massiveness of Romanesque architecture is well illustrated in the monastic Church of Saint Michael, built as an offering by Bernward, bishop of Hildesheim, in north-central Germany [14.16, 14.17]. Built in 993–1022 just north of Hildesheim, it was unprotected by the town walls, accounting perhaps for its relatively small windows at ground level and its walls being more than five feet thick. It was what Martin Luther might have described later as *eine feste Burg,* "a mighty fortress," for the attacks of the Hungarian Magyars and Nordic Vikings were only just ending during this time. That massiveness and sense of security reflect the uncertainty of temporal life, paralleled in the passage from the Gallican, or French, liturgy. In France, the moonlight raids of the Vikings, who slipped silently upriver in their shallow-draft longboats, were an ever-recurring danger, so the faithful clung to this prayer: "Let not our own malice within us, but the sense of thy long suffering be ever before us, that it may unceasingly keep us from evil delights and graciously guard us from the disasters of this night."[5]

Saint Michael's, severely damaged during World War II but now carefully restored, is a modified basilican plan, whose basic pattern is very similar to that suggested in the Saint Gall plan. Not only does Saint Michael's have an eastern transept with

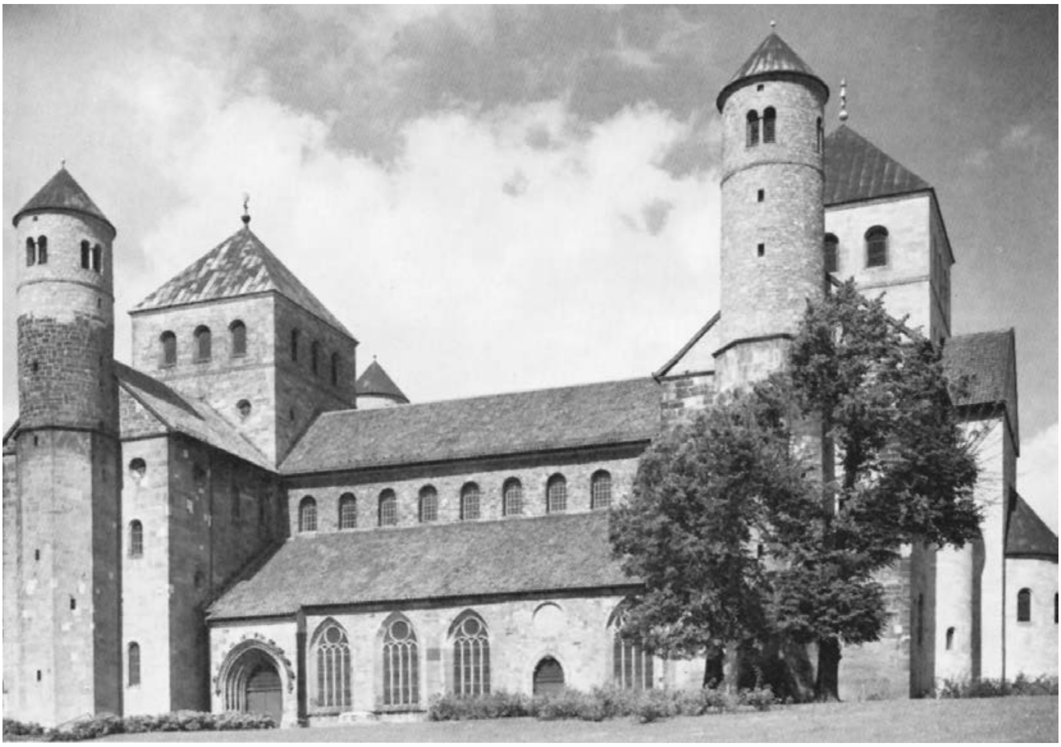


14.15. Cluny III. Aerial perspective. Although much larger than the Saint Gall scheme, the placement and relationship of the numerous buildings at Cluny are nearly the same as shown in the Saint Gall diagram. Drawing: Kenneth J. Conant; courtesy, Loeb Library, Harvard University.

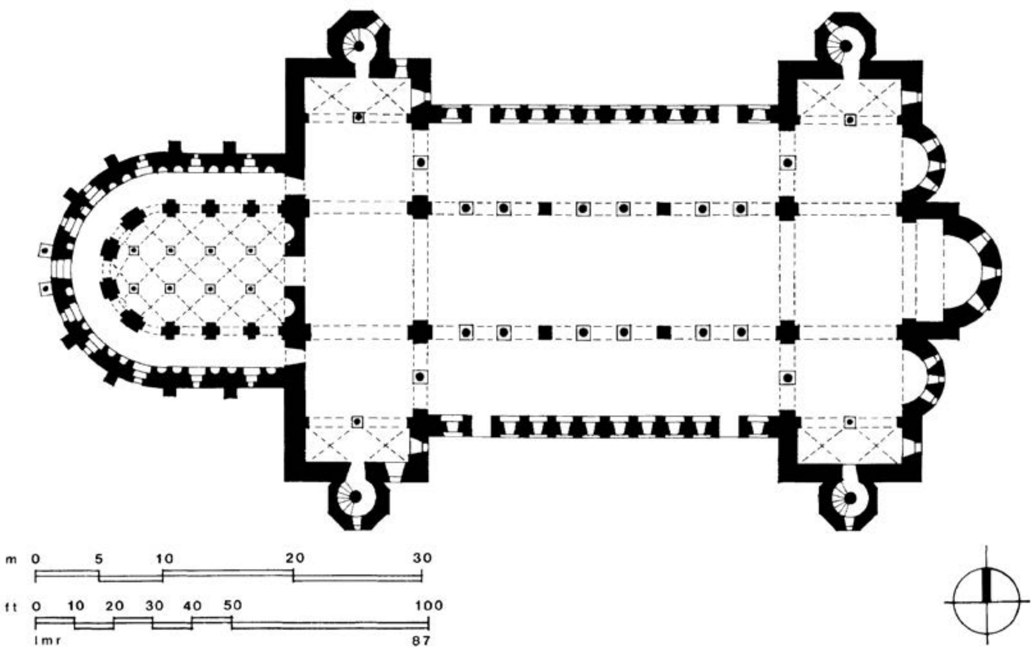
small apses flanking the larger traditional one in the center, but there is a western transept as well, connecting to a large chapel-like apse, where the main altar may have been placed (in German medieval churches, this came to be called a westwork). The eastern apses and the double transepts provided for as many as twenty-five altars where various relics could be displayed and where the monks could say Mass during the course of each day. For the same reason, the monastic church at Cluny had two transepts and a wealth of apses, also originally housing multiple altars.

Romanesque Pilgrimage Churches. Although many religious buildings were paid for by the tithes exacted from peasants and freemen, the two centuries after 1000 were also marked by genuine piety and religious fervor and an upsurge in contributions for religious buildings, especially after the reforms advocated by the Cluniac clergy began to have effect. People of the High Middle Ages, whether farmwife, cleric, knight, princess, or bishop, lived far more in anticipation of the next life than Europeans or Americans generally have since that time. An eternal life of damnation or bliss in heaven was very real for medieval people, and the sculpture that began to embellish the portals of monastic churches served to crystallize their aspirations. An integral part of the architecture, such sculpture served a practical, instructive function for a population that was largely illiterate, including many parish priests who could read only enough Latin to get through daily Masses.

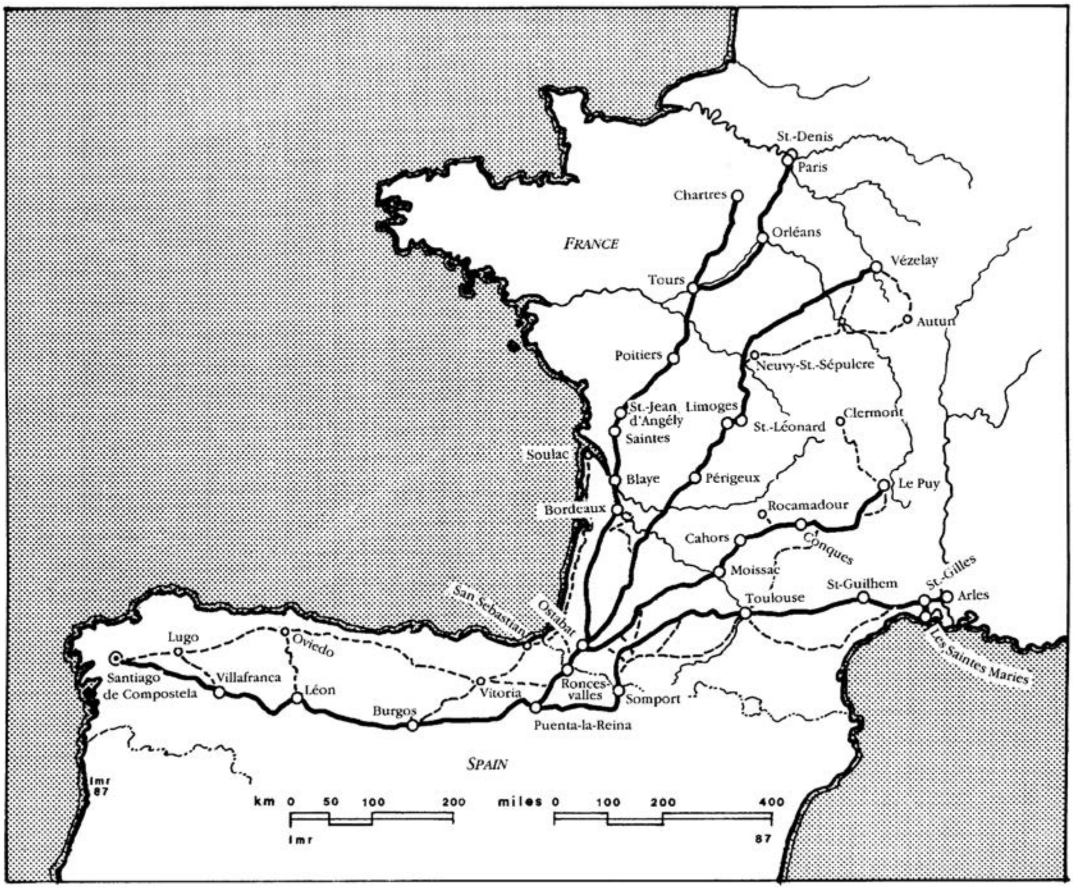
The gradual decrease in attacks from outside forces such as the Vikings and the growing sense of personal security were matched by a rise in religious fervor in the tenth through twelfth centuries. This religious fervor was especially focused on the cult of relics, in which the bones of saints and martyrs, encased in bejeweled and gilded reliquaries, were believed to effect miraculous cures. As travel became more feasible with more settled political conditions, the faithful began to undertake traveling to churches and sites where there were relics reported to work cures. Those churches and monasteries that found themselves lacking suitably powerful relics went to great lengths to get them—even to the point of



14.16. Monastery Church of Saint Michael, Hildesheim, Germany, 993–1022. View. Because this was built outside and north of the walls of the city, the church has massive stone walls to withstand attack. Yet the towers point heavenward, so that the church is both a stronghold and a gate to heaven. Photo: A. F. Kersting, London.



14.17. Church of Saint Michael, Hildesheim, Germany. Plan. The double ends of the church show the impact of ideas crystallized in the Saint Gall plan. Drawing: L. M. Roth.



14.18. Map of the medieval pilgrimage routes, 1000–1250. Drawing: L. M. Roth, after Kenneth J. Conant.

stealing them from other churches or monasteries. Typically, the French churches of the tenth through twelfth centuries were dedicated to local saints—namely, Gauls who had been executed in the periodic Roman persecutions, becoming early martyrs for the faith.

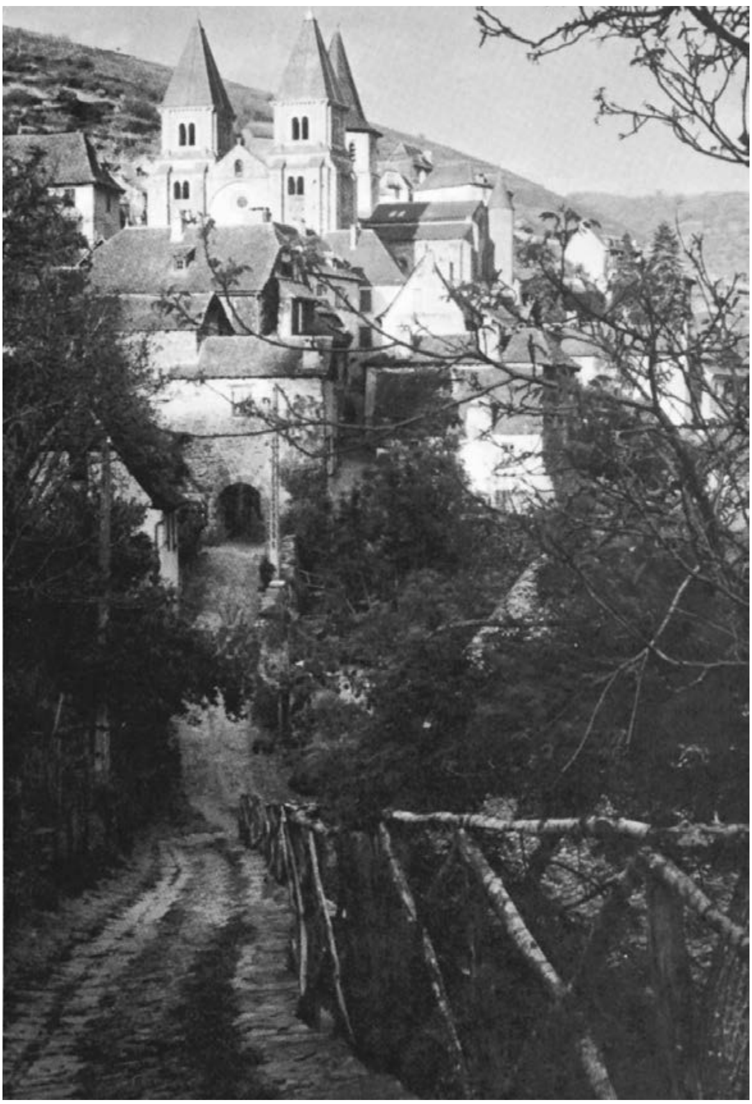
The pilgrimage journey itself was nearly as important as visiting the churches, for the pilgrims developed a spirit of comradeship that made the long and arduous trek more pleasant. Although the fourteenth-century pilgrimage described by Geoffrey Chaucer is of a later time and in a different land, his *Canterbury Tales* reveal much of the life of the people who undertook them:

> When April with his showers sweet with fruit
> The drought of March has pierced unto the
>   root
> And bathed each vein with liquor that has
>   power
> To generate therein and sire the flower, . . .
> Then do folk long to go on pilgrimage,
> And palmers to go seeking out strange
>   strands,
> To distant shrines well known in sundry
>   lands.
> And especially from every shire's end
> Of England they to Canterbury wend,
> The holy blessed martyr there to seek
> Who helped them when they lay so ill and
>   weak.[6]

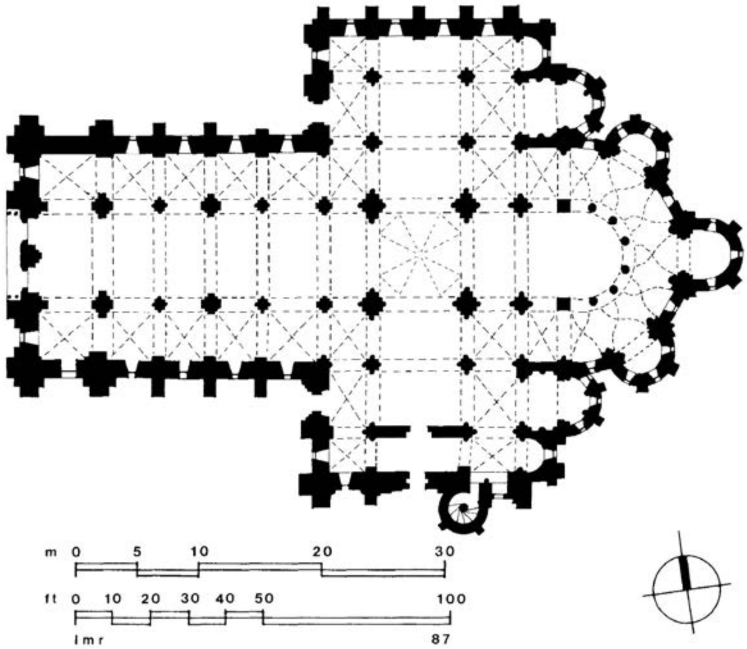
During the eleventh and twelfth centuries in France, churches and monasteries set up a network of way stations like a giant fan that directed the faithful toward the Pyrenees. There, the pilgrimage roads merged into one road that led west through northern Spain to the ultimate goal, the great Church of Saint James, Santiago de Compostela, believed to be the repository of the remains of the Apostle James [14.18]. The routes started in the north at Chartres, at the abbey of Saint-Denis near Paris, at Vézelay with its valuable relics of Mary Magdalene, at Le Puy, and to the south at Arles and Saint-Gilles. Two monastic churches along the pilgrimage route can illustrate the type that came to characterize the Romanesque pilgrimage church: the smaller Church of Sainte-Foy at Conques and the larger Church of Saint-Sernin at Toulouse, very much like the Church at Santiago de Compostela.

Sainte-Foy, Conques. Rising over the pilgrimage road from Le Puy to Moissac, France, on the slopes of the low mountains of the Massif Central at Conques, is the Church of Sainte-Foy, originally part of a monastery that is now gone. Miraculously, the church was untouched during the French Revolution, including its many rare reliquary treasures, the most important of which is the gold statuette that houses the remains of Sainte Foy, a twelve-year-old Christian girl who was martyred in 303. Although she died elsewhere, in the ninth century a monk carefully plotted to steal the remains and bring them to Conques, where they have remained.

To house the gold reliquary and other treasures, the Church of Sainte-Foy was built in 1040–1130 [14.19, 14.20, 14.21]. Its plan incorporates a new arrangement developed at Tours, where the growing attraction of relics had presented problems in conducting normal monastic church services. The



14.19. Church of Sainte-Foy, Conques, France, 1040–1130. Photo: Richard Tobias.



14.20. Sainte-Foy, Conques. Plan. The plan shows the solution to circulation through the church, with a continuous ambulatory passage around the choir. Drawing: L. M. Roth.

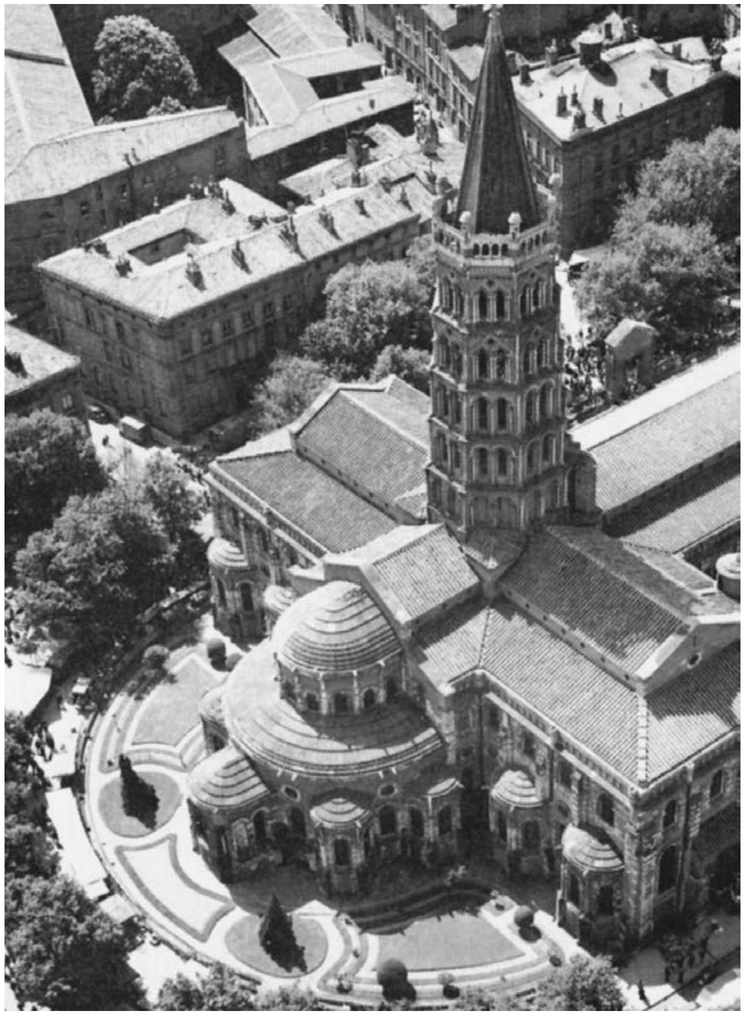
crowds of pilgrims kept crossing paths with the processing monks. The solution devised at Tours, and used at Conques, was to give the church two spatial shells—one a series of connected outer passages for visitors, leading to chapels holding the relics, and the other the inner basilica space for the monks and clergy. Because monastic churches had to accommodate a number of monks near the altar, what formerly had been a simple semicircular apse became a deeper space called a choir. Around this, and behind a screen of columns that supported the curved wall above, was a walkway, or an *ambulatory,* from which radiated apsidial chapels containing the relics. This entire easterly combination of parts—choir, ambulatory, and radiating chapel—came to be called the *chevet* in France. The transept was now shifted nearer the center of the church, and it too had side aisles connecting to the ambulatory around the choir and to the traditional side aisles of the nave. Thus, pilgrims could move from the narthex inside the west doors to the side aisles and pass completely around the church, while the clergy occupied the choir and celebrated Mass.

Sainte-Foy at Conques also incorporated stone vaulting over all internal spaces, whereas previous churches such as Saint Michael's at Hildesheim had flat ceilings fastened to large wooden roof trusses. At Sainte-Foy the nave barrel vault is 68 feet (20.7 m) from the floor. The vault is about 2 feet (0.61 m) thick and stiffened by transverse arches. The nave vault's considerable outward thrust is absorbed by the arches and vault in the gallery over the side aisles, which then transmit the forces to the thick buttresses in the outer wall. There are, therefore, no clerestory windows directly into the nave, but instead windows along the side aisles and in the gallery over the aisles, with the result that the overall illumination level in the church is comparatively low.

Saint-Sernin, Toulouse. The Church of Saint-Sernin in Toulouse, begun about 1077 and essentially completed by 1096, with the nave vaulted about 1125, was dedicated to Sernin (Saturnin), the first bishop of Toulouse, martyred in the fourth century [14.22, 14.23, 14.24, 14.25]. Although much longer than Sainte-Foy (359 feet in length as opposed to 173 feet [109.4 m versus 52.7 m]) and broader in the transept, Saint-Sernin has a nave only slightly higher than that of Sainte-Foy and with nearly the same proportions of width to height, 1 to 2.5. Furthermore, Saint-Sernin is more complicated spatially, since it has two side aisles along the nave. But as at Conques, the inner side aisle has a gallery over it sheltering the arches that resist the outer pressure of the immense barrel vault over the nave, and the light here is similarly low. The major source of light in the nave is from the large rose window, constructed later over the western entrance.

Saint-Philibert, Tournous. The problem of getting more light into the church was one that pushed Romanesque architects to find new solutions. It was perhaps not purely a physical concern, for they felt drawn to light as a spiritual metaphor. However, the technical means available to masons during the period 1000 to 1150 were limited, resulting in some interesting solutions. One of the more innovative is found in the nave vaulting of the Church of Saint-Philibert at Tournous, just north of Cluny in Burgundy, France. Originally built to house relics of Saint Valérien, the church received the additional relics of Saint Philibert when monks, driven from their northern island monastery by Norsemen, brought their precious relics to Tournous. The monastery at Tournous itself suffered attacks by the Magyars in 937, followed by destruction by fire in 1007. The monastery church at Tournous was then rebuilt, with special emphasis on covering the nave and chevet spaces with stone vaults to reduce the danger of fire. The solution worked out in the nave was unique [14.26]. Tall, undecorated, cylindrical piers carry semicircular arches opening into the side aisles; these side aisles are covered by groin vaults. Resting on the massive cylindrical nave piers are short, stout, engaged columns supporting diaphragm arches that cross the nave, and these diaphragm arches in turn support transverse barrel vaults (there is a wooden roof above). The repeated barrel vaults running perpendicularly across the nave cancel out each other's lateral thrusts, leaving only the lateral forces at the ends of the nave to be dealt with. Even though the

14.21. Sainte-Foy, Conques. Interior. Photo: Architecture Photos, Paris, SPADEM.

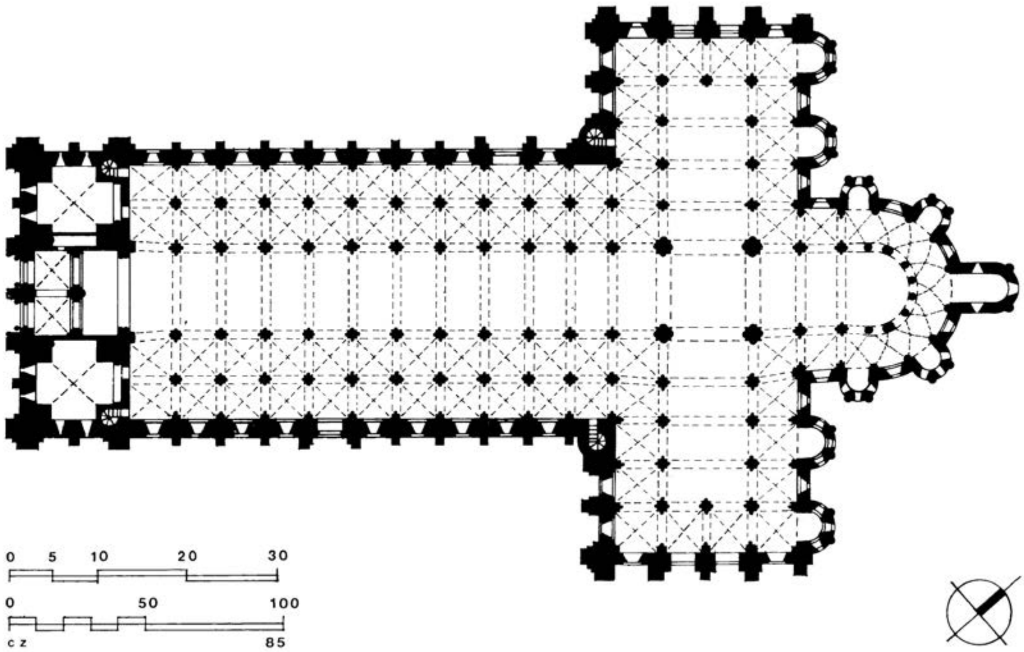


14.22. Church of Saint-Sernin, Toulouse, France, 1077–1125. Aerial view of the east end (chevet). Photo: Yan, Toulouse.

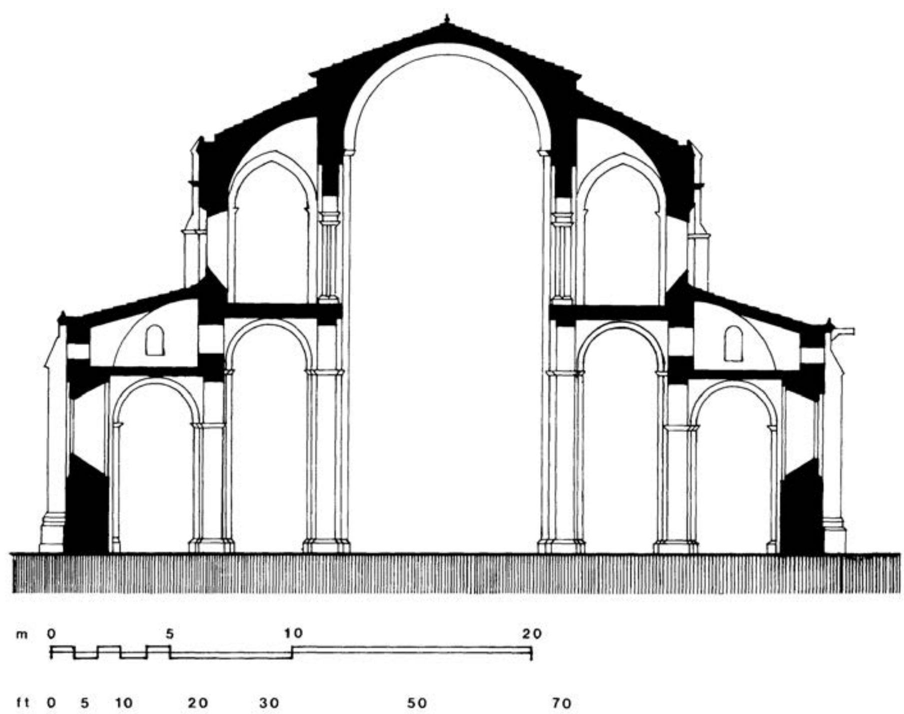
clerestory windows were not opened up to take full advantage of the available wall space, the level of light in the nave of Saint-Philibert is higher than was previously the case.

Romanesque Churches in Italy. An adherence in central Italy to the Classical tradition in design is well demonstrated in the small Benedictine abbey Church of San Miniato al Monte, just outside Florence, Italy [14.27]. This hillside church overlooking Florence was built in 1062 to circa 1200. It is an aisled basilica without transept. The wooden truss roof over the nave and "choir" rests on marble-veneered masonry walls carried by arcades of near-correct Classical Corinthian columns. More significant here for later developments in Florence, the facade is encrusted with a system of rectangular veneer panels and a Corinthian arcade made up of numerous inlaid colored marbles. This facade is not so very far distant from the clear geometries of Roman architecture, so that looking at San Miniato one can understand why the Italian Renaissance would begin here.

Durham Cathedral. One of the last Romanesque churches to rely solely on the sheer mass of its walls to support its vaulting is the cathedral at Durham, England, built by Bishop William de Carlief in 1093–1133 [14.28, 14.29]. Rising on the bluff over the curve of the Weir River at this northern outpost of Norman England, the cathedral shared this natural defensive site with a castle. The nave arcade alternates between huge square piers with engaged colonnettes and massive cylindrical piers incised with various chevron and geometric patterns. Over the side aisles is a gallery, and over the gallery are



14.23. Saint-Sernin, Toulouse. Plan. When the tower was built over the crossing, the crossing piers were greatly enlarged; they are shown here as they were prior to this addition. Drawing: C. Zettle, after Dehio.



14.24. Saint-Sernin, Toulouse. Section through the nave. Drawing: L. M. Roth, after Dehio.

14.25. Saint-Sernin, Toulouse. In this interior, as at Saint-Martin-du-Canigou, the difficulty of admitting light in a barrel-vaulted nave is clear; much of the light comes through the later Gothic rose window at the west end. Photo: Jean Roubier, Paris.

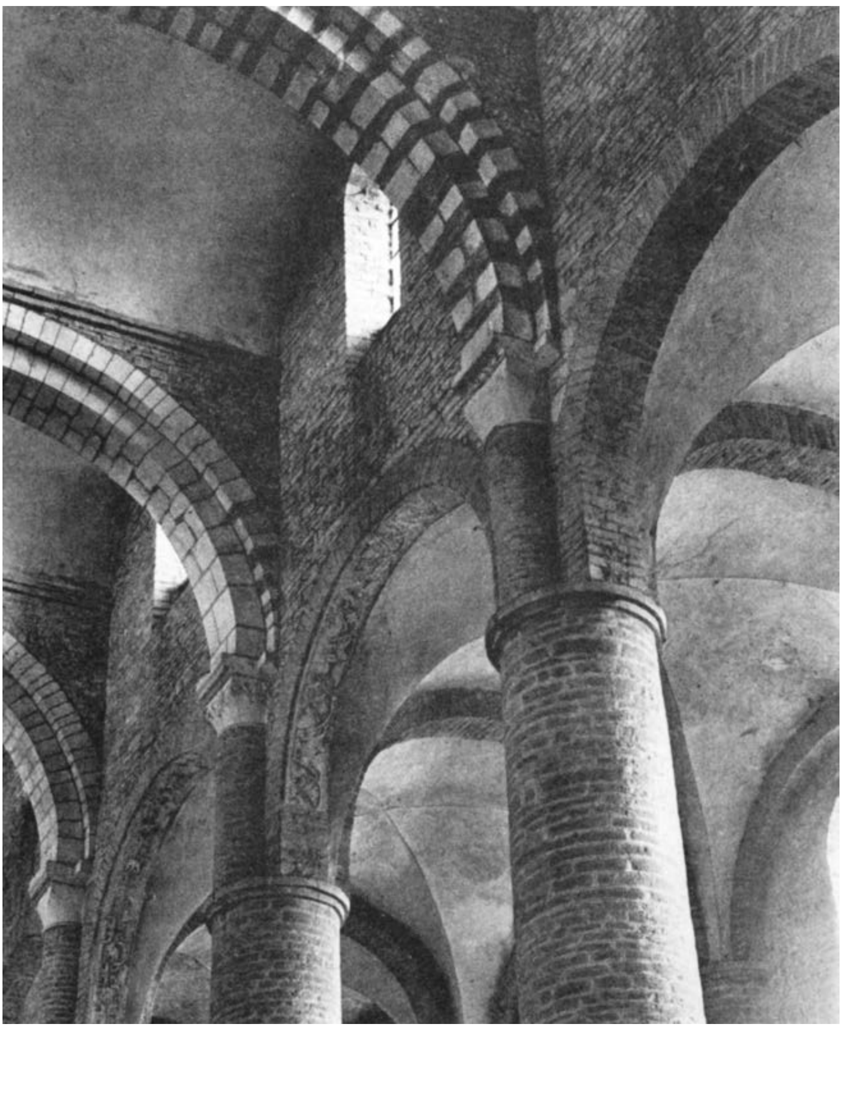
clerestory windows, made possible by the daring and innovative use of rib vaults over the nave. Yet, the lateral forces exerted by the massive vaults are gathered in the thick walls of the nave and conducted down through the stout piers and column of the nave. Although there are arches in the gallery that appear in section drawings to be roofed-over flying buttresses, they were not connected structurally to the piers receiving the weight of the vaults; they seem to have been built only to carry the sloping roof over the gallery. Accordingly, the round-headed clerestory windows are smaller than the space available, for the wall still needed to convey the weight of the vault to the piers below. But much more innovative was the use of segmented, or pointed, arches in the vaults, so that the tops of the vault centers are roughly the same height as the outer edges. Nonetheless, even though one finds here all the basic elements necessary for Gothic rib vaulting—ribs, pointed arches, and lateral "external" bracing (anticipating flying buttresses)—the emphasis is still on mass resisting vertical and lateral thrust, and all of the working parts of the structure are visible to the eye in the nave.

The round-arched architecture of the Early Middle Ages that gradually became Romanesque never quite rid itself of that massiveness bred of defense. The great, vaulted naves of Saint-Sernin and the similar Santiago de Compostela further demonstrated the limitations of Romanesque construction. Reliant on the sheer power of mass to abut and restrain the tremendous outward thrust of thick nave barrel vaults, Romanesque architecture could not open up to the light, not even with the innovations employed at Tournous or Durham. In the new phase into which medieval architecture now passed, the presence of light, the symbol of God's divine Grace, became the preeminent symbol; the church building had to become transparent, and when it did so it was no longer Romanesque but Gothic.

The High Middle Ages: Gothic Architecture

It is customary to say that Gothic architecture was invented in 1141 for Suger, abbot of the monastery of Saint-Denis, a town just north of Paris. What Suger and his architects and builders did was to integrate a number of improvements in late Romanesque church architecture, including pointed arches and rib vaulting. Somehow they sensed that these elements of design might work together synergistically, each expanding the potential of the other, to create a lighter and more visually transparent architecture. What Suger wanted was to replace walls of stone with membranes of stained glass, which filtered and transformed sunlight so that it symbolized divine illumination.

Gothic architecture was also the physical expression of a new, assertive, and comparatively positive outlook on life in the here and now, as contrasted to the emphatic focus of the Romanesque period on a life in the hereafter. The audacity of thirteenth-century bishops, burghers, and masons in starting churches so large and complex that the structures required several generations to be completed is an indication of the confidence of the period. By 1200, the apprehensive outlook of previous centuries had



14.26. Saint-Philibert, Tournous, France, c. 1008–c. 1120. Interior. To bring in light, the masons devised a unique scheme of transverse barrel vaults, carried by arches crossing the nave. Photo: Jean Roubier.

14.27. San Miniato al Monte, Florence, Italy, 1062–c. 1200. At San Miniato the continuing influence of Roman architecture is seen in the clear geometric patterns in the marble veneer. Photo: Vanni Art Archive/Art Resource, NY.

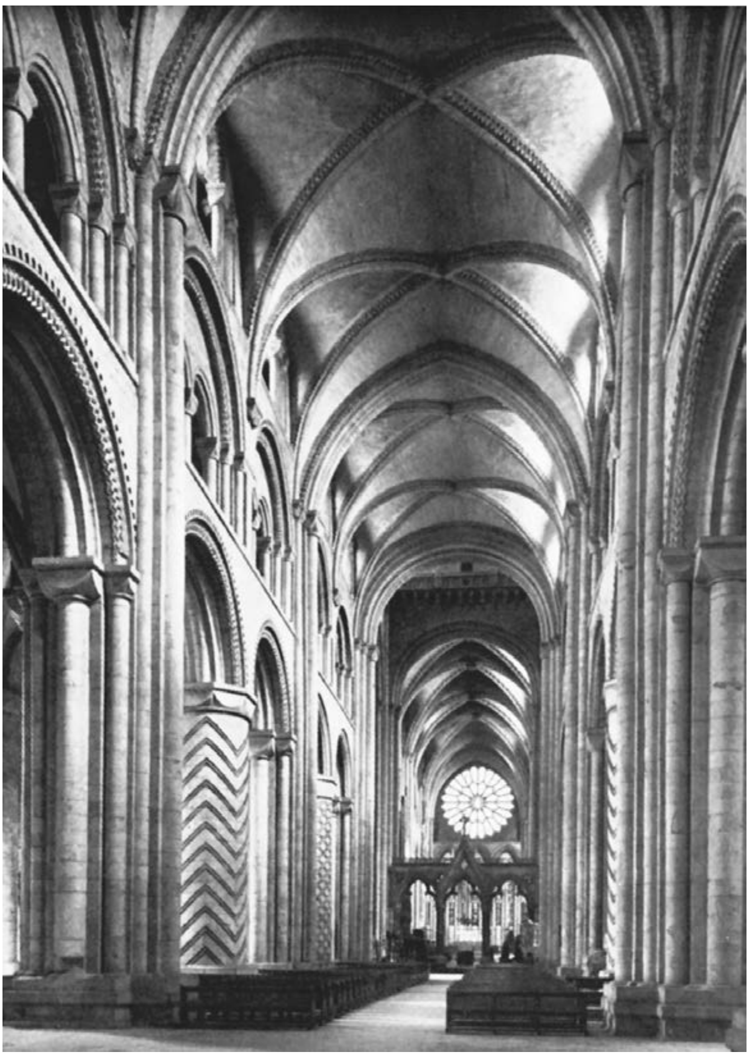
begun to be replaced with a more positive outlook. This is not to say that life expectancy suddenly was appreciably longer or that warfare had decreased but, rather, that people looked to temporal life with greater anticipation. The curious contradiction was that this embrace of earthly life should have resulted in an architecture that so emphatically aspired to heaven. It is significant, too, that the new joy in human existence paralleled a growing adoration of the Virgin Mary as an exemplar of earthly womanhood and a new measure of respect for women in general.

The unifying agent across Europe continued to be the church. The focus of human action remained religious life, so that the buildings that most advanced architectural design and technology were those built by the church, whether they were cathedrals, monasteries, schools, hospitals, or the new universities that began to emerge in this period.

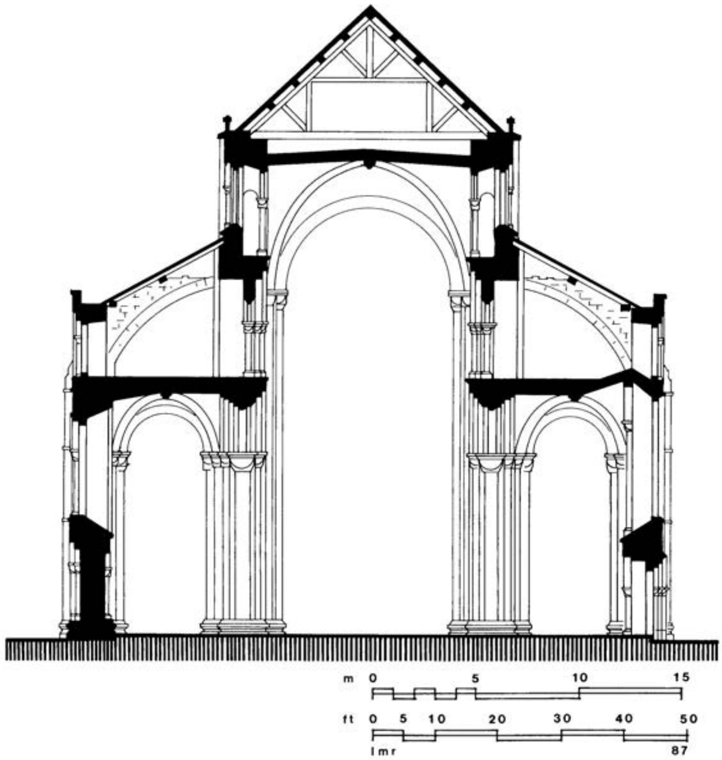
Political and Social Changes: The Reemergence of the City

The most important political and social change in Europe was the growing awareness of nation-states united by common cultures and languages. In England and France, there emerged strong central monarchies that gained power as the nobles lost some of their sovereignty. In France, this consolidation of royal authority began around Paris and the province of the Île-de-France, extending to the north into Flanders (what is now Belgium), with its rich trade in wool and textiles, and south into central France and Burgundy. Louis VI, with the political advice of his friend Abbot Suger, greatly advanced this process of consolidation during 1140 to 1180. The west of France, however, still consisted of areas governed by the Duke of Normandy, who also claimed the throne of England. After the Norman conquest of England in 1066, therefore, these could be considered English territories. The ensuing bitter and bloody struggle of English and French monarchs for dominion in western France—the Hundred Years' War, lasting from 1337 to 1453—was one development that marked the end of the Middle Ages.

Europe was transformed socially during the Late Middle Ages by two forces that reinforced each other—the reemergence of cities and the growth of commerce and trade [14.30]. In some places, old Roman towns on major trade routes were reinhabited; elsewhere, new towns appeared. The principal agent in accelerating urban growth was the Crusades. As ineffective as the Crusades were in establishing a permanent Western colony in the eastern Mediterranean, they were enormously successful in generating a spirit of adventurousness in the Western mind. As a result of the travel initiated by the Crusades and the necessity of establishing supply lines, Europeans moved into the Mediterranean, creating the basis of a trade network. Spices and cotton cloth were brought back from the Arab territories of the eastern Mediterranean, funneled through Venice and Genoa, and transported into northern Europe. Amber, furs, and other goods traveled southward from Germany and Russia into Italy for shipment to the East. Farmlands, exhausted by a thousand years of agriculture, were converted to pasture for sheep, and the weaving of woolen cloth became an important industry in England, Flanders, and Italy. Florence became a center for the cloth trade in the south, while Bruges became the comparable northern center in Flanders, and both became wealthy in the process. Pisa became a



14.28. Durham Cathedral, Durham, England, 1093–1133. Nave interior. The nave vaults of Durham were among the first in England to have diagonal ribs and the first in which the ribs have slightly pointed profiles. Photo: A. F. Kersting, London.



14.29. Durham Cathedral. Cross section. Although there seem to be arches buttressing the nave piers, these arches carry only the roofs over the side galleries. Drawing: L. M. Roth, after Kenneth J. Conant, Carolingian and Romanesque Architecture, 800 to 1200 *(1966).*

center for finance, especially for the papacy. Paris and Marseilles in France; London, Bristol, and York in England; Bruges and Ghent in Flanders; and Frankfurt and Nuremberg, among other German cities—all became important centers of transshipment of trade goods.

These cities would be small by twenty-first-century standards, with populations of ten thousand to seventy thousand people; only such cities as London, Paris, Florence, and Venice had populations that reached one hundred thousand. Ninety-five percent of the total population of Europe was still rural, but the 5 percent who congregated in cities soon dominated the life and culture of Europe. The old agrarian feudal culture was gradually replaced by an urban mercantile culture. A new word entered the European vocabulary: *burgher,* or *bourgeois,* meaning a person who lived in a city, and usually someone who operated a business. The rising bourgeoisie, this new class of merchants and bankers, soon rivaled the nobles and clergy in influence. Joining the merchants in controlling the emerging cities were craft guilds, organizations that trained apprentices, set standards of conduct and workmanship, and provided support for members' widows and children. The cities were places of increased personal freedom, and serfs who longed for this liberty had only to remain safe within the walls of a city for a year and a day to be considered freed from their bonds to their lord.

The rising bourgeoisie had fluid wealth, for money was again being coined, and they used this money to make profitable loans to kings and princes to finance their military campaigns (despite the church's prohibition against charging interest for the use of money). With the development of a monetary economy instead of a barter economy came changes in business, such as accounting, double-entry bookkeeping (first used in such Italian commercial centers as Florence), letters of credit, and insurance companies.

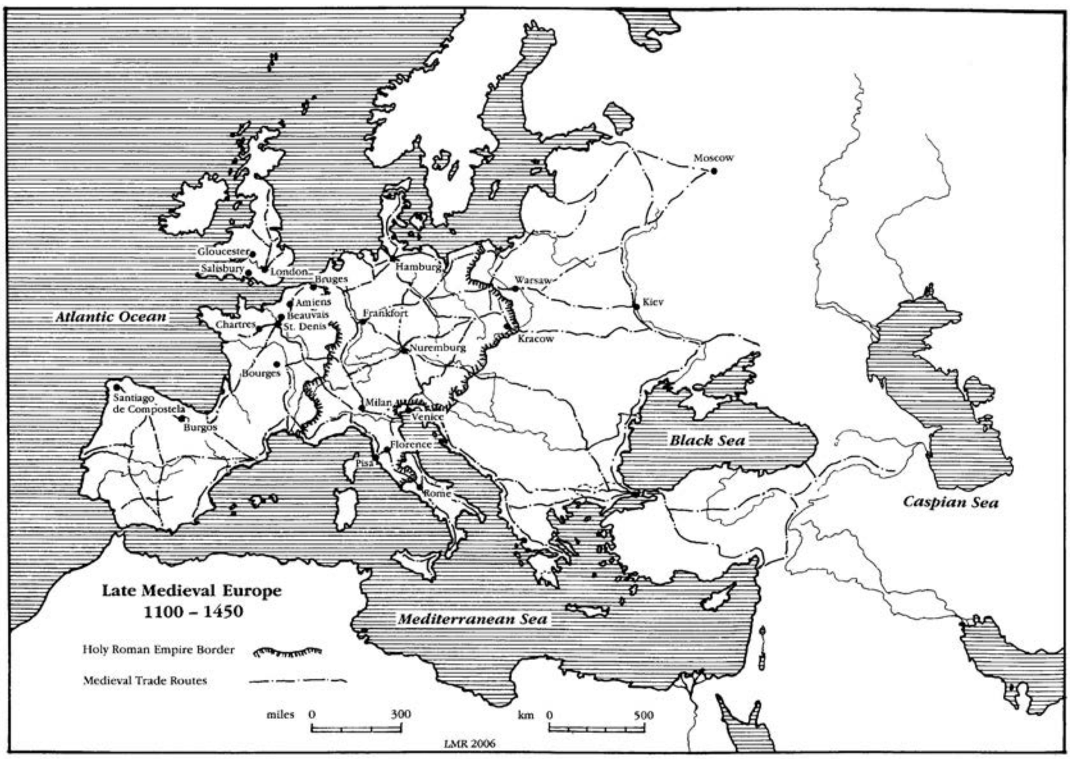
The consequence of these various social and commercial developments, and the resulting reemergence of cities as a major economic force during the thirteenth and fourteenth centuries, is that Gothic architecture is largely an urban architecture. The great monuments documenting the rise of Gothic architecture are not primarily isolated monasteries or pilgrimage churches but urban cathedrals, building projects initiated by influential urban bishops and paid for by wealthy urban businessmen and craft guilds.

These Gothic cathedrals differed from their Romanesque predecessors not only in structural form but also in their dedication, and this bears on important related social and religious changes. Almost uniformly, the urban cathedrals (most especially in France) were dedicated to the Virgin Mother of Christ, to Our Lady, Notre-Dame, rather than to local saints (although they did contain subsidiary chapels dedicated to local saints). This change in dedication was due to the veneration being given to Mary, the mother of Jesus Christ, by the early twelfth century. The veneration of the Virgin paralleled an important shift in attitude toward women in general in the later Middle Ages. From the time of Saint Augustine in the fifth century, women had been viewed as temptresses and as the source of evil (had not Eve tempted Adam and caused the expulsion from the Garden of Eden?). As medieval lords lessened their day-to-day focus on military power, they fostered the development of a refined court etiquette and an interest in the arts and literature—a development that elevated the position of women. The result was the emergence of the code of chivalry and the concept of unconsummated, romantic love. The Virgin Mary was seen as incorporating the perfect virtues of the noble lady; she was the Queen of Heaven who interceded on behalf of humankind like a mother for her children, just as the lady of the manor might intercede with her lord on behalf of their subjects. Accordingly, one after another, the soaring new churches built in Europe were dedicated to the Virgin Mary.

Religious Changes: Scholasticism

Christianity, benefiting from the invigorating effects of the Cluniac reforms, enjoyed a time of renewed fervor. Yet, the growing interest in the secular world also had an impact on religion. There arose a thirst for knowledge and a rational understanding of religious faith that resulted in the establishment of universities in many major cities. The University of Bologna, founded around 1158, was the first, and gradually became known as a center for the study of religious and civil law. The University of Paris, founded around 1200, specialized in the study of theology. At this time, all universities were branches of the church, and their faculty members were clerics.

The method used to ascertain truth by the scholars of the thirteenth century was scholasticism, the application of Classical Aristotelian logic



14.30. Map of Europe, 1250–1450.

to explain and reconcile inconsistencies between early church writings, the civil law compiled by Justinian, and canon law. It was inevitable that such investigations would lead to doubt, but as Abelard, one of the principal philosophers in Paris, observed, doubt would lead to inquiry and inquiry to truth. The universities collected the works of Aristotle and other classical authors, many of the volumes having been obtained as Arabic translations from Islamic scholars. Indeed, it was only through the Arabic transcription of Greek and Latin manuscripts that many of the Classics survived through reverse-translation in the Renaissance. These and other works were studied and debated in the universities.[7] This endeavor to fully reconcile faith and reason reached its zenith in the work of Thomas Aquinas (c. 1225–1274), who set himself the task of reconciling Aristotelian logic with the writings of the early church fathers. His *Summa theologica* systematically covered the entire literature of the church, beginning with the earliest writings, and attempted to create a coherent, logical doctrine as a hierarchical construction of greater principles dominating subsidiary ideas.

The Gothic Cathedral

The Gothic cathedral was yet another by-product of the Crusades, for when the first Crusaders saw Constantinople on their way to the Holy Land, they marveled at the size and wealth of the city and the vast scale and splendor of Hagia Sophia. There was nothing to compare with either that city or Justinian's vast church in England, France, or anywhere else in Europe. It is no mere coincidence that the great wave of cathedral building started shortly after the First Crusade ended and the Crusaders returned home.

The urban cathedral also was the physical expression of Saint Thomas Aquinas's *Summa theologica;* the building, too, was a hierarchical organization of related parts representing a balance of structural forces that corresponded to the reconciliation of Classical logic and Christian faith. The Gothic cathedrals were covered virtually from top to bottom with sculptural representations of biblical stories. Perhaps the most dramatic innovation was the virtual elimination of the structural walls of the church; in their place appeared membranes of colored glass depicting stories from scripture. Thus, in stone and colored glass, the entire building became a Bible for the illiterate, and what was especially important, the visual imagery was known and accessible to all—lord, merchant, servant, and serf alike.

The Abbey Church at Saint-Denis. The opening up of the wall for stained-glass windows was first achieved in the new abbey Church at Saint-Denis, begun by Abbot Suger about 1135. Suger (1081–1151), the son of peasants, demonstrated such unusual intelligence as a boy that he was admitted to the abbey school at Saint-Denis. There he became a close friend of his fellow student Louis Capet, who was to become King Louis VI. Suger rose through the ranks of the monks, became the assistant of Abbot Adam, and, after Adam's death, was elected abbot of Saint-Denis in 1122. The Benedictine abbey of Saint-Denis, about 6 miles (9.6 km) north of Paris, had existed before the time of Charlemagne and was dedicated to Denis. The saint had been martyred in the third century and was one of the first missionaries to the Gauls; he is believed to have been the first bishop of Paris. Since the seventh century, Frankish and French kings had been buried in the abbey church rebuilt by Charlemagne, and after 1120, the insignia of the French monarchs were kept at the abbey. As a result, Denis came to be seen as the patron saint of France. While Louis VII was leading the Second Crusade, 1147–1149, Suger was appointed his regent, so that to Suger, the fate of the abbey, of its church, and of France became intricately intertwined.

Upon becoming abbot, Suger embarked on a program of returning the monks to a life of piety and of repairing the greatly dilapidated monastic buildings, especially the abbey church, which had become far too small for the urban population that crowded into it on feast days. In 1135–1140, Suger constructed a broad and soaring new west facade of the church, with two towers over a three-bay narthex [14.31]. Three innovations distinguished the new facade. First, there was a clear geometrical compositional scheme, which, Suger wrote, was devised "by means of geometrical and arithmetical instruments" and which governed the placement of the masses of the tower and the position of the grouped window openings.[8] Second, between the towers and admitting light to the extension of the old church nave was a great, round window, the first of the rose windows that so distinguished later Gothic churches. And third, the three entrance doors of the new west front were recessed behind ranks of successive jamb columns and concentric archivolts, all covered with carefully organized sculpture relating to biblical kings and queens and hence, by extension, the monarchs of France. Regrettably, much of this sculpture was deliberately defaced in subsequent centuries, most especially during the French Revolution.

The most important change, however, was the new choir built by Suger soon after, in 1141–1144.

14.31. Abbey Church of Saint-Denis, Saint-Denis, France, 1135–1144. West facade. In his first addition to the Carolingian church, Abbot Suger provided the basis for subsequent Gothic church facades, particularly introducing the large round rose window. Photo: © Vanni Archive/Art Resource, NY.

In the library at Saint-Denis, then one of the largest in France, were ancient documents said to have been written by Dionysius the Areopagite, erroneously believed by some to be Saint Denis himself. These mystical writings merged Christian doctrine with what Erwin Panofsky has described as the "fundamental oneness and luminous aliveness of the world."[9] Throughout the writings of Dionysius, God is described as "the superessential Light" or "the Father of Lights," and Christ is described as the "first Radiance." Such passages suggested that this pure, heavenly radiance could be simulated through an analogy to earthly light. To Suger, humans need not be ashamed of their sensory perception and sense-controlled imagination; instead of rejecting physical sensory reality, they could hope to transcend it by absorbing it. As Suger put it:

> Thus, when—out of my delight in the beauty of the house of God—the loveliness of the many-colored gems [on the new altar reliquaries] has called me away from external cares, and worthy meditation has induced me to reflect, transferring that which is material to that which is immaterial, on the diversity of the sacred virtues: then it seems to me that I see myself dwelling, as it were, in some strange region of the universe which neither exists entirely in the slime of the earth nor entirely in the purity of Heaven; and that, by the Grace of God, I can

> be transported from this inferior to that higher world in an anagogical manner.[10]

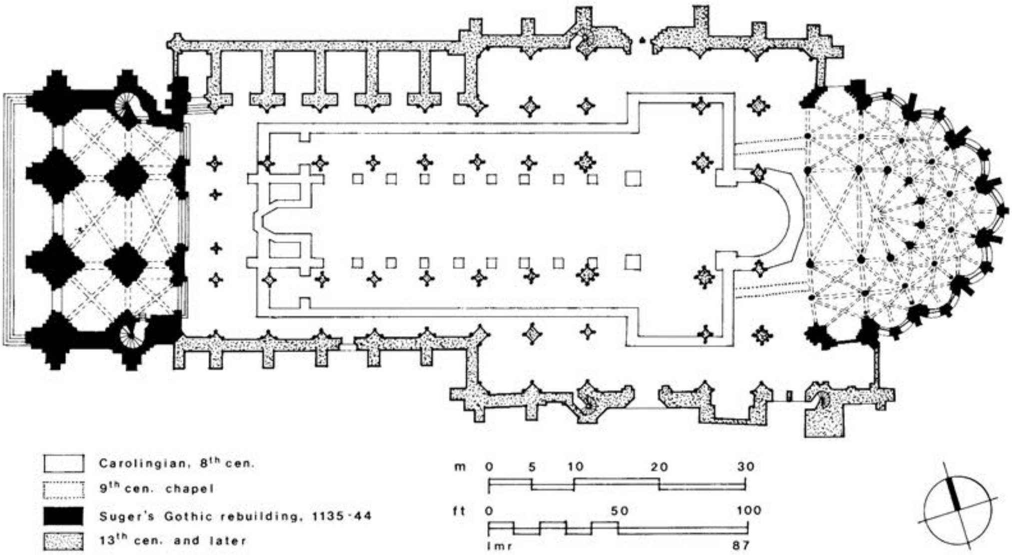
The new choir of Saint-Denis was to be suffused by a divine radiance, earthly light filtered through sacred images in stained glass. As Suger wrote, "Bright is the noble edifice which is pervaded by the new light."[11] Around the foundations of the old Carolingian choir, and more than doubling its capacity, was a double ambulatory [14.32, 14.33]. From the outer ambulatory extended seven chapels, each with two large windows that reduced the walls to narrow bands adjoining the buttresses. Suger described them as "a circular string of chapels by virtue of which the whole [church] would shine with the wonderful and uninterrupted light of the most luminous windows, pervading the interior beauty."[12] The inner ambulatory and the outer ambulatory chapels were covered by vaults articulated by ribs of pointed or broken arches. To put the central keystone of the pointed arch ribs at roughly the geometric center of the vault, the ribs were also broken or bent in plan. The resolution of the structural forces was such that the vaults were supported on the slenderest of twelve columns (which, Suger wrote, were symbolic of the apostles). As a result, the interior had a lightness that made the vaults appear to be rising and tied down by the columns, as it were, rather than being massive and bearing down heavily upon the columns, as had been characteristic of Romanesque vaults. What had been, by comparison, the somber lament of Romanesque architecture suddenly became the lilting hymn of Gothic lightness. (The medieval French term for this new architecture was *style ogivale,* "pointed-arch style," to identify the new technique being used; the modern term *Gothic* is a later, derogatory expression invented by fifteenth-century Italian writers to suggest the "barbarism" of such medieval architecture.)[13]

Notre-Dame of Amiens. Within a half-century, in a score of cities radiating out from Saint-Denis and Paris, and inspired by the lightness and structural articulation of Suger's church, Gothic cathedrals sprang up. Before 1450, in France alone, more than eighty cathedrals were built, plus five hundred monastic churches and hundreds of smaller parish churches. As Jean Gimpel has suggested, once it became apparent that the military reconquest of the Holy Land was impossible, it was as if the conquest of architectural space became a substitute, leading to a new "cathedral crusade."[14]

Medieval masons did not instantly open up walls to expansive glass, despite Suger's eloquent writing, but gradually, as they experimented in pushing masonry technology to its limits, the cathedrals became larger and lighter, literally and visually. After Saint-Denis came the cathedrals at Noyon, begun in 1151; Laon in 1160; and Paris in 1163 [14.34]. Up to this time, the ribbed vaults over the central naves were no higher than 80 feet (24.3 m). Below them, however, opened up expansive clerestory windows, a radical departure from the heaviness and darkness of Romanesque barrel vaults. At Notre-Dame in Paris, when the 108-foot-long (32.9 m) nave was extended westward from the chevet, the size of the gallery windows was further increased, which meant that the nave vaults had to be braced in an unconventional way. Previously, oblique tilted arches, resisting the outward thrust of the nave vaults, had been hidden under the side aisle roofs, but now they would need to be placed above the aisle roof, outside and exposed, sloping from the upper nave wall to vertical extensions of the outer buttresses of the side aisles [14.35]. Thus, flying buttresses were created. This innovation then led to the Early Gothic churches of Chartres in 1194 [see 4.5, and p. 68], Rouen in 1202, and Reims in 1211. By the time the last of these were begun, cathedral architecture had reached the stage called High Gothic, fully developed in all its constituent and integrated parts—pointed arches and broken rib vaulting, skeletonized structure, and exterior flying buttresses.

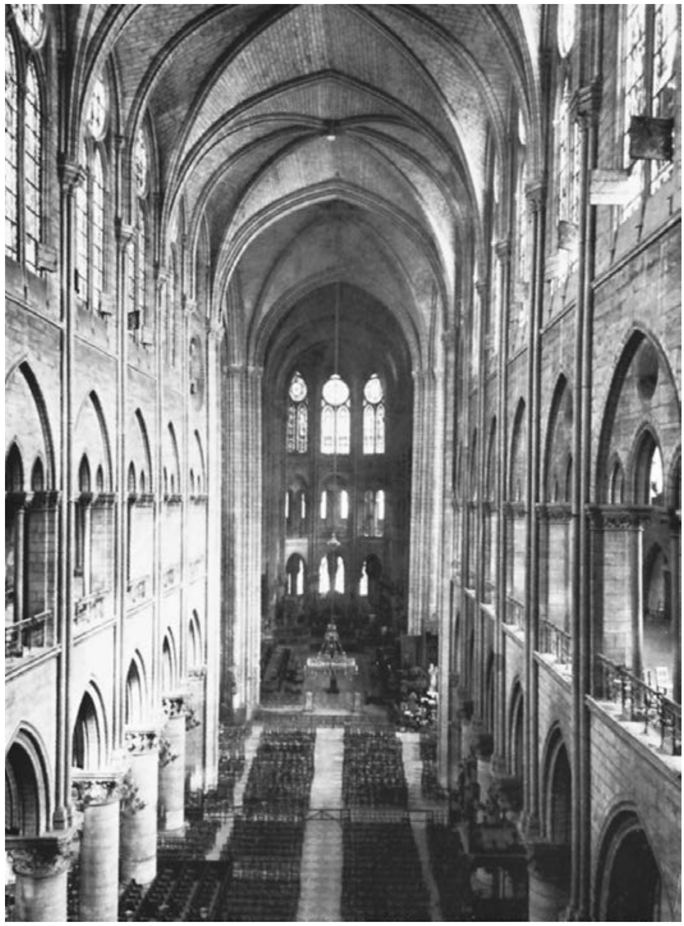
The cathedral of Notre-Dame at Amiens, the next of these great churches to follow, exploits all these features and was built in a relatively brief period, beginning in 1220 and finished in 1269, so it incorporates fewer modifications to the original scheme than do many other cathedrals. For that reason, the cathedral is often said to be the representative example of the fully developed French Gothic cathedral [14.36, 14.37]. Notre-Dame at Amiens, like so many other Gothic cathedrals, replaced an older church destroyed by fire. The decision to rebuild was made immediately after the fire at Amiens in 1218, but construction was not ready to get under way until 1220. The bishops directing the work were Evrard de Fouilly and his successor, Geoffrey d'Eu. Three architects supervised construction, although the basic design seems to have been decided by the first, Robert de Luzarches, who began construction at the western towers, narthex, and nave. The transept and choir were carried forward by Thomas de Cormont, and the church was brought to completion in 1269 (except for the tops of the west towers) by his son, Regnault de Cormont. The towers were then finished at the end of the fourteenth century.

More than any previous medieval building type, the Gothic cathedral was quickly standardized in

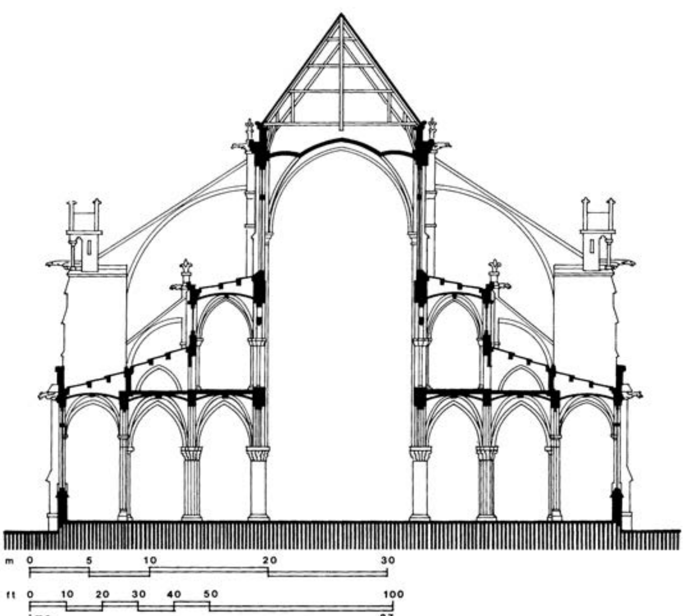


14.32. Saint-Denis. Plan, showing the new west towers and choir by Suger. The old Carolingian church is shown in dotted outline, and the later Gothic nave is shown in solid outline. (Note: The ninth-century east end is not shown in its entirety, so as to clarify the reflected rib plan of Suger's new choir.) Drawing: L. M. Roth, after S. Crosby.

14.33. Saint-Denis. Interior of the choir ambulatory. By combining rib vaults and pointed arches with careful resolution of structural forces, Suger's architects were able to achieve unprecedented lightness of structure and to open the walls to large panes of stained glass. Photo: University of Munich, Kunstgeschichtliches Seminar.



14.34. Church of Notre-Dame de Paris, Paris, France, 1163–1250. Interior. In the choir and nave of Notre-Dame in Paris the innovations of Suger's architects at Saint-Denis were used to transform the upper clerestory windows into huge panels of stained glass. Photo: Jean Roubier, Paris.

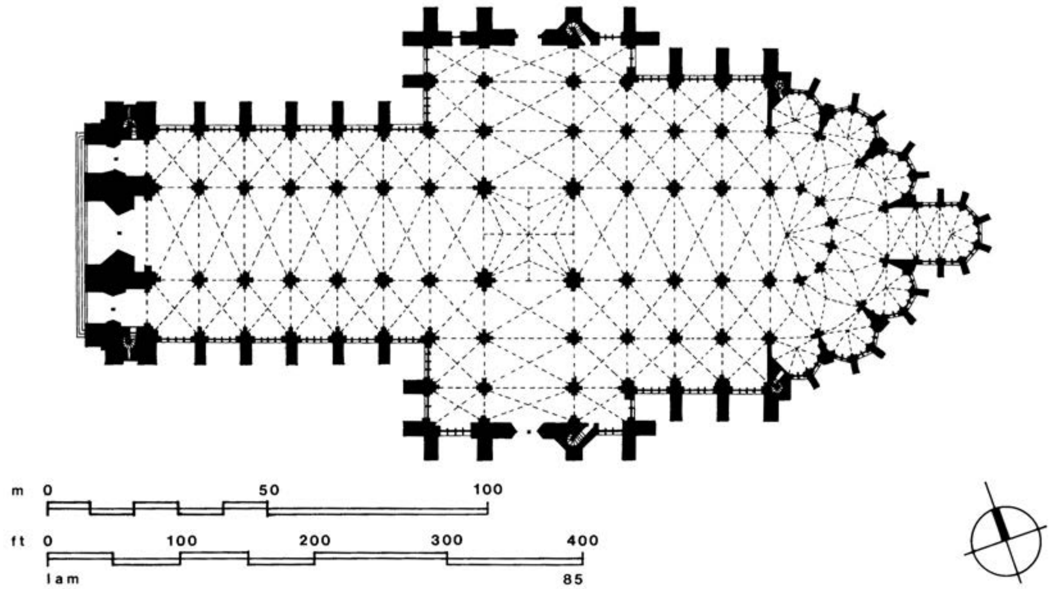


14.35. Notre-Dame de Paris. Cross section of the nave, showing the flying buttresses used to transmit the lateral forces of the roof and vaults down to the outer buttresses. Drawing: L. M. Roth, after B. Fletcher, A History of Architecture *(New York, 1931).*

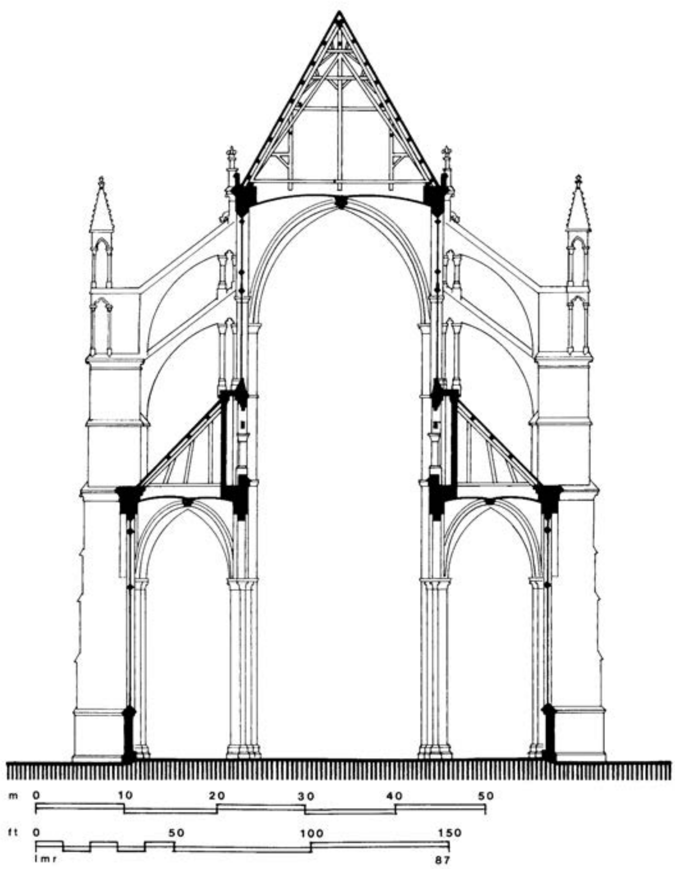
its plan and basic components. There were, of course, distinctive regional variations in Gothic cathedrals, such as the comparatively low and horizontal character of English churches or the more highly colored ornamentation of Italian examples. Yet, the basic organization was relatively uniform. The cross-shaped plan was derived from Romanesque pilgrimage churches, with nave, side aisles, transept arms and crossing, and the chevet with ambulatory and radiating chapels enclosing a round-ended choir. The radiating chevet chapels were dedicated to various saints, often local martyrs, with the central chapel most often dedicated to the Virgin, Notre-Dame.

The principal change in plan at Amiens was the greater size of the choir, for the choir often had nearly as many bay units as the nave, so that the transept was roughly at the middle of the body of the church. This arrangement reflected directly on how the cathedrals were paid for and how they were used, for typically only the choir (sometimes excluding the surrounding ambulatory and chapels) legally belonged to the diocese. The nave, transept, and aisles, in contrast, often legally belonged to the city, were paid for by the various craft guilds, and often were used for secular gatherings. The other major change from the Romanesque plan was the creation of elaborated entrances not only

14.36. Robert de Luzarches, Thomas de Cormont, and Regnault de Cormont, Notre-Dame de Amiens, Amiens, France, 1220–1269. View of the west front. Built in a relatively short period, this cathedral exemplifies the High Gothic in France. Photo: © LL/Roger-Viollet/The Image Works.



14.37. Notre-Dame de Amiens. Plan. The plan shows the increasing size of the choir in High Gothic cathedrals, forcing the transept arms toward the middle of the building. Drawing: L. Maak, after Dehio.



14.38. Notre-Dame de Amiens. Cross section through the nave. Pairs of flying buttresses were used to transmit the forces of roof and nave vaults to the external buttress piers. (The roof trusses shown here have been adapted from Viollet-le-Duc's drawing of those at Reims; the original wooden trusses at Amiens were replaced long ago.) Drawing: L. M. Roth, after Dehio and Viollet-le-Duc.

at the west end of the nave but at the end of each transept arm.

Externally, aside from the exposed and increasingly thin flying buttresses, the major changes in the Gothic cathedral included dramatic vertical towers. In France, this took the form of a pair of towers at the west entrance, whereas in England, a great tower typically perched over the crossing.

Internally, Notre-Dame at Amiens consisted of side aisles (sometimes two on each side of the nave) covered with rib vaults [3.31, 14.38, 14.39]. The aisles opened through an arcade of tall, pointed arches to the nave. Above the arcade was a dark, narrow passage in the thickness of the nave wall, the triforium gallery, whose height corresponded to that of the sloping wooden shed roof protecting the side aisle vaults. Above the triforium passage, the stone wall disappeared and became slender piers, opened up by broad, stained-glass clerestory windows subdivided by delicate stone tracery. These slender piers, appearing as clusters of elongated colonnettes, continued up from the capital of the arcade piers, each colonnette in the bundle rising up to one of the ribs overhead, the longitudinal, transverse, or diagonal arches in the rib vault over the nave.

The network of thin colonnettes in the clerestory piers, as well as the stone tracery, emphasized the vertical reach of the Gothic cathedral. This strong sense of verticality also was emphasized by an optical illusion. A cross section of Amiens would nearly fit inside a cross section of the Pantheon,

14.39. Notre-Dame de Amiens. Interior looking up to crossing and transept vaults. Photo: Vanni Archive/Art Resource, NY.

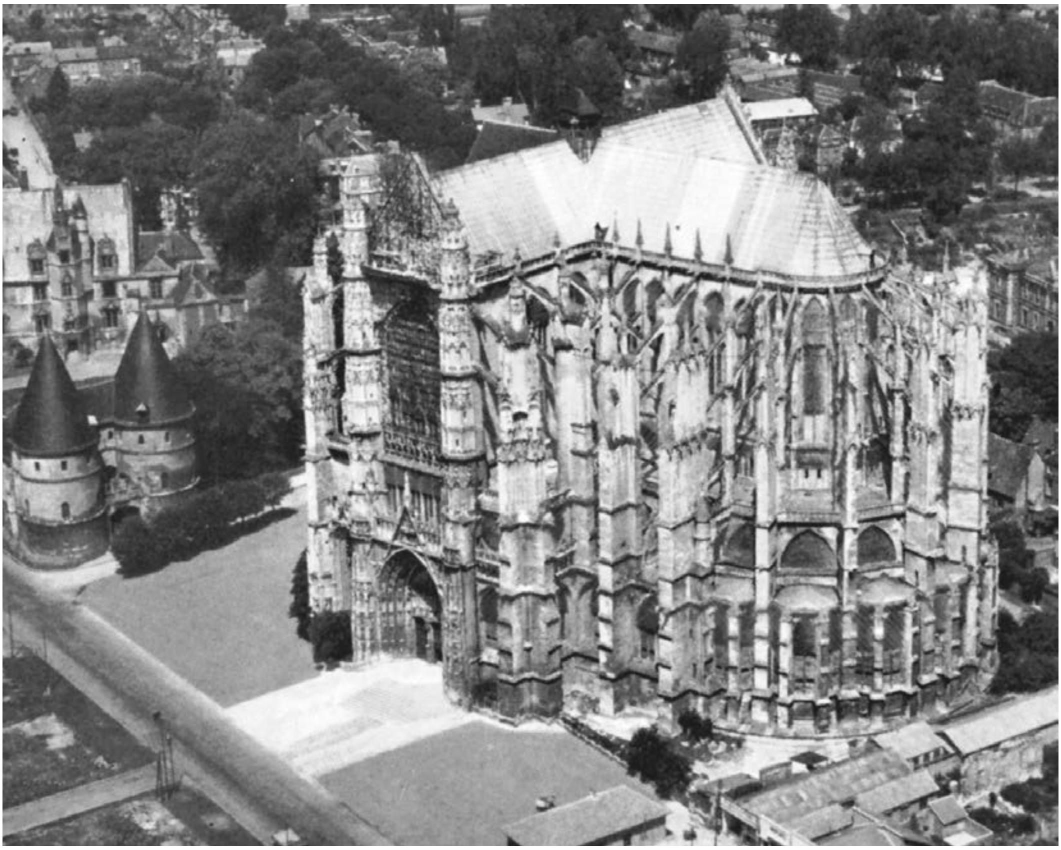
which measures 142.5 feet (43.4 m) in height and diameter. The vaults of Amiens rise 138 feet (42.1 m) from the nave floor, and the width is nearly 150 feet (45.7 m) to the aisle walls. Yet, Amiens and the other Gothic cathedrals appear much higher than they actually are, since all the elements of the design reach upward. Contributing to the optical illusion of great height are the proportions of the nave. At Amiens, the nave width is roughly 45 feet (13.7 m), so the ratio of width to height is 1 to 3.1, whereas the ratio at both Sainte-Foy at Conques and Saint-Sernin in Toulouse is markedly lower, around 1 to 2.5. (In the Pantheon in Rome, the ratio of width to height is almost precisely 1 to 1.) Further strengthening the sensation of height is the infusion of light in the Gothic cathedral, for the upper walls dissolve in light. There are, in fact, no true upper walls but rather the series of slender piers carrying an umbrella of stone vaults; between the piers are the large panels of stained glass, through which passes an ethereal light, casting soft-edged colored patterns on the limestone piers, arcades, and floor below.

Above the stone nave vaults of a Gothic cathedral, and unseen from the floor, was yet another substantial structure—a steep wooden trussed roof [14.38]. At Amiens, the peak of the roof outside is 200 feet (60.9 m) above ground. These steep roofs, effective in shedding rain and snow, also caught the wind, so that two sets of flying buttresses were typically required along the sides: the lower flyers transmit the outward thrusts of the stone nave vaults to the externalized buttresses, and the upper ones carry the wind loads of the tall wood-framed roofs to the buttresses.

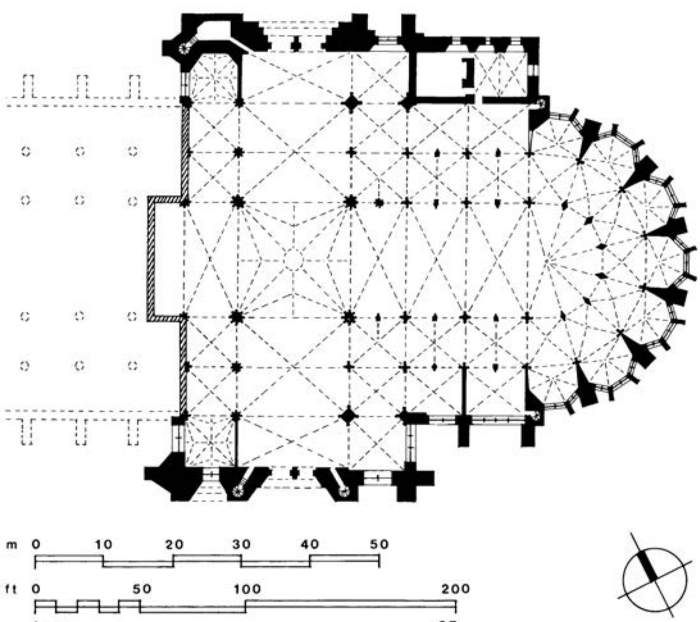
Saint-Pierre, Beauvais. Like modernist architects in the twentieth and twenty-first centuries, medieval master-masons sought to dematerialize structure to make the church an analogue of the ethereal, heavenly city. Yet there appeared to be a point that their empirical knowledge, gained by trial and error, could not safely exceed. This limit was reached in the huge Church of Saint-Pierre at Beauvais, another prosperous trading center in wool and textiles, about 44 miles (71 km) north of Paris. The earlier, tenth-century cathedral was partially burned in 1180 and then completely destroyed by fire in 1225. Immediately, a new church was proposed by Bishop Milon (Miles) de Nanteuil. Three successive (and as yet unidentified) masters constructed the choir, ambulatory, and chapels and covered the chevet in stone vaults between 1225 and 1272 [14.40, 14.41, 14.42]. The original vaults were quadrapartite, divided into four segments by two diagonal ribs; in this and other respects, the plan was nearly the same as that of the chevet of Amiens (as yet incomplete, since Amiens was built from the west eastward). But at Beauvais, the scale was grander, for the choir vaults were 51 feet wide (15.5 m) and soared to 157.5 feet (48 m); the ratio of width to height was therefore exactly the same as that at Amiens, but the actual size was 14 percent larger. Just the arches of the ambulatory arcade by themselves were 69.67 feet high (21.2 m), or 1 foot higher than the center of the nave barrel vault at Conques. Even more light flooded Beauvais, for the triforium passage was glazed as well, eliminating the last suggestion of solid wall.

Apparently because of design errors in making the external buttresses too small to resist the forces created by wind loads, the buttresses gradually bent and cracked; on November 29, 1284, the choir vaults at Beauvais collapsed.[15] Repairs were undertaken in 1322–1337 by another unknown master-mason. Believing that an inadequate system of support in the ambulatory piers had caused the collapse, he inserted additional piers between the original piers of the choir and rebuilt the vaults in sexpartite form, with diagonal ribs and an additional cross rib. The extra piers stabilized the structure, and the vaults have stood firm since. The inserted piers, however, doubled the number of verticals, further emphasizing the unsurpassed height of the vaults. A decade after the choir was finished, construction of the crossing and nave was halted first by the Black Death and then by the Hundred Years' War. Not until 1500 were the transept arms and crossing built; this construction was begun by Martin Cambiges and finished by Jean Vast in 1548. It was then proposed to build a great tower over the crossing, and in 1564–1569, after prolonged study and discussion, Jean Vast erected a stone spire reaching up 490 feet (150 m). Unbraced by any adjoining nave structure on the west side, the delicate transept piers under the tower bulged outward, and finally, on April 30, 1573, the tower collapsed. After the rubble was cleared away, a decision was made not to complete the church. The transept vaults were rebuilt and the west side enclosed, but Saint-Pierre at Beauvais has remained truncated ever since.[16] By the latter part of the sixteenth century, as the French historian Desjardin later observed, it was "not the time to build cathedrals anymore. The schools for masters, sculptors, glaziers, and painters, which had been inspired by their creation, were dying all over the place."[17]

Salisbury Cathedral. In French cathedrals, the vertical line dominated. Although the interior elevation



14.40. Church of Saint-Pierre, Beauvais, France, 1225–1548. Aerial view of the incomplete cathedral. Designed with a plan similar to that of Notre-Dame in Amiens, the church at Beauvais was significantly larger and more delicate; after repeated collapse of the vaults, the church was left unfinished. Photo: Prèsidence du Conseil Phototèque, Paris.



14.41. Saint-Pierre, Beauvais. Plan. The solid portion shows what was finished; the outlined section shows where the bays of the nave would have continued. Drawing: L. M. Roth, after Dehio.

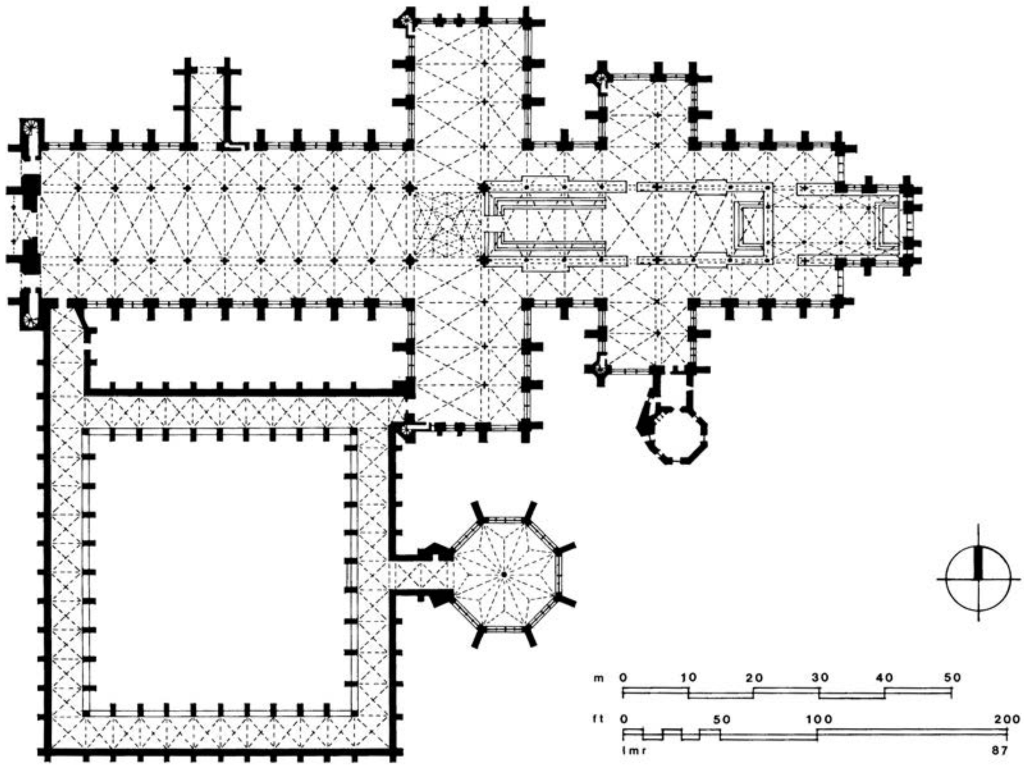
14.42. Saint-Pierre, Beauvais. View of the choir. Photo: Anthony Scibilia/Art Resource, NY.

was divided into three distinct zones (arcade, triforium, and clerestory), the lines between those zones were increasingly crossed by bundles of slender colonnettes that ran continuously from floor to vault top and back down to the floor, symbolic representations of the way the forces of gravity were conveyed to the ground.

In England, a very different model of cathedral design evolved. The horizontal line was stressed by lateral extension of the cathedral, by keeping the vertical dimensions much lower than they were on the Continent, and by stressing the continuous horizontal moldings and string-courses of masonry that marked the edges of the three horizontal divisions of the interior elevation. English churches also incorporated two basic plan differences, compared with Continental counterparts. First, since the English structures were often inspired by Cistercian monastic models, they had two transepts. Second, the churches had flat east ends, as advocated by the Cistercian monks, so that instead of a curved chevet, there is a flat stained-glass window-wall.

Salisbury Cathedral, built in 1220–1266, illustrates all these typically English attributes [14.43, 14.44]. The strikingly vertical tower was an addition of the early fourteenth century. Salisbury Cathedral is an interesting contrast to Amiens, especially since both were started the same year, 1220, and both are nearly the same length—450 feet (137.2 m). Salisbury Cathedral was built on new ground, outside the old city of Sarum, and hence had far more open space around it than was typical of Continental Gothic urban churches; eventually a new city, a trading center for wool and cloth, grew up around the new Salisbury cathedral. Although nearly as long as Amiens, Salisbury Cathedral is only 78 feet (23.8 m) wide overall. Its nave is 37 feet wide (11.3 m), with vaults 81 feet

14.43. Salisbury Cathedral, Salisbury, England, 1220–1266. Aerial view. Salisbury has more open space around it than do urban French cathedrals. Photo: Aerofilms Ltd.

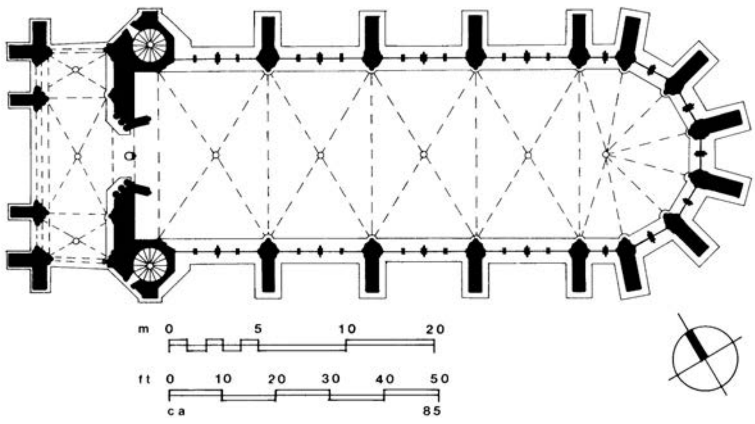


14.44. Salisbury Cathedral. Plan. Because of the strong Cistercian influence, English cathedrals typically have flat east ends with a large window instead of a rounded chapel. Drawing: L. M. Roth, after Dehio.

high (24.7 m), so the ratio of width to height is just 1 to 2.2, much less than in Amiens or Beauvais. The result is a stronger horizontal aspect compared to the decidedly vertical emphasis felt in the naves of Beauvais or even Amiens [1.12, p. 8].

The Sainte-Chapelle, Paris. In France, the drive to make the building frame a true skeleton, to eliminate all sense of the wall as a structural mass, was achieved in the lofty choir of Beauvais, but it is especially dramatic in the small private chapel of the king, the Sainte-Chapelle, attached to the royal palace on the Île-de-la-Cité in Paris. This project was undertaken by Louis IX and his architect, Thomas de Cormont, in 1240–1247, to house the relics Louis had collected, including purported pieces of Christ's Crown of Thorns and pieces of the True Cross, as well as the iron lance, the sponge, and a nail used in Christ's crucifixion. The chapel, measuring just 32 feet in width and 99.5 feet in length (9.75 by 30.33 m), was attached to the royal palace with a relatively low ground-floor chapel for palace retainers and lesser nobility [4.28], but a tall upper chapel on the main floor (the second floor) connected directly to the royal apartments. The structure of this upper chapel was reduced to nothing more than a series of buttresses spaced 15 feet (4.6 m) apart [14.45, Plate 8]. The walls were entirely of stained glass, and the stone vaults were painted deep blue with gold fleur-de-lis stars, the royal emblem appearing in the vault of heaven. Damaged during the French Revolution but restored to lustrous brilliance in the nineteenth century by Eugène Viollet-le-Duc, the chapel is luxurious in the extreme. Perhaps we should think of this building less as a church in the usual sense of the word and more as an architecturally scaled reliquary, filled with precious religious objects.

Wooden-Roofed Churches. The cut stone vaulting used so effectively in cathedrals and royal chapels was beyond the means of rural parishes, so these smaller village churches were covered with wooden roofs. In medieval England, especially, timber roof construction achieved an excellence of structure and a delicacy of sculptural enrichment that re-



14.45. Thomas de Cormont, Sainte-Chapelle, Paris, France, 1240–1247. Plan. In the upper chapel, the building is reduced to isolated piers, allowing for walls made up entirely of stained glass. Drawing: P. Boundy, after H. Stierlin.

mained unsurpassed. In addition to covering parish churches, various forms of roof trusses were used over meeting halls and to enclose large tithe barns in which offerings of grain were stored. The same technology was employed to construct the heavy timber roofs over the masonry vaults of the cathedrals. For spans wider than 20 feet (6 m), hammerbeam trusses were developed, with the principal uprights supported by projecting brackets or hammerbeams [see 3.32]. Numerous Late Gothic examples of hammerbeam truss roofs survive in England, such as in Saint Botolph's at Trunch in Norfolk, or the double-hammerbeam roof of Saint Wendreda's, March, in Cambridgeshire. The culmination of this technology was reached in the massive hammerbeam roof over the hall of Westminster Palace, a royal residence then outside the city of London [14.46]. The masonry walls of the hall, built by Henry Yevele in 1394–1400, were covered by a hammerbeam roof spanning 68 feet (20.7 m) and designed by the king's master carpenter, Hugh Herland.

Late Gothic Architecture

As happened with Greek and then Roman architecture, basic forms were first worked out, and then, in succeeding centuries, were made increasingly complicated and more heavily ornamented, as was the case with the so-called Roman Baroque architecture of the late Roman Empire. The same kind of movement away from structural directness in favor of ornamental embellishment occurred in the Late Gothic period as well. In France, this attention to ornament appeared in decorative forms, particularly in the stone tracery of stained-glass windows. The tracery had the wavy fluidity of flames; such curvilinear forms were said by the French to be *flambant,* "flaming," or "flamboyant," a word still used to convey a sense of extravagant excess.

Perhaps the best example of an entire church in this Late Gothic style is Saint-Maclou in Rouen, near the mouth of the Seine River in Normandy [14.47]. When the Hundred Years' War ended and the English were finally driven out of Normandy, a period of active building commenced there. One of the buildings undertaken was Saint-Maclou, 1434–1514. A parish church, it is 180 feet (55.9 m) long, with nave vaults that rise 75 feet (22.8 m). Its most flamboyant portion is the five-sided porch, built last, in 1500–1514. The hoods over the doors are stretched vertically and transformed into an open interlace of curving, flame-like tendrils.

In England, the final form of the Gothic was called Perpendicular, because of the emphasis on the vertical in closely spaced, repeated lines. An early use of Perpendicular Gothic was in the rebuilding of the cathedral at Gloucester, a Norman building that had formerly been the abbey Church of Saint Peter. The repository of the remains of the murdered King Edward II, the church at Gloucester prospered greatly as a point of pilgrimage, permitting extensive reconstruction. The Perpendicular style is illustrated most clearly in the rebuilt choir there, 1337–1351, designed perhaps by William Ramsey or Thomas of Canterbury [14.48]. The round-headed arches of the Romanesque lower arcade were overlaid with delicate tracery, and broad clerestory windows were opened up above. The entire east wall was filled with an enormous window. The new vaulting of the choir also illustrates what happened to rib vaulting in England; in these ***lierne*** vaults, the ribs were multiplied to the point at which, as here, they become a decorative filigree over the vault surface.

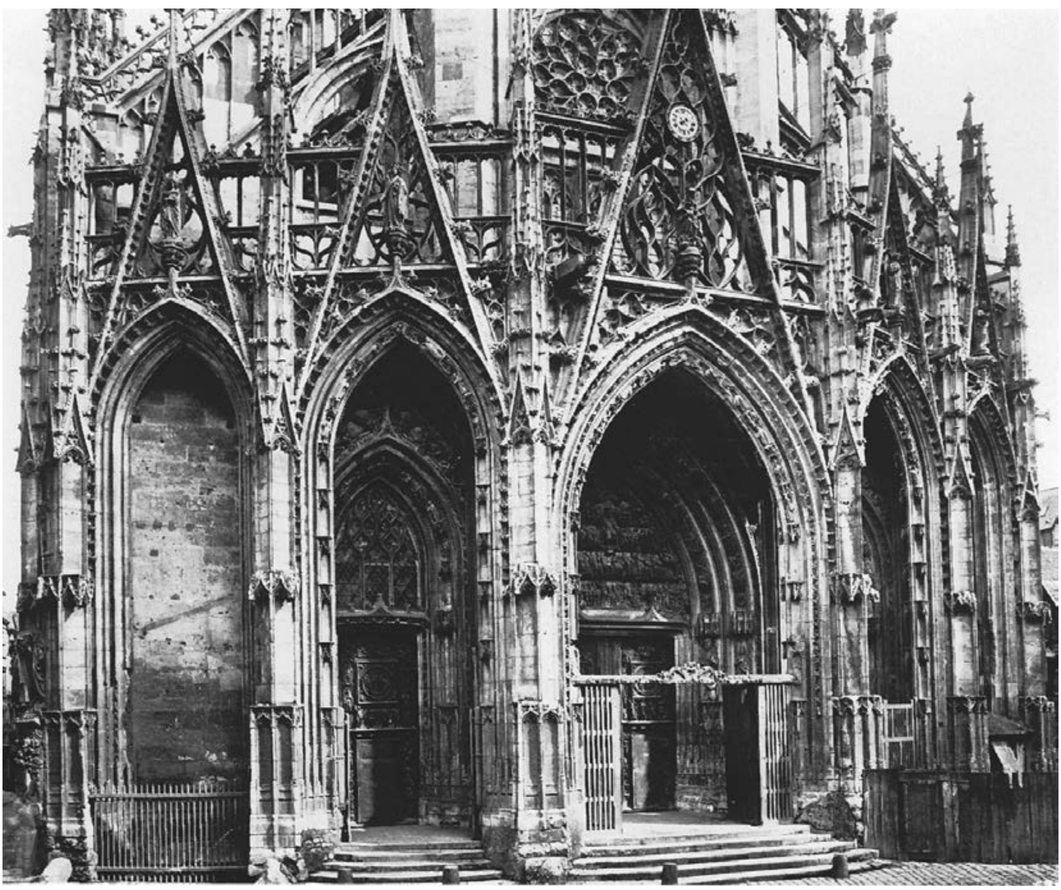
14.46. Henry Yevele and Hugh Herland, Westminster Hall, Palace of Westminster, London, England, 1394. Interior. Spanning 68 feet (20.7 m), this is one of the largest surviving medieval wooden roof trusses. Photo: Country Life, London.

Also introduced, in the cloister walk at Gloucester in 1351–1412, was the unique form of English fan vaulting, in which a dense cluster of thin ribs radiates out from each column, like an inverted, curved cone. This type of vault reached its fullest expression in such Late Gothic examples as King's College Chapel, Cambridge University, built by Reginald Ely, with vaults by John Wastell, in 1446–1515 [14.49]. Commissioned by King Henry VI, this was larger than other college chapels and patterned more after the choirs of cathedrals, that at Gloucester being the particular model. When construction was completed under Henry VII, the technique of fan vaulting was used here at its grandest scale; the walls are completely dissolved in glass, and the vaults, windows, and detailing are in complete harmony. King's College Chapel is considered the most majestic of all Perpendicular interiors.[18]

Domestic and Public Architecture

With the rise of cities and the accumulation of private bourgeois wealth, a new urban residential architecture emerged. Adjacent to the cathedrals appeared the houses of the bishop and archbishop and the residences of the clergy associated with the operation of the cathedral. These buildings often enclosed in an irregular way (as in front of the cathedral at Noyon) a plaza that was the site of fairs and religious plays. Early cities sprang up around monasteries, and the rich and active monastery at Cluny had many houses built around it in the twelfth century. Although the facades of some of these survive, the interiors often have been rebuilt many times. Viollet-le-Duc was able to reconstruct a typical house plan [14.50]. It had a large shop room on the ground floor opening to the street by means of a broad, arched window-wall. Behind this commercial space was a court, and behind that, the kitchen. On the upper level were the living quarters, with a combined living-dining room and a bedroom in front overlooking the street, an open court to the rear, and a rear bedroom over the kitchen. The third floor had sleeping quarters for apprentices and storage for merchandise and supplies.

Just as cities became a new driving force in late medieval culture, so too did merchants increase the scope of their business, becoming bankers and money brokers. Merchant bankers became the new patrons of architecture, and the late buildings of the Middle Ages were buildings they commissioned—their residences, guild halls, and town halls. The large house of Jacques Coeur in Bourges illustrates this new urban type well [14.51, 14.52]. Jacques Coeur (1395–1456), the son of a furrier, was born in Bourges, a cloth-producing city in the virtual center of France. He became a merchant and, eventually, one of the most important businessmen in France as a result of his international trading contacts. His operations included trading exchanges for cloth, silk, jewels, armor, spices, salt, wheat, and wool, with warehouses across France, Belgium, Scotland, and Italy supplied by his own fleet of merchant ships. He also became steward of the royal



14.47. Saint-Maclou, Rouen, France, 1434–1514. The elaborate open tracery of the facade marks this as Flamboyant (flame-like) Gothic. Photo: Bildarchiv Foto Marburg; Art Resource. New York.

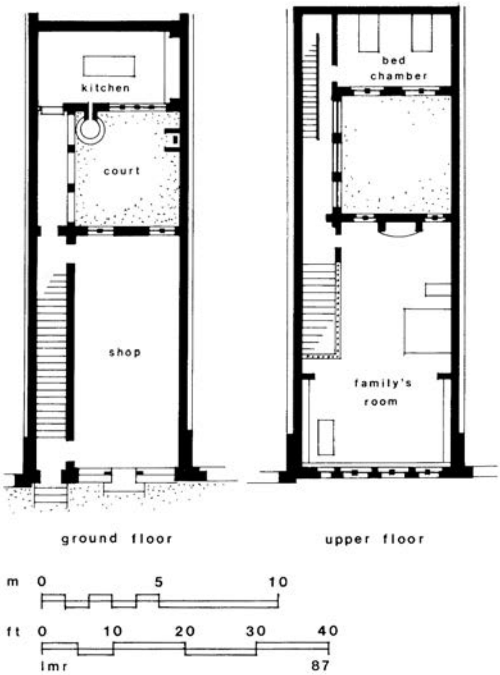
14.48. New choir, Gloucester Cathedral, Gloucester, England, 1337–1351. Interior. In England, Late Gothic architecture became emphatically vertical, as demonstrated in the numerous vertical mullions of the window in the new choir of Gloucester Cathedral. Photo: W. Swaan.

funds and banker for the court during the reign of Charles VIII, lending money to the king for the conquest of Normandy, which made Coeur in essence the French minister of finance.[19]

Altogether Coeur acquired forty manors throughout France, but in 1443–1451 he built a magnificent house for his family in Bourges, purchasing a portion of the old defensive walls of the city and adding wings that wrapped around a commodious court open to the street. Although constructed in one building campaign, the parts of the house present an irregularity of plan and profile, a flexibility and freedom of delicate ornament that suggest numerous additions over time. The house had public rooms and galleries on the ground floor, with large kitchens and an equally large general dining room. The family's private chambers were on the second floor and included a richly embellished private chapel.

Important expressions of municipal prestige and power were the large town halls and cloth-trading halls built in the urban centers of northern France and Belgium at the end of the Middle Ages. Although designed to accommodate their new commercial and municipal functions, stylistically these buildings borrowed extensively from the vocabulary developed for church buildings, using pointed arches and elaborate tracery. The town hall in Bruges, Belgium, survives nearly intact, a fortunate accident of the historical development of that cloth-trading center [14.53]. Situated 10 miles (16.1 km) from the sea and just 30 miles (48.3 km) north of the present French border, Bruges (*Brugge* in Flemish) emerged during the twelfth and thirteenth centuries as the single most important port city in the Flemish textile trade and fur trade with England and Scandinavia. The money funneled through the city made its

14.49. Reginald Ely and John Wastell, King's College Chapel, Cambridge University, Cambridge, England, 1446–1515. Interior. Unique to England was the fan vault, as found in King's College Chapel, suggesting a grove of trees. Photo: A. F. Kersting, London.

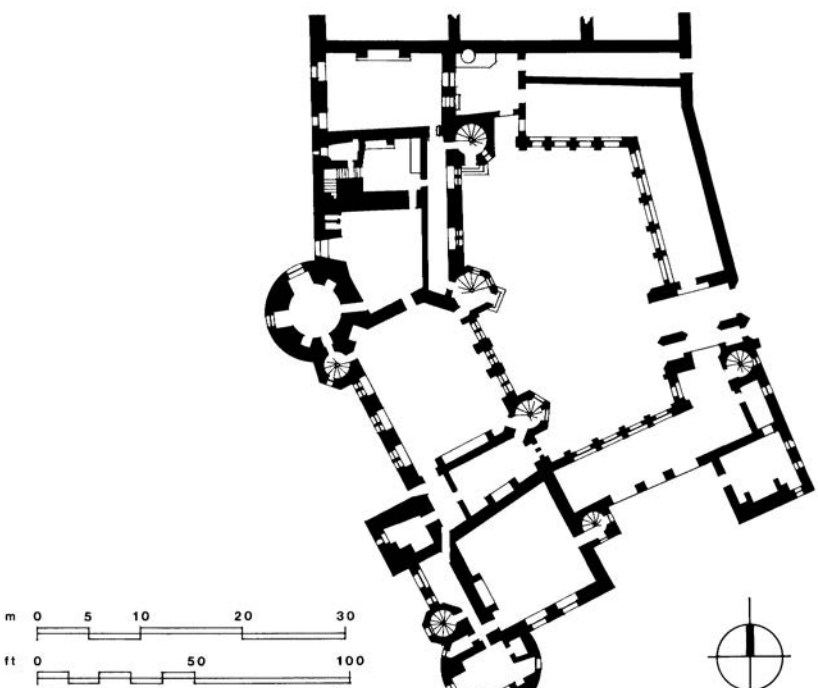


14.50. Merchant's house, Cluny, France, twelfth century. Plan (as reconstructed by Viollet-le-Duc). Drawing: L. M. Roth.

burghers wealthy, and this affluence and municipal pride were expressed in the construction of a town hall in 1376–1420 and of the cloth hall, with its rather top-heavy tower finished in 1482, which dominates the plaza in the old part of the city. The reason medieval Bruges survives almost intact is that the Zwijn River, the city's access to the sea, silted up in the fifteenth century, and commercial activity then shifted to Antwerp. Later, when a canal was opened to the sea, Bruges grew only slowly. It never regained its position as a vital commercial hub in modern times, as Antwerp did. Bruges never experienced modern industrial development or the proliferation of a network of railroads and therefore never became a target for bombardment during the twentieth-century wars that leveled Antwerp and destroyed so much European architecture.

Gothic Architecture: An Architecture of Aspiration

Despite the rise of cities as economic and political centers in the Gothic period and the resultant flourishing of secular life in the growing cities,



14.51. House of Jacques Coeur, Bourges, France, 1443–1451. In the construction of this grand house, new sections were added to the old city walls, incorporating the old round towers. Drawing: L. M. Roth, after Viollet-le-Duc.

14.52. House of Jacques Coeur. View of the courtyard. Although the building has the complex geometries of something that has been added to over centuries, this was built in one campaign. Photo: Bridgeman-Giraudon/Art Resource, NY.

14.53. Cloth Hall, Bruges, Belgium, c. 1240 to late fifteenth century. By the end of the Middle Ages, secular architecture was beginning to assume great importance, borrowing forms and decorative details from earlier religious architecture. Guild halls, such as this one, became symbols of civic pride. Photo: L. M. Roth.

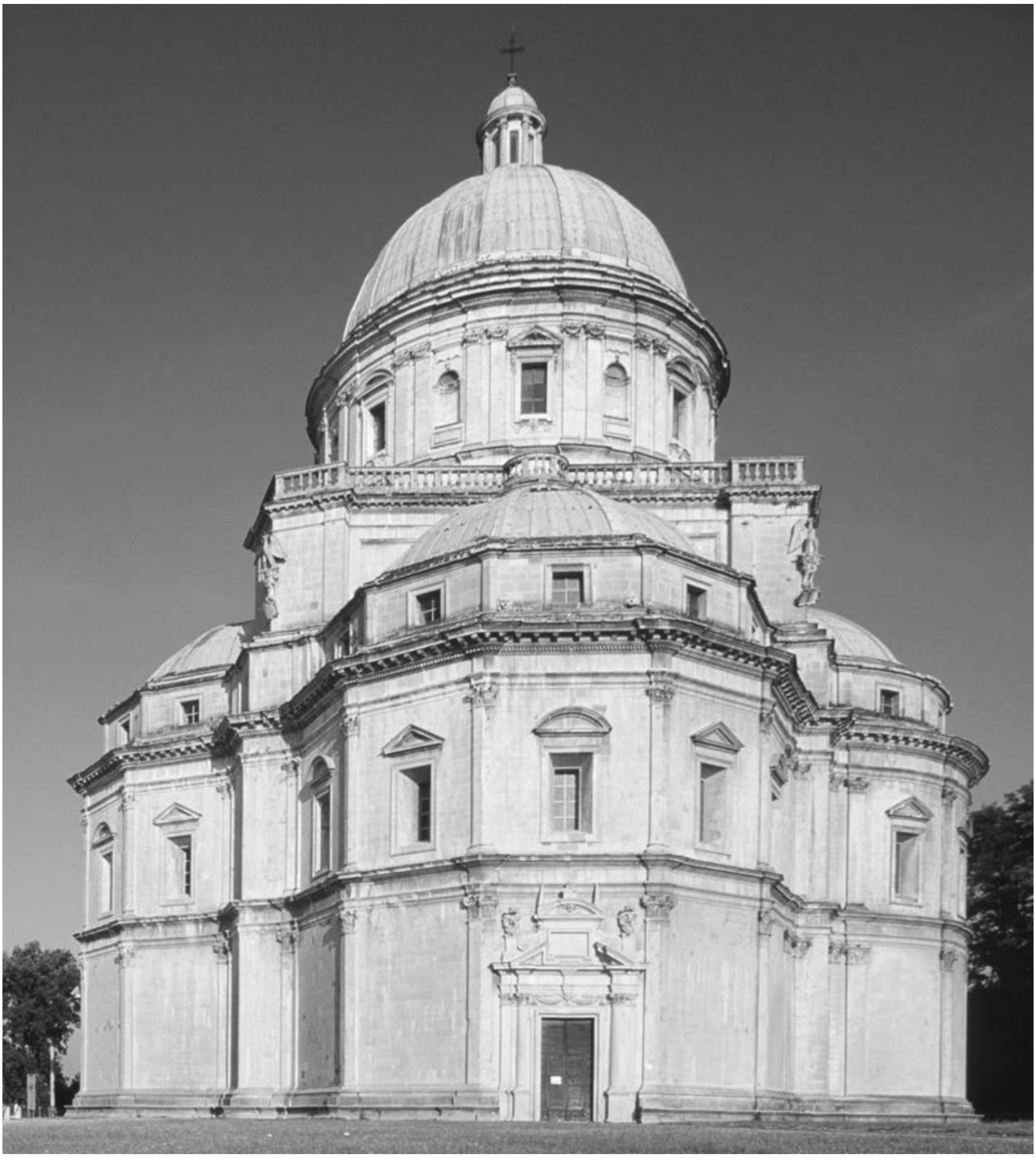
people's essential concern in earthly life remained gaining the assurance of heaven. Accordingly, the building of great urban cathedrals, driven by swaggering civic pride combined with sincere religious piety, provided the arena of the most probing architectural experimentation. The Gothic architecture of town halls and private residences was based on forms developed for the cathedral, and the result was an urban form of organic integration, rising in vertical lines.

The Middle Ages ended in a series of unfortunate concurrent disasters. Climate investigations in the latter part of the twentieth century reveal that, beginning about 1300, a cooling in the Northern Hemisphere brought about what has been labeled "The Little Ice Age" that lasted as late as 1850. By 1315, in particular, weather in the summers became unpredictable and was extremely cold and wet, causing widespread crop failures across Europe that resulted in famine. For more than two centuries during this time period, people had been moving into the cities, and the rate of population growth increased so much that the population of Europe nearly doubled between 1000 and 1300. Fields depleted from decades of over-farming produced diminished yields and, in 1315–1317, at the beginning of the Little Ice Age, strange weather caused outright crop failures resulting in famine followed by plague. Furthermore, as the general state of health suffered, in 1348, in the port cities of central Italy, a disease appeared that swept through the population, disfiguring its victims with hundreds of black pustules that preceded a lingering death. A form of bubonic plague, it was called the Black Death. Because medieval physicians were unable to conceive that the disease was spread by fleas on rats, their implausible preventive measures had no effect. As the plague spread the length and breadth of the Continent in the next two years, upward of 40 percent of Europe's population died—at least twenty-five million people perished.

Meanwhile, the church hierarchy began to splinter. From 1309 to 1377, the popes left Rome and took up residence in Avignon, in southern France, in what became known as the Babylonian Captivity. Various political factions within the church supported different claimants to the papal crown, and during 1378 to 1417, there were no fewer than three concurrent, competing popes.

From the East appeared yet another threat, the Islamic Seljuk Turks, who conquered all of what is now Turkey, pressed hard against the last tiny fragment of the once-great Byzantine Empire, now shrunken within the walls of Constantinople. Eventually, in 1453, after long resistance, Constantinople fell to the Turks, persuading many Greek scholars in Constantinople to begin an exodus to Italy.

Yet, in the face of these compounded tribulations, first in central Italy by 1400 and then spreading quickly across Europe, there blossomed a growing optimism in human potential and a renewed respect for the intellectual and artistic achievements of Classical Greece and Rome. Encouraged in part by the arrival of the emigrating Greeks from the beleaguered East, Italian scholars, painters, sculptors, and architects set out to equal the efforts of thirteenth-century theologians in their reconciliation of Christian belief with the intellectual rigor of Classical thought. What the Italian artists and architects endeavored was to reconcile the beauty of Classical art with Christian thought, to create a new architecture and art that was both Christian *and* Classical. As the Middle Ages faded, a new spirit was born, a rebirth of a classical humanism, a renaissance.



15.15. Cola da Caprarola (possibly with Baldassarre Peruzzi), Santa Maria della Conzolazione, Todi, Italy, 1508–1607. This church represents the ideal rational Renaissance church based on integrated circular and square forms, resulting in integrated cubical and domical components. Photo: © Tips Images/Tips Italia Srl a socio unico/Alamy.

Chapter 15

Renaissance Architecture

Renaissance artists firmly adhered to the Pythagorean concept "All is Number." . . . Architecture was regarded by them as a mathematical science which worked with spatial units: parts of that universal space for the scientific interpretation of which they had discovered the key in the laws of perspective. Thus they were made to believe that they could re-create the universally valid ratios and expose them pure and absolute, as close to abstract geometry as possible. And they were convinced that universal harmony could not reveal itself entirely unless it were realized in space through architecture conceived in the service of religion.

—*Rudolf Wittkower,* Architectural Principles in the Age of Humanism, *1949*

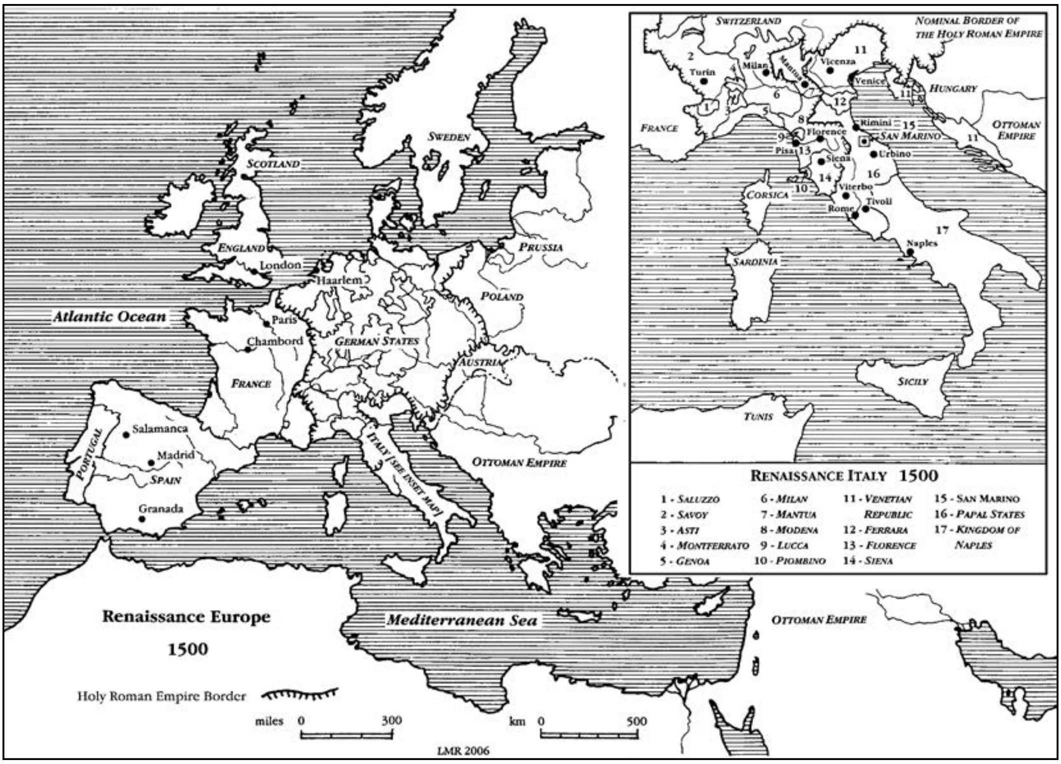
Gothic architecture was made up of an assembly of parts worked out for each building individually. It was an architecture adaptable to any situation, but it was not an architecture determined by universal, formal norms. To the Italians of the fifteenth century, Gothic architecture, with its roots in northern European sources, evoked an uncivilized, brutish period that they began to call the dark age that separated the glories of ancient Greece and Rome from what they saw as their own enlightened time. Emboldened by their flourishing urban (and urbane) culture, they set out to match the intellectual and artistic achievements of the ancients.

The Italians, especially the Florentines, began to view history in a new way. They perceived human history not as a divinely ordained continuum but as a series of successive periods, some characterized by great human accomplishment. More important, they sensed that they were at the start of a new age of vast possibilities, an age that could equal the achievement of the ancients. They had a new confidence in their intellectual capacity and desired a new architecture, one expressing the mathematical clarity and rationality they perceived in the divine order of the universe. Such a new architecture no longer needed to point heavenward, but, like Roman architecture, would stress a balance of vertical and horizontal elements in forms reflecting human proportions. This new architecture, visually clear and rationally organized, first appeared in Filippo Brunelleschi's Ospedale degli Innocenti (Foundling Hospital) in Florence [see 15.7 later in this chapter]. Light and graceful, this building was based on Roman sources and governed in the arrangement of its parts by a recognizable proportional system. Here was an architecture rooted in the human intellect, serving not primarily to convey religious dogma but to provide for the very human needs of orphaned children.

Coupled with this new sense of human potential and history was the perception of the artist as a humanist scholar—not simply an artisan or a craftsman but a philosopher in paint and stone. Thus, it became extremely important to record the aspirations and achievements of contemporary artists, a task the painter Giorgio Vasari took upon himself. Writing in 1550 about the fourteenth-century painter Giotto, Vasari said that Giotto's work marked a *rinascita,* a "rebirth," of Classical solidity of form and human expression.[1] This Italian term, translated into French, became *renaissance*.

Italy in the Fifteenth Century

When the Renaissance began about 1400, there was no single Italian nation but, rather, a series of duchies, republics, and kingdoms along the Italian peninsula [15.1]. These city-states were in constant competition with each other, which periodically led to armed conflict. Such internal division encouraged



15.1. Map of Europe, c. 1500. Drawing: L. M. Roth.

the strong monarchies of neighboring France and Spain to intervene frequently, and in fact the southern half of Italy and Sicily became a client kingdom of Spain. Running across central Italy toward Venice were the papal states, provinces ruled directly by the pope as a purely secular kingdom. Included in the northern extension of the papal states were the cities of Rimini and Urbino. North of the papal states were various sovereign states dominated by the duchy of Milan and ruled by the Sforza family; there was also the duchy of Ferrara, which was ruled by the d'Este family. Along the northwestern coast was the Republic of Genoa, and on its northern boundary, extending into the Piedmont and the Alps, was the duchy of Savoy. At the head of the Adriatic Sea on the northeast coast was the Republic of Venice, which had extensive holdings at Isatria and Dalmatia on the eastern Adriatic shore (today, the coastal regions of Croatia and Bosnia). Immediately north of Rome and the region of Latium was the Republic of Siena, in many ways the archrival of Florence. Both Venice and Florence, in particular, prospered through commerce—Venice through maritime trade to the eastern Mediterranean, and Florence through the wool trade to northern Europe.

Florence had been a relatively quiet and minor town during the Early Middle Ages. Founded on the Arno River as Florentia as a colony for Roman soldiers in the first century BCE, by the third century CE it had developed into a provincial capital. During the successive rule of the Goths, the Byzantines, and the Lombards, monasteries in Florence kept alive the older culture. Beginning as part of the southern edge of Charlemagne's empire, Florence gradually won greater autonomy in the Holy Roman Empire. Early in the twelfth century, the Commune of Florence became a free city and, by the end of the twelfth century, had gained control of the surrounding region of Tuscany. Later, Florence suffered politically, with warring factions first supporting papal power in the thirteen century and then resisting papal political authority in the fourteenth. These internal conflicts sometimes escalated into conflict with nearby cities. Meanwhile, the Republic of Florence expanded during 1300 to 1500 to extend to the city of Rocca to the east, to Cortona to the south, and encompassing the coast of the Mediterranean from Piombino to the south up to and including Pisa to the north. Gradually, Florentine businessmen came to dominate others in Italy, and the florin they began minting in the thirteenth century soon became the de facto currency of Europe.

The Renaissance Patron

Another change that characterized the Renaissance concerned the patronage of art and architecture. Increasingly, cardinals, popes, and other individuals, especially merchants and bankers, commissioned buildings, sculpture, and paintings for themselves, for the churches they patronized, and for their cities. In Italy, the first major patrons of the new architecture were the merchants who governed Florence, especially the powerful Medicis. After the Black Death and continuing up to 1434, Florence had experienced chaotic rule until the ascent of Giovanni di Bicci de' Medici (1360–1429) and his son Cosimo (1389–1464), merchants who prospered in the Florentine textile industry. Cosimo and his grandson Lorenzo, although without benefit of official title, ruled Florence through skillful diplomacy, frequent magnanimity, and personal flourish. Following the example of Giovanni, the Medicis made it the duty of a wealthy citizen to provide public and religious buildings for the citizens. Giovanni de' Medici began the rebuilding of the church and monastery of San Lorenzo and was especially involved in the building of the Foundling Hospital (discussed in a later section). Cosimo de' Medici built major additions at three churches in Florence, constructed a monastery at Fiesole outside the city, paid for the renovation of Santo Spirito in Jerusalem, and sponsored additions to two monasteries in Assisi and San Marino. In addition, he refurbished several family villas outside Florence, one of which he put at the disposal of Marsilio Ficino, where, free of disruption, Ficino could pursue his translation of Plato into Latin.

Cosimo's grandsons Lorenzo, Giovanni (later Pope Leo X), and Giulio (later Pope Clement VII) continued this creative work. Of them all, perhaps Lorenzo, called the Magnificent (1449–1492), was the most dazzling political and artistic figure—businessman, banker, connoisseur of art and literature. He was a friend and a colleague of such writers and philosophers as Pico della Mirandola and Marsilio Ficino, the theorist and architect Leon Battista Alberti, the sculptor Donatello, the painters Ghirlandaio and Botticelli, and the young sculptor Michelangelo. Lorenzo and his contemporary, Duke Federico di Montefeltro of Urbino, were ideal Renaissance princes. The Medici were adept at political diplomacy (and the art of war when necessary), were skilled linguists and writers, were collectors of ancient manuscripts and works of art, and were highly discriminating patrons of painting, sculpture, and architecture. They were the very embodiment of the Renaissance Man. Humanist Federico di Montefeltro built a well-proportioned and elegantly simple ducal palace at Urbino, where he installed one of the most important private libraries in Italy; there, he and the members of his court discussed at length what made for the well-conducted life, conversations later used as the basis for Baldassare Castiglione's *Book of the Courtier* (written in 1508–1518). That book in turn became the textbook for the education of a humanist gentleman for the next three centuries.

Humanism

The renewed interest in antiquity that marked the Renaissance began with the rereading of the works of the ancient authors, especially Latin authors such as Cicero and Virgil, and such Greek works by Plato and Aristotle as were then available in Latin. But what set this younger generation of scholars apart from the earlier Scholastics was that the Renaissance scholars were less interested in how the ancients could be interpreted to corroborate scripture and church dogma than in what the ancients had to say in their own right. The mid-fourteenth-century Florentine poet Petrarch stressed the study of the ancient authors and reliance on one's own observations, as evident in his famous climb of Mount Ventoux in southern France in 1336, a journey taken solely for the pleasure of surveying the beauty of the countryside. Saint Augustine had warned against drawing too much pleasure from the senses, but Petrarch contradicted this admonition, carrying up the mountain a copy of Virgil, on which he reflected along the way. Adjoining Duke Federico's study at Urbino was an open loggia, or porch, from which he could scan the surrounding countryside. This new awareness and appreciation of the natural landscape was one of the important contributions of the Renaissance. The interest in the landscape, as nature and design, can be seen in the pastoral background in the portraits painted of the duke and duchess of Urbino.

Moreover, the new generation of scholars wanted to read the original words of the ancients, not medieval glosses or commentaries, and thus was set in motion the hunt for ancient documents in Latin and Greek in monastic libraries. Indeed, for the humanists, Greek and Roman history became more real than that of their own recent past, which Leonardo Bruni would dismiss as a "dark middle age." Such study also meant that humanists had to develop linguistic skills to correct the errors in medieval copies of ancient manuscripts. This objective inquiry was further reinforced by the fortuitous arrival of numerous Eastern Greek scholars, especially in Florence in the mid-fifteenth century, as they fled beleaguered Constantinople. With the support of Cosimo de' Medici, the Florentine Marsilio Ficino focused his energies on translating into Latin all the known works of Plato. In 1462, Cosimo de' Medici established what came to be called the Florentine Academy, supervised by Ficino and Pico della Mirandola; here, Platonic Greek philosophy was discussed by scholars, students, and such educated amateurs as Cosimo.

There emerged from such intensive reading of Classical literature a new program of instruction, rooted in *humanitas,* "humanism," a term first used by the Florentine scholar Leonardo Bruni, who called for a new sort of education based on a close reading of ancient Greek and Latin authors. Humanism was a philosophical view that emphasized the importance of the power of human values, achievement, and endeavors as distinct from received religious instruction. Humanism stressed objective inquiry guided by human reason, leading eventually to a mathematical approach to comprehending and configuring reality. The humanists viewed history as the record of human aspiration and fallible judgments rather than as an inevitable unfolding of a preordained divine scenario. They did not reject Christianity but, rather, sought to reconcile the Classical view of human potential with Christian belief. Humans were still viewed as God's creation, possessing free will to pursue their own destiny, but humanists also celebrated the dignity of the individual human being and the wonder of human achievement.

Perhaps the best summary of the humanist view of human potential was given by Giovanni Pico della Mirandola in his "Oration on the Dignity of Man," written in 1486, almost an echo of Virgil's repudiation of limits for the Romans. God had assigned Adam no static place in creation, writes Pico, for

> neither a fixed abode nor a form that is thine alone nor any function peculiar to thyself have We given thee [Pico has God say to Adam], to the end that according to thy longing and according to thy judgment thou mayest have and possess what abode, what form, and what functions thou thyself shalt desire. . . . Thus, constrained by no limits, in accordance with thine own free will, in whose hand We have placed thee, shalt ordain for thyself the limits of thy nature. We have set thee at the world's center that thou mayest from thence more easily observe whatever is in the world.[2]

After a millennium, man was once more the measure and measurer of all things. Everything was possible for humankind, believed Pico, for to man "it is granted to have whatever he chooses, to be whatever he wills." There was also rekindled that desire for excellence in human achievement that the Greeks had called *arete,* for as Pico further observed, mankind is "not content with the mediocre, [but] we shall pant after the highest and (since we may if we wish) toil with all our strength to obtain it."[3] Alberti wrote that to humans "is given a body more graceful than other animals, to you power of apt and various movements, to you most sharp and delicate senses, to you wit, reason, memory like an immortal god." And very much the same idea was voiced just over a century later in Shakespeare's *Hamlet:*

> What a piece of work is man!
> How noble in reason! how infinite in faculty!
> In form, in moving, how express and
>   admirable!
> In action, how like an angel!
> In apprehension, how like a god!
> The beauty of the world!
> The paragon of animals!

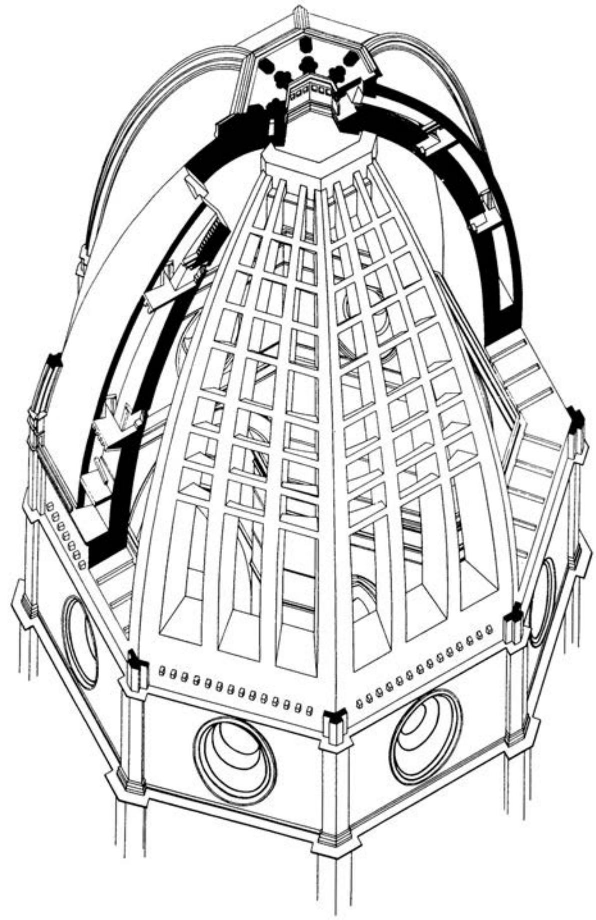
Roman Building Scale Re-achieved: Brunelleschi's Dome

This desire to stretch human limits and to match the building achievements of the ancients was boldly exemplified in the dome Filippo Brunelleschi completed over the crossing of the cathedral in Florence, Santa Maria della Fiore, 1420–1436. The large cruciform Gothic church had been begun about 1296 after designs by Arnolfo di Cambio. Its east end, consisting of octagonal chapels around an octagonal crossing, was greatly enlarged by Francesco Talenti half a century later, creating a crossing that was now 138.5 feet (42.2 m) across and had to be vaulted. Moreover, church officials decreed that no support scaffolding resting on the floor could be used so as not to disturb ongoing church activities. On the basis of traditional medieval building practices, the proposed dome vault seemed impossible to build. And yet, as Brunelleschi knew from his detailed examination of the ancient buildings in Rome, the Pantheon was proof that such a span had been vaulted once. He resolved to do it again.[4]

15.2. Filippo Brunelleschi, Dome of Florence Cathedral, Florence, Italy, 1418–1436. The dome of the cathedral of Florence rises over the city as a bold gesture of civic ambition. It was the largest such dome attempted since antiquity. Photo: Scala/Art Resource, New York.

Brunelleschi had begun thinking about how it could be done as early as 1403 or 1404, when he began his numerous visits to Rome to study its ancient architecture, particularly the dome of the Pantheon and other large domes. Some of these, like the ruin called the Temple of Minerva Medica, clearly revealed their inner structure of brick arches embedded in the concrete. By 1417, he had devised a method, but exactly how it was to be built Brunelleschi did not reveal at the outset, so afraid was he of his ideas being stolen and the credit taken by others. Thwarted by officials who considered his verbal explanations nonsense, and faced with numerous counterproposals from a large number of distinguished builders called together by the cathedral tribunal, Brunelleschi then challenged them all by saying that whoever could make an egg stand on its end on a slab of marble should be the builder of the dome. Repeated attempts to do this by all the other builders failed. Brunelleschi then took the egg and, gently crushing the very end of the shell against the slab, made the egg stand up. When the others protested that, of course, they could have done as much, he retorted, yes, and any one of them could build the dome if he showed them his ideas. This convinced the tribunal that Brunelleschi should be entrusted with the task.[5]

Construction of the great dome began in 1420 [15.2]. In terms of form and profile, the dome of the Florence cathedral is technically not a Classical design; in structural terms, it is more properly termed an enormous medieval eight-sided cloister vault. It has a steep, pointed profile, and its construction method owes much to Gothic technique. The dome is actually two domes, one nested inside the other, a thicker one inside and a thinner one outside [15.3].[6] The main armature of the dome is created of stone arches, thick ones at the eight corners and two smaller ones between each of these main ribs; these ribs tie the inner and outer dome



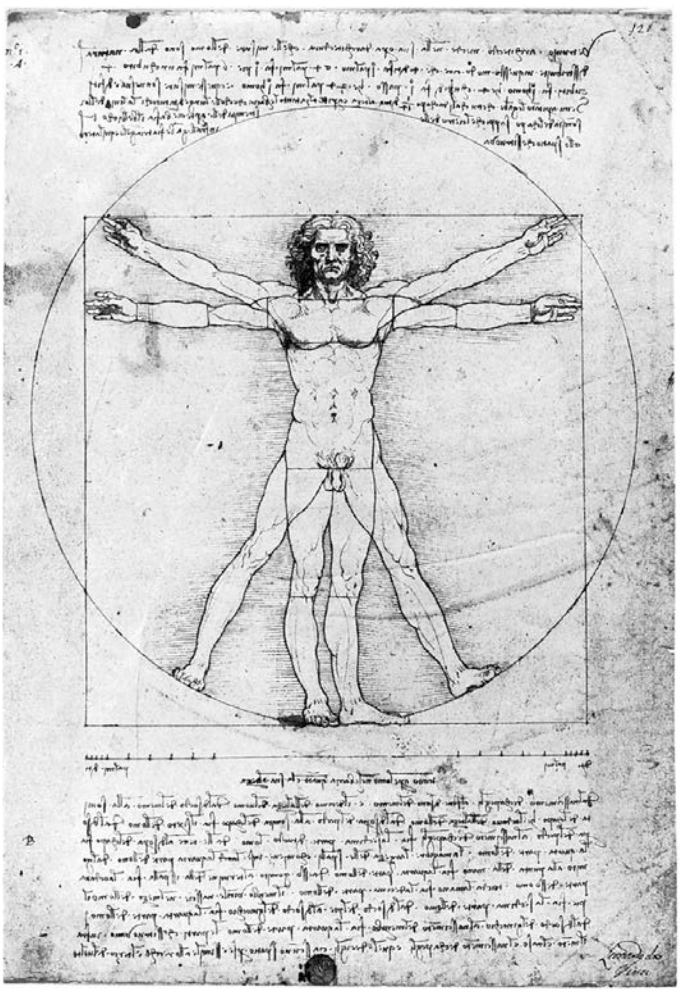
15.3. Dome of Florence Cathedral. Axonometric cut-away view, showing the method of construction, employing ribs and double shells. From P. Sanpaolesi, La cupola di S. M. del Fiore *(Florence, 1965).*

shells together. The key to avoiding massive wooden centering underneath was to build the dome on all sides simultaneously, thereby creating in essence one ring on top of another, each ring acting as its own keystone. The eight curved sides were built of purpose-made large brick, several laid horizontally and then one positioned vertically, creating a spiraling herringbone pattern that keyed each course of brick to those several courses above and below, and preventing the new courses from slipping while the mortar cured and became firm. Moreover, the main and secondary curved vertical ribs are connected by nine horizontal stone rings, which are actually circular within the thickness of the two shells. Any tendency to burst outward was countered by two rings of sandstone reinforced with iron bars and an additional one of wood members. Besides solving these structural and construction problems, Brunelleschi also designed the variety of massive machines for lifting the stone and brick. On the temporary platforms erected below the work under way (attached to the dome itself), he installed food vendors and toilet facilities so the workmen would not need to make repeated arduous and time-consuming trips to the ground level.

The dome proper was topped off in 1434. The overall outline of the dome was predetermined by di Cambio's and Talenti's substructure, but Brunelleschi's study of Roman architectural detail and his inventiveness are more clearly seen in the white stone ***lantern*** he designed to cover the top of the dome. Designed before Brunelleschi's death in 1444, its parts were not hoisted and the lantern not finished until 1461. It is not so much the formal or ornamental properties but the sheer size of Brunelleschi's dome, and its ingenious and original construction techniques that mark it as a Renaissance creation. The Roman scale of building was again alive in Italy. Florence took enormous pride in the dome, and the humanist scholar and theorist Leon Battista Alberti (1404–1472) praised Brunelleschi's achievement, all the more extraordinary since Brunelleschi had no direct precedent in antiquity; the dome, Alberti said, was "unknown and unthought-of among the ancients." Brunelleschi's achievement seemed to Alberti to be the mark of this remarkable time and place: "We discover unheard-of and never-before-seen art and sciences without teachers or without any model whatsoever."[7]

Vitruvius and Ideal Form

The architectural bible for the new generation of humanist patrons and architects was the *Ten Books on Architecture,* by the Roman architect Vitruvius. The books were much discussed during the fifteenth century and published in one edition after another, beginning in 1486, with the first illustrated edition by Fra Giocondo appearing in 1511. The ideally proportioned forms described by Vitruvius were derived from the ideal geometric forms discussed by Plato in *Philebus*—forms generated by straight lines and circles, as well as the solids created by these forms in three dimensions. Plato had been convinced that such forms not only had inherent beauty but were "eternally and absolutely beautiful."[8] Vitruvius drew from such ideas in his third book, devoted to the design of temples, for basic to temple design were symmetry and proportion. Ideal systems of proportion, he observed, can be found in the perfect proportions of the human body. For example, the foot is one-sixth the height to the top of the head, and the face—from chin to nostrils, nostrils to eyebrows, and eyebrows to hairline—is divided into thirds. He also described how the ideal Platonic Phileban shapes, the square and the circle, are incorporated in the proportions of the human body [15.4]:



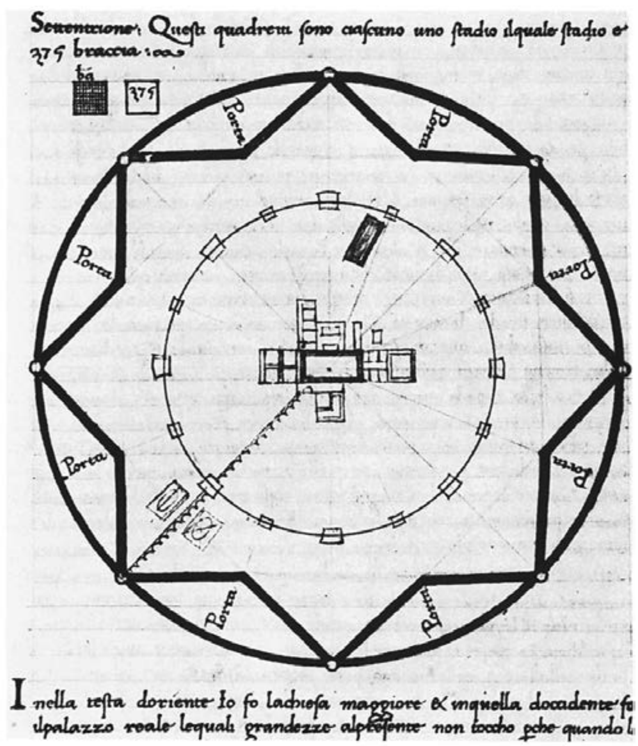
15.4. Leonardo da Vinci, drawing of the ideal Vitruvian man, c. 1485–1490. For Leonardo, as for Vitruvius, the form of the human body contained within it the essence of ideal form (the perfect geometry of the circle and the square) as well as ideal proportional relationships. Leonardo reveals these in the dividing lines marked on the body. Photo: Alinari/Art Resource, NY.

> For if a man be placed flat on his back, with his hands and feet extended, and a pair of compasses centered at his navel, the fingers and toes of his two hands and feet will touch the circumference of a circle described therefrom. And just as the human body yields a circular outline, so too a square figure may be found from it. For if we measure the distance from the soles of the feet to the top of the head, and then apply the measure to the outstretched arms, the breadth will be found to be the same as the height, as in the case of plane surfaces which are perfectly square.[9]

Renaissance architects sought clearly expressed numerical relationships in their designs, recalling the mysticism of Pythagoras and his followers. Galileo Galilei wrote later that it was not possible to understand the "book" of creation "if we do not first learn the language and grasp the symbols in which it is written. This book is written in a mathematical language, and the symbols are triangles, circles, and other geometrical figures, without whose help it is impossible to comprehend a single word of it."[10]

The circle was an especially attractive form for Renaissance designers, symbolizing the perfection of God. Not only did the circle and the square thus provide the ideal forms for church plans, but planners even adapted circular schemes in plans for new towns. Antonio Averlino, called Filarete, worked in Milan during the 1460s on a manuscript discussing the new rational and classically inspired architecture; in it he laid out a model new town, called Sforzinda after his patron. The plan consisted of an octagonal star-shaped city with streets radiating from a central market square [15.5]. Because of the political difficulties then besetting Italy, no such new towns were built at that time, but in 1593, such an ideal city was built when the Republic of Venice began construction of Palmanuova, a fortress city northeast of Venice to protect the exposed plain of Fruili from attack by the Turks [15.6]. Believed by some to have been designed by Vincenzo Scamozzi, it is a nine-pointed star, with bastions for artillery around its perimeter. Its nine principal radial streets and circumferential connectors conform to the ideal pattern and served the practical purpose of enabling supplies and munitions to be moved equally well from centralized storehouses to wherever they were needed.

Renaissance architects sought to shape space using modular units based on whole-number proportional relationships. The circle and the square



15.5. Antonio Averlino (called Filarete), plan of the ideal city of Sforzinda, from his treatise on architecture, written c. 1461–1462. Filarete (a name adapted from Greek, meaning "Lover of Virtue") was the first Renaissance designer to use the ideal form of the circle as the basis for a city plan. Photo: From Filarete, Il trattato d'architettura.

15.6. Vincenzo Scamozzi (attrib.), Palmanuova, Italy, begun 1593. Palmanuova was a new town, built according to the ideal circular model. Photo: Aerofilms, London.

became the basic design modules of their architecture, with the boundaries of these modules being delineated by Classical columns, arches, and entablatures derived from Roman sources. Beauty was seen to rest in the careful arrangement of proportionally related parts. Alberti offered this summary in his book *De re aedificatoria* (On Building), written about 1450: "Beauty is that reasoned harmony of all the parts within a body, so that nothing can be added, taken away, or altered, but for the worse."[11] Echoing Pythagoras, Alberti was convinced that "the very same numbers that cause sounds to have that *concinnitas* pleasing to the ears, can also fill the eyes and mind with wondrous delight."[12]

Brunelleschi and Rationally Ordered Space

Among the first buildings to demonstrate this mathematical proportioning was Brunelleschi's Foundling Hospital in Florence, designed in 1419 for his patron Giovanni de' Medici and the silk guild [15.7, 1.15].[13] Across the front of the building and facing the piazza, an arcade with monolithic Corinthian columns carried the lightest of semicircular architraves and a stretched entablature. The columns are so proportioned that they are spaced exactly as far apart as they are tall, defining squares in elevation; the columns are also as far from the rear wall as they are high, thus delineating cubes in space. The delicate semicircular arches carried by the columns are half again as high, so that in terms of the length of the radius of the arch, the bays have a three-dimensional whole-number ratio of 2 to 2 to 3.

Like nearly all other Renaissance architects, Filippo Brunelleschi (1377–1446) was trained as an artist, a master goldsmith in the silk guild; but more unusual, he was also a scholar who read some Latin. Vasari reports in his *Lives of the Artists* that, after losing the competition for new bronze doors for the Florentine baptistery, Brunelleschi turned to the study of architecture because he felt architecture was "more useful to mankind than either

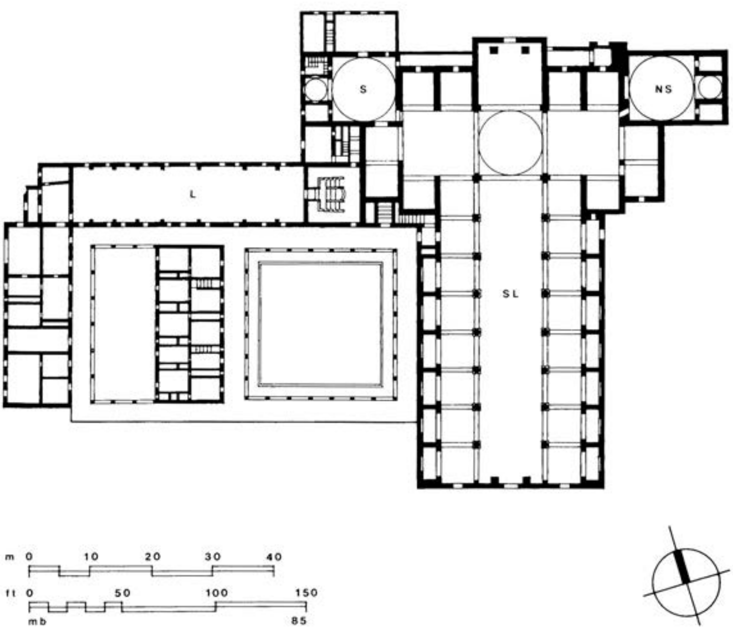
15.7. Filippo Brunelleschi, Foundling Hospital, Florence, Italy, 1419–1424. Brunelleschi used the ideal of pure circles, squares, and cubes to determine the proportions of the arcade across the front of this orphans' asylum. Photo: Scala/Art Resource, NY.

sculpture or painting."[14] While he was perfecting his constructional scheme for the cathedral dome, Brunelleschi was at the same time designing the Foundling Hospital and tackling the problem of developing a rational mathematical scheme for accurately depicting on a painted flat surface the arrangement of objects on real three-dimensional space—that is, he set out to rediscover the mathematical perspective that Roman painters had used. Alberti was also working on this problem at the same time in Rome.

Once Brunelleschi had formulated the basis of mathematical perspective, he then turned his attention to duplicating this objective spatial order in his architecture. In 1418, he was engaged by Giovanni de' Medici to rebuild the Church of San Lorenzo in Florence, beginning with a new square sacristy capped by a dome on pendentives and then turning to the reconstruction of the main vessel of the monastic church [15.8, 15.9]. His objective was to create a volume organized into cubes of space: large cubes forming the choir and transept arms, with four cubes forming the naves, each defined by dark stone Corinthian columns and pilasters.

Because he had to adapt the plan of San Lorenzo to fit among existing structures, Brunelleschi was unable to make this mathematical scheme fully coherent in all its details and subdivisions throughout, but in his Church of Santo Spirito, begun in 1436, Brunelleschi created what he considered his most successful design, due in large part to the space where it would be built: an open area unhampered by existing walls [15.10, 15.11]. The plan of the church is generated by the central cubical bay of the crossing, surmounted by a dome on pendentives. From this, duplicate cubes extend to form the choir and transept arms. Each of these, in turn, is flanked by two smaller cube units forming the side aisles; each is one-fourth the volume of the larger units. From the central crossing extend four large cubical bays for the nave. Along the side aisles around the church, Brunelleschi planned to have numerous small, semicircular apses. Since the radius of each would have been one-half the width and height of the side aisle bays, what the viewer would have seen from the end of the nave would have been a series of units increasing in a proportional progression. From the diameter of the side

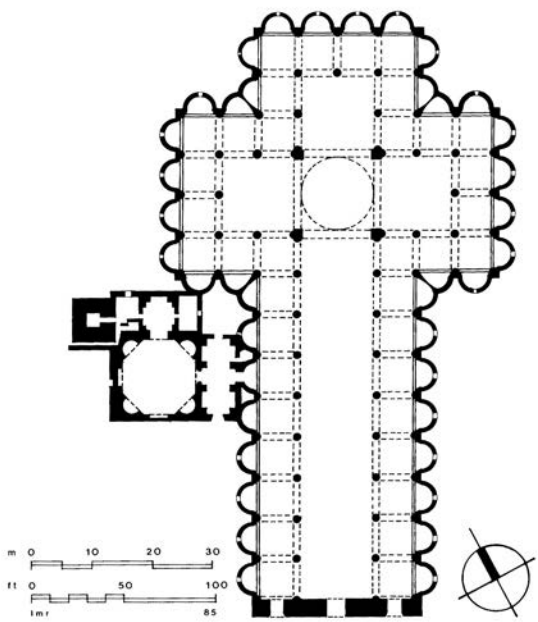
15.8. *Filippo Brunelleschi, Church of San Lorenzo, Florence, Italy, 1418–1446. View of the nave. Photo: Marvin Trachtenberg.*



S = Library (Michelangelo)
NS = New Sacristy (Michelangelo)
S = Sacristy (Brunelleschi)
SL = Church of San Lorenzo (Brunelleschi)

15.9. *San Lorenzo. Plan. Drawing: M. Burgess.*

15.10. Filippo Brunelleschi, Church of Santo Spirito, Florence, Italy, 1436–1482. View of the nave. Given an open site, Brunelleschi was able to realize his goal of a building completely determined by mathematical proportions. Photo: Nicolas Sapieha/Art Resource, NY.



15.11. Santo Spirito. Plan. Drawing: L. M. Roth.

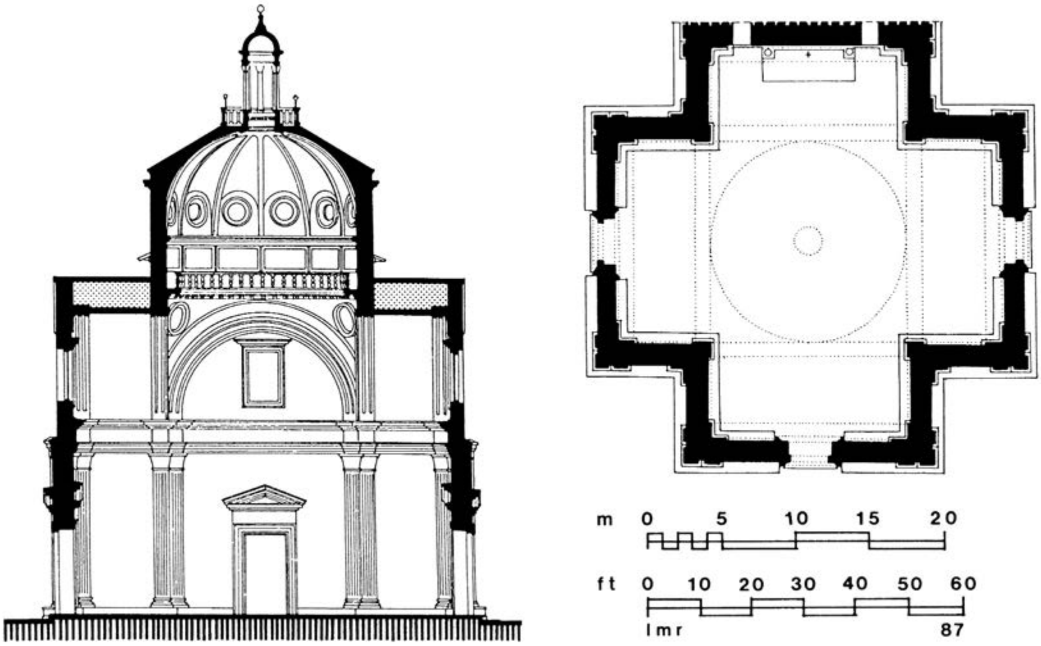
aisle apses to the height of the central nave, the progression would go from 1 to 2 to 3 to 4 to 5. In other words, the visitor would see a fully three-dimensional representation of a building as a constructed perspective, each architectural element assigned a precise place in a rationally ordered scheme. Instead of the medieval transcendent mystical experience, here was a celebration of human reason in the service of the church.[15]

Idealized Forms and the Centrally Planned Church

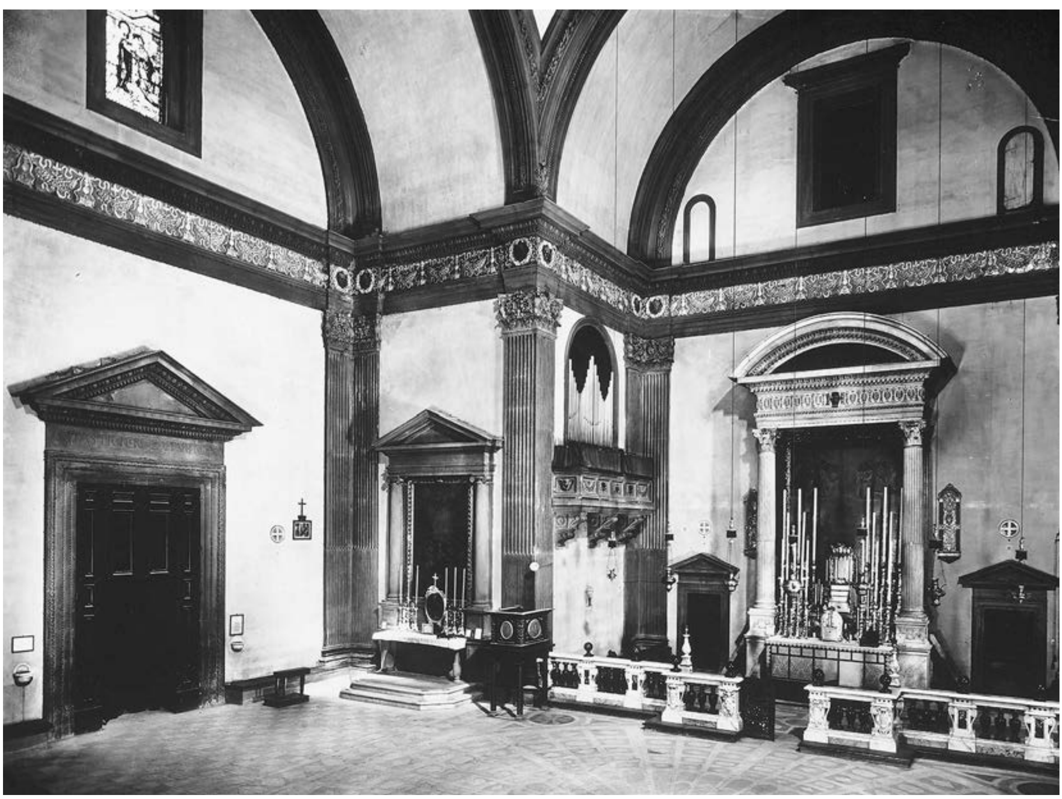
To theorists such as Alberti, the circle and the centralized plan generated from it were highly evocative religious symbols of the perfection of divinity, forms found also in the proportions of the human body patterned, so scripture declared, in God's image. A dome, placed over the center, became the outward manifestation of this centrally focused plan. An early example of the square plan surmounted by a dome was Brunelleschi's Pazzi Chapel, in the cloister court of the Church of Santa Croce, Florence. Designed perhaps in 1423–1424 but not built until 1442–1465, the chapel was paid for by the Pazzi family. Here again, Brunelleschi had to adjust an otherwise ideal plan to fit the chapel among existing buildings.[16] In 1460, Alberti devised a square plan with short arms for the Church of San Sebastiano in Mantua, but construction was changed after his death and little remains today of Alberti's original design.

Perhaps the clearest expression of the use of the circle and the square as generative modules is the small Church of Santa Maria della Carceri by Giuliano da Sangallo (1445–1516).[17] Built in 1485–1491 in the town of Prato, 11 miles (17.7 km) northwest of Florence, it is based on a square plan projected vertically into a cube [15.12, 15.13, 15.14]. Above the cube, pendentives form a circular plan from which rise a short drum and a ribbed dome, lit by twelve bull's-eye windows at the base and a lantern at its top. From the cube base, half-cubes project laterally, forming the arms of a compact Greek cross plan. Internally, the edges of the volume are marked by dark stone Corinthian pilasters, entablature, and architraves, sharply contrasting with the unadorned white stucco walls.

15.12. Giuliano da Sangallo, Santa Maria delle Carceri, Prato, Italy, 1485–1491. Sangallo used the proportional ideal to construct a centralized church generated by a square and cube at its center. Photo: Alinari/Art Resource, NY.



15.13. Santa Maria delle Carceri. Plan and section. Viewed together with the exterior, the plan and section demonstrate the exact correspondence of part to part, inside and out, an idea central to the Renaissance concept of ideal form. Drawing: L. M. Roth, after Murray, Architecture of the Italian Renaissance *(London, 1963).*



15.14. Santa Maria delle Carceri. Interior. Photo: Alinari/Art Resource, NY.

Externally, each component of the interior is revealed by the stone trim attached to the brick structural wall. The outer entablature corresponds to that inside, the upper attic level corresponds to the barrel vaults over the arms, and the pediments (and the central block they run into) correspond to the short drum inside carrying the dome. The church is a rational exercise in the extrapolation of parts from the central cube module, extended by half-cubes and semicircles in every direction; every part of the exterior announces what is to be found inside. There are no intellectual discordances but, rather, perfect uniform conformity to proportional harmony.

Even more thoroughly and perfectly developed in its schematic unfolding in space of circles and squares, half-domes and cubes is the freestanding church of Santa Maria della Consolazione in Todi, Tuscany, built in 1508–1607 from designs of Cola da Caprarola perhaps assisted by Baldassarre Peruzzi, apparently greatly influenced by Donato Bramante [15.15, p. 364].

Alberti's Latin Cross Churches

In many instances, Renaissance architects did not have open sites on which to build their churches but, rather, had to adapt their preference of centralized Classical forms to existing Late Gothic basilican plans. Leon Battista Alberti had confronted this problem in 1450–1461 in putting a new exterior shell around the Church of San Francesco in Rimini, a coastal city on the Adriatic ruled by Sigismondo Malatesta [15.16].[18] Alberti created a deeply arcaded new wall that enveloped the old church walls in a way that recalled the massiveness of the Colosseum in Rome; in the arched voids was room for ceremonial sarcophagi for members of the Malatesta family. At the end of the church, Alberti devised an entry derived from Roman triumphal arches, with arches to the left and right repeating the rhythm of the arches on the side walls. (The side walls were to have been deep niches as well, containing the sarcophagi of the duke and his mistress; but out of structural necessity, the openings had to

15.16. Leon Battista Alberti, Church of San Francesco (the Tempio Malatestiano), Rimini, Italy, 1450–1461. This new shell, wrapped around an existing medieval church, is based on Roman triumphal arch forms. Photo: Scala/Art Resource, NY.

15.17. Leon Battista Alberti, detail from letter to Matteo de' Pasti, November 18, 1454. Inserted in the text of Alberti's letter is a sketch of this detail, showing Matteo de' Pasti how to make the transition from the lower side aisles to the taller center nave. Drawing: L. M. Roth, based on Alberti's sketch.

be filled in.) Between them, a larger central arch encloses a door framed by a Classical architrave and capped by a pediment. The details throughout reveal Alberti's detailed study of Roman ruins.

Above the entry, Alberti was confronted with the problem of making a graceful transition from the tall center nave to the lower side aisles with their shed roofs. Unfortunately, this upper section was never finished according to Alberti's design. Nevertheless, in a letter of November 18, 1454, to his supervising architect, Matteo de' Pasti, Alberti gives us an idea of not only what he had in mind but also the importance of proportional relationships throughout the entire scheme. "Remember and bear well in mind," Alberti firmly instructs Matteo, "that in the model, on the right and left sides along the edge of the roof, there is a thing like this" (and here he inserted a little sketch [15.17]), "and I told you I am putting it there to conceal that part of the roof that will be put on the inside of the church. . . . You can see where the sizes and proportions of the pilasters come from; if you alter anything you will spoil all that harmony."[19]

We should remember that although Alberti was extremely well educated and an accomplished, multitalented individual, he did not have the practical training of an artist or architect. Hence, we should carefully note the way he relied on builders to carry out his conceptual designs. His letter to Matteo de' Pasti illustrates this collaboration well.

Later, in 1458–1471, Alberti improved on this connection between side aisles and nave in the facade he designed for the existing Church of Santa Maria Novella in Florence [15.18]. This time, he used long, curved volutes to make a graceful transition from the square of the upper part of the nave block to the two squares of the lower part of the facade.

Because the Rimini design was developed through correspondence with Alberti's supervising architect, Matteo, the Church of San Francesco was not fully resolved in all its parts. Much more thoroughly studied, however, was Alberti's last building, the Church of Sant' Andrea in Mantua, designed in 1470 but built closely following his intentions by Luca Fancelli and finished in 1493, the year after Alberti's death [15.19, 15.20, 15.21]. Once again, Alberti had to deal with existing conditions, fitting his new facade against the existing bell tower that could not be removed; hence, the facade is a slightly reduced version of the main part of the church itself. But the major problem that Alberti confronted, and one that contradicted his strong predisposition for symbolic centralized plans, was that such plans simply do not accommodate the processional liturgical service of the Catholic Church; for such a liturgy, the longitudinal basilican plan had long before proved itself superior. Repeatedly, from the Italian Renaissance up to Sir Christopher Wren's Greek cross proposal for Saint Paul's, London, about 1672, architects would repeatedly propose idealized centralized plans, either circular or square, only to have church officials insist on a Latin cross plan.

This struggle between the ideal and the practical would be documented in the dramatic pendulum swings in the designs for the new Saint Peter's basilica in Rome during the sixteenth century. Thus, in Sant' Andrea, Alberti had to do what Brunelleschi had done previously in Florence: devise a scheme that was both centralized around the crossing and yet provided the focus toward the altar of a basilican plan. His solution, inspired by Brunelleschi, perhaps, had the massive solidity of Roman baths instead of the delicacy and lightness of San Spirito. Sant' Andrea's crossing cube extends in three short barrel-vaulted wings, forming transepts and choir. On the fourth side, the barrel vault is extended in three bays to form the nave. Like the heavy center vaults of the Basilica of Maxentius, Alberti's coffered nave vault, 60 feet (18.3 m) across, is supported by massive lateral piers connected by smaller cross barrel vaults. These buttressing side vaults cover deep chapels between the piers.

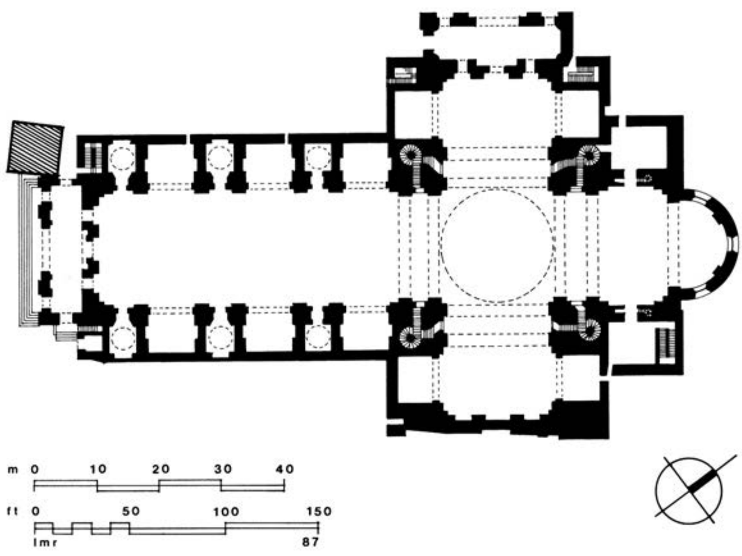
In his reduced entrance facade portico, Alberti clearly demonstrated this internal organization by showing a center barrel vault supported by vaulted side chapels. The facade, with its recessed entry, is also another variation on the Roman triumphal arch, with a lower Corinthian order supporting the central arch and a colossal Corinthian pilaster order carrying the broad Classical pediment. As a further demonstration of proportional design, the entire facade, from edge to edge, and from pavement to the pediment crown, neatly fits inside a square.

Bramante and the New Saint Peter's, Rome

Like Alberti, Donato Bramante (1444–1514) preferred centralized plans for religious buildings. Bramante was trained as a painter in Urbino but

15.18. Leon Battista Alberti, facade of Santa Maria Novella, Florence, Italy, 1458–1471. In this facade design for an existing medieval church, Alberti pursued further his ideas of uniting the parts of the design by means of proportional systems as well as volutes to make the transition from tall nave to lower side aisles. Photo: Scala/Art Resource, NY.

15.19. Leon Battista Alberti, Sant' Andrea, Mantua, Italy, 1470–1493. Front. Slightly reduced in size to fit next to the existing tower, the facade parallels every part of the interior of the church and is so proportioned that it fits into a perfect square. Photo: Alinari/Art Resource, NY.



15.20. Sant' Andrea. Plan. Although Alberti philosophically preferred centralized plans based on squares and circles, here he bowed to the wishes of the clergy and developed a traditional Latin cross plan, carefully proportioned and using repeated modules. The hatched area is the existing tower. Drawing: L. M. Roth.

switched to designing buildings when he moved to Milan.[20] In 1499, when the French occupied Milan, Bramante moved to Rome, where he received the commission for a small martyrium to mark the spot where, according to one traditional account, Saint Peter had been crucified. His patrons were Ferdinand and Isabella, king and queen of Spain, more widely known to posterity for their patronage of Columbus's voyages to the New World. In writing about the ideal centralized church, Alberti had used the Latin word *templum,* "temple"; Bramante took Alberti literally, deriving his martyrium for Saint Peter from such round peripteral Roman temples as the one at Tivoli. The result was the Tempietto ("Little Temple") in the cloister of San Pietro in Montorio, Rome, 1500–1502 [15.22]. Bramante carefully proportioned the Tempietto so that its overall height to the base of the dome is equal to its width, and the ratio of width to height in the encircling Doric colonnade is repeated in the width to height of the drum of the dome. The Doric columns were reused Roman artifacts, but the frieze was designed by Bramante after that of the Temple of Vespasian, with the instruments of pagan ritual in the Roman model transmuted into instruments of the Mass and papal symbols. Hence, in form, proportion, and ornamental detail, the diminutive building recalls Roman architecture at its purest, re-created and reshaped in the service of the church.

With the election of Giuliano della Rovere as Pope Julius II in 1503, an aggressive and vigorous humanism was introduced to the papal court. Besides consolidating his temporal power in the papal states, Julius II had great ambitions for Rome as the queen city of the church, ending the city's medieval slumber and returning to it something of the glory it had displayed in antiquity. During the Middle Ages the city of Rome had dwindled in population, and now occupied less than a quarter of the space it had once filled. Throughout the city stood the mammoth ruins of pagan Rome, rising proud if rather dilapidated over the medieval city that had shriveled in upon itself. The venerable Constantinian basilican churches, built nearly twelve centuries before, had been in constant use and had even withstood the onslaughts of successive invaders. All were dilapidated and in need of repair. Chief among these, and next to the papal palace on the Vatican Hill, west of the Tiber and thus outside the

15.21. Sant' Andrea. Interior. The nave is covered by a massive brick barrel vault with deep coffers, recalling Roman baths. Photo: Scala/Art Resource, NY.

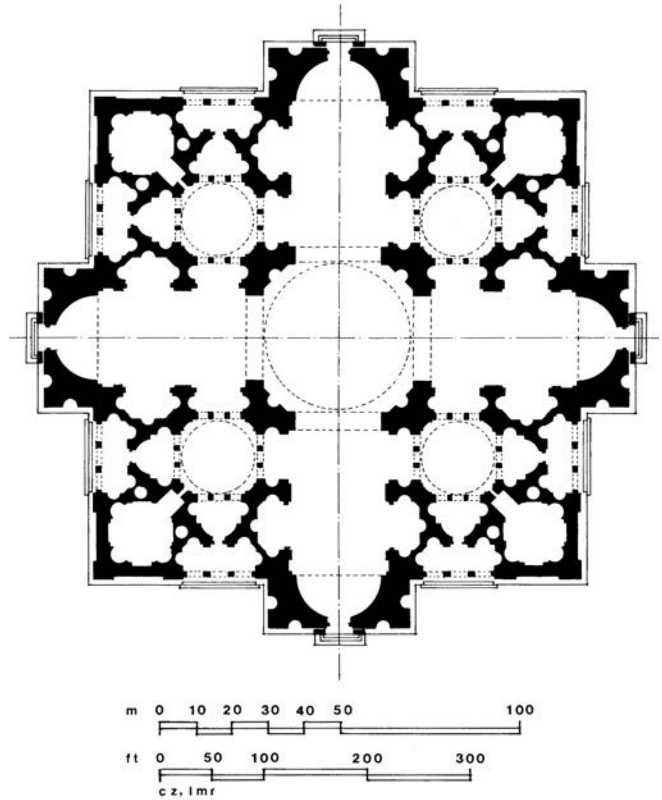
15.22. Donato Bramante, Tempietto of San Pietro in Montorio, Rome, Italy, 1500–1502. Originally planned to be surrounded by a circular arcade, this little temple appropriates pagan Roman forms and motifs to proclaim the importance of Saint Peter as founder of the Christian church in Rome. Photo: Scala/Art Resource, NY.

actual city of Rome, was the great Constantinian pilgrimage basilica of Saint Peter's.

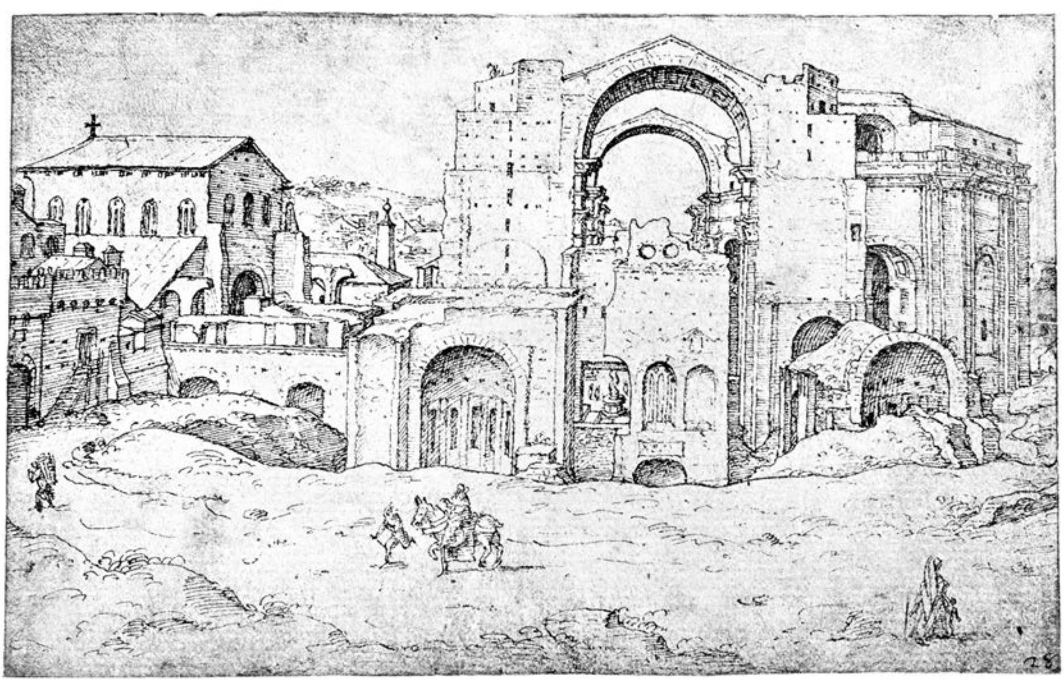
Gathered in Rome at this time were humanist artists and architects of the highest caliber—the sculptor Michelangelo, the young painter Raphael Santi, and Bramante, his uncle. Julius II resolved to put them to work rebuilding the papal possessions according to the new vision of human power, a testament to the glory of God as well as to the power of the papacy. He sent Michelangelo up the scaffold in the Vatican chapel built by Julius's uncle, Pope Sixtus IV (the Sistine Chapel), to paint the ceiling frescoes. Raphael was assigned to paint frescoes in the papal apartments, depicting the victory of humanist theology [see 7.10]. And in 1504 Bramante was appointed to design and build a new Saint Peter's, bigger than Constantine's church, embodying the ideals of the new architecture and proclaiming the power of an invigorated Christianity while surpassing the achievement of pagan antiquity. Not incidentally, the new Saint Peter's was also to reclaim the position of the greatest church in Christendom, now that Justinian's huge, domed Hagia Sophia had been captured just fifty years before and converted into a mosque.

For the new Saint Peter's Basilica, Bramante devised a vast martyrium, providing for a gigantic dome over the crypt of Saint Peter's burial and the former apse of Constantine's basilica [15.23, 15.24]. The dome alone was to be 136 feet (41.5 m) in diameter, nearly equal in size to that of the ancient Pantheon but raised far higher. Instead of resting on a massive ring wall as in the Pantheon, this dome was to be lifted aloft on four molded corner piers supporting pendentives, its outward thrust transmitted to the barrel vaults radiating from the pendentives between the piers. Around the four central piers would run an ambulatory connecting with four vast chapels on the axes of the arches. In the corners of the vast square plan were to be auxiliary chapels. Bramante's scheme—perhaps inspired by a drawing in one of Leonardo da Vinci's sketchbooks that Bramante may well have seen in Milan—combined the clear logical form of the Greek cross with Roman barrel vaults and hemispherical domes. Circles and squares, cubes and hemispheres were nested and interlocked around each other in a huge pyramidal pile. Altogether, the church would have been roughly 528 feet (161 m) square, and Bramante may have intended to create an even larger, paved, square piazza around the church.[21] Clearly, this was a project to rival in scale those of the Romans. Construction began on the piers for the great dome in 1506, when Bramante was sixty-one; when he died in 1514, only the four massive piers, the barrel vaults connecting the piers, and the lower portions of the radiating walls had been completed [15.25].

15.23. Donato Bramante, medal showing Bramante's design for the new San Pietro in Vaticano (the new Saint Peter's), Rome, Italy, 1504–1514. The medal, struck by Cristoforo Caradosso when the foundations of Bramante's church were laid, records the original design. Bramante proposed a huge martyrium with an elevated dome nearly as big as that of the Roman Pantheon. Photo: British Museum, London.



15.24. Saint Peter's, Rome. Plan (reconstructed from a half plan). The simple scheme of Saint Peter's has a central square surmounted by a dome, surrounded by an ambulatory passage, apses at the ends of the crossed axes, and towers at the four corners. Drawing: C. Zettle and L. M. Roth.

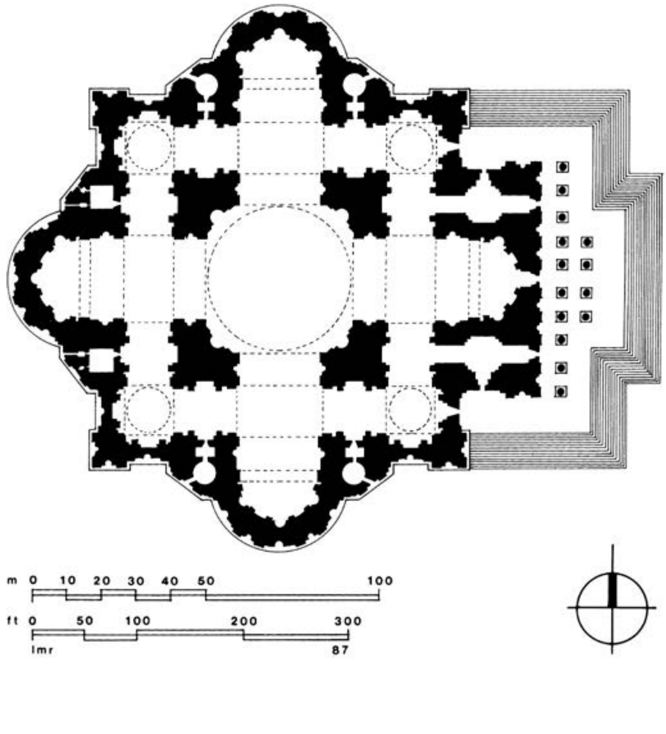


15.25. Maerten van Heemskerck, drawing of Saint Peter's under construction, c. 1532–1535. The Dutch artist van Heemskerck visited Rome when building on Saint Peter's was temporarily halted; he made several drawings of the arches silhouetted against the sky. To the left is visible a portion of the old Constantinian St. Peter's still standing. Photo: Scala/Art Resource, NY.

Such a project proved enormously expensive, and to finance it, Julius had authorized the sale of papal indulgences. Such indulgences had been first granted in 1343 by Pope Clement VI, who declared that because of the great piety of the religious during the early years of the church, a heavenly "treasury of merit" had accumulated. Those who feared eternal damnation could obtain some of this merit through a papal indulgence obtained by doing good works; later, the requirement of good works was modified to the giving of alms. In time, this practice degenerated to the outright sale of indulgences. In Germany, where the indulgences were vigorously hawked by Johannes Tetzel—a flamboyant agent specially hired for the purpose—such flagrant abuses prompted a German Augustinian monk to question the sale and post ninety-five theses for debate concerning church reform on the door of the castle church of Wittenberg on October 31, 1517. The monk was Martin Luther, and that act immediately polarized German princes, many of whom wished to be freed of papal control. Originally wishing only to argue for reform within the church, Luther succeeded instead not only in setting off the religious Reformation but also in encouraging the throwing off of political control, forever splintering Christianity into argumentative factions.

The popes who followed Julius II (who had died in 1513 and thus was spared seeing how his architectural project split the church) eventually had to deal with the problem of division, the most serious difficulty the church had faced since separation from the Eastern Orthodox Greek Church in 1054. There were external political threats as well, particularly the invasion of Italy by German troops of the Holy Roman Emperor, who sacked Rome in 1527. Consequently, after 1517, there was little construction on the new basilica; the new portions stood only partly constructed, while the old Constantinian fragments remained inside, only partly demolished.

Under succeeding popes and their selected architects, Bramante's centralized plan was changed repeatedly on paper and in models, first into a more traditional, longitudinal basilica and then back to some variant of a centralized plan, and this ambivalence continued for decades. Not until after the election of Alessandro Farnese as Pope Paul III was work seriously resumed in 1546, when new plans were prepared by the aged Michelangelo. Perhaps Michelangelo's training as a sculptor, as someone intimately familiar with the great weight of stone, enabled him to see the flaws in Bramante's original design; it had far too much enclosed volume with too little mass to support the huge, elevated dome. Michelangelo pulled in the walls, thickening them even more and creating a tighter and more solid perimeter to the plan [15.26]. He also made another important change, for although he retained the sense of a centralized plan with four arms of equal length, he proposed making one of them the entry by ending it in a huge colonnaded temple front,



15.26. Michelangelo Buonarroti, Saint Peter's, Rome, 1547–1590. Plan. In comparison to Bramante's plan, Michelangelo's is denser and provides more support for the dome; it also deviates from Bramante's strict centrality by providing for an entrance portico on the east side. Drawing: L. M. Roth, after Letarouilly.

thereby creating a sense of ambiguity—was the design centralized or not? Under his direction, the western walls were built with immense Corinthian pilasters whose scale defies easy comprehension [4.16]. Michelangelo's dome was finished in 1585–1590, after his death, by Giacomo della Porta and the engineer Domenico Fontana, but the church was still not finished, for the east end stood incomplete and the approach toward the building had not yet been made clear; these tasks would be undertaken by later architects in the Baroque period.

Residential Architecture: Merchant Prince Palaces

In prosperous mercantile Florence, a new standard of urban residential design, sponsored by the rising merchant princes, replaced the cramped houses of the fourteenth century with large residences of Classical grace. In most of these palazzi and villas, the architects confidently devised an original blend of ancient Roman architectural themes with local tradition.

The Palazzo de' Medici

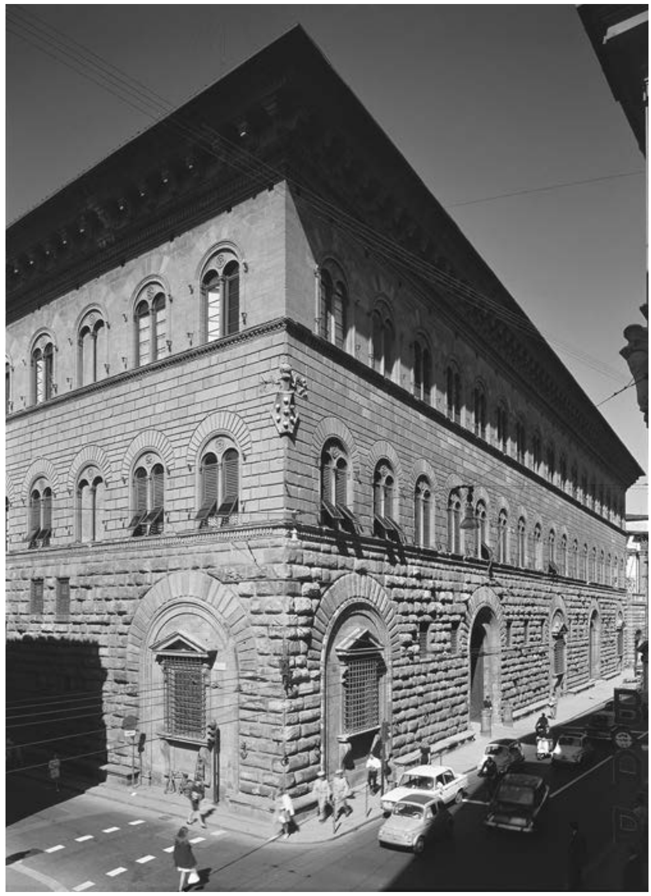
In 1444, Cosimo de' Medici proposed to build a large residence for his family, with space on the ground floor to accommodate his business offices.[22] It was to be located on the Via Larga, then at the edge of town. At first, Cosimo had Brunelleschi prepare a model of the new house, but his design was so novel and imposing that Cosimo rejected it, fearing it would excite his townsmen to envy. As Vasari reports, Brunelleschi was so angry at losing this esteemed commission that he smashed his model "to smithereens."[23] Cosimo then engaged a more conservative architect, Michelozzo di Bartolomeo (1396–1472).[24] The palazzo that Michelozzo then designed combined the sobriety of traditional medieval Florentine residences with a sense of gravity and proportion and attention to Classical Roman detail [15.27, 15.28]. The rusticated joints of the masonry were a gesture to local tradition, but the graduation from rough, quarry-faced masonry on the ground level, to channeled joints in the middle floor, to a perfectly smooth surface in the upper floor was new. Also modern was the massive cornice, adapted from ancient Roman models; it was decidedly Classical and proportioned to the overall height of the building, as though associated with an invisible order of pilasters or engaged columns. Inside, the rooms were arranged around a central court, which opened up at the bottom through an encircling arcade of delicate Corinthian columns. Appearing quiet and empty in modern photographs, the court then was alive with the comings and goings of clients, family members, and the artists and writers Cosimo supported, and it was ornamented with ancient statuary and such contemporary sculptures as Donatello's heroic *David*.

The Palazzo Rucellai

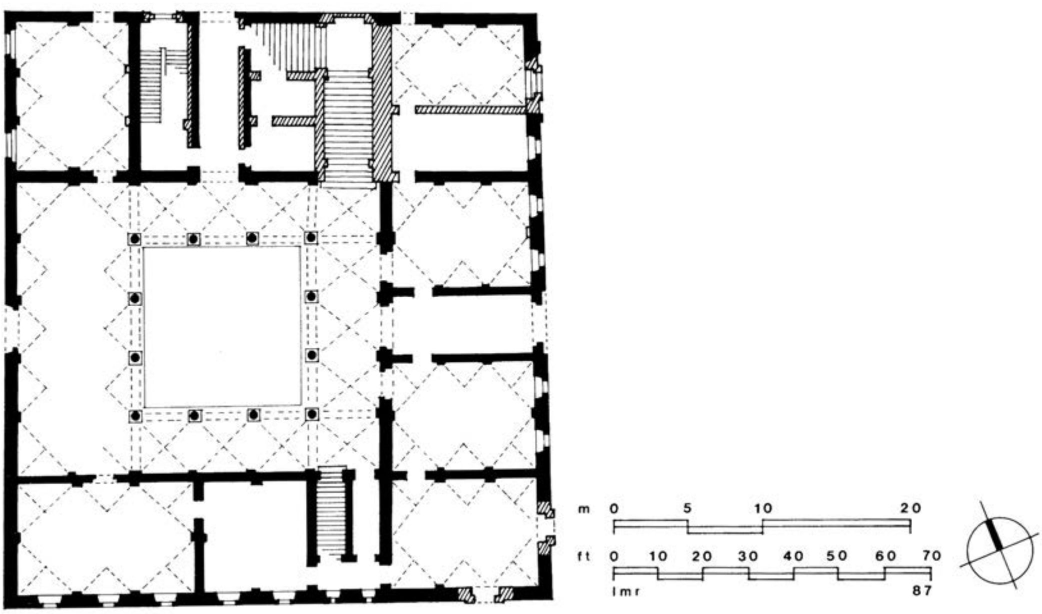
A more radical departure in facade design was made by Alberti in his remodeling of the Palazzo Rucellai, begun about 1452 [15.29]. Giovanni Rucellai, whose fortune derived from making *oricello,* the red dye for which Florence was famous and from which the family name derived, purchased the houses adjoining his birthplace at the corner of the Via della Vigna and the Via del Palchetto. Alberti was asked to design a new facade, unifying the combined properties. Wishing to give a sense of modular order to the traditional rusticated Florentine wall, Alberti superimposed three orders of pilasters, as the Romans had done in the orders applied to the Theater of Marcellus in Rome and the Colosseum, with Tuscan Doric on the bottom, a variant of Ionic in the middle, and a loosely interpreted Corinthian at the top. The entablatures of the orders serve as bases for the surmounting pilasters and windows, and the uppermost pilasters carry a large cornice proportioned roughly to the height of the building. The pedestal base at the street is rusticated on the diagonal to suggest Roman *opus reticulatum* concrete. Thus, Alberti combined selected traditional elements with the new interest in Roman architecture and a logical reuse of Classical orders to create a proportioned module across the facade.

The Palazzo Farnese

This sense of balance, repose, and order was maintained and developed in subsequent urban palazzi, as illustrated in the immense Palazzo Farnese in Rome, begun in 1515 by the architect Antonio da Sangallo the Younger (1485–1546) for Cardinal Alessandro Farnese before he became Pope Paul III [15.30]. By the early sixteenth century, following the activity started by Julius II, Rome had again become a center of power, and princes of the church vied to display their importance through imposing architectural projects. The Palazzo Farnese was one such example, surpassing anything yet done in Rome. Cardinal Farnese held enormous power in the Vatican, having a retinue of three hundred persons. Following his election to the papacy as Paul III in 1534, he had Sangallo enlarge the palazzo, then



15.27. Michelozzo di Bartolommeo, Palazzo de' Medici, Florence, Italy, 1444–1460. Although the heaviness of the palazzo and the window details were derived from earlier Florentine city houses, the careful proportioning of parts and the massive Classical cornice show Michelozzo's study of antiquity. Photo: Scala/Art Resource, NY.



15.28. Palazzo de' Medici, Florence. Plan. Drawing: L. M. Roth, after Murray, Architecture of the Italian Renaissance *(New York, 1963).*

15.29. Leon Battista Alberti, Palazzo Rucellai, Florence, Italy, begun c. 1452. Alberti based his facade (actually a remodeling of existing houses) on Roman sources, using superimposed pilasters to create a varied rhythm and to visually support the crowning cornice. Photo: Scala/Art Resource, NY.

still under construction. Eventually, the third floor of the facade and much of the rear of the palazzo was completed during 1547–1559 by Michelangelo, who modified the third-floor design.

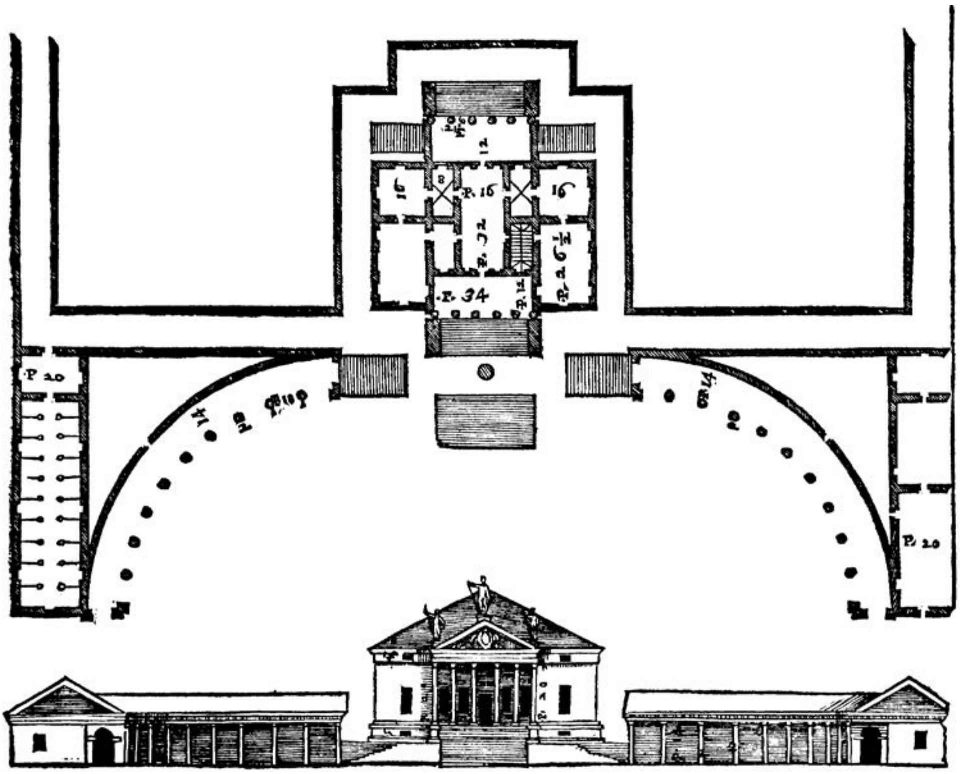
The Villas of Palladio

By the time Michelangelo had finished the third floor of the Palazzo Farnese in 1559, Renaissance architecture as the clear and intellectual expression of form through simple mathematical proportions was being modified into a more subtle and intellectually complicated idiom later called Mannerism (discussed below). Nonetheless, one architect working in the mid-sixteenth century in the region of the Veneto (the area north and west of Venice) continued to exploit the simple cubic volumes and elemental forms of the early Renaissance, particularly in the exteriors of his buildings. He was Andrea Palladio (1508–1580), one of the few architects of this period to be trained as a builder; it was later in his life that he was given a humanist education in the classics, through the support of his patron, Giangiorgio Trissino.[25] During his career, he built public buildings and urban palazzi in his adopted city, Vicenza; two important churches in Venice; and, finally, the Teatro Olimpico in Vicenza. But in numbers alone, the buildings Palladio designed the most were farm villas; he produced more than forty around Venice and Vicenza.

Early in the sixteenth century, desiring to make their finances more secure, Venetian nobles used the funds accumulated through maritime commerce to buy up and reclaim low-lying, marshy lands that had been agriculturally unproductive for centuries. Palladio was commissioned to design numerous working farms for these lands, and he devised a variety of plans, simple in layout, proportionally composed, and yet functionally practical. The Villa Badoer at Fratta Polesine, 37 miles (60 km) southwest of Venice, begun in 1556, exemplifies in plan the practical use of curved Classical colonnades to connect the stables and storage sheds with the main house and the exploitation of whole-number proportional systems in the sizes of the rooms [15.31]. In nearly all of these villas, Palladio incorporated a temple front; he believed that Romans had adapted that form from their early houses and, desiring to emulate the ancients, he "restored" the colonnaded portico to the private house.

His best-known and most imitated villa was not strictly a working farm but more a suburban retreat for Paolo Almerico, a retired papal court official.[26] The villa was located just outside the city of Vicenza. Palladio in fact used the word *suburbana,* "suburban," to describe its location in the book he published of his own work, *I Quattro libri dell' architettura* (Four Books of Architecture) (Venice, 1570). This was the Villa Capra, called the Villa Rotonda because it focused not on a single entrance facade but on a cylindrical rotunda at the center capped by a dome visibly poking through the roof. This central rotunda connected to four identical columnar porticos on each of the four sides [15.32, 7.12]. The use of a dome in a private residence was a novel departure on the part of Palladio, for up to this time, such a form, symbolizing the heavens and divinity, had been reserved for churches. The house was, as Palladio wrote, not strictly a villa but a *belvedere,* an elevated pavilion designed to offer pleasing views over the surrounding countryside. From the central rotunda, passages extend to the temple porticoes on each of the four sides of the square house, so that even from the center of the house one can view the pastoral landscape. In its symmetry and the proud way it is lifted up on the hill surveying the landscape below, the Villa Capra summarizes the confident spirit of the Renaissance and its ideal of a rational, intelligible order superimposed on nature. At the center of it all—quite

15.30. Antonio da Sangallo the Younger (the upper floor was completed by Michelangelo), Palazzo Farnese, Rome, Italy, 1515–1559. This palazzo, a regal and imposing residence befitting the status of newly elected Pope Paul III, brings to subtle perfection the ideas and forms used by Alberti in the Palazzo Rucellai. Photo: Scala/Art Resource, NY.



15.31. Andrea Palladio, Villa Badoer, Fratta Polesine, Italy, begun 1556. Basing his theories on studies of music, Palladio designed his farm villas using proportional number systems, shown clearly in the dimensions he noted on the plans published in his Four Books of Architecture. *Photo: © Wayne Andrews/Esto. All rights reserved.*

15.32. Palladio, Villa Capra (Villa Rotonda), outside Vicenza, Italy, begun c. 1550. Taking advantage of the elevated setting, Palladio gave this villa four identical facades opening out to the countryside, all governed by a system of proportional relationships. Photo: © Wayne Andrews/Esto. All rights reserved.

literally in this case, at the focus of the domed rotunda—stands man, the "measure and measurer of all things." Palladio translated into architectural forms Pico's "Oration," for the human being is indeed set "at the world's center that thou mayest from thence more easily observe whatever is in the world."

Mannerism: Renaissance Perfection in Play

As mentioned earlier, Classical order in Florentine architecture appeared in 1418 in the work of Brunelleschi. By the time Bramante had completed the Tempietto in 1502, Renaissance architecture had achieved a clarity of form and precision in the adaptive reuse of Classical architectural forms that is called the High Renaissance. The goal of this architecture was purity, a state of absolute balance and rational order. Yet, once this state of perfection was achieved in such designs as Bramante's Tempietto and his new Saint Peter's—once the rules had been set down—they were quickly flouted by a few architects in favor of subtle variations on the rules, deviations from the established norm. In their restless quest of innovation, these High Renaissance architects were not content to stop their manipulation of form once the rules had been defined. The result was that High Renaissance architecture lasted less than half a century before it was replaced, about 1530, by a subtle tension and a whimsical playfulness later called Mannerism. It is also possible that the artists' deliberate rejection of vaunted High Renaissance pure form was a cynical reaction to the sacking of Rome in 1527. The sense of universal order and rationality so carefully nurtured during the fifteenth century was dramatically and symbolically swept away in this political debacle, and artists found an escape in exercising their fancy and rejecting formal discipline.

One artist whose work dramatically illustrates this change was Michelangelo Buonarroti (1475–1564).[27] From the beginning, Michelangelo's building design took liberties with what were considered the rules established in antiquity, and his later architecture is built up of increasingly ambiguous and

15.33. Michelangelo, Medici Chapel, in San Lorenzo, Florence, Italy, 1520–1526. Designed to complement the sacristy added to San Lorenzo by Brunelleschi, this was to hold the tombs of the Medici family members. In addition to the sculpture of the tombs, the walls were filled with invented architectural ornament. Photo: Scala/Art Resource, NY.

complex forms. His revised design for Saint Peter's, for example, was both centralized and yet not quite, for it had an emphasized portico entrance. His Medici Chapel, added to San Lorenzo in Florence, 1520–1526, has blind ***aedicule*** frames (carried by brackets, not short columns or pilasters), whose squeezed crowning pediments barely fit into their allotted space between dark stone paired pilasters [15.33]. His later staircase, providing entrance into his library at San Lorenzo, 1558–1571, has pairs of muscular Tuscan Doric columns recessed into niches in the wall [15.34, 15.35, 15.36]. But instead of bearing down on substantial pedestal bases, the heavy pairs of columns appear to be carried by light, curved scrolls attached to the wall. In the center of the room, the staircase has three parallel flights (which one to choose?) that fan out toward the bottom, creating a perspective illusion of depth greater than there truly is. The staircase, in fact, is made the major element of this room, in direct contradiction to Alberti's explicit instructions in his *De re aedificatoria:* "The fewer staircases in a building and the less room they take up, the less of an inconvenience they will be."[28]

Michelangelo's replanning of the Capitoline Hill in Rome, the Campidoglio, conceived as early as 1536 and built during the mid-sixteenth century, introduced order to the irregular geometry of the existing buildings. In the new facades and buildings he added, Michelangelo shaped not a square but a trapezoidal space, in the center of which is not an ideal and unequivocal circle but an oval drawn in the paving pattern [15.37]. In every one of Michelangelo's architectural designs, what appear at first to be standard Classical architectural elements are in fact subtly manipulated in defiance of the standards of conventional Classical design, for Michelangelo was molding them as elements in gigantic sculpture. Vasari, who personally knew Michelangelo well, described how in the Medici Chapel at San Lorenzo "he did the ornamentation in a composite order, in a style more varied and more original than any other master, ancient or modern, has ever been able to achieve. . . . He departed a great deal from the kind of architecture regulated by proportion, order, and rule which other artists did according to common usage and following Vitruvius and the works of antiquity, but from which Michelangelo wanted to break away."[29]

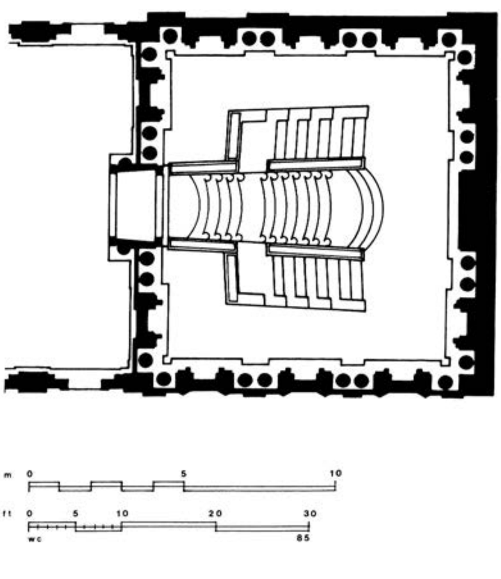
In Mannerist planning, the circle was replaced by the oval as a governing modular device, beginning with Michelangelo's Piazza del Campidoglio. The ambiguity of the oval typifies the Mannerist method of design. It is at the same time centered and yet suggests two foci; it is round and yet has a major and a minor axis. Giacomo Barozzi da Vignola used the oval in two small Roman churches, first in Sant' Andrea in the Via Flaminia, 1550–1554, only 28 feet (8.5 m) across the short dimension, and then in the slightly larger Sant' Anna dei Palafrenieri, begun about 1565 [15.38].

The Palazzo del Te

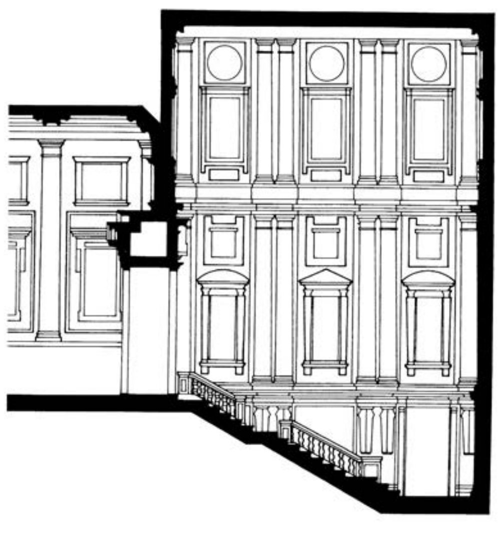
The playfulness of Mannerist architecture is perhaps most evident in the Palazzo del Te, 1527–1534, built just outside Mantua for Duke Federigo Gonzaga by Giulio Romano (c. 1492–1546).[30] It was to house the duke's renowned stud farm and to provide a pleasant suburban retreat. Having a relatively open site, Giulio Romano spread the building out, placing the living quarters in one principal level in a large square around a spacious central court. Romano was obliged, however, to incorporate portions of a building that already stood on the site. The exterior masonry of the one-story building is deeply rusticated and has heavy pilasters, which correspond to no upper load at all; since the pilasters are disposed in different rhythms on each wall, they create odd combinations when they meet at the corners. Toward the garden, the existing older building was faced with new arcaded bays that give the initial impression of being identical in their constituent elements but which, on closer inspection, turn out to differ in each successive adjoining bay [4.18; see the discussion of this building in Chapter 4].

Romano's most dramatic flouting of the Classical orders is in the court [15.39]. There, the rustication is even more pronounced, and the pilasters have been transformed into more emphatic, engaged Tuscan Doric columns. In the wide bays are windows (some of them blind, that is, with no opening), capped by what appear to be triangular pediments, yet the bottom cornice of the pediment is missing, and instead of being supported by pilasters, the parts of the pediment are carried by emphatic brackets. Inside the would-be pediment, the keystone of the flat arch of the window swells to fill completely the available space. Above the entrances to the court are larger pediments, also carried by brackets, their bottom cornices replaced by huge keystones pushing up from the arch below. Resting on the engaged columns, where there should be straight entablatures, are what appear to be flat arches, and as a kind of architectural joke, the keystones seem to be slipping out of place. In fact, inside the palazzo, Giulio Romano painted highly illusionistic frescoes that show the building falling down around the observer.[31]

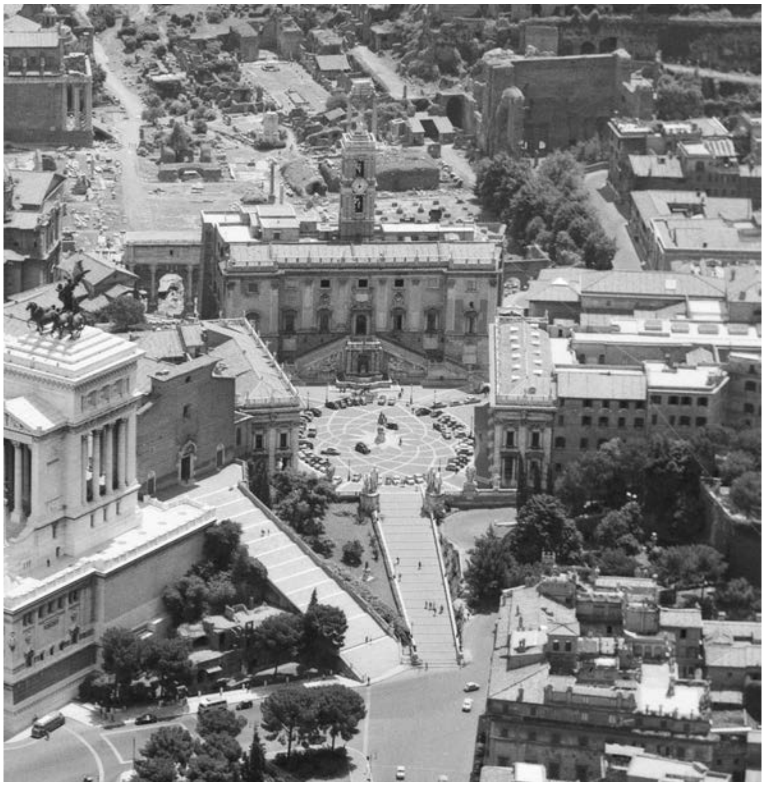
15.34. Michelangelo, Staircase, Library of San Lorenzo, Florence, Italy, 1558–1571. The tiny room accommodating the staircase up to Michelangelo's library is crammed with dark, massive architectural elements contrasted to the white walls. Photo: Scala/Art Resource, NY.



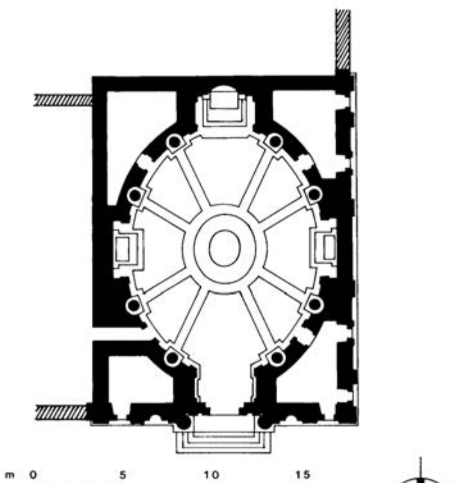
15.35. Staircase, Library of San Lorenzo. Plan. Drawing: W. Chin.



15.36. Staircase, Library of San Lorenzo. Section. Drawing: W. Chin.

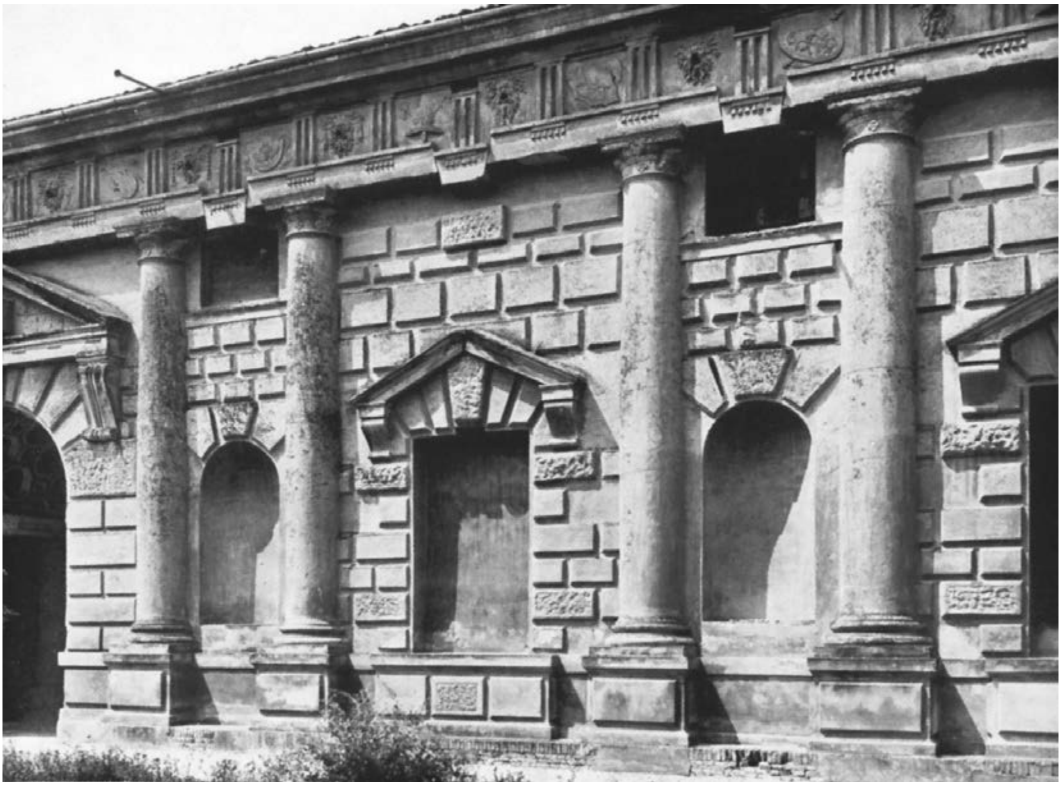


15.37. Michelangelo, Capitoline Hill (Campidoglio), Rome, Italy, designed 1536. Intended to give new civic importance to the heart of ancient and medieval Rome, Michelangelo's Campidoglio incorporated new facades in front of existing buildings to enclose a trapezoidal space reinforcing a processional axis. Photo: Charles E. Rotkin/ Corbis.



15.38. Giacomo Barozzi do Vignola, Church of Sant' Anna dei Palafrenieri, Rome, Italy, begun c. 1565. Vignola was among the first architects to turn away from the circle as a generating form for buildings, using instead the more ambiguous oval. Drawing: L. M. Roth, after P. Murray, Architecture of the Italian Renaissance *(New York, 1963).*

Giulio Romano enjoyed the full support of the duke, who paid him handsomely, making possible the construction of Romano's own house in Mantua in 1544. The facade is similarly filled with unorthodox architectural gamesmanship [15.40]. The masonry is again rusticated, the surfaces of the stones having the appearance of being worm-eaten, or *vermiculated*. The windows of the basement were designed to disappear below the street without a base line. What should be a sill course, or molding, just above the ground-floor windows is displaced by the large voussoirs of the flat arches, so the molding reads instead as a dotted line across the facade. Another molding, or belt course, with a most unusual profile marks the line between floors and serves as the base line for the upper windows, but in the center, it is heaved up over the central door by the entrance arch to suggest an incomplete pediment. Within the arcade of the upper floor are inset windows framed with architraves of novel design; they, too, are missing the bottom cornice of their crowning pediments. And the entablature that brings the entire composition to an end is resting on nothing more than the oversized keystones of the arches below. There is hardly one element in the Classical vocabulary that Giulio Romano did not deliberately



15.39. Giulio Romano, Palazzo del Te, Mantua, Italy, 1527–1534. View of the inner court. In the inner court, architectural elements are exaggerated, some are missing altogether, and what should be a straight architrave beam has keystones slipping out of place. Photo: Gabinetto Fotografico Nazionale, Rome.

vary in detail or violate in some way, and yet the effect is subtle; only a person who knew thoroughly the rules of Classical design would grasp the irony and whimsy of Giulio Romano's facade.

Late Italian Renaissance Gardens

As noted earlier, with the renewed appreciation of such Latin works as Virgil's *Georgics* came a new appreciation of nature and idyllic life in the countryside. Another area in which Mannerist designers quickly excelled, preparing the way for designers in the Baroque period, was garden design. "Landscape architecture," or perhaps more correctly "garden design," had been revived early in the fifteenth century as another manifestation of Classical civilization. The new Renaissance gardens were inspired by the villas described by Scipio, Cicero, and Horace, and especially by the two villas that Pliny the Younger described at length in his *Letters*. Many wealthy families such as the Medici had farm enterprises in the countryside, with associated utilitarian buildings. To these farmhouses were soon added gardens, as in the villas of the Medici. The gardens were usually orthogonal grids of planted beds (parterres), delineated by gravel walks and disposed in one or more flat terraces.

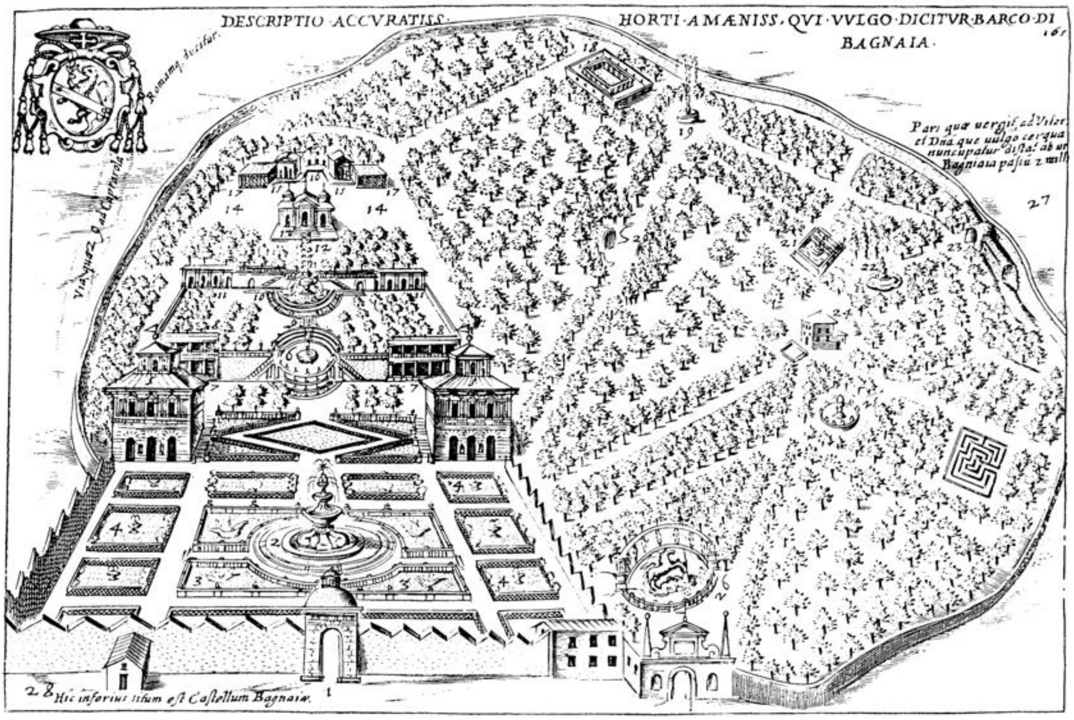
The increasing subtlety and variety of Mannerist architecture finds its landscape parallel in the Villa Lante at Bagnaia, a small village about 3 miles (3.2 km) east of Viterbo, which is a town 37 miles (60 km) north of Rome. Toward the end of the fifteenth century, Cardinal Raphael Riario, bishop of Viterbo, enclosed the woods on the hill above the village as a summer retreat. The present villa was developed by Cardinal Gambara, subsequent bishop of Viterbo, beginning in 1566; it was finished by Cardinal Montalto in 1590. After 1875, it was in the charge of the Lante family. Who precisely was the designer is not known, but Vignola is one proposed candidate.[32]

The plan of the Villa Lante exploits its sloping topography [15.41, 15.42]. At the lowest point, next to the village, is a large square terrace with twelve planted beds around its perimeter and a fountain

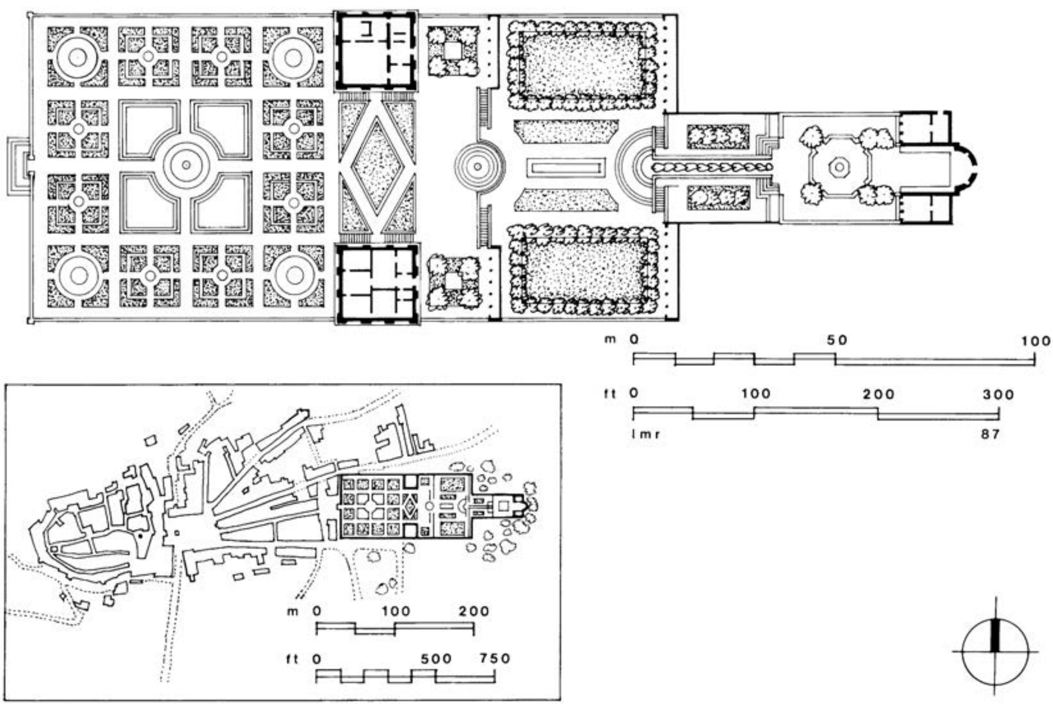
15.40. Giulio Romano, house of the architect, Mantua, Italy, 1544. In this design, too, what appears at first to be in accordance with the rules of fifteenth-century design is full of omissions, changes, and invention. Photo: Gabinetto Fotografico Nazionale, Rome.

at the center. Just east of this, the land rises and the visitor ascends ramped and angled stairs between twin ***casinos*** (summer pavilions used for entertainment) that frame the central controlling axis. Behind these casinos are further terraces, reached by stairs built into the retaining walls. Each higher terrace is progressively more enclosed, planted with larger trees creating a denser canopy. The uppermost terraces also are more restricted in size, with a water chain (a long, narrow cascade) spilling down the center axis. At the top of the hill, in a thicket of trees, is a small pavilion covering a grotto from which the water issues in a spring; all the lower cascades and fountains are symbolically fed by the water that pours forth here. Around this uppermost pavilion, the trees and shrubs are wilder in form, so that the garden terraces proceed from the most cultivated at the lower level to the most primal at the top. All of this graduation and shift in detail is contained in an area no more than 756 feet (230.3 m) long and 250 feet (76 m) wide at the widest, easily comprehensible and toured in a single afternoon (although well worth much longer stays).

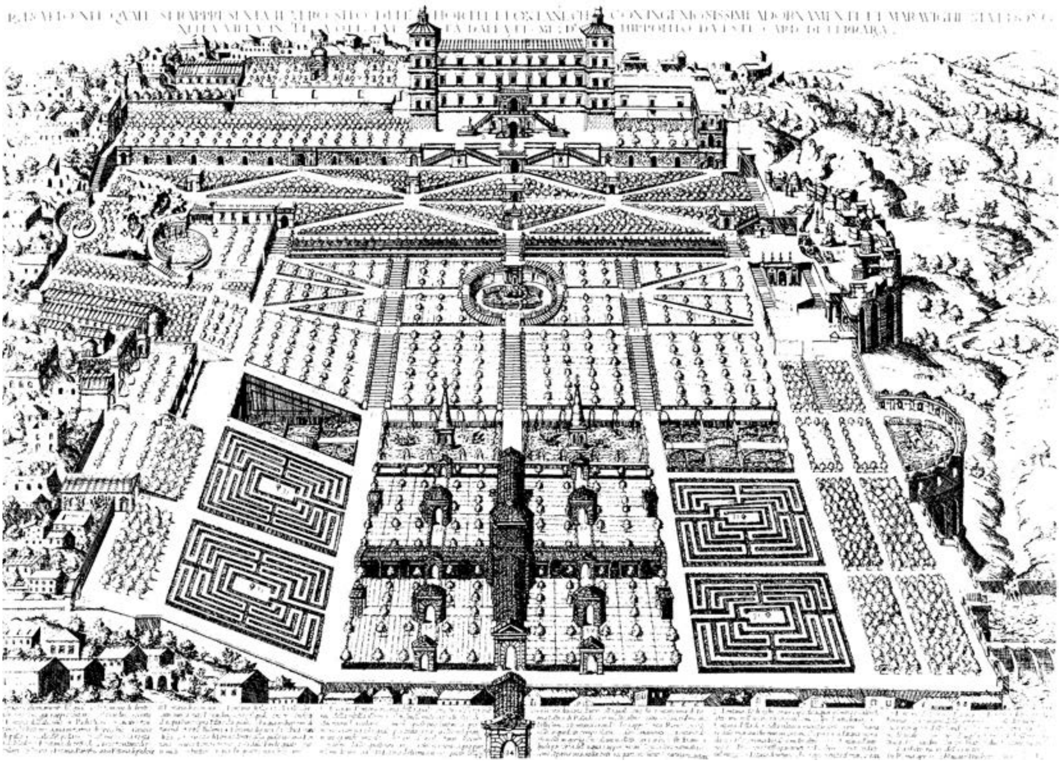
More complex and larger in scale is the Villa d'Este, designed for Cardinal Ippolito d'Este at the ancient resort of Tivoli in the hills 16 miles (25 km) east of Rome. Here, many wealthy ancient Romans had built retreats, none grander than a sprawling villa built by Hadrian, in 118–124. In these villas, they could enjoy summer breezes and escape the heat, noise, and congestion of the city. The general design of the Villa d'Este, nearly 700 feet (213 m) square, was devised about 1550 by architect Pirrio Ligorio. The hydraulic engineer who diverted water from the Aniene River for the waterworks was Orazio Olivieri, and the famous waterworks themselves were designed by Tommaso da Siena [15.43]. The villa terrain was rugged, rising sharply on the southeast and northeast sides, and the garden design exploited the changes in elevation for dramatic fountains. Running on an axis extending northwest from the rather plain villa building, the gardens are laid out in terraces descending to a large parterre on the northwest side. This is divided into the more traditional square planted beds, but on approaching from the southeast, the visitor passes one cross axis after another. At the southerly edge of the large terrace is a major cross axis called the Terrace of the Hundred Fountains, for its retaining walls are lined with hundreds of water jets in cascading rows [15.44].



15.41. Vignola (attrib.), Villa Lante, Bagnaia, near Viterbo, Italy, begun 1566. Aerial perspective. From G. Lauro, Roma Vetus et Nuova, *1614; courtesy of Avery Library, Columbia University.*



15.42. Villa Lante. Plan. The inset shows the relationship of the villa to the adjoining village of Bagnaia. Drawing: L. M. Roth.



15.43. Pirrio Ligorio, Orazio Olivieri, and Tommaso da Siena, Villa d'Este, Tivoli, Italy, begun c. 1550. This garden takes advantage of the rugged landscape for the creation of terraces and innumerable fountains; such Mannerist designs provided a total sensory experience. Photo: Engraving by G. Lauro, 1641; courtesy of Avery Library, Columbia University.

Perhaps even Petrarch, who ventured up Mount Ventoux years earlier solely for the pleasure of the view, would have been surprised at the sensual pleasures such gardens provided for their visitors, for every sense was touched: in the color of clipped plant materials, the sound of sighing wind and splashing water, the soft caress of moss contrasting with the roughness of stone, the honeyed scent of boxwood and blossom, and the taste of the water. Such captivating examples of the Italians' mastery of natural elements were much admired by visiting ambassadors of the French king to the papal court and would soon inspire garden architecture in France.

The Renaissance Exported

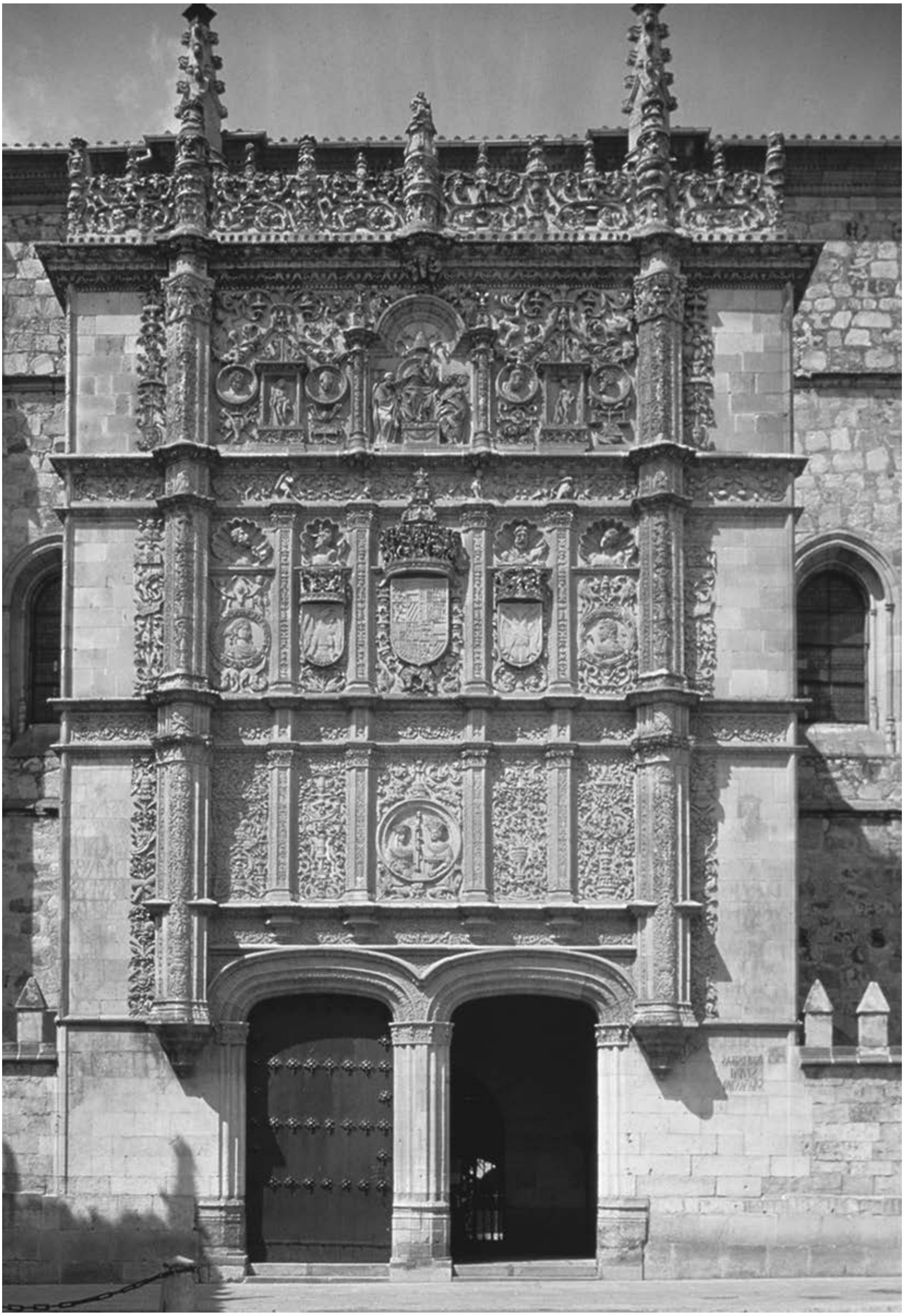
The use of Classical details and Renaissance architectural ideals had begun to move beyond Italy by the end of the fifteenth century. One of the most important agents in this diffusion was the printing press, as architectural treatises aimed at both patron and practicing architect began to appear in growing numbers.[33] The crucial ancient publication, *De architectura* (later called the *Ten Books on Architecture*), by the Roman architect Vitruvius, appeared in Latin versions in 1486 and in an illustrated Latin edition in 1511. It was further translated into the vernacular Italian in 1521 and then appeared in other European languages (French, 1547; German, 1548; English, 1669). Alberti's Latin *De re aedificatoria* was published in 1485, followed by translations into Italian, French, and Spanish during the following century. Sebastiano Serlio began to produce practical and popular books on Renaissance design in 1537 (in Italian); eventually, this series grew to seven volumes, of which the last was published in 1575. Although Serlio had been first to analyze (and illustrate) the differences in the five orders, a more authoritative reference was provided in Giacomo Barozzi da Vignola's *La Regula delli cinque ordini d'architettura* (Rules of the Five Orders), published in Italian in 1562 [7.11]. Palladio's *I Quattro Libri dell' Architettura* (Four Books on Architecture) was published in 1570. Beginning in 1715, English translations set off a sweeping Palladian revival in England and then in its American colonies, lasting through the eighteenth century.

Direct contact also spread the new architecture. Due to numerous military expeditions into Italy, the French monarch Francis I was acquainted with contemporary architectural developments there. In fact, a number of Italian artists and architects decided that political conditions were so unsettled at home that they accepted invitations to work in France. The best known of the painters is Leonardo da Vinci, who was supported by Francis I in his last years. Among the architects who moved to France was Serlio, who was commissioned to work on the royal château at Fontainebleau and who published several of his later volumes in France.

When Renaissance architecture first appeared outside Italy, it typically incorporated elements that grew out of local building traditions continuing from the Middle Ages. Most often, this meant the continued use of basic building mass configurations with a decorative overlay of Classical details imperfectly understood. In each country, this development resulted in a particular and recognizable character. In the Low Countries and the Germanic states, small-scale Classical details, typically in stone in contrast to the overall brick structures, were applied to the vertically oriented urban houses with their distinctive stepped gables fronting on the street. Good examples appeared in the square in front of the town hall in Antwerp, and still surviving is the Vleeshal (Meat Hall) in Haarlem, the Netherlands, 1601–1605, by Lieven de Key [19.8].

In Spain, particularly in the southerly provinces so recently won back from the Islamic Moors, the newly emerging Classical buildings were strongly influenced by local traditions of Moorish Islamic art. Small-scale Classical details were clustered in dense profusion around central doors and windows. Good examples of this include the portal of the Royal Hospital of Santiago de Compostela, 1501–1511, by Egas, and the entry portal of the University Library at Salamanca, 1525–1530 [15.45]. One imposing exception to this intensity of decoration was the austerity of the large addition to the Alhambra Palace, Granada, started for Charles V in 1527 by Pedro Machuca, who was clearly influenced by Italian Platonic formal ideals. It is believed that Machuca studied in Italy and trained under Michelangelo. In the

15.44. Villa d'Este, Terrace of the Hundred Fountains. The long cross axis contains hundreds of vertical and horizontal jets. Photo: Vanni Archive/Art Resource, NY.



15.45. University of Salamanca, Salamanca, Spain, 1533. In early Spanish Renaissance architecture, embellishment is composed of small Classical details amassed in dense clusters around principal doors. Photo: Kavaler/Art Resource, NY.

15.46. Pedro Machuca, Court of the Palace of Charles V added to the Alhambra, Granada, Spain, begun 1527. In contrast to the emphasis on masses of dense small-scale ornament customary in Spanish Renaissance buildings, here Machuca employs strongly austere Roman Classical elements. Photo: © imagebroker/Alamy.

exterior of the palace Machuca used massive rusticated masonry, but on the interior he devised a delicate circular colonnaded courtyard set in the square mass of the palace addition [15.46]. There could have been no clearer demonstration of the triumph of the exacting Renaissance Classicism of the new Christian monarch over the embroidered ornamentalist delicacy created by the displaced Muslims whose elegant Alhambra palace stands immediately adjacent.

In England, the application of Classical details can be found in country houses built during the reign of Elizabeth I. What had once been fortified dwellings were now opened up with large, glass windows, the remaining walls overlaid with loosely interpreted engaged columns and entablatures. A good example is Wollaton Hall, Nottinghamshire, 1580–1588. It was designed by the master mason Robert Smythson for Sir Francis Willoughby, sheriff of Nottinghamshire, in anticipation of official visits by Queen Elizabeth. Its medieval castle antecedents are evident in such elements as the corner towers and the sense of a center keep, but the exterior is covered with Classical details that stress the horizontal layering of the individual floors [15.47]. In England, especially, the roofs became nearly flat, hidden behind parapets and Classical balustrades at the roof line.

During the reigns of Elizabeth's Stuart successors, a different interpretation of Italian Classicism appeared, at least in the architecture commissioned by the court; its influence was limited at the start but would garner enormous respect and influence several generations later. This was the architecture of Inigo Jones (1573–1652), who emerged from relative humble origins to become the principal designer at court. He traveled several times to Italy, paying particular attention to the architecture of Palladio around Venice and Vicenza. His first masterwork, showing this Palladian influence, was the country house he designed in 1616 for the Queen Mother, Anne of Denmark, at Greenwich on the Thames. Composed of two rectangular blocks connected by a central linking hyphen block, the south front, with its emphasis on clearly discernible proportional systems, shows well the restraint of

15.47. Robert Smythson, Wollaton Hall, Nottinghamshire, England, 1588. The thin layers of low-relief Classical details mark this as early English Renaissance, but the corner towers with the tall central "keep" profile reveal the debt to medieval castles. Photo: Jarrold Publishing/The Art Archive at Art Resource, NY.

Palladio's exteriors. The mature Renaissance in England is well represented by the Banqueting House, 1619–1622, designed by Jones as an addition to the royal palace at Whitehall, then just outside London [15.48]. Retaining the nearly flat roof hidden behind a balustrade, it too shows Jones's close study of the work of Palladio. In addition to the carefully proportioned engaged orders (Tuscan Doric below and Ionic above), the building is so proportioned that the single internal room, used for state banquets, formal receptions, and court masques, had the form of a perfect double cube.

In France, too, the generic medieval castle form was encrusted with Classical details, as can be seen in the royal château at Chambord, on a branch of the Loire River about 97 miles (160 km) southeast of Paris. It was begun for Francis I in 1519 and was built circa 1520–1550. As with Wollaton Hall in England, the plan of Chambord clearly reflects medieval sources, with a lower enclosure and a tall "keep" tower. At the corners of the outer enclosure and the central block are huge, squat, round towers big enough to contain suites of rooms in what were called *appartements.* This Italian idea was the contribution of the architect Domenico da Cortona; the building's construction, however, was supervised by the French master mason Pierre Nepveu. Every section of the château is capped by its own steep roof form, especially the round towers with their tall, pointed cones [15.49]. A view at close range reveals that the walls are articulated everywhere by attached pilasters, carrying entablatures that wrap

15.48. Inigo Jones, Banqueting House, Palace at Whitehall, London, England, 1619–1622. The balanced proportions and reduced embellishment give evidence of Jones's admiration of Palladio's work. Photo: © Angelo Hornak/Corbis.

15.49. Domenico da Cortona with Pierre Nepveu, Château de Chambord, Chambord, France, 1519–1550. Built originally for Francis I, the château's basic design was by an Italian architect, but the overall massing is still Medieval, based on traditional castle forms. The walls however are covered with low-relief Classical details. Photo: Erich Lessing/Art Resource, NY.

15.50. François Mansart, Château de Maisons, originally the village of Maisons, near Paris, France, 1642–1646. Although the forms have been clarified and the Classical details thoroughly mastered, the separation of pavilions and wall segments is continued, and the pavilions are capped by tall roofs that soon came to be called by the architect's name (spelled "mansard" in English). Photo: Bridgeman-Giraudon, Art Resource, New York.

around the entire building. Significant for the future of château design in France was the extension of the axis of the château out into the vast hunting park of more than 13,000 acres (5,261 hectares). The extended controlling axis was suggested by the axial design of Italian gardens.

As in England, the French corner towers eventually became flattened into projecting bays or pavilions, typically one at each corner of the château mass and in the center of each facade. The roofs remained tall and visible, emphasized by even taller roofs over the projecting bays or pavilions. This unique French development is well illustrated by the Château de Maisons, built outside Paris in 1642–1646 for the minister in charge of finances under Louis XIII, René de Longueil, by François Mansart [15.50]. In fact, these rising emphatic roof forms became so associated with this particular architect that the distinctive pavilion roof shape is still called by his name, now spelled *mansard*. As in Jones's Banqueting House, the Classical details are used sparingly to accentuate the precise proportions of the parts of the building, inside and out.

An Architecture of Humanist Ideals

The humanist scholar architects of the Renaissance, nearly all of whom were trained as painters or sculptors, sought to create a new architecture cleansed of the mysticism of what they liked to call the crude work of the Goths. The new humanist architecture was to be rationally comprehensible, formed of planes and spaces organized according to clear, numerical proportional systems, its edges and intervals delineated by the crisp elements of the ancient architectural orders. It was to be a celebration of human intellectual powers, but it was also an architecture that invited and rewarded pleasurable human response. But once that door to sensory delight had been opened, there was no holding it shut. Indeed, religious and political Counter-Reformation developments during the sixteenth century soon demanded that Italian painters, sculptors, and architects create a new fusion of the arts, with the specific purpose of deliberately stimulating emotions and invoking a renewed and sanctioned religious mysticism. The essence of static linear Classical elements of column, entablature, pediment, and arch remained, but the intellectual formal austerity was replaced with a new, deliberate sensualism. This change, only hinted at in Mannerist whimsy, shortly would be transformed into full-flown Baroque theatricality.

AM-1. Temple I, Tikal, Guatemala, c. 730–745 CE. Jutting upward in a level landscape, these man-made artificial mountains proudly rise over the surrounding forest. Photo: Gianni Dagli Orti/The Art Archive at Art Resource, NY.

Ancient Architecture in the Americas

By his reckoning, and if there were favorable winds, he had thought it would be a journey of no more than eight weeks sailing to the west. And, as he expected, his crew did sight land at just about the right latitude. But what Cristobal Colón did not know was that his calculation of the diameter of the earth was off by at least a third. He planned to reach the islands off China and then Mainland China itself, but instead Christopher Columbus (as Colón's name was later spelled) stumbled upon two entire continents that lay unexpectedly in the path he had imagined; even more surprising, the indigenous people possessed gold and silver. The natives' initial generous greetings coupled with their possession of gold would be their undoing. Their "guests" almost immediately became their conquerors.[1]

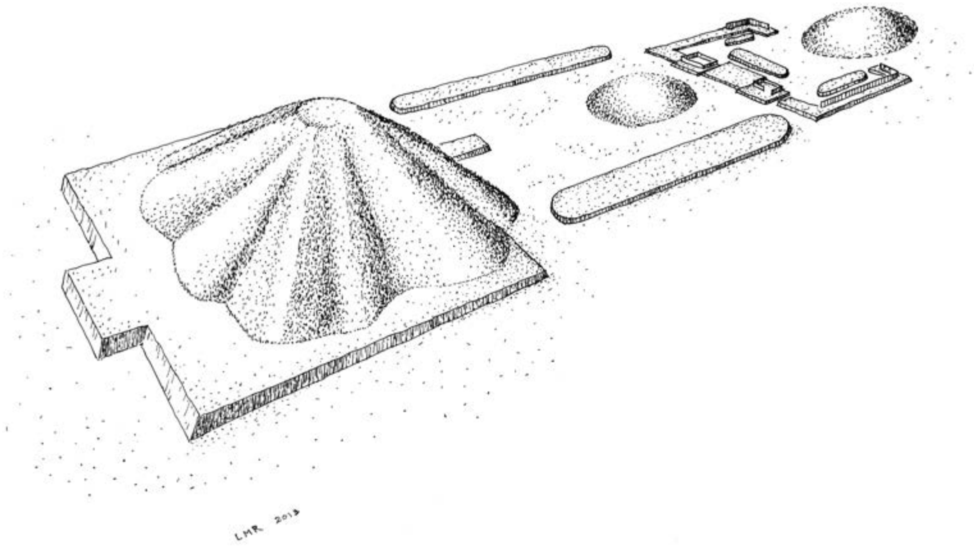
While the European invaders recognized that the native peoples built permanent durable structures and practiced agriculture in ways understandable to them, they could not recognize that the pictures and symbols drawn on white-painted tree bark was a written language.[2] Regrettably, virtually the entire Mayan library—the records of their thoughts and history—was wantonly destroyed. The intruders also failed to grasp the deep antiquity of the cultures and building traditions of the New World.

Central America

In Central America cultures of significant accomplishment in sculpture and architecture developed beginning with the Olmec in 1500 BCE and ending with the Aztec in 1521 CE.[3] The names of virtually all of these groups (particularly those ending in "-tec") are adapted from Nahatl, the Aztec language, since these people knew of past civilizations or had conquered their descendants by the time the Spanish arrived in 1517. Moreover, many of these groups still exist today, including the Mayan, the Zapotec, and the Mixtec, living in portions of southern Mexico or on the Yucatan peninsula.

The center of the oldest of these Central American civilizations, the ***Olmec*** (which flourished from 1,500 to 300 BCE), was located near modern-day La Venta, Tabasco, Mexico. The Olmec developed an early form of glyphic writing, truly monumental stone-carved sculpture, the practice of ritual ball-playing, and the development of the Central American pyramid form [AM-2]. After twenty-five hundred years of erosion, the packed-earth, hill-like La Venta pyramid is presently 110 feet (33 m) high; careful examination suggests it was perhaps originally square with terraced sides and indented corners. This pyramid sat at the north end of an elongated plaza oriented almost due north, with raised platforms along both sides.

The Olmecs originated the basic long-count calendar further developed by their cultural descendants, the Maya; most significant is that this kind of calendar requires the use of a symbol for zero—a concept that eluded the ancient Greeks and Romans, who had trouble grasping the idea that something could be nothing. Olmec social organization was well developed, as is suggested by the many enormous carved basalt portrait heads found in their settlements, including a number at La Venta. Carved out of great boulders transported more than fifty miles, these huge, individualistic heads measure in height from just under 5 feet (1.5 m) to as much as 11 feet (3.4 m) and weigh between 25 and 55 tons each. It is estimated that their quarrying, transportation, and final



AM-2. La Venta central plaza, La Venta, Tabasco, Mexico, built c. 1000–600 BCE. Among the many cultural activities that the Olmec introduced in Central America was the pyramid form to mark important ceremonial spaces. Drawing: L. M. Roth, after M. Coe, Mexico: From the Olmecs to the Aztecs, *2nd ed. (New York, 1994), p. 71.*

carving would have required the labor of several thousand people for months and hence required significant social organization.

Teotihuacán—the civilization that developed high in the Mexican Basin and began around the start of the common era and lasted until about 750 CE—is as mysterious today as it was to the Aztecs when they first encountered its ruins. Teotihuacán was one great city of perhaps 150,000 people with several satellite communities. Through the center of the city ran a broad avenue 145 feet (45 m) wide, today called the Street of the Dead, extending almost due south from the Pyramid of the Moon, an earth mound encased in stone terraces and measuring 152 feet (46 m) high and 492 feet (150 m) wide at the base. South of the Pyramid of the Moon is the similar but far larger Pyramid of the Sun, rising to 208 feet (63 m) and 738 feet (225 m) wide at the base [AM-3]. Stepped terraces and elevated platforms define the Street of the Dead, leading to further terraces and temples, including the Ciudadela ("citadel") in whose court rises the small pyramid of Quetzalcoatl. To the sides of this axial focus were palaces, residential groups, and a large market area.[4]

While the Teotihuacaños pushed the size of pyramid building to extraordinary heights, neither they nor the many pyramid-building cultures that followed them built in the ancient Egyptian manner (using massive blocks of squared stone stacked one upon the other). Rather, Central American pyramids are usually layers of packed earth, sometimes with internal reinforcing retaining walls of rough dressed stone, but with the exterior then veneered with carefully dressed stone often incorporating significant amounts of sculpture.

For the Maya, and the Aztecs after them, pyramids were begun by being built over underground or surface-built vaulted burial chambers for ruling lords; subsequent rulers would add a new burial chamber and enclosing layers to create a new pyramid with a new stone casing, finally building a new temple on top. This could occur repeatedly, one layer upon another, increasing the size of the resulting final pyramid. A second distinctive feature was the pyramid's flat top with a surmounting temple reached by one pronounced steep staircase (as at Palenque) or, more rarely, one stair on each of the four sides. A third feature in many lower platform pyramids, as at Teotihuacán, was the ***talud-tablero*** method of terrace construction, with two distinctive parts.[5]

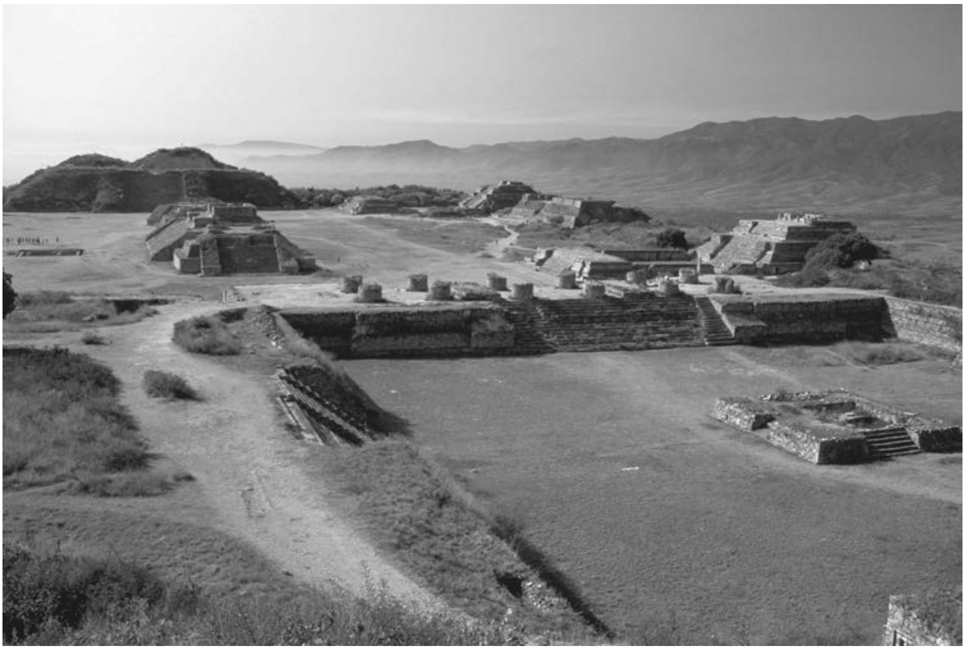
AM-3. View of the Avenue of the Dead and the Pyramid of the Sun, Teotihuacán, Mexico, c. 600–700 CE. The residents of the powerful city of Teotihuacán created a model of formal stone ceremonial architecture and imposing pyramid building that influenced all later Central American cultures. Photo: © SuperStock/Alamy.

Sometimes the *tablero* panel might have one or several nested encircling frames [see the platform pyramids visible in the foreground, AM-3].

The ***Zapotec*** civilization, centered in what is now Oaxaca, Mexico, flourished from around 600 BCE to 700 CE; conquered by the Aztecs around 1500, they became part of Spanish Mexico about twenty-five years later. The cultural center of the Zapotec was at Monte Albán on a leveled ridge (a type of man-made mesa) that rises roughly 1,300 feet (400 m) above the Valley of Oaxaca. Begun around 500 BCE, the city on the ridge-top acquired a number of terraced pyramids and elevated platforms aligned on an axis that runs nearly due north and south. A large pyramid-topped southern platform and a cluster of small platforms define a court to the north, and a single extended linear platform rises in the center of the defined plaza [AM-4].

In contrast to the centralized social and political structure of the Zapotec and Toltec states (which made them comparatively easy to conquer by the Spanish), the ***Maya*** never formed a unified regional political structure. Instead, there were fifty or more independent Mayan city-states, often at war with each other. Nonetheless, this advanced culture included an elaborate glyphic language (deciphered at the end of the twentieth century), extensive astronomical knowledge, and the celebrated three-cycle inter-meshed calendar that began in 3114 BCE and reached the end of a long-count *bactun* (*b'ak'tun*) on December 21, 2012. Not having a single political center, the Maya were never truly conquered by the Spanish, and today they still live in small villages on lands they have occupied for more than two millennia.[6]

The Mayan city of Tikal in Guatemala, which thrived from 200 to 800 CE, is identified by its steep stepped pyramids grouped around what is called the Great Plaza, their tops serving as platforms for temples crowned with tall crests or combs [AM-1]. Palenque, in Chiapas, Mexico, flourished a bit later, from 600 to 800 CE, but the modern artist's re-creation of just a portion of the city, a view looking west over the Temple of the Cross, corrects the modern-day impression that the buildings were white [Plate 20]. Fragments of the stucco coating from the buildings reveal that virtually the entire city was painted orange-red, with the complex sculptural panels painted in a rainbow of brilliant colors. Several rooms inside the Temple of the Cross contain steep corbeled



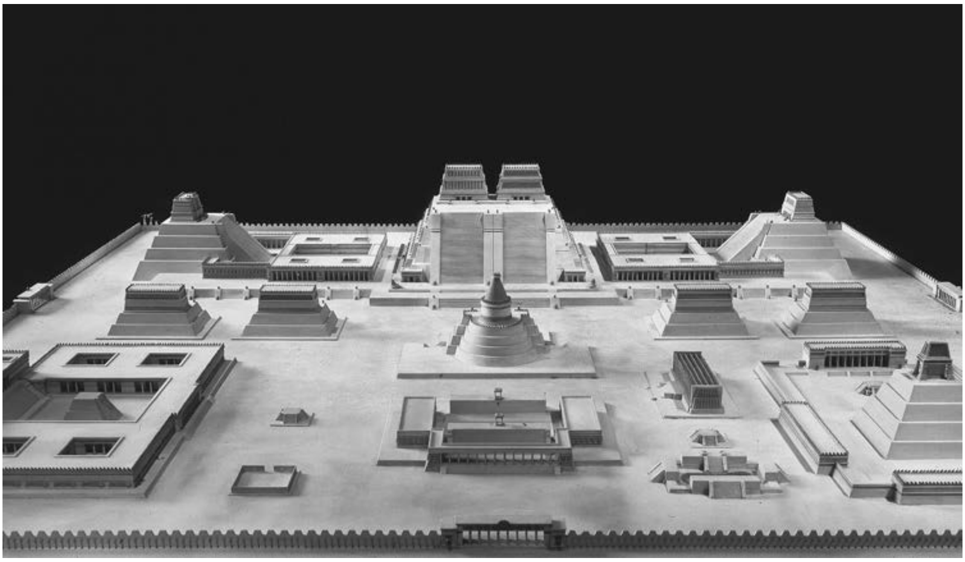
AM-4. Mesa top plaza, Monte Alban, Mexico, begun c. 500 BCE. On a Mesoamerican acropolis, this plaza was the center of the Zapotec state. Photo: © Jack Kurtz/The Image Works.

vaults forming their tops. Unlike a curved Western-style vault, a corbeled vault is built of flat stones placed progressively over one another, relying on the weight of the material above to keep them from tipping inward.

In sixth-century central Mexico, long after the Teotihuacaños had disappeared from their remarkable city, the forceful ***Mexica*** people gradually conquered their neighbors, eventually creating what they called the Triple Alliance, but which we now collectively refer to as the Aztec Empire, using their term for themselves. After migrating around central Mexico, the Mexica settled on a protected cluster of islands roughly in the middle of large Lake Texcoco, and began building the city of Tenochtitlan. As the Mexica conquered surrounding city-states, they created an ever-growing empire. By the start of the fifteenth century, the Aztec Empire included all of lower-central Mexico stretching from the Gulf of Mexico to the Pacific, including the modern states of Veracruz, Puebla, Oaxaca, Guerrero, Morelos, and Mexico.

The city of Tenochtitlan grew steadily [Plate 21]. The major causeways led to four principal thoroughfares wide enough (as the Spanish described them) for ten horses to pass; these main streets divided the city into four quarters (*campan*), each of which in turn was divided into twenty districts (*calpulli*) that were crisscrossed with smaller streets. Canals also connected the *calpulli,* each of which had a market square. Two double aqueducts brought in water from springs at Chapultepec, and the estimated two hundred thousand or more residents were said to bathe twice each day. At the very center of the orthogonal plan was the large Plaza Major (as the Spanish called it), which was the principal temple district, with several extremely tall steep pyramids and temples as well as numerous building platforms.

In May 1519, when Hernando Cortés and his five hundred soldiers landed on the Mexican coast, he asked to meet Moctezuma in his capital, Tenochtitlan. The astonished Spaniards were wholly unprepared for the sight that stretched before them when they reached the hills overlooking Lake Texcoco and sighted Tenochtitlan. Before them lay orderly villages built both on the shore and on the islands, the causeways crossing the lake, and, where they converged, a vast city, bigger than any in Spain, laid out in an orderly grid. Rising at its center were pyramids. One



AM-5. Ceremonial complex, the plaza major, and the Templo Mayor, Tenochtitlan, Mexico, fifteenth century. At the center of the expansive ordered city was the dual pyramid dedicated to the two major gods of the Aztecs, Tlaloc and Huitzilopochtli. The round temple in front of the Templo Mayor was dedicated to Ehecatl-Quetzalcoatl. Model, National Anthropological Museum Mexico. Photo: Gianni Dagli Orti/The Art Archive at Art Resource, NY.

of Cortés's soldiers, Bernal Díaz del Castillo, described their first sighting of Tenochtitlan in his book titled *The True History of the Conquest of New Spain:*

> We came to a broad causeway and continued our march. . . . And when we saw all those cities and villages built in the water, and other great towns on dry land, and that straight and level causeway leading to Mexico [Tenochtitlan], we were astounded. These great towns and pyramids and buildings rising from the water, all made of stone, seemed like an enchanted vision. . . . Indeed, some of our soldiers asked whether it was not all a dream.[7]

But when Cortés and his group were escorted up the tallest pyramid to view the entire urban complex, the Spaniards were horrified at the sight of copious human blood spilled from the daily sacrifices (the victims' still-beating hearts were removed and offered to the sun god).[8] The Spaniards' initial awestruck wonder at the careful planning and splendid construction of the pyramids, temples, and palaces was immediately turned. Today, little evidence of the many impressive buildings they saw remains above ground; everything was destroyed and buried to erase what was seen as a horrific past[9] [AM-5]. The great pyramid (the Templo Mayor) was reduced to its foundations, and the Cathedral of Mexico City was begun on the site in 1573 (dedicated in 1656, though construction continued). With the obliteration of the great central temple dedicated to the dual gods Tlaloc (god of rain) and Huitzilopochtli (god of war), the Aztec world collapsed.

The architecture of the native peoples of the Americas, involving sites across two continents, is a subject that presents many complex issues, since it involves so many cultural structures and religious values spread over a span of nine thousand years. Most of these people lived in large family groups and had intimate connections to each other, and they lived in a much closer relationship with the earth and understood its recurring natural cycles with an immediacy that eludes people today.[10] Nonetheless, we can yet recapture for our own architecture similar ways of connecting with each other and the earth.

16.45. Johann Balthasar Neumann, Pilgrimage Church of Vierzehnheiligen, Franconia, Germany, 1742–1772. View of the nave. In such southern German pilgrimage churches as this, much of the credit for the dazzling interiors must go to the stucco carvers, gilders, and painters; at Vierzehnheiligen these artists included Johann Michael Feichtmayr, Johann Gerg Übelhõr, and Giuseppe Appiani. Photo: Helga Schmnidt-Glassner, Stuttgart.

Chapter 16

Baroque and Rococo Architecture

> The Renaissance building exists to be admired in its splendid isolated perfection. The Baroque building can only be grasped through one's experiencing it in its variety of effects. . . . Baroque unity is achieved—at the expense of the clearly defined elements—through the subordination of the individual elements to invigorate the whole. Baroque space is independent and alive—it flows and leads to dramatic culminations.
>
> —*Henry A. Millon,* Baroque and Rococo Architecture, *1961*

Renaissance architects of the fifteenth and sixteenth centuries endeavored to create new rational, mathematically describable forms based on what they understood of the Classical architecture of ancient Rome. They even invented a term to describe their decisive break with the Gothic past, saying their work marked a renaissance, or rebirth. Some of the architects of the seventeenth century, however, who continued to develop this Classical architecture, especially in Italy, made of it something quite different from what had been imagined by Alberti and Brunelleschi. They coined no special term except their word for "modern" to contrast their work with that of the fifteenth century. The nearest equivalent is the term *maniera,* used by Vasari in the 1550s to describe affectation and deliberate stylization. This is the origin of the modern term Mannerism.[1] In continuing to seek new forms, in exercising their newly won artistic prerogative to invent, these seventeenth-century architects created an architecture that became what Renaissance architecture was not—complex, multilayered, molded, and plastically or sculpturally shaped.

It is difficult to assign one descriptive term to encompass all European architecture from 1600 to 1750, for several independent courses of development were being pursued simultaneously. By no means, even in Italy, was the work of the most adventurous architects generally viewed approvingly. Cassiano dal Pozzo, writing in 1657, considered the true arbiters of good architectural design to be represented by Brunelleschi, Bramante, Serlio, Palladio, and Vignola, "who took the true proportions of those perfectly regular orders from Roman buildings. Departing from these always leads to errors." In surveying the recent work around him, dal Pozzo could only comment: "It's the great disgrace of our age that, although it has before it such beautiful ideas and such perfect rules in venerable, old buildings, none the less it allows the whim of a few artists who wish to break away from the antique to bring architecture back to barbarism."[2] In a lecture given in 1664, Giovanni Pietro Bellori said: "Everyone images in his head a new idea of architecture in his own manner . . . so that they deform buildings. . . . They use, almost deliriously, angles and broken and distorted lines; they tear apart bases, capitals and columns with crowded stucco decoration and trivial ornaments and with faulty proportions, in spite of the fact that Vitruvius condemns such novelties."[3]

Some French critics took a similar view, as did Augustin Charles D'Aviler, who, in his *Cours d'Architecture* (1693–1696), decried "those architects [who] consider their caprices to be ingenious inventions, and say that it is an error to constrain oneself by the rules, when one can make new ones."[4] Early in the eighteenth century, Germain Brice published a description of Paris, heaping invective on the incomplete Theatine church of Sainte Anne-la-Royale, by Guarino Guarini (the church was destroyed in the 1820s). Brice offered some comfort to his readers, saying they should "not be sorry that work on the church . . . has remained incomplete; the bizarre idea underlying the design gives no reason to hope that the church would turn out well. . . . Guarini has imitated Borromini only at his worst and most ridiculous, not following his master in everything as he should have done, and his caprice has spoilt everything!"[5] But these objections against the liberties being taken with the old Renaissance rules were voiced by a minority.

As Gothic architecture had been named in derision by Renaissance writers, so too the term *baroque* was used by eighteenth-century French critics like Diderot and also by Goethe to denigrate the architecture of the seventeenth and early eighteenth centuries. To them, the curving, heavily embellished architecture of seventeenth-century Rome, with its corkscrew columns and bent or curving entablatures, was as much a deviation from proper architectural norms as a twisted pearl was from the pure spherical norm. They applied to that "misshapen" architecture the derogatory Portuguese term used for misshapen pearls: *barocco,* "baroque." Gradually, however, the term *baroque* came to be used by late-nineteenth-century art historians such as Heinrich Wölfflin in a much more positive, descriptive sense, to indicate any art form that was elaborated, embellished, and complex, compared to preceding simpler forms.[6]

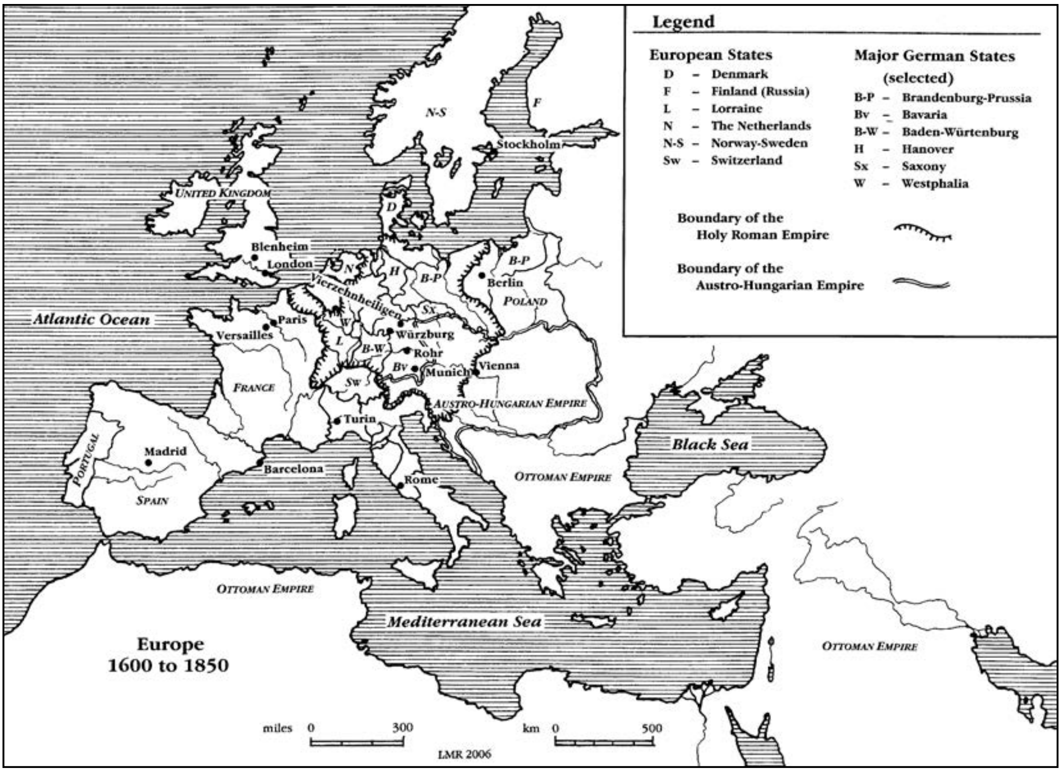
In the century and a half from 1600 to 1750, the architecture of court and church in Europe can be said to have developed along two parallel lines. Generally speaking, in the areas of southern Europe that had opposed the Reformation—Spain, Italy, Bavaria, and Austria, for example—the curvilinear qualities of Baroque architecture were widely adopted. In northern Europe, even Catholic France, architects such as the Frenchmen François Mansart and Jules Hardoiun-Mansart and the Englishman Sir Christopher Wren continued to use what they considered Classical architecture, conforming to the standards set up by Bramante and Vignola but working at a larger scale and with more sculptural plasticity. For their work, therefore, the term *Baroque* has a different sense.

The celebratory nature of Baroque architecture is clearly illustrated in one of the last buildings to adhere to these principles, the church of Vierzehnheiligen (Pilgrimage Church of the Fourteen Holy Helpers) in Franconia, Germany, built by Johann Balthasar Neumann in 1742–1772 (discussed below). Whereas Renaissance architecture gave the visual impression of being comparatively simple, as with Giuliano da Sangallo's church of Santa Maria delle Carceri, Prato [15.12], Baroque architecture was made deliberately and consciously complex. Instead of clarity, there was desired ambiguity; instead of the uniformity of elements and overall effect, there was studied variety; instead of regularity, contrast. Whereas previously there had been planar forms, with an emphasis on the surface, now the emphasis was placed on elasticity and spatial depth. The Early Renaissance buildings had most often been human in scale; seventeenth-century architecture often became superhuman in scale. Renaissance architecture had stressed easily perceived forms, but the new architecture projected a sense of mystery, so that where the interest had once been in intellectual comprehension and cerebral satisfaction, now it shifted to creating an emotional impact.

An Architecture for the Senses

The reasons for the shift toward visual complexity about 1600 are several. First, as in any period of artistic creativity in which the goal is to achieve a state of stasis, once that goal is reached, a reaction sets in. The Classical perfection and restraint of Athenian architecture of the fifth century BCE was transformed into the more visually and plastically complex Hellenistic architecture of the fourth and third centuries BCE. Similarly, the austere architecture of the Roman Republic became the heavily ornamented and plastically molded architecture of the late Roman Empire. So, too, Late Gothic architecture became more and more elaborate, with proliferating ribs that eventually pulled free of the vault surface altogether. In each of these periods, the latter stages of development can be described as "baroque."

Second, in Italy, France, Spain, and central Europe, there was a particular religious aspect to this dramatic change in architectural character. This stimulus was the Counter-Reformation, the delayed but decidedly emphatic reaction by the Catholic Church to the reforms advocated by Martin Luther. For numerous political and ecclesiastical reasons, Popes Leo X and Clement VII had postponed reacting to Luther; those first years free of challenge were critical in allowing the German states and the Baltic region to reject the domination of Rome and, in the case of some clerics, to refute the basic tenets of Roman Church dogma. Soon, other splinter groups moved beyond Luther's modest position, advocating even more drastic restructuring of the Catholic Church and changes in worship. These more radical factions were led by Ulrich Zwingli in Zurich and John Calvin in Geneva, Switzerland. The Calvinists, as they came to be called, soon controlled half of Switzerland, numerous duchies in Germany, the Netherlands, and Scotland. For a time, the continued existence of the Roman Church might have seemed in question [16.1].



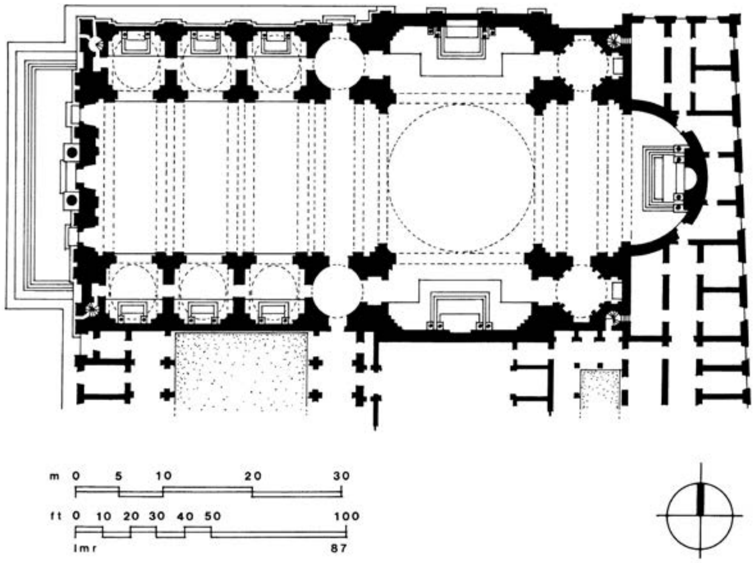
16.1. Map of seventeenth- and eighteenth-century Europe. Drawing: L. M. Roth.

Not until 1545 did Pope Paul III (Alessandro Farnese) convene the first of several church councils that met at Trent to respond to the Protestant revolt. The final decrees of the Council of Trent were deliberately and decidedly not conciliatory toward the Protestants, and thus the breach was made irreparable. Some of the most flagrant abuses identified by Luther were indeed corrected, but whereas Luther had advised priests to marry, the council absolutely reaffirmed priestly celibacy. Whereas Luther and Calvin rejected the authority of the Church as the sole interpreter of Scripture, the council adamantly insisted on it. These and other points had to do with dogma, but others had a direct bearing on church design and visual imagery. Luther (and Calvin even more vigorously) rejected the veneration of saints, but the council emphatically endorsed the practice. While the Calvinists preached the elimination of all sensory stimulation in worship, the council insisted that music, painting, sculpture, and architecture were powerful instruments enhancing religious devotion. Accordingly, the council strongly encouraged the use of architecture, painting, and sculpted images to create a mystical, supportive atmosphere for worship.

Baroque Churches in Rome

The most active campaign within the Roman Church to recover the faithful was led by Ignatius of Loyola, a Spaniard, who had established a new militant religious order in 1540, the Society of Jesus (the Jesuits). Ignatius was only one of many zealous champions of the Roman Church who were quickly canonized after their deaths. Another was Carlo Borromeo. Other new religious orders, including the Theatines (1524) and the Capuchins (1535), also arose in response to the Protestant threat, but it was the Jesuits especially who led the fight against the heretics.

In 1568, the Jesuits began construction of a central administrative convent and mother church, the church of the Gesù, Rome, from designs by Vignola [16.2]. It was a large church clearly adapted from Alberti's Sant' Andrea in Mantua, but designed following the explicit instructions of the patron, "Il gran Cardinal" Alessandro Farnese, to facilitate



16.2. Giacomo Barozzi da Vignola, Church of the Gesú, Rome, Italy, 1568–1577. Plan. In order to emphasize preaching in this mother church of the newly founded Jesuit order, Vignola used a Latin cross plan, directing the attention of the worshipers to the altar. The plan was closely patterned after Alberti's Sant'Andrea in Mantua. Drawing: L. M. Roth, after Peter Murray, The Architecture of the Italian Renaissance *(London, 1963).*

preaching. It had short transept arms covered with barrel vaults and a third short arm forming the choir, terminating in a semicircular apse. The broad nave, covered by a barrel vault, was flanked by square side chapels. This aspect of the church was Late Renaissance in its clarity of form; only in the facade, designed later by Giacomo della Porta in 1573 [16.3], was there a hint of the complexity that would develop into the Baroque. The facade, too, is derived in part from Alberti, from his facade for Santa Maria Novella in Florence [15.18], but it is more plastically molded, with paired engaged columns and nested pediments, one inside the other. Jesuit missionaries carried this church image with them, and its variations appear across Europe, as in Saint Michael's in Louvain, Flanders (Belgium), and throughout the New World.

In strictly architectural terms, the Baroque emphasis on sculptural plasticity can be seen at its fullest in the facade of the Church of Saints Vincent and Anastasius (Santi Vincenzo ed Anastasio), Rome [16.4]. Designed by the architect Martino Lunghi the Younger in 1646–1650 for Cardinal Jules Mazarin of France, it is another variant on the pattern established by the Jesuit church of the Gesù seventy years before.[7] Now, however, the pilasters have become fully disengaged, freestanding columns, and, in the center section, they stand in triplicate, carrying three nested pediments. The pediments, moreover, are cut away at the top, opening voids that are filled with garlands and carved figures. In fact, all parts of the surface are enlivened with projecting architectural members or figural sculpture.

This compulsion to enrich, embellish, and overlay reached its zenith in Spain, where the Classical architectural vocabulary of the Renaissance was combined with a love for pattern and surface ornament, the legacy of the Islamic Moors. An example is in the interior of the sacristy of the Cartuja in Granada, begun in 1730 by Francisco Hurtado and decorated in 1742–1747 by an unidentified stucco carver [16.5]. Here, attached to an underlying system of arches resting on pilasters, is layer upon layer of ornament, to the degree that the basic structural system is obscured and everything becomes an intricate pattern of light and shadow in which the eye is drawn endlessly from part to part.

An Architecture of Emotional Power

The sculptor and architect Gian Lorenzo Bernini (1598–1680) summarized most clearly the impact of the Council of Trent and provided the prototype for the emotion-inducing function of the arts.[8] In 1645, Bernini began work on a chapel for Cardinal Federico Cornaro of Venice, to be built in the left transept of the church of Santa Maria della Vittoria (one of the many churches in Rome influenced by the Gesù). Santa Maria della Vittoria had been designed by Carlo Maderno and built in 1608–1620, with the facade finished later. For Cornaro in the upper part of the transept-chapel, Bernini designed an illusionistic fresco around the window, showing billowing clouds and angels, some of the clouds carved in high relief in stucco and covering up parts of the architectural moldings [16.6]. The surfaces

16.3. Giacomo della Porta, facade of the Gesù, Rome, Italy, 1573–1577. Giacomo della Porta, who completed the Gesù façade, was also inspired by Alberti, and used large curved volutes to make the transition from the high nave to the lower side chapels. Photo: Scala/Art Resource, NY.

of wall and vault curve together and are covered with molded clouds so that the intersection of wall and vault disappears and the physical boundaries of the space become blurred.

Below is a miniature theater, or so it appears to us today, and if the parallel to the theater might seem to us sacrilegious we should recall that Bernini, among his many activities, was busy designing sets, scenery, and machines for various theatrical productions. The marble-paneled side walls of the chapel contain "box seats," in which Bernini depicted members of the Cornaro family reading and discussing the miraculous event being enacted on the "stage" in the end wall of the chapel. At the

16.4. Martino Lunghi the Younger, Church of Saints Vincent and Anastasius, Rome, Italy, 1646–1650. In Italy, the Baroque church facade reached its point of fullest plastic development in this example; no part of the surface is untouched by layered embellishment. Photo: Alinari/Art Resource, NY.

center of the composition, paneled in yellow, gray, and green marble, is an ***aedicule*** that curves forward as though being pushed forward by some force behind it, breaking the pediment. On the "stage" is the figure of Saint Teresa of Avila, one of the new Counter-Reformation saints, who described in her autobiographical meditations a visitation by an angel carrying a golden spear with which he penetrated her heart, causing her exquisite spiritual ecstasy. Bernini re-creates that moment in his *Ecstasy of Saint Teresa,* conveying it in carnal terms so that the observer could easily grasp a transcendent spiritual experience through its everyday secular physical counterpart. The miraculous event is illuminated from a hidden source, a window behind the pediment of the stage, whose flood of light is embodied by the gilded rays that stream down behind the figures. The autonomy of architecture is here eliminated, becoming commingled sculpture and painting meant to convey to the viewer a mystical experience. Architecture as an independent, rational structural frame is transformed into a unity or fusion of the visual arts as propaganda. Architecture has become but one constituent part in what was "a total work of art."

In Baroque architecture and art, the line between three-dimensional reality and mystical illusion was increasingly blurred. In 1672–1685, the ceiling decoration of the Gesù was completed by Giovanni Battista Gaulli. On the barrel vaults of the Gesù, thickly modeled architectural moldings of stucco were placed, framing illusionistic frescoes showing clouds and angels rising to heaven. But in places, the billowing clouds spill out of the frames, making it difficult for any viewer standing on the floor of the church to distinguish between the real paneled vault surface and the perspective illusion. Even more dramatic was the nave vault fresco of the church dedicated to Saint Ignatius (San Ignazio), Rome, designed by Padre Orazio Grassi in 1626–1650 [16.7].

16.5. Francisco Hurtado, Sacristy of La Cartuja, Granada, Spain, 1730–1747. Interior. Baroque enrichment was most elaborate in Spain and its dominions, and perhaps nowhere as elaborate as in the carved stucco work of this interior whose detailed elaboration conceals underlying pilasters. Photo: MAS, Barcelona.

The vaults were painted by Padre Andrea Pozzo in 1691–1694 and show the Glory of Saint Ignatius, in an illusion of architectural elements extending into the open sky, with clouds and angelic figures accompanying the figure of Saint Ignatius. When this is viewed from the right spot on the floor of the church, it is nearly impossible to tell that one is actually looking up at a curved barrel vault, for the reality of the curved planar surface has been completely eradicated by the illusion of the perspective. Rational interpretation of a visual perception has been overpowered by mystical experience.

This kind of mystical presence appealed greatly to the southern Germans, who remained loyal to the Church of Rome and rejected Luther's reforms. In the richly embellished pilgrimage and monastic churches built in Bavaria in southern Germany in the early eighteenth century, such rhapsodic illusionism was pushed even further. Among the most skilled practitioners were the brothers Cosmas Damian and Egid Quirin Asam, both trained in Italy, Cosmas as a fresco painter and stuccoist and Egid as a sculptor. Hence, they combined to a high degree all the skills necessary to produce the most powerful emotional effects. One of their most striking creations was the sculptural complex at the end of the choir of the Augustinian Priory Church of the Assumption at Rohr, Germany, a tiny village near Regensburg, 1717–1722 [16.8]. A series of screens of columns carrying pieces of broken pediments serve to shield the eye from the sources of light to the sides. Beyond these "wings," or "tormentors" (to use theatrical terminology once again), on the "stage" is the figure of the Virgin Mary ascending to heaven, rising from an open sepulcher surrounded by figures dramatically registering various stages of amazement. The figure of the Virgin literally hovers in the air, assisted by two angels, in

16.6. Gian Lorenzo Bernini, Cornaro Chapel, Santa Maria della Vittoria, Rome, Italy, 1647–1652. In the arm of the transept of this church, Bernini created, in effect, a miniature theater, with the members of the Cornaro family in boxes overlooking the divine mystery of the Ecstasy of Saint Teresa onstage; above them the fresco ceiling shows the heavens opening up. This eighteenth-century painting (in the Staaliches Museum of Schwerin, Germany) shows, as no photograph can, the effect of the light both in the upper vaults and on the figural sculpture below. Photo: Erich Lessing/Art Resource, NY.

apparent defiance of gravity, for she is supported from behind by hidden projecting bars of iron. Here, the emotional impact of Bernini was pushed as far as technology then allowed. If Bernini's Saint Teresa is a portrayal of a past miraculous event, at the Rohr church such a miracle actually seems to be taking place before our very eyes.

The Central Plan Modified: Bernini's Churches

The broad longitudinal plan of the church of Gesù quickly became the model for seventeenth-century Roman Catholic churches, but the centralized plan did not disappear altogether. For smaller chapels and votive churches, the oval was often the generating form. This direction had already been suggested by Vignola in his diminutive Sant' Anna dei Palafrenieri, Rome, 1565 [15.38], which served as the point of departure for Bernini's church of Sant' Andrea al Quirinale, Rome, 1658–1670, a church sponsored by Cardinal Camillo Pamphili to serve the Jesuit novices living on the Quirinal Hill. The round plan of Bernini's church is clearly evident from the curve of the upper walls visible as one nears the church [16.9, 16.10]. The half-oval walls, counter-curving out to enclose the entry, greet the approaching worshipper and give a hint of what one may expect to find inside. This concave curve is countered in the convex curve of the portico, which is capped with a broken curved pediment. Inside, one discovers that the line of movement is along the short axis of an oval plan, not along the more dominant, longer axis. In fact, there is no true

16.7. Padre Andrea Pozzo, nave vault fresco, Church of San Ignazio, Rome, Italy, 1691–1694. Pozzo completely disguised the intersection lines of the groin vaults so that the viewer, when standing at the right spot on the church floor, can scarcely guess that this is a curved barrel vault; instead, the viewer looks up into the heavens witnessing the Glory of Saint Ignatius. Photo: Archivi Aliknari, Florence, Italy.

perpendicular axis, for there are four chapels or recesses on each side of this short longitudinal axis, meaning that a perpendicular cross axis would run into the ends of spur walls and not into chapel recesses. The principal altar on the short axis is contained in a niche behind a portico made with paired red-veined marble Corinthian columns; behind the altar is a painting depicting the martyrdom of Andrew and, again, illuminated by a hidden source of light. The Corinthian columns carry a pediment scooped out at its center to accommodate an ascending figure of Saint Andrew. Over all rises an oval dome, punctuated by carved figures of angelic cherubs who flit among and over the top of the architectural elements.

Bernini also used an oval to solve his single largest building project, the great piazza in front of Saint Peter's basilica in Rome, which finally brought this ambitious church to completion in 1667, a century and a half after it had been started by Bramante [16.11, 16.12]. Before Bernini was given this task, the basilica itself finally had been enclosed by Carlo Maderno, but not until the last change was made in the plan. After the incessant vacillation between central and longitudinal plans, the final decision was made to extend a nave from Michelangelo's east arm. Maderno added the bays of the nave in 1605 and finished the broad facade in 1612.

Still, the space in front of Saint Peter's was ill defined. A broad space was needed to accommodate the crowds who gather at Easter to receive the papal benediction, *Urbi et orbi,* "upon the city and the world." Bernini's problem was that the older

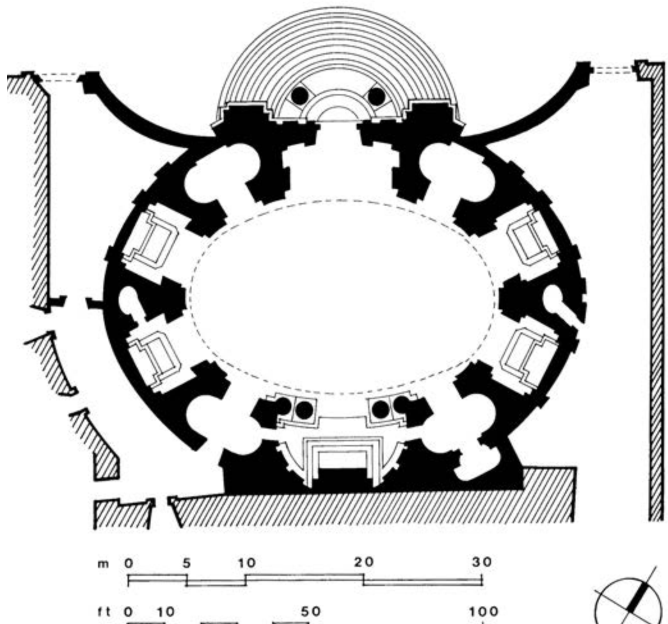
16.8. Cosmas Damien Asam and Egid Quirin Asam, altar of the Priory Church of the Assumption, Rohr, Germany, 1717–1722. The Asam brothers pushed the illusionism of Bernini to the emphatic extreme, depicting the Virgin Mary seemingly hovering in space (but lifted from behind by hidden supports), and lit by concealed windows to either side. Photo: Hirmer-Verlag, Munich.

existing buildings of the Vatican palace intruded from the north, making it impossible to create one large, simple geometric enclosure. His solution was to divide the piazza into two component parts, the portion immediately next to the facade being a trapezoid and the more distant portion an oval enclosed by curved Tuscan Doric colonnades focused on two fountains. Between the fountains, there was already an Egyptian obelisk, erected here at the instructions of Pope Sixtus V as part of his replanning of Rome in 1585–1590. Bernini viewed the wide, encircling, semi-oval colonnades as the motherly arms of the Church, which, he said, "embrace Catholics to reinforce their belief, heretics to reunite them with the Church, and agnostics to enlighten them with the true faith."[9]

Borromini's Churches

Bernini's chief rival in Rome was Francesco Borromini (1599–1667).[10] The two men were unlike in almost every way. Bernini, trained as a sculptor, had the support and patronage of some of the most powerful figures in the Roman Church, including Maffeo Barberini, who reigned as Pope Urban VIII, and Fabio Chigi, who became Pope Alexander VII. Bernini moved at ease among some of the most powerful individuals of his time, even including Louis XIV, the king of France. Bernini's prodigious creations in architecture, sculpture, painting, and theater design, coupled with his air of confident buoyancy and social ease, brought him international acclaim. Borromini, in contrast, was a reclusive and

16.9. Gian Lorenzo Bernini, Church of Sant' Andrea al Quirinale, Rome, Italy, 1658–1670. Bernini announced the oval of the plan in the curving arms of the walls shaping the entry recess. Photo: Scala/Art Resource, NY.



16.10. Sant' Andrea al Quirinale. Plan. Bernini turned the oval so that the principal line of movement is along the short axis. Drawing: L. M. Roth, after Norberg-Schulz, Baroque Architecture *(New York, 1974).*

16.11. Gian Lorenzo Bernini, Piazza of Saint Peter's, Rome, Italy, 1656–1667. Aerial view. The arms of the vast piazza, adjusted to avoid existing Vatican Palace buildings, were intended by Bernini to symbolize the welcoming and embracing arms of the church. Photo: Charles Rotkin/PFI.

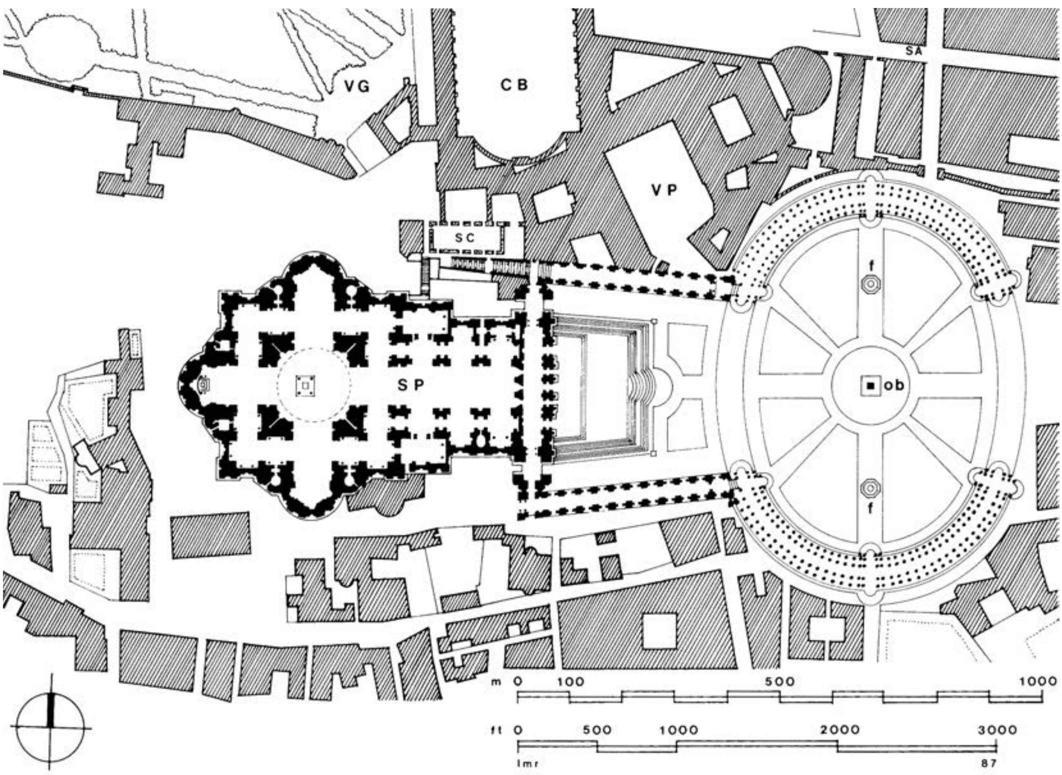
brooding man; trained as an architect, he won limited recognition and received his commissions from smaller organizations. Yet, he manipulated space and the traditional Classical orders far more sculpturally than did Bernini. Borromini rose to prominence with the small church and compact monastery he designed in 1634 for the Spanish Trinitarian Order, San Carlo alle Quattro Fontane (Saint Charles at the Four Fountains), built 1634–1641. The church was often called simply San Carlino because of its diminutive size [16.13, 16.14]. Its formal name derives from the fact that it sits at the intersection of two new streets that Pope Sixtus V had cut through Rome, at the corners of which four new public fountains were built.

Borromini's radical departure in the design of San Carlino was to base the entire composition, both in plan and in section, not on the traditional module of the column and its diameter—as had been the rule since the time of the Greeks—but, rather, on a complex union of the symbolic equilateral triangle (for the Trinity) and also on multiples of circles and ovals. This approach may have been inspired by Borromini's contemporary, Galileo, who described the universe as being based on geometrical, triangular relationships. Borromini's surviving drawings show the essential modular derivation, for the delicate lines of the overlapped triangles are clearly visible among the heavier outlines of the walls.[11] He began with two large equilateral triangles joined on a common base and then enclosed them in an oval; this determined the basic ground plan. In enclosing the ground floor, however, he used spaced pairs of columns carrying an undulating cornice that has the fluidity of extruded clay rather than the linearity of traditional stone lintels. Above this is a transitional level, with four pendentives that rise to form the oval base ring for a deeply coffered oval dome. The dome, in turn, is opened at the top by a lantern, at the very top of which is the figure of the dove of the Holy Spirit encircled by an equilateral triangle—the key to the entire composition.

In 1662, Borromini was called back to complete construction of the facade, designed earlier [16.15]. In this, too, he used a system of generating triangles related in plan to the triangles he had employed in the interior, resulting in a facade that undulates like rolling waves, one of the first such undulating Baroque facades. The curved entablatures and the surfaces packed with architectural and sculptural ornament prepare the visitor for the unorthodox interior.

Despite its striking departures from the canons of Classical design, the church was immediately sought out by visitors to Rome, and the procurator general of the order wrote that members from numerous countries asked for plans of the church, and that "in the opinion of everybody nothing similar with regard to artistic merit, caprice, excellence, and singularity can be found anywhere in the world." The procurator general was clearly aware of the special character of the building, a character that would later become common in Baroque architecture, for he wrote that everything in it "is arranged in such manner that one part supplements the other and that the spectator is stimulated to let his eye wander about ceaselessly."[12] Another intriguing account is found in the official history of San Carlino, in which the author comments on how many visitors the small church had, many returning again and again. After noticing a notable visitor returning repeatedly—a French cardinal, as it happened—the chronicler asked the visitor if his time might not be used more advantageously visiting the many large, important churches in the city, such as St. Peter's or the Gesù. "It is true that they are magnificent buildings," the visiting cardinal replied, "but once one has seen them the first time, one has no desire to see them a second time. But one does want to see this church of S. Carlo a second time, because it never gets boring; it always seems new, as Bede said of the divine essence."[13]

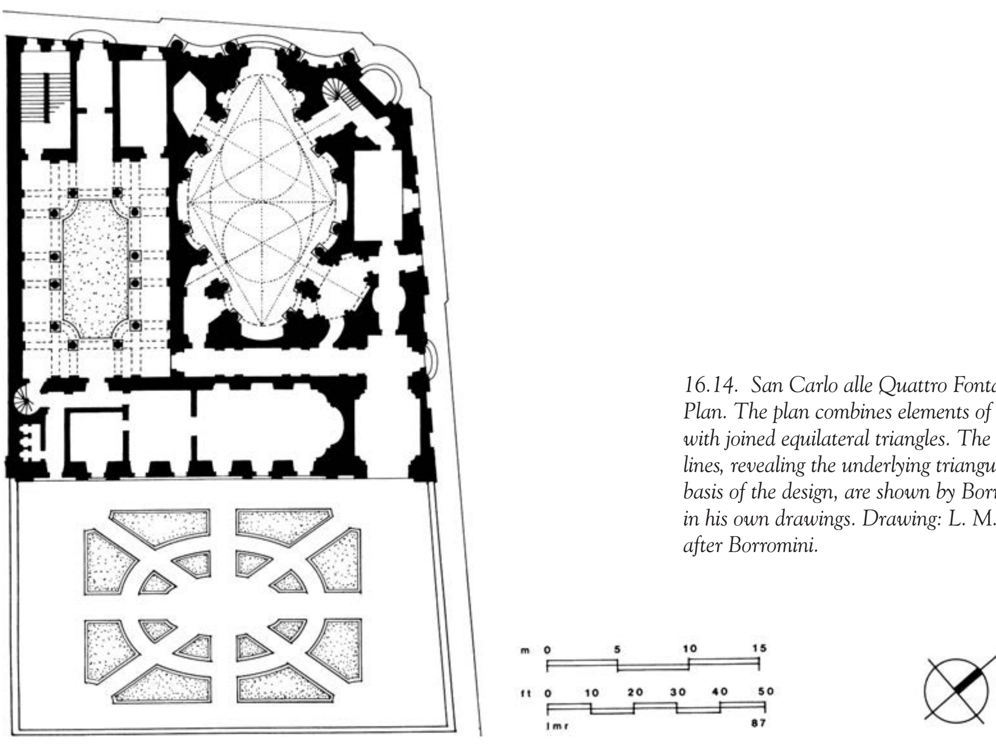
Borromini again used a centralized plan in the chapel of Sant' Ivo della Sapienze, which he added to the University of Rome in 1642–1660 [16.16, 16.17]. Sant' Ivo was built at the end of the long courtyard, which had been built earlier by Giacomo



CB = Cortile del Belvedere
f = fountains
ob = obelisk
SA = Sant' Anna dei Palafrenieri
SC = Sistine Chapel
SP = Basilica of Saint Peter
VG = Vatican Gardens
VP = Vatican Palace

16.12. Piazza of Saint Peter's. Plan. Bernini carefully planned the open space to incorporate existing fountains and the Egyptian obelisk previously re-erected there by Domenico Fontana. Drawing: L. M. Roth, after Letarouilly and Nolli.

16.13. Francesco Borromini, Church of San Carlo alle Quattro Fontane, Rome, Italy, 1634–1641. Interior. The heavily sculpted elements of this miniature church are positioned according to a proportional system generated by equilateral triangles. Photo: Alinari/Art Resource, NY.



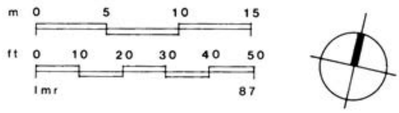
16.14. San Carlo alle Quattro Fontane. Plan. The plan combines elements of the oval with joined equilateral triangles. The dashed lines, revealing the underlying triangular basis of the design, are shown by Borromini in his own drawings. Drawing: L. M. Roth, after Borromini.

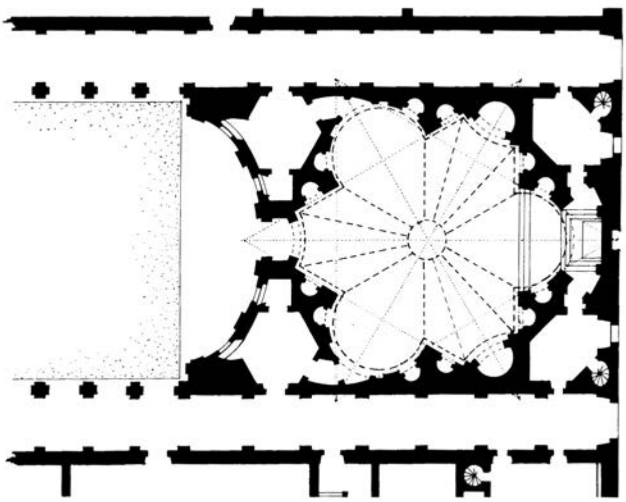
16.15. San Carlo alle Quattro Fontane, facade built 1662–1667. Exterior. Photo: Scala/Art Resource, NY.

della Porta, in 1585–1590. This church, too, was based on a system of equilateral triangles, but in this instance, they were laid atop one another, forming a six-pointed star around a hexagon. Again, the triangles are clearly delineated in Borromini's own drawings.[14] Such a form had almost never been used before, since it makes no provision for perpendicularly crossed axes, as does a square or an octagonal plan. Three of the lobes of Sant' Ivo, corresponding to the points of one triangle, end in semicircular apses, whereas the other three, corresponding to the second triangle, are pointed but have convex walls pushing in at the points. The inherent conflict in this system (since opposing faces of the interior are different in form) is reconciled by a massive molded cornice, resting on the substantial Corinthian pilasters that articulate the planes of the walls; this cornice undulates around the space and holds it together. A unique and deeply molded dome rises directly from this cornice, following the convolutions of the star-shaped plan below.

Guarini's Churches

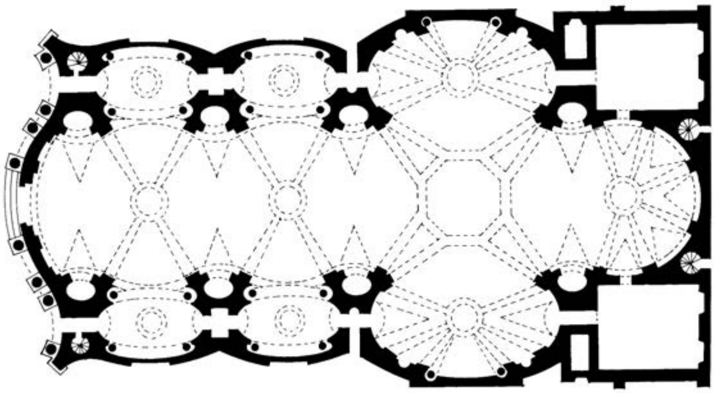
This molding of space, as though by tremendous forces that bend and curve walls, was further developed in the city of Turin, in northern Italy, by Guarino Guarini (1624–1683).[15] Guarini entered the Theatine Order at age fifteen and was sent to Rome, where he studied theology, philosophy, mathematics, and architecture. The architecture of Borromini, then under construction, was a powerful influence on him, as was, to a lesser extent, that of





16.16. Francesco Borromini, Collegiate Church of Sant' Ivo della Sapienza, Rome, Italy, 1642–1660. Plan. This plan, too, was generated by equilateral triangles, to form a Star of David. Drawing: L. M. Roth, after Borromini.

16.17. Sant' Ivo della Sapienza. Interior, dome. Photo: Scala/Ministero per i Beni e le Attività culturali/Art Resource, NY.



16.18. Guarino Guarini, Santa Maria della Divina Providenza, Lisbon, Portugal, 1652–1663 (destroyed by earthquake, 1755). Plan. Guarini used a series of overlapping ovals as the generating elements in this church. Drawing: L. M. Roth, after Guarini.

Bernini. Guarini traveled across Europe on behalf of the Theatines, building churches for the order in Portugal and France. In 1652–1663 the church of Santa Maria della Divina Providenza in Lisbon was built to his design [16.18]. Although the church was destroyed in the earthquake of 1755, its plan was recorded in engraved plates in Guarini's posthumous book, *Architettura civile* (Turin, 1737). The reverse curves of the facade recalled the facade of San Carlino, but the interior was a reshaping of the traditional Latin cross plan exemplified in the Gesù; each of the component spaces was based on an oval—ovals overlapping ovals, in fact—and the ribs of the vaults, instead of crossing transversely from one pier to another, were to cross the bays of the nave diagonally.

Guarini was engaged by Carlo Emanuele of Savoy, who was rebuilding and enlarging Turin as the capital city of the emerging duchy of Savoy. Among the important commissions given to Guarini was that for a palace for the ducal family, the Palazzo Carignano, built 1679–1683. Inspired by the Louvre's grand, undulating facade, which was designed by Bernini in 1664, Guarini also designed his palace around a central oval salon, with an external concave reverse curve modulating to a projecting central convex projection. The palace was beautifully executed in brick.

The House of Savoy happened to possess one of Christendom's most famous relics, the Holy Shroud, believed to have received the imprint of the body of Christ when he was entombed. Carlo Emanuele desired to build a special chapel at the end of the cathedral of Turin to house the precious shroud, and he gave the task to Guarini. Built in 1667–1690, the Cappella della Santissima Sindone (Chapel of the Holy Shroud) consists of a round base from which rise three pendentives, converging to a somewhat smaller circular ring [16.19]. On this ring rests a hexagonal arcade that forms the base of a dome. This dome, however, was unlike any ever built before, for it consists of six segmental arches resting on the arcade, and six smaller segmental arches resting on the crowns of the first six, and six smaller arches resting on the crowns of the second layer, and so on, diminishing by stages to the top of the dome. Within each of these superimposed arches is a window, so that the dome is filled with light filtering in through the offset stacked window openings. It is an architecture that Galileo might well have understood, perhaps, for although complex in form, it has a mathematical clarity and a directness of structural function.

Baroque Scale

Another of the attributes that sets Baroque architecture apart is the enormous jump in scale, from the circumspect arcades of Brunelleschi and the superimposed orders of Alberti, to vast complexes that surpass the limits of human visual perception. A Renaissance building, as exemplified by Sangallo's diminutive church of Santa Maria della Carceri, essentially can be broadly understood at a glance, and the relationship of its component parts is almost immediately recognized, at least sensed subliminally. Baroque buildings, in contrast, are so large and complex that they cannot possibly be comprehended in a single glance.

This change in complexity and scale was one of the first manifestations of the Baroque spirit, evident in the proposal of Pope Sixtus V to replan the city of Rome [16.20]. Although Sixtus V occupied the papal throne for only five years, 1585–1590, his vision has determined the shape of Rome ever since. This sweeping reorganization of the city was

16.19. Guarino Guarini, Cappella della Santissima Sindone (Chapel of the Holy Shroud), Turin, Italy, 1667–1690. Interior, dome. This dome, sheltering the famous Shroud of Turin, is built up of superimposed diminishing arches, enclosing windows that admit a diffuse light into the chapel. Photo: Wim Swaan, London.

another response of the Counter-Reformation; it was, in part, an effort to encourage pilgrims to visit Rome, to see the major sites associated with the earliest years of Christendom. When the earliest Christian churches, especially the large major basilicas, were built in Rome in the fourth and fifth centuries, they rose in the spaces near the edges of the city, in those areas where there was available open ground. Several, such as Sant' Agnese and Saint Peter's, were built over cemeteries. As a result, the great basilicas of San Lorenzo, Santa Croce, San Giovanni in Laterano, and, of course, San Pietro (Saint Peter) were scattered at the edges of what had been the ancient Roman metropolis; later, during the Middle Ages, these peripheral areas had been largely abandoned. The principal entry to the city was at the north, through the Porta del Popolo, into the then irregular Piazza del Popolo. Getting to these dispersed ancient basilicas from the Porta del Popolo was difficult and meant traversing large parts of the ruin-strewn expanses of the ancient city. Sixtus V resolved to bring order out of this chaos.

Although Sixtus V conceived the grand scheme, its implementation was left to his engineer and architect, Domenico Fontana. He and Sixtus V proposed cutting a new street, the Strada Felice (Felix, or Felice, was the pope's given name), from the Piazza del Popolo straight through the center of the ruins of the old city, toward the huge basilica of Santa Maria Maggiore at the center of the old city, continuing on to Santa Croce to the south [16.21]. Where the Strada Felice crossed the existing Strada Pia, the intersection of the four fountains was created (San Carlino would be built there later). Sixtus V corrected the alignment of the existing Via Gregoriana, radiating off the Piazza Santa Maria Maggiore and running toward the cathedral of San Giovanni in Laterano, to improve its circulatory function. Another major street was cut to the east, from the Strada Felice to San Lorenzo. And a new street was cut from the Piazza Santa Maria Maggiore, the hub of Sixtus V's design, to the vicinity of the Capitoline Hill (Michelangelo's Campidoglio) and the hub of medieval Rome. Other streets were planned by Sixtus V as well. Though they were intended to further knit together the dispersed basilicas, the streets were not immediately built. In addition to these new streets, Sixtus V built an aqueduct, the first influx of fresh water since Roman times, and this, the Aqua Felice, also bore his name. Its waters were discharged in a public fountain on the Strada Pia.

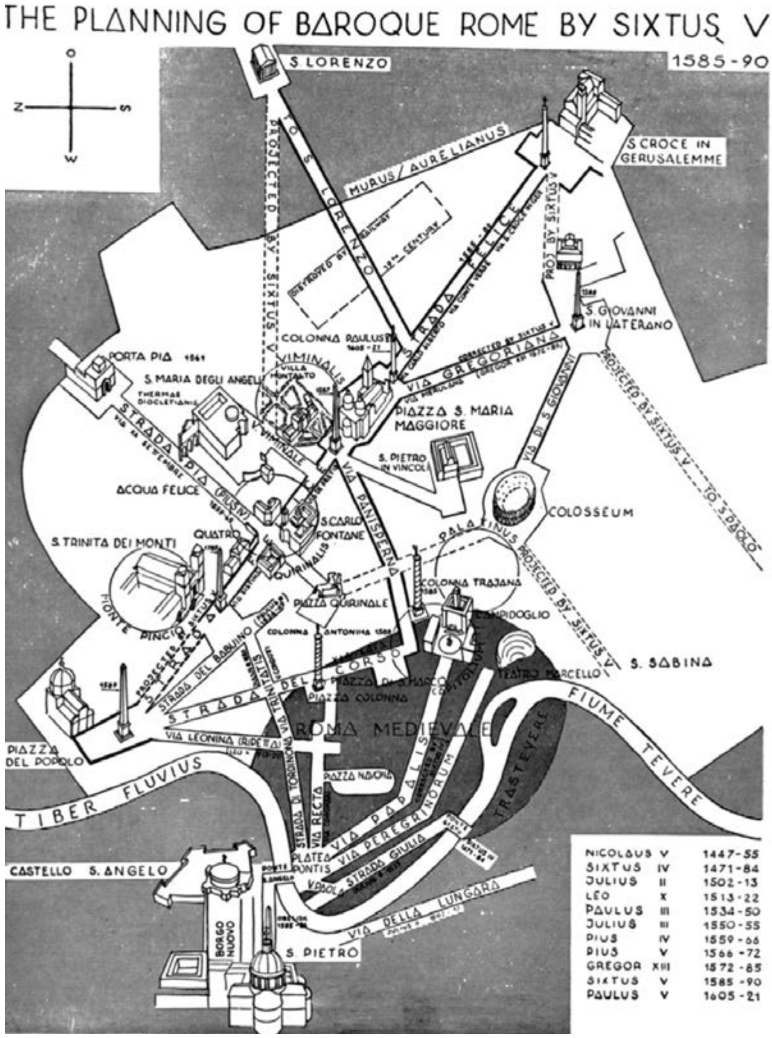
The nodes of Sixtus V's plan were the great basilicas, and in front of each basilica, a piazza was opened up. To mark these spots and to make them visible along the distance of the straight new

Am = *Flavian Amphitheater*
AQ = *Sant' Andrea al Quirinale*
BC = *Baths of Caracalla*
BD = *Baths of Diocletian*
C = *Castel Sant' Angelo*
JL = *San Giovanni in Laterano*
L = *San Lorenzo fuori le Mura*
MA = *Santa Maria degli Angeli*
MM = *Santa Maria Maggiore*
P = *Piazza del Popolo*
Q = *San Carlo alle Quattro Fontane*
SA = *Sant' Agnese*
SC = *Santa Croce*
SPe = *San Pietro in Vaticano (Basilica of Saint Peter)*
SPa = *San Paolo fuori le Mura*
T = *Santa Trinitá dei Monti*

16.20. The new streets of Rome planned by Sixtus V in 1585. Plan. The straight new streets were planned to create a net connecting the great pilgrimage churches in Rome, with the repositioned Egyptian obelisks being markers in front of each of them. Drawing: L. M. Roth, after Nolli.

streets, Sixtus V had Fontana re-erect Egyptian obelisks that had lain about in the ruins of the ancient city for several centuries. Not since Roman times had such huge stone monoliths been moved and erected, and Fontana had to reinvent the necessary machinery and organize the synchronized teams of men and horses to do the work. So, in front of each basilica, as place markers beckoning to the pilgrim, rose again the re-consecrated obelisks. One of these was the obelisk in front of Saint Peter's, raised in 1586, around which Bernini would later shape his piazza.

Ironically, as Sixtus V reorganized Rome, the secular power of the papacy was beginning to diminish,



16.21. Diagram of the replanning of Rome by Sixtus V. Although the scale is imprecise in this view looking to the southeast, the simplification makes the connections between the churches easier to see. From S. Giedion, Space, Time and Architecture *(Cambridge, MA, 1941).*

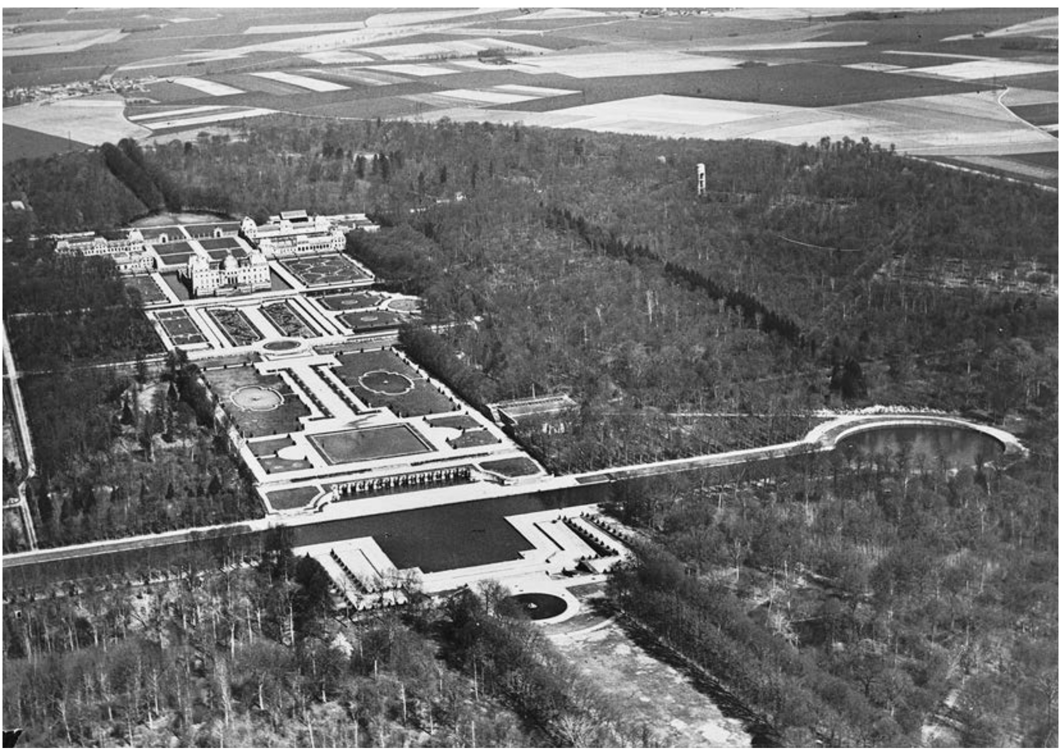
and few of his successors were able to summon the resources to initiate such vast projects on a citywide scale. The kings of the European nation-states, however—particularly the French monarchs—were increasing their power at just this time, and very shortly they were able to undertake even more expansive projects, both for their own estates and palaces and in reshaping their principal cities.

French Baroque: Versailles

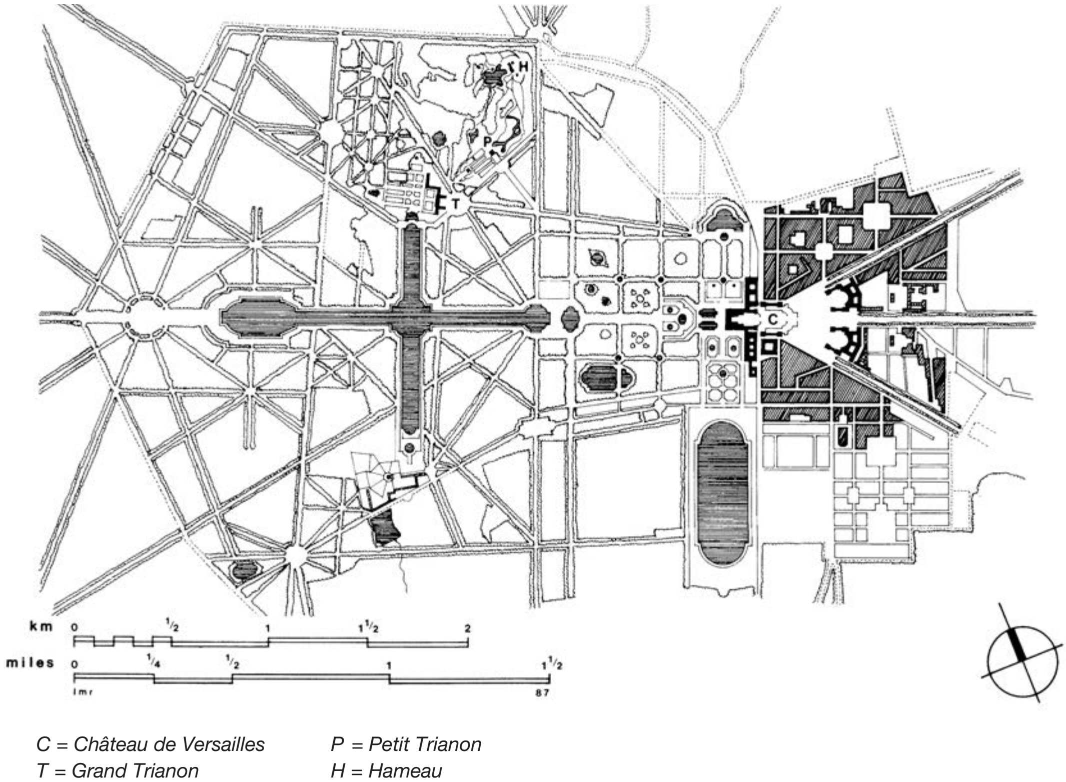
Implicit in the street plan that Sixtus V devised was the notion of linking elements within the city with a system of axial lines in an irregular network, fixing the ends of these axes with the newly erected obelisks. The concept of axial arrangement of buildings in space (largely abandoned since Roman times) soon became fundamental to French architecture and urban planning, beginning in the seventeenth century. The idea of extending the axis of the château at Chambord out into the landscape would be pushed to its limit in the royal château at Versailles. Like the royal château at Blois and Chambord, Versailles was originally a royal hunting lodge not far from Paris, but from 1661 to 1710 it was enlarged by Louis XIV on a scale rivaling that of the Rome of Sixtus V. The grounds were extended farther by later monarchs, until the French Revolution in 1789.

Versailles, about 14 miles (22 km) southeast of the heart of Paris, had been a small village with an adjoining hunting retreat favored by Louis XIII, as it was by his son, Louis XIV. The father had built a relatively modest brick and stone hunting lodge in 1624, enlarged it in 1631–1636, and had several geometric garden parterres laid out immediately west of the château, defining an axis centered on the lodge and stretching westward into the landscape. When Louis XIV reached maturity in 1661 and assumed personal control of the government operations, he began an extensive enlargement of Versailles. He used the team of architect, landscape architect, and painter-decorator that his minister of finance, Nicholas Fouquet, had assembled to build and landscape his own private country house outside Paris at Vaux-le-Vicomte in 1657–1661 [16.22]. However, Fouquet had taken a huge strategic misstep of building for himself a château and landscaped estate much finer than anything owned by the king. A month after Fouquet played host to the nobles at a grand inauguration celebration at Vaux-le-Vicomte—replete with a ballet by Molière, music by Lully, decor by Le Brun, and fireworks—he was arrested on charges of embezzlement. Vaux-le-Vicomte was shortly thereafter confiscated by the king, and its designers and builders were put to work rebuilding Versailles to make it even larger and grander than Vaux-le-Vicomte.[16]

The architect Louis Le Vau (1612–1670) was instructed by the king to wrap a new and larger building around his father's château, leaving the original building relatively untouched. The painter-decorator Charles Le Brun was charged with designing all the interiors, including the allegorical paintings to celebrate the king, his rule, and his military victories using numerous allusions to Apollo, the sun god. And the landscape architect André Le Nôtre (1613–1700) was to begin the first of several extensions of the gardens in terraces to the north, south, and especially west of the château. All of the parterres (the hedge-framed planted beds) and the radiating allées were laid out in relationship to the grand axis of the château, running through the king's own rooms at the center [16.23]. Le Nôtre's gardens combined the intricacy of texture, detail, and color of the best Italian gardens with the sense of vast scale of Sixtus V's plan for Rome. Since there were no dramatic changes of



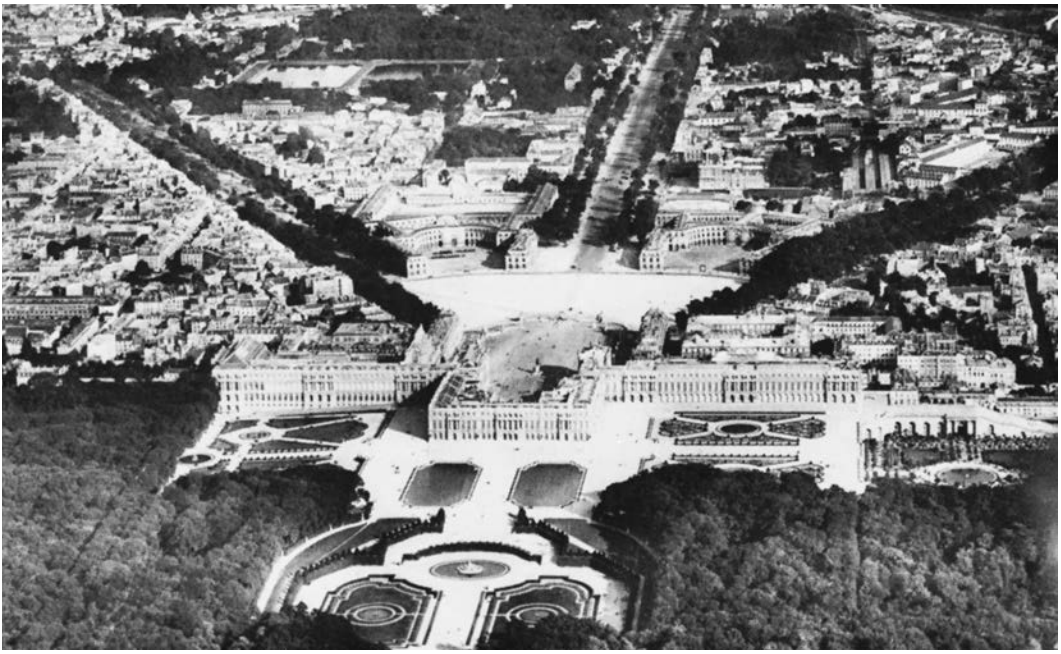
16.22. André Le Nôtre (landscape designer) and Louis Le Vau (architect), Château de Vaux-le-Vicomte, Maincy, near Melun, France, 1657–1661. Nicholas Fouquet assembled a masterful team of landscape architect (Le Nôtre), architect (Le Vau), and artistic designer (Le Brun) to create this country retreat that surpassed (for the moment) any of the estates of King Louis XIV. Photo: Roger Viollet/Getty Images.



16.23. Louis Le Vau and André Le Nôtre, Château de Versailles, Versailles, France, 1661–c. 1750. To the east is the village and to the west the gardens; both are laid out around a single axis that runs through the center of the king's chambers at the core of the château. Drawing: L. M. Roth, after the Delagrive engraving of 1746.

level in the landscape, Le Nôtre maintained visual interest by using water in basins, long pools—the Grand Canal was over 1 mile (1.6 km) long—and hundreds of fountains. The fountains were supplied by a system of pipes and aqueducts fed by a huge pumping apparatus called simply "the Machine at Marly," which raised water from the Seine River.

During 1678–1688, there was a second major phase of construction at Versailles, when the architect Jules Hardouin-Mansart added the Galérie des Glaces (Hall of Mirrors) along the west front [16.24, 16.25]. Then, wings, tripling the bulk of the château, were added to the north and south [16.23]. These wings housed much of the nobility now required to reside at Versailles, for Louis XIV had moved the entire mechanism of government to his rural retreat, abandoning Paris. The population at Versailles continually expanded; when Louis XIV died, in 1715, the nobility numbered about 20,000 persons (of which 5,000 lived in the château itself); military staff and servants numbered roughly 14,000; and the townspeople, who provided services for the court, numbered another 30,000, making a total population within the château and adjoining town of Versailles around 64,000 people. The expanded château building alone measured 1,250 feet (381 m) in length, and the entire landscape of Versailles, including both the park and the town, measured more than 2.7 miles by 2 miles (4.2 by 2.9 km). Here was an expansion of scale that Italian Baroque architects could only have begun to imagine. In contrast to the compact Villa Lante at Bagnaia, here was a building complex and a landscape that could hardly be understood even over a lifetime of exploration, a man-made landscape that stretched along the great east-west axis extending from the heart of the château nearly as far as the eye could see. Multiple axes converged on the bedroom of the king—and, behind it, the imposing Galérie des Glaces—symbolizing the centralized focus on the person and absolute power of the king. When Louis XIV had said "l'état c'est



16.24. Louis Le Vau and Jules Hardouin-Mansart, aerial view of the Château de Versailles, 1661–1688, and later. With the wings added by Hardouin-Mansart, the château stretched nearly 1,250 feet (381 m) in length, north to south. Photo: Caisse Nationale des Monuments Historiques et des Sites/SPADEM.

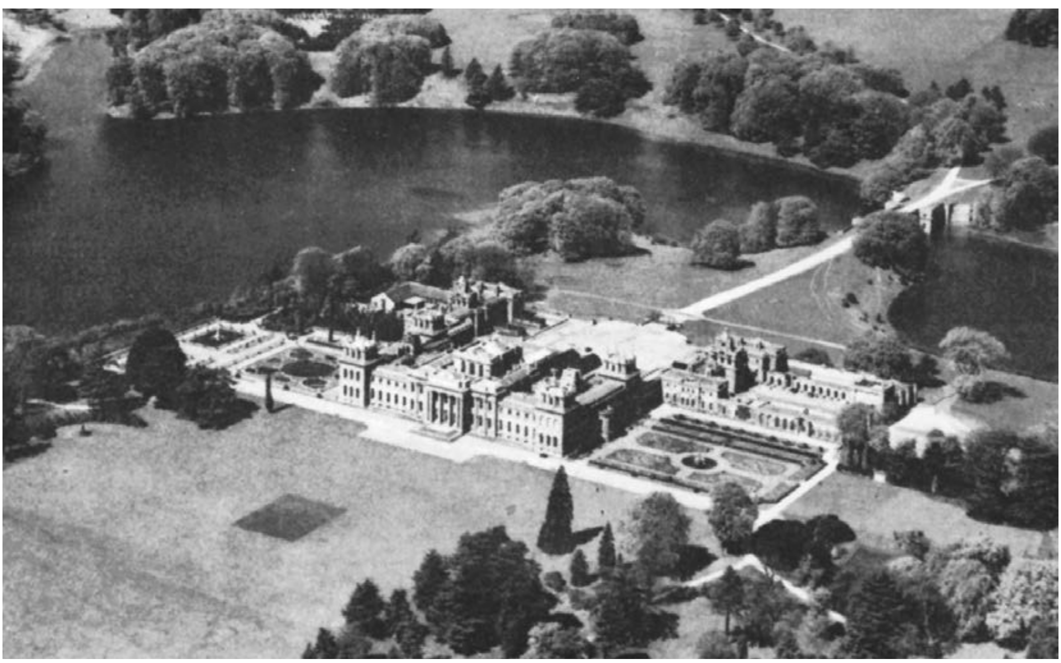
16.25. Jules Hardouin-Mansart, Galerie des Glaces (Hall of Mirrors), Château of Versailles, 1678–1688. This grand room replaced a terrace overlooking the gardens; tall windows face the gardens westward, and matching banks of mirrors on the opposite walls reflect the light throughout the room. Photo: © RMN-Grand Palais/Art Resource, NY.

moi" (The state is me), he meant not only that he was personally taking control of the machinations of his government but also that the declaration was a proud emphatic statement of his rule as absolute monarch, as his palace at Versailles physically and symbolically displayed.

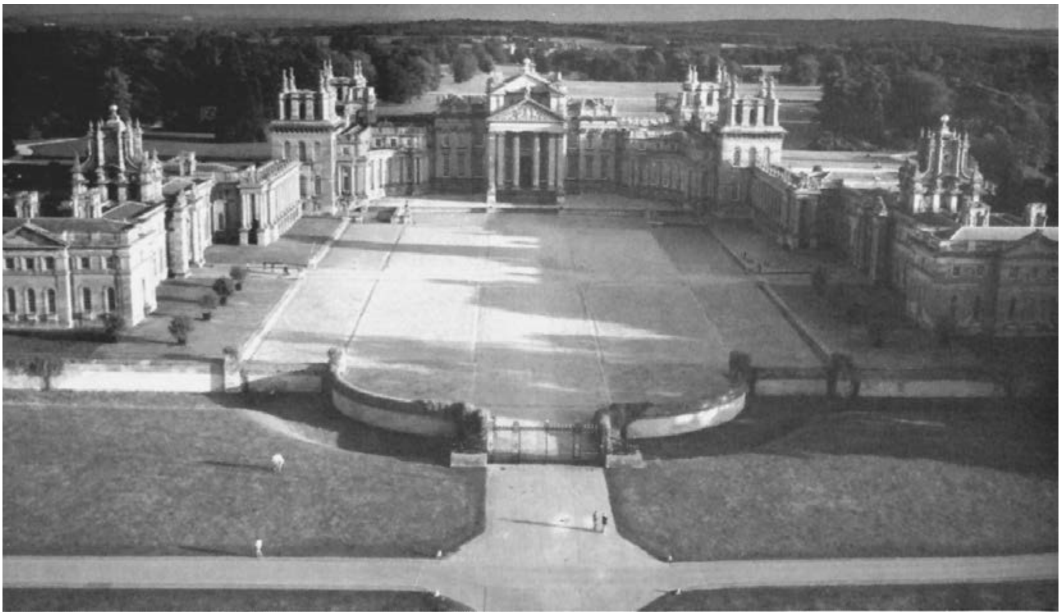
English Baroque

Baroque architecture could be described as a celebration of absolutism, whether it was the commanding power of the Church or the absolute rule, by divine right, of pope and king. In England, however, absolutism as it was known in France was increasingly curtailed by the actions of Parliament. The power of the Crown in Britain had been reduced by the rise of the conservative Whig aristocracy, which, working with the king or queen, governed through Parliament. Hence, English monarchs never had the control of the treasury that would have enabled them to build for themselves a Versailles, and thereby spared themselves that sense of myopic privileged isolation that, in part, eventually led to the bloodbath of the French Revolution. Not that the English people were actually spared the expense of such a building enterprise, however, for an equivalent to Versailles *was* built, presented as the gift of the nation to a private citizen. The building was Blenheim Palace; paid for by Parliament, it was built in 1705–1725 at the request of Queen Anne as a gesture of thanks to John Churchill. The reason for this generosity was that Churchill, general of the English army and head of forces allied with England, had defeated the armies of Louis XIV at the small German village of Blenheim in 1704, establishing a new balance of power on the Continent. In gratitude for his services, the queen made Churchill the Duke of Marlborough and granted him the royal manor of Woodstock outside Oxford, where the great house was to be built. Since the house was being paid for with public funds, its designer, the talented amateur Sir John Vanbrugh (1664–1726), continually enlarged the plans, so that it became (as was said waggishly) more a monument to the deed than to the doer. Eventually, the exorbitant cost put John Churchill and his wife, Sarah, into royal and public disfavor, and the mansion was left not quite finished.[17]

Vanbrugh, assisted by architect Nicholas Hawksmoor, laid out the house in three huge parts—a

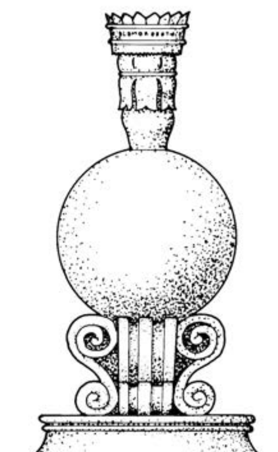


16.26. Sir John Vanbrugh with Nicholas Hawksmoor, Blenheim Palace, Oxfordshire, England, 1705–1725. This English version of Versailles was built by the nation as a gift to John Churchill, general of the king's army. The grounds visible in this aerial view are the result of later re-landscaping in the 1760s by landscape architect Lancelot "Capability" Brown, who replaced the original geometric French parterres with the meadows and copses of trees in the new style of the English Garden Park. Photo: Aerofilms, London.



16.27. Entrance court, Blenheim Palace. The design builds in scale toward the center, overpowering the approaching visitor. This is more museum than private residence, more a monument to the deed than to the doer. Photo: Angelo Hornak, London.

kitchen court, a stable court, and the central main block of the house—all enclosing a vast entrance court [16.26, 16.27]. The components of this ensemble, each highly embellished with extensive ornamentation, were focused toward the center, leading to the curved quadrants and the central pedimented portico that rises over the axial entrance. The scale, of both ornament and building elements, is huge. It is, in fact, less a private residence than a national monument, and the ornament everywhere attests to this if one knows how to read it. In the pediments are images of heaped-up battle trophies, and peppered all over the picturesque roofline atop the massive clustered chimneys are clear symbols of the house's political meaning. The finials are actually stylized representations of a ducal coronet sitting atop a cannonball crushing a fleur-de-lis—symbolic of the duke victorious over the French king [16.28]. Such theatricality was basic to Baroque architecture, and it is significant that the bombast of Blenheim Palace was created by Vanbrugh, who was by training a professional dramatist.



16.28. Blenheim Palace. Detail of the ornament used atop the chimneys, symbolically showing a duke's crown on a cannonball on top of and crushing the French fleur-de-lis. Drawing: L. M. Roth.

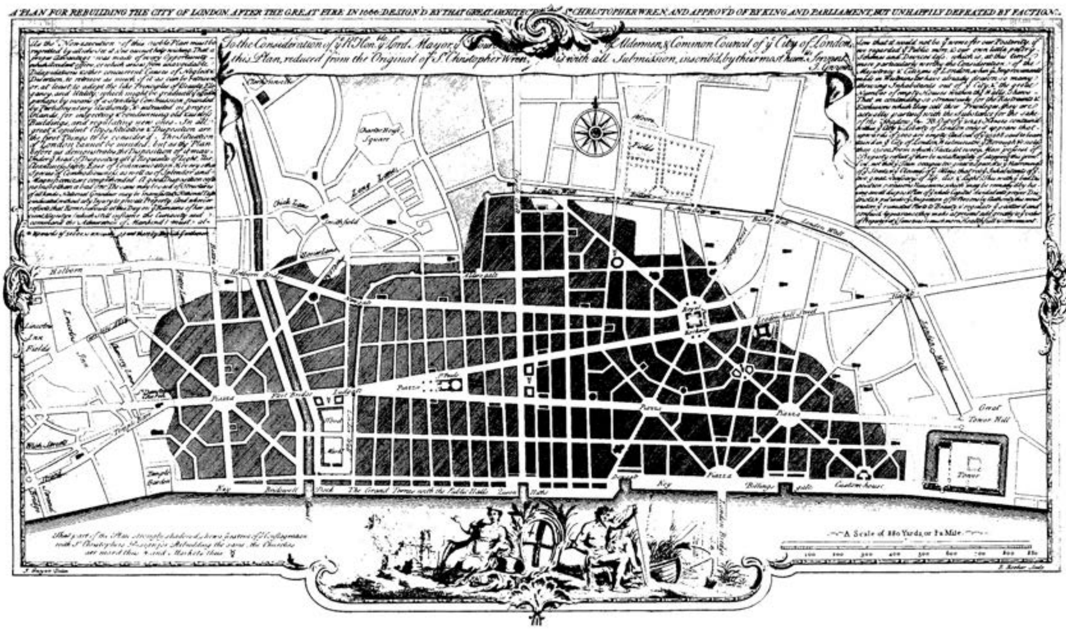
Just as the French embraced Baroque complexity in design in their own particular way, so too the complexity of Baroque design is found in a distinctly English way in the great number of London churches designed by Sir Christopher Wren. How the need for so many churches at once came about takes us to the story of the Great Fire of London and to the state of urban planning in England during the mid-eighteenth century.

In the case of Sixtus V's new plan for Rome, the land lay relatively open owing to the shriveling down of Rome during the Middle Ages. Rome was not a true *tabula rasa* ("cleared table"), since ruins stood everywhere, but these did not impede progress in making the new streets. However, in the case of London, nearly sixty years later, that city was in fact laid to waste, turned into a true *tabula rasa,* because of a disaster in the autumn of 1666. In the dark hours after midnight, September 2, 1666, a fire broke out near the Thames in central London in the area just north of London Bridge. At first the blaze appeared controllable, but the city's Lord Mayor refused to let nearby buildings be demolished to create what would now be called a firebreak. Soon the conflagration exceeded the power to extinguish it and spread, growing steadily in intensity, becoming a firestorm consuming everything in its path as winds pushed the flames north and west. Finally, beginning on Thursday, September 5, the flames began to die down and finally the Great Fire was extinguished. Deaths were limited since people quickly fled before the flames, but the destruction was catastrophic. Exact figures are impossible to determine, but it is estimated that 13,500 dwellings were destroyed along with 87 parish churches and Gothic St. Paul's Cathedral, 44 commercial buildings, nearly all the major public buildings and city offices, and even 3 of the city's western gates since the fire jumped the old city walls. According to estimates based on the 2012 value of the British pound, the value of the buildings lost was £1.5 billion.[18]

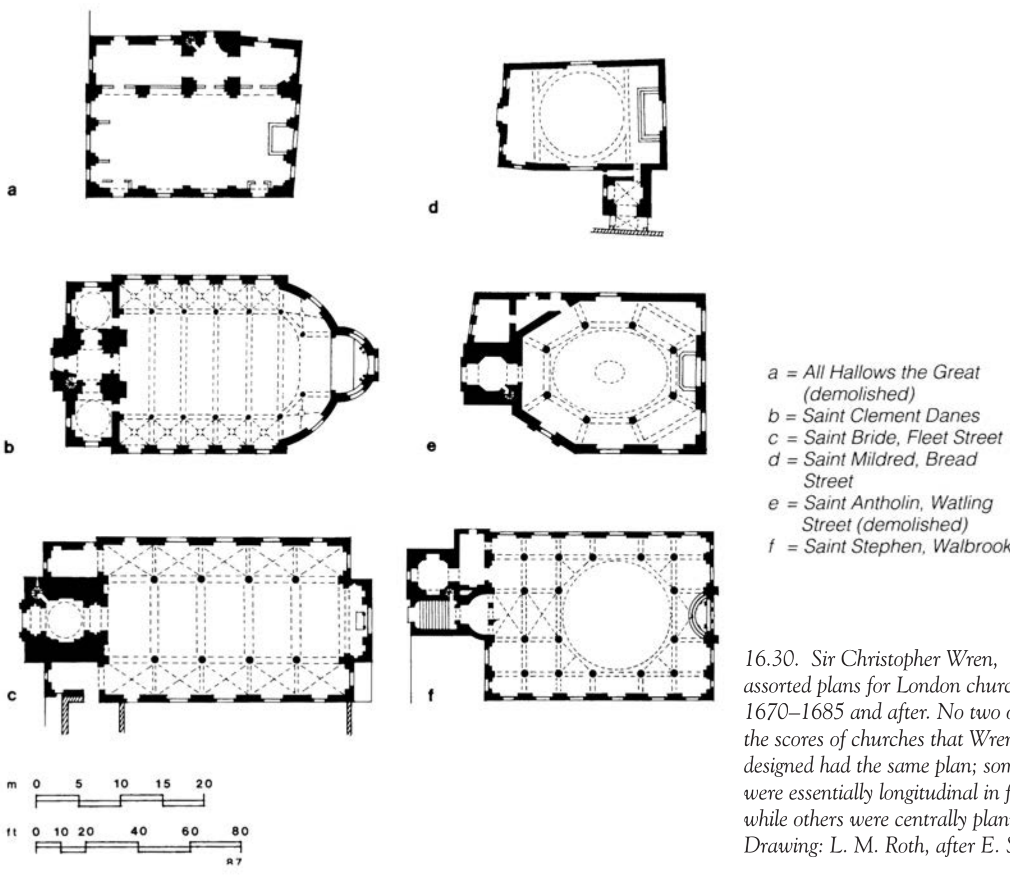
British architects and natural scientists of the day were well aware of planning projects in France and of what had been designed for Rome, and they proposed several plans for the rational restructuring of old medieval London, now swept away, with broad straight streets. Even King Charles II favored the idea. One proposed plan that received serious consideration was prepared by Sir Christopher Wren [16.29]. The black area shown in the engraved version of Wren's plan indicates the area that was burnt over. Wren proposed a grid of secondary streets extending north from the river, with broad primary thoroughfares running east to west and connecting to existing old streets. Many ran on diagonals that focused on major buildings such as the new Saint Paul's and the Royal Exchange. On London's west end Wren even proposed an octagon of radiating streets, cleverly designed to connect with the ends of existing streets beyond the fire's limits. Next to nothing came of any of these idealistic city plans (even Wren's), so that the previous tangle of medieval streets was largely reestablished (though some were made wider), but new building codes now required construction of brick and stone, forbidding wood. Sadly, rebuilding London was a triumph of commercial expediency over planned artistic clarity.

An immediate need for many churches quickly arose from the fire. Christopher Wren (1632–1723) was by education a mathematician, an astronomer, and a scientist, but his avocation in architecture and building construction led to his being appointed Surveyor-General of the King's Works in 1669; this meant he was in effect chief architect to the Crown.[19] He had already overseen construction of a number of his own building designs, and completed a trip to France (where he met Bernini briefly), when the fire gave him his unparalleled opportunity. As Surveyor-General, Wren was responsible for providing designs for the scores of small London parish churches that had disappeared in the flames. Of the 87 destroyed Gothic churches, 51 were rebuilt, since several parishes were consolidated. Because almost no new churches had been built in England since medieval times, the problem Wren faced was how modern English Protestant churches ought to be designed. The urban building sites were often constricted between adjoining properties, but a few sites had true rectangular lots. Wren's ingenuity demonstrated itself in the unending variety of plans he devised for these churches, some centralized in plan, others rectangular [16.30]. All were devised, as Wren wrote, to facilitate the worshippers' hearing the words of the speaker. Prior to the fire, London's medieval skyline had been a forest of slender Gothic spires rising over the old churches, and Wren undertook to restore that image—but in Classical terms. The new towers he designed consisted of diminishing stages of Classical squares and octagons, belvederes and cupolas, rising to slender spires [16.31].

Wren's greatest achievement was the rebuilding of Saint Paul's Cathedral, whose Gothic bulk formerly rose over old London. When it was determined that the old stone walls were too badly damaged by the fire to permit reconstruction, the site was cleared, giving Wren his opportunity to design an ideal centralized cathedral. His first scheme, prepared about 1670, was an enormous Greek cross (the arms connected by curved quadrants rather than meeting in more traditional right angles), the whole capped by a great dome resembling that of Saint Peter's, Rome, but simpler in ornamentation [16.32]. At the request of cathedral officials, Wren then modified the design by adding a domed vestibule at the west, which resulted in an axial building. The clergy and royal family were still dissatisfied, however, insisting that Wren devise a still more traditional basilican plan, with choir, transept



16.29. *Sir Christopher Wren, new plan for rebuilding the City of London, 1666. In working out a new plan for the city after the disastrous fire of 1666, Wren used broad, straight thoroughfares focused on several nodes, as in the scheme of Sixtus V for the new Rome. From the engraving published of Wren's plan, 1666 (Historic Urban Plans, Inc., Ithaca, New York, USA).*



16.30. *Sir Christopher Wren, assorted plans for London churches, 1670–1685 and after. No two of the scores of churches that Wren designed had the same plan; some were essentially longitudinal in form while others were centrally planned. Drawing: L. M. Roth, after E. Sekler.*

16.31. *Sir Christopher Wren, Church of Saint Mary-le-Bow, London, England, 1670–1680. In re-creating the image of tall Gothic spires in the new City churches, Wren used stacked diminishing Classical elements. Photo: A. F. Kersting.*

wings, and nave. This he did, devising the final plan for the start of construction in 1675 [16.33].

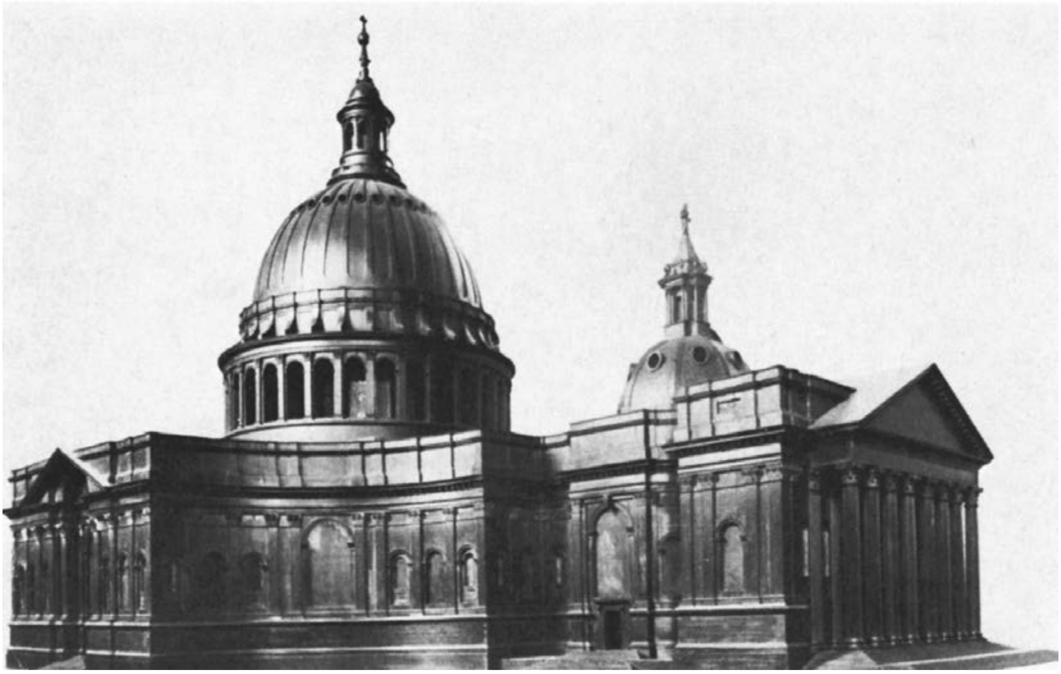
As construction proceeded upward, Wren continuously studied and modified the upper portions of the cathedral, particularly the design of the dome, which was finished in 1709 [16.34, 16.35]. The result is a building of studied proportions full of curious paradoxes. The choir and nave have a traditional high-nave/low-side-aisle profile, with the square bays of the nave covered by shallow saucer domes resting on pendentives. The outward thrusts of these domed vaults are transferred to the outer side walls by parabolic flying buttresses, but these are hidden behind the false second-level upper walls, which are simply a screen (their "windows" are blank). Instead of four massive piers under the dome in the manner of Bramante, Wren used eight smaller pendentives over eight piers to support the broad dome—a solution he had experimented with in the much smaller parish church of Saint Stephen, Walbrook, London, 1672–1679, where the dome was a plaster shell with a modest diameter of 43 feet (13.1 m) [see 16.30f].

The lower inner dome of Saint Paul's has a maximum span of 112 feet (34.1 m), but the structural wall of the drum actually slopes inward and diminishes to a reduced diameter of 101 feet (30.8 m) at roughly the level of the top of the colonnade running around the exterior of the dome. In fact, the dome in its entirety is composed of three shells: the lower shell, visible from the floor; an inner brick cone to support the crowning stone lantern; and an outer shell of timber framing and lead sheeting, proportioned in size to the overall size of the cathedral. Altogether, the innermost dome rises to a little over 214 feet (65.2 m), while the outer dome with its lantern and crowning orb and cross stretch to 366 feet (111.6 m).

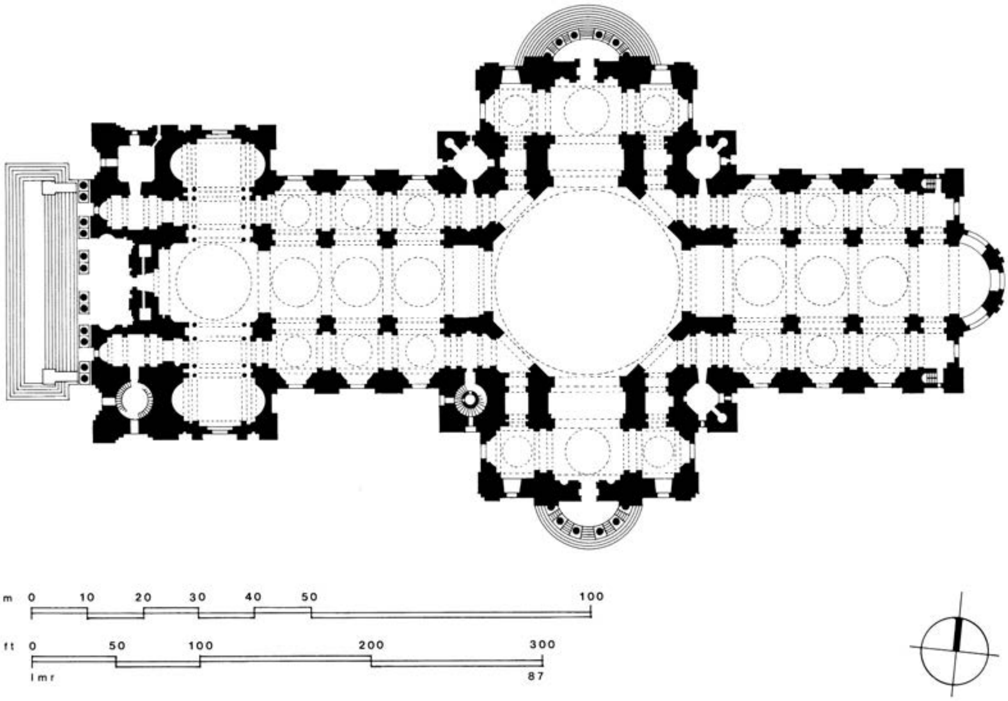
Wren's mathematical and geometrical studies persuaded him that the incline of the drum walls should follow the direction the forces would take coming down from the upper brick cone and outer dome [16.36]. Wren understood, too, that lateral forces would not be fully resolved in his design, and therefore he incorporated iron chains banding the dome at several locations. Accordingly, Saint Paul's is a complex and brilliant fusion of traditional plan form and Renaissance-Baroque formal elements and scale, its structure mathematically studied for utmost stability and efficiency.

The Baroque Staircase

As noted in the discussion of Michelangelo's San Lorenzo Library staircase in Chapter 15, Alberti



16.32. Sir Christopher Wren, Great Model design for Saint Paul's Cathedral, London, England, 1673. In his early schemes for Saint Paul's, Wren employed the ideal forms of the Renaissance.



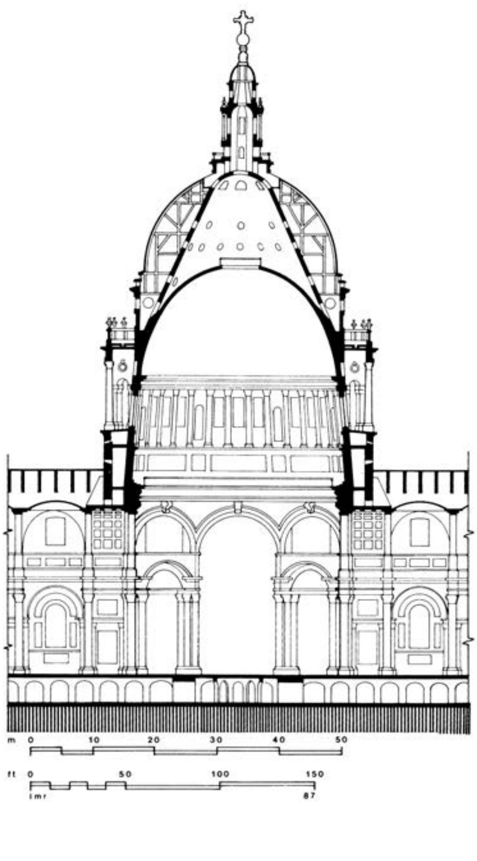
16.33. Saint Paul's Cathedral, c. 1675. Final plan. In the final scheme for the building, Wren bowed to the Crown's and the clergy's desire for a more traditional Latin cross, but he still retained his great dome for the crossing. Drawing: L. M. Roth, after A.F.E. Poley, St. Paul's Cathedral, London . . . *(London, 1927).*

16.34. Saint Paul's Cathedral. Exterior, facade. Photo: A. F. Kersting, London.

had written that the smaller the stairs in a building, the better. Baroque architects and their patrons, contrary to this advice, delighted in creating expansive rooms especially for stairs, molding sequential interior spaces, alternately dark and then light, some areas confining, some expansive. This elaboration of staircase development was most vigorous north of Italy, especially in the German-speaking areas of Bavaria and Austria. The German and Austrian architects of the early eighteenth century deliberately ignored Alberti's proscription, placing the staircase in a special room of its own and exploiting its spatial potential. It was not unusual for the staircase to be the single most developed part of a German or an Austrian Baroque palace.[20]

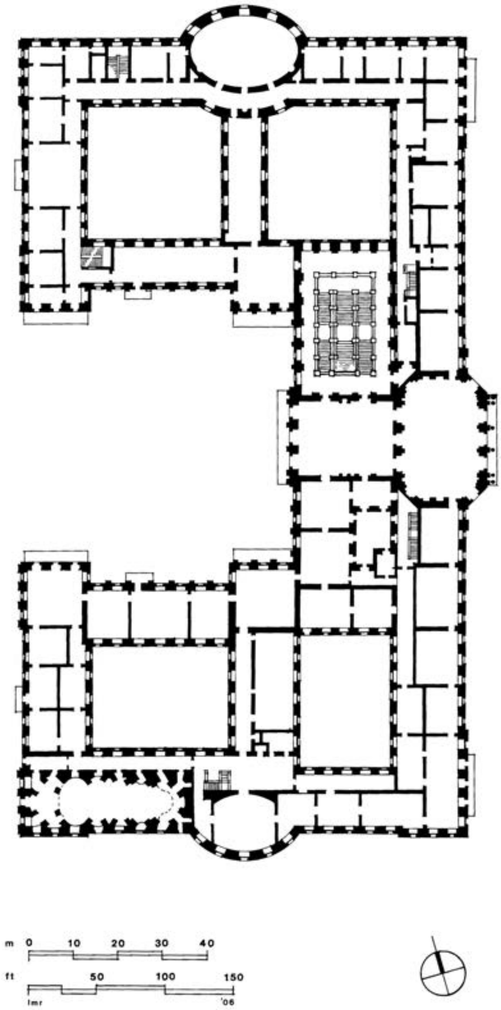
Numerous examples of such elaborated stairs survive, including the imposing *Scala Regia* in the Vatican Palace designed by Bernini, 1663–1666, and the curved double stairs of Guarini's Palazzo Carignano in Turin. The Guarini example likely inspired the similar double-curved staircase in the Episcopal residence of the Prince-Bishop of Speyer, at Bruchsal, in eastern Germany just outside Speyer. The Bruchsal stair was built during 1728–1752 and designed

16.35. *Saint Paul's Cathedral. Exterior of the dome as finished. Note the dual layering of the body of the church, which allowed the complete upper order to be visible above the roofs of the surrounding buildings. Visible in the foreground on the right is the tower of the parish church of Saint Augustine, rebuilt by Wren in 1683–1695 following the fire (but damaged by bombing, 1940–1943). Photo: Dave Pressland/FLPA/Science Source.*



16.36. *Saint Paul's Cathedral. Section through the dome. Drawing: L. M. Roth, after Poley.*

16.37. Johann Balthasar Neumann, Prince-Bishop's Palace, Würzburg, Germany, 1737–1742. Stair Hall. In German Baroque palaces, the most important space was often the ceremonial stair hall. Photo: Helga Schmidt-Glassner, Stuttgart.



16.38. Prince-Bishop's Palace, Würzburg, Germany. Plan. The plan clearly shows that the stair hall is the largest single room in the palace. Drawing: L. M. Roth.

by Johann Balthasar Neumann (1687–1753). Neumann, in fact, became something of an expert in elaborate stair design, designing another staircase for the schloss or palace at Brühl, 1743–1748.[21]

Perhaps the best example of such spatial complexity in stair design is, again, by Neumann. This was created for the sprawling palace for Prince-Bishop Johann Philipp Franz Schönborn in Würzburg, in central Germany. Neumann was brought in to complete the staircase in 1737–1742, inside a building started from plans by two other architects. The palace itself was in the form of a wide U, with a center pavilion opened up by three huge doors so that, in accordance with the prince-bishop's wishes, his carriage could escape the rain and pass into the building, where he could alight at the foot of the grand staircase. The staircase was housed in the largest single room on the ground floor [16.37]. In technical terms, the stair has what is called an imperial plan, meaning that it has a central flight that ends in a landing at the rear wall and that it then divides into two flights (running in the opposite direction parallel to the lower flight), which ascend the remaining distance [16.38]. The entire staircase is enclosed in a room almost twice as long and wide as the stair itself; this permits an enclosing balcony at the upper level, so that one ascends into a larger, lighter space. The coved ceiling vault was later embellished by the Venetian fresco painter Tiepolo in 1752–1753, with figures representing the four continents and, in front of the illusionistic parapet, a portrait of Neumann himself.

Rococo Architecture: The End of the Baroque

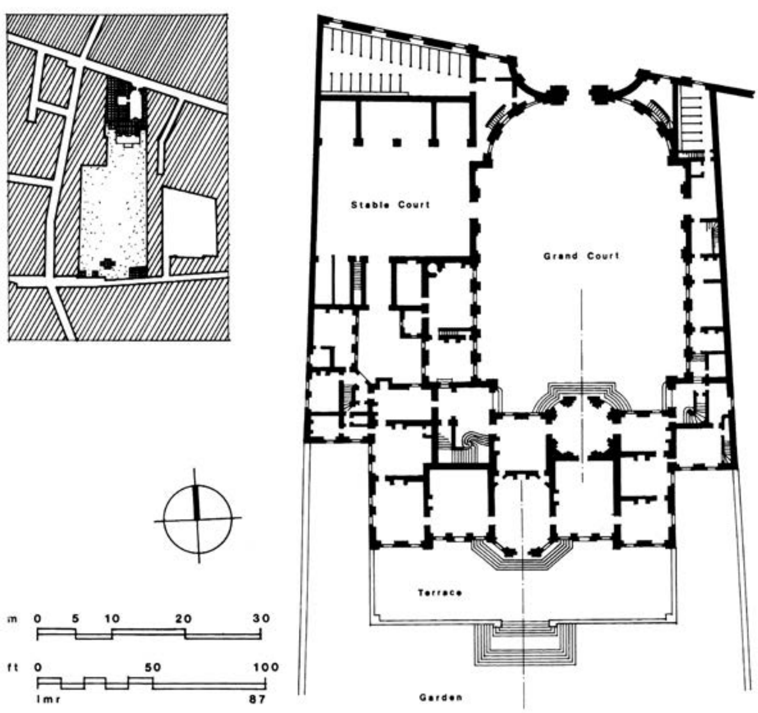
The last phase of Baroque architecture in France moved away from the heavy architectural decorative elements and deep colors of the early seventeenth century in favor of more slender decorative features and a much lighter palate of colors. The use of light colors and the delicate, irregular, curvilinear ornament were part of an architectural reaction that began in Paris in the 1720s and swept through Europe by the mid-eighteenth century. As with other stylistic labels, *rococo* began as a derogatory term invented by the later Neoclassicists in the 1790s. They derived the word *rococo* from the French *rocaille* ("shell"), which is used in reference to the shell-encrusted grottos fashionable in gardens at the beginning of the eighteenth century.[22]

During the lifetime of Louis XIV, when all members of court were required to live at Versailles, they found themselves either in cramped, ill-maintained quarters in the château itself or in whatever costly accommodations they could find in the town. Le Brun's pervasive heavy Baroque Classical interiors came to be viewed as oppressive by those forced to live there. As soon as Louis XIV died, there was a mass exodus from Versailles (and a collapse of the local real-estate market). The nobles returned to Paris, where they erected spacious private houses, ***hôtels***, principally in what were then the western outskirts of the city. These hôtels were built on large, irregular parcels that permitted an entrance court off the street, leading to a carriage court (with a side opening to the stables) and the entry pavilion of the house. There was often a spacious private garden to the rear. A good example of the new freedom in domestic design is the Hôtel de Matignon, Paris, by Jean Courtonne, 1722–1724 [16.39]. The plan shows another break from the insistent axial symmetries of Versailles, for the entrance court facade is much narrower than the garden facade, yet both are bilaterally symmetrical. This means that the axis of the entry is shifted to the side in a complex interlocking of rooms to become the axis of the garden facade.

These hôtels were built low to the ground, with the principal rooms on the ground floor, opening directly onto garden terraces by means of what came to be called French doors. Those parts of the wall not filled with large windows or doors were often glazed with mirrors, and the effect of the tall doors and the many mirrors was to create a blaze of light, deemphasizing the sense of structure. The rooms inside these hôtels were most often painted ivory, cream white, or in pale pastel tints, and paneled with delicate frames formed of lacy tendrils and wisps of gilded ornament. While the overall scheme of wall panels might possess balanced symmetry, the ornamental devices were based on motifs drawn from nature, and close inspection often reveals irregular elements. These Rococo interiors must have seemed like a breath of fresh air after the somber interiors of Versailles, loaded with heavy pilasters and entablatures. Instead of the static orders of antiquity, this new Rococo ornament derived from natural forms—shells, flowers, seaweed—particularly if there was a double S-curve. The character of the Parisian style is epitomized in the interior of the Salon de Princesse of the Hôtel de Soubise, remodeled by Germain Bouffrand in 1732–1745 [16.40]. Whereas Baroque architecture and its illusionistic visions had begun in Rome to express religious mysteries, Rococo architecture was developed in Paris as a purely secular style; it was also perhaps the first architectural idiom to arise primarily as a style of residential interior decoration.

The Amalienburg

Within a decade, Rococo had become the fashionable style of interior decorating across Europe, and in fact the most fully developed examples are those by French-trained designers working in Germany. Even more resplendent than the interiors of the Salon de Princesse in Paris are those of the small hunting lodge, the Amalienburg, built in the grounds of the Nymphenburg, the royal Bavarian retreat outside Munich inspired by Versailles. The Amalienburg was built in 1734–1739 for Amalia, wife of the elector of Bavaria, from designs by François Cuvilliés (1695–1768), who had been born in France and



16.39. Jean Courtonne, Hôtel de Matignon, Paris, France, 1722–1724. Plan. After the death of Louis XIV in 1715, the nobility returned to Paris, where they built new residences with one or two stories on large irregular parcels in the open outer fringes of Paris. The axial formal plans were adjusted to the irregularities of the sites. Drawing: L. M. Roth, after Levey and Kalnein, Art and Architecture of the Eighteenth Century in France *(Harmondsworth, England, 1972).*

16.40. Germain Bouffrand, Salon de Princesse, Hôtel de Soubise, Paris, France, 1732–1745. In the salons of the Parisian hotels, a new, light and airy style of interior decoration—Rococo—was developed, as exemplified in this room. Photo: Scala/ Art Resource, NY.

trained in Paris but was employed in the royal household in Bavaria from the age of thirteen onward [16.41]. The comparatively plain white exterior of the diminutive Amalienburg gives one little preparation for the delicate encrustation of silver filigree set against an azure blue background that covers nearly every surface of the central Mirror Salon not glazed or covered by mirrors. In the adjoining rooms, the walls are pale yellow with silver leaf on the delicate paneling [Plate 22]. The profusion of carved and gilded stucco work by Johann Baptist Zimmermann made painted panels unnecessary. No other Rococo interior ever surpassed this.

Vierzehnheiligen

In the German-speaking states, the intensity of ornamentation in eighteenth-century buildings was in large part delayed compensation for the long period of deprivation caused by the Thirty Years' War, 1618–1648, which devastated the economies of all the German bishoprics and principalities (although those in the Catholic south were less ravaged than in the Protestant north). Fought by Swedish, French, Spanish, and Austrian imperial armies on German soil, this bitter prolonged clash of Catholics against Protestants, together with the famine that followed, reduced the population across Germany by 15 percent and, in some areas of the north and along the Rhine, by as much as 66 percent. The shattered local economies did not fully recover until the dawn of the eighteenth century, when the great palaces and pilgrimage churches in southern Germany began to be built.

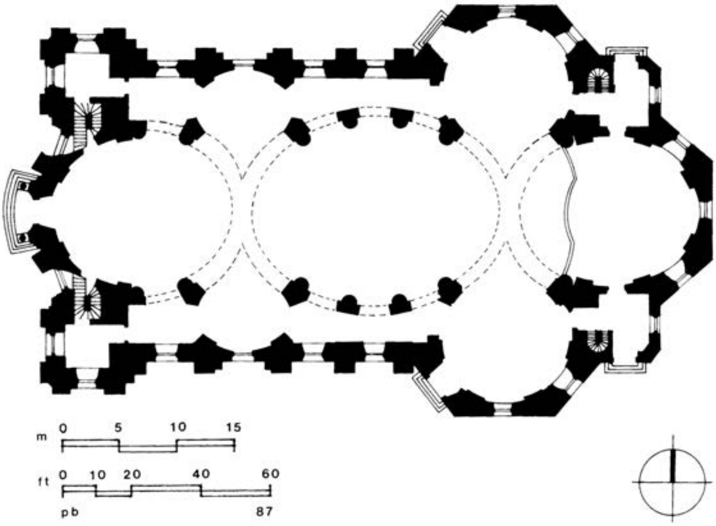
A number of new Benedictine monasteries and monastic churches were built in the early decades of the eighteenth century. A good example is the Benedictine Abbey at Ottobeuren, in southwestern Bavaria just below Memmingen, designed by Joseph Effner and J. M. Fischer. Inside the abbey church

16.41. François Cuvilliés, exterior view of the Amalienburg Pavilion, on the grounds of the Nymphenburg Palace, outside Munich, Bavaria, Germany, 1734–1739. The fullest expressions of Rococo were made by French artists working in Germany, as in this hunting pavilion. The central round salon is completely lined with glass, either in French doors or in mirrors. Photo: Erich Lessing/Art Resource, NY.

are elaborate carved stucco work and exuberant Rococo wood cases for the twin matching pipe organs. The many eighteenth-century pilgrimage churches built in Bavaria and southern Germany were also emblems of a rise in religious fervor. These German/Austrian pilgrimage churches tend to be isolated in the countryside, unlike urban churches or abbey churches. One good example is the pilgrimage church of Die Wies, set in the countryside of southern Bavaria not far from Steingaden and built from designs by Dominikus Zimmermann in 1744–1754.

Perhaps the most splendid of the pilgrimage churches is the Basilica of Vierzehnheiligen, set on a high, wooded ridge near the Main River, in the Ober-Franken region, near Lichtenfels, Bavaria. Here, in 1445, a shepherd had a vision of the Christ Child surrounded by fourteen child-like angels, who later came to be called the Fourteen Saints in Time of Need. A pilgrimage church of Vierzehnheiligen (Fourteen Holy Helpers) was soon built there, and in 1742, work began on replacing that building with a grander one from plans prepared by Johann Balthasar Neumann. The supervising builder, G. H. Krohne, however, blithely deviated from Neumann's design, modifying the plan so that the principal shrine of Vierzehnheiligen would be in the center of the nave instead of in the choir under the main altar. In 1744, Neumann was engaged to take over construction himself, to rectify as best he could the errors that Krohne had introduced. Since the position of the altar with respect to the outer foundations was now fixed, Neumann decided to make the spatial divisions of the church more fluid, reshaping the interior plan as a series of interlocked and overlapping ovals, the largest one containing the main shrine [16.42, 16.43, 16.44]. Hence, the internal, curved arcades, capped by ellipsoidal plaster domes, have no particular relationship to the exterior of the church. The vaults of the choir and the large nave oval meet in curved rib arches over the crossing where one would expect to find a dome. The main pilgrimage shrine was placed at the center of the large oval in the nave, over the spot where the vision occurred; this arrangement allowed pilgrims to circulate around

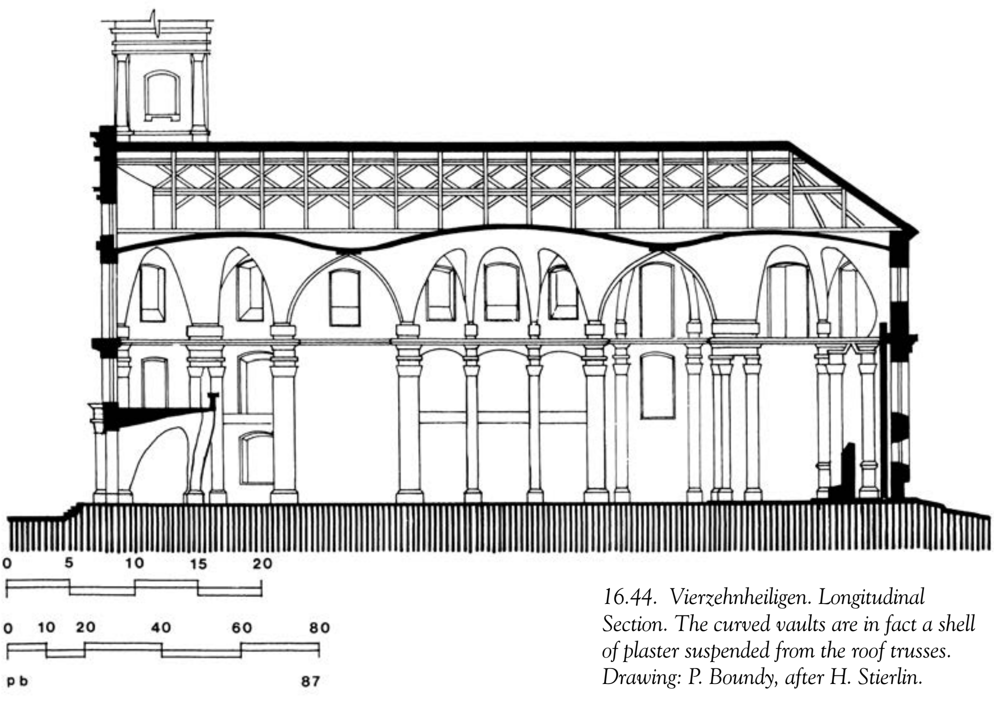
16.42. Johann Balthasar Neumann, Vierzehnheiligen (Pilgrimage Church of the Fourteen Helpers), Franconia, Germany, 1742–1772. From the outside, this pilgrimage church would appear to have a traditional Latin cross nave-with-side-aisles plan. Photo: Marion Dean Ross.



16.43. Vierzehnheiligen. Plan. Neumann's plan uses overlapped ovals throughout, creating a fluidity of movement from part to part. Drawing: P. Boundy, after H. Stierlin.

the church and not disturb the celebration of the Mass at the altar located in the choir.

The interior embellishment, carried out in 1744–1772, is also a superb example of the work of the Late Rococo stuccoists Johann Michael Feichtmayr and Johann Georg Übelhör and the painter Giuseppe Appiani [16.45, p. 414, Plate 10]. The white piers and vaults are covered with gilded tendrils, which also frame the vault paintings. Here, as in most Rococo German and Austrian churches, the colorful and beautifully veined marble columns are not stone but actually painted plaster called ***scagliola***. There was no desire to express structural reality, for even the vaults overhead are plaster on wooden lath suspended from the wooden roof trusses. On the contrary, this is a purely environmental shell, defining interconnected spaces and manipulating light, bouncing it from the inner side of the encircling piers, suffusing the interior with a soft radiance. The interior is a world of delicate and

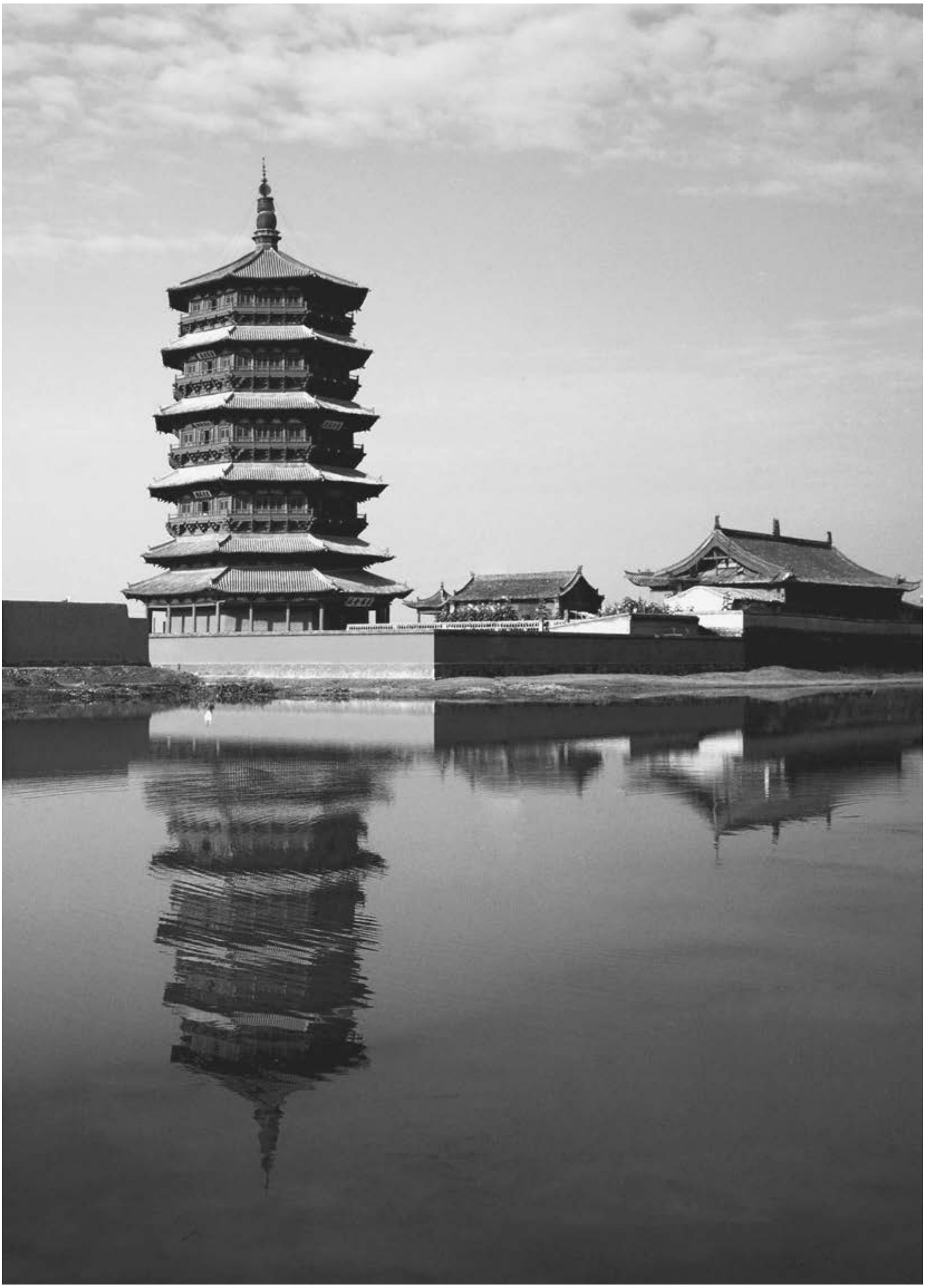


16.44. Vierzehnheiligen. Longitudinal Section. The curved vaults are in fact a shell of plaster suspended from the roof trusses. Drawing: P. Boundy, after H. Stierlin.

joyful artifice, making the strongest possible contrast with the mundane world outside. To pilgrims entering the church, it must have seemed like the shepherd's vision—a foretaste of paradise.

An Architecture of Artifice

In their striving for the fullest possible effects of molded space, manipulated light, brilliant color, and sensuous detail, Baroque architects and their later Rococo counterparts created an architecture that, increasingly, was concerned predominantly with the shaping of space and almost not at all with expression of the fundamental underlying structure of architecture. Architecture became, quite literally, an exquisite and colorful veneer that was applied over something else; it was visual effect with very little structural truth. By the time Vierzehnheiligen was being completed in the early 1770s, however, a radical change was already well established in France, an abrupt turn toward a fully rational architecture in which, conversely, structural truth was now to control visual effect. The pendulum was swinging sharply back to the rationalism of Renaissance purists. Yet, there was no return to the Renaissance style itself, for an objective knowledge of history as a scientific discipline had emerged in the meantime. On the basis of what they were now learning about antiquity, these avant-garde Parisian architects now sought to create a rational modern architecture reformulated structurally from the ground up in the light of a new understanding of ancient architecture.



CH-1. Sakyamuni Pagoda, Fogong Buddhist Monastery, Yingxian, Shanxi Province, China, 1056. Built of wood (the oldest pagoda building in China), this vertical tower form was inspired by the lower domical mound form of the Indian stupa; this example shows the remarkable transformation of the simple series of small disks of the chattra *feature atop Indian stupas into a soaring vertical temple tower. Photo: © Li Wenkui/Xinhua Press/Corbis.*

Chinese Architecture

Although Chinese trade goods, particularly silks, were known and highly valued in the West since before Roman times, it was the eighteenth-century European mania for tea that brought the two worlds into collision in the early nineteenth century.[1] Portuguese merchants, followed by the Dutch, first reached China by sailing around Africa, trading for tea, and then introducing it to Europe. The Dutch called the beverage *thee,* and *tea* became the word customarily used in Europe; the Chinese word, *cha,* was not widely used in the West.

By the end of the seventeenth century, tea had become the aristocratic drink of choice, and by the eighteenth century it was served in fashionable *salons* throughout western Europe. The formal serving of tea prompted the development of delicate porcelain serving pieces and the miniaturization of spoons (to become "tea" spoons), together with a huge increase in the consumption of tropically grown sugar as a sweetener. Accompanying the growing export of tea from China was a special Chinese porcelain ware painted with blue designs as part of the glazing. The pictures on this "blue ware" fueled an interest in Chinese landscape images, particularly those that depicted landscapes in the distinctive flattened perspective typical of Asian landscape painting. The rapid increase in the formal drinking of tea, and the creation of porcelain ware with Chinese images of landscape for serving it, became integral to the craze for "Chinoiserie"—a fascination with Chinese design, Chinese art, Chinese garden design, and Chinese architecture. For roughly a century, from about 1700 to 1800, "Chinoiserie" flourished, resulting in the making of splendid porcelain ware, "Chinese" interior and furniture design, and far-fetched Chinese garden "follies," as well as the creation of asymmetrical picturesque landscapes that produced the English garden park movement. By the end of the eighteenth century, this landscape movement had spread, resulting in "jardins anglais" in France (even at Versailles) as well as "Englisch gärtens" in German-speaking states across Europe.[2] But as to a correct understanding of the true principles and major achievements of Chinese architecture and garden design, European ignorance of China was considerable. The underlying concepts of true Chinese design would become better understood in the West only a century and a half later.

One principle of Chinese philosophy is the concept of yin and yang, literally "shadow and light," the fundamental, interdependent, and complimentary pairing of necessary opposites: odd and even, dark and light, night and day, low and high, cold and hot, water and fire, female and male. For millennia before direct contact with Western culture began in the sixteenth century, China's social structure had long been shaped by this yin and yang duality, well represented, as it turns out, by the two complimentary Chinese philosophical systems that resulted from the teaching and writings of two sages of the fifth century BCE—Confucius (Kong Fuzi) and Laozi (Lao-Tse). These two contrasting but complementary systems would suffuse Chinese architectural and landscape design for all the centuries following. Confucianism (based on the teachings of Kong Fuzi, "Master Kong," commonly Romanized as "Confucius") originally was developed to instruct pupils in their search for personal integrity and honorable values and, by extension, to promote logical orderly governance. Kong Fuzi moved with a few followers from place to place in China, endeavoring for years to find a ruler who would use his principles to create an orderly and honorably balanced system of governance. Confucianism is rooted in a sense of underlying rational order; in a person's adherence to absolute integrity, obedience to authority, veneration of ancestors, and respect for one's elders; and in an ordering of the relationship of the individual to the family, the family to the larger community, and the community to the state. A summation of the teachings of Confucius is found in the *Analects of Confucius*—the rules of conduct and behavior uttered by the master and later collected and written down by his followers.

In dramatic opposition to Confucianism, the philosophy of Laozi is called Daoism (from *Dao,* "the way"). It relies not on rational analysis or on observing prescribed rules of behavior but, rather, on embracing and celebrating the spontaneous variation of nature. In contrast to the codified rules of Confucianism, Daoism is nonauthoritarian and mystical. Adding to this philosophical dualism, at about the start of the common era, Buddhism was introduced to China, and these two Chinese philosophical systems were soon brought into alignment with the religious tenets of Buddhism.

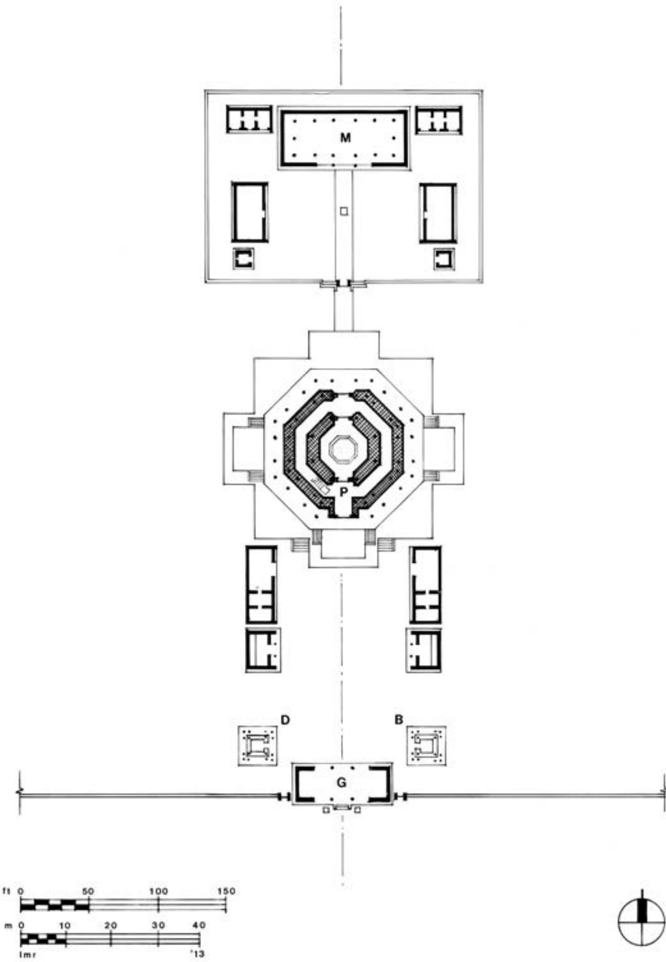
Buddhism, though it does incorporate philosophical elements, is primarily a religious system. In the first century of the modern era, Chinese Buddhist temples were built in the Chinese wood-frame tradition; none of these survive. More significant (if the number of surviving examples is any indication) was the impact of the Indian stupa, transmuted in China as the *pagoda.*

Built as a monument marking the location of the remains of Buddha or some other revered holy person, the stupa was almost immediately transformed in China from a low rounded mound into a slender vertical multistage or tiered tower, derived in part from the multilevel *chattra* pinnacle atop the stupa, but also drawing inspiration from the established Chinese practice of building watchtowers. The term *pagoda* was derived from the Sanskrit *dagoba* (which means "stupa"). The horizontal levels of the pagoda, resembling the superimposed parasols in the Indian *chattra,* were enlarged to become encircling projecting narrow roofs or eaves. This is well illustrated in the twelve-sided brick pagoda of the Songyue temple complex at Song Mountain, Henan Province, built in 523 CE—the oldest surviving example. This pagoda has fifteen slightly projecting roof eaves, diminishing by increasing degrees so that the tall elliptical profile resembles the tall *shikhara* towers of Indian Hindu temples. Other Tang dynasty pagodas (also built of masonry) are square in plan and have fifteen or so closely spaced encircling eaves or roofs.

From this evolved the Chinese timber-framed pagoda, with superimposed broader eaves carried by the densely stacked timber brackets known as the *dougong* (*tou-kung*) system (also used in Buddhist temples) and seen, for example, in the pagoda at Fogong Temple at Yingxian, Shanxi Province, built in 1056 [CH-1]. Broader than the earlier brick or masonry pagodas, the Fogong pagoda has six major projected roofs protecting smaller, less projected intermediate encircling balconies. In early Chinese Buddhist temple complexes, the pagoda is typically the largest and most important building, firmly centered on the axis that runs straight from the entry gate to the main hall at the far end containing the images of the Buddha [CH-2]. In the Fogong pagoda, there were also five additional, progressively smaller Buddha statues, one on each of its internal levels.

The principal statuary viewing halls in such temple complexes were rectangular wood-framed buildings with heavy cantilevered roofs supported by regularly spaced wood columns lifting up multiple superimposed projecting *dougong* brackets intended to reduce the length of the cantilevered roof rafters. The oldest surviving Chinese wood temple is the Nanchan Temple on Wutai Mountain in Shanxi Province, begun in 782 CE [CH-3]. A good example of the earliest temple type, the Nanchan Temple is comparatively constrained in size, whereas in subsequent centuries these halls grew to be quite large. Typical, too, is the orientation of the Nanchan Temple with its long side to the front. In important Chinese public buildings—whether the great halls in Buddhist monasteries, the central building in larger house compounds, or the central throne room hall in the imperial palace—the width of a facade was seen as a measure of a building's importance. The best-known example is the enormously broad front of the Hall of Supreme Harmony (*Taihedian*) at the very center of the imperial Forbidden City Palace in Beijing (first built in 1406 but rebuilt in 1695–1697 after several fires). The huge hall, used for the most important imperial ceremonies, is nearly 210 feet (63.96 m) wide across the front and only 122 feet (37.2 m) in depth.

The Confucian ideas of an orderly system, intended to promote and maintain social order, are well illustrated by one of the oldest manuscripts to survive in China, *Kaogong ji* (The Artificer's Record) from the fifth century CE. This remarkable document is a guide for laying out cities, outlining general principles that also hold true for residential compounds, including the largest such compound in China, the sprawling complex of the imperial household and governmental



CH-2. Fogong Monastery, Yingxian, Shanxi Province, China, 1056. Plan of principal buildings. Though the original gate has been rebuilt, the plan shows the strong axial arrangement from front gate to the main hall. ***G*** *= front gate;* ***B*** *= bell tower;* ***D*** *= drum tower;* ***P*** *= pagoda;* ***M*** *= main hall. Drawing: L. M. Roth, after L. Liu,* Chinese Architecture *(New York, 1989).*

center of Ming and Qing China—the Forbidden City at the center of Beijing. In essence, Chinese culture is about protective containment: the nation is bounded by a wall (the Great Wall to keep out the "barbarians"); the city is bounded by a wall (the Chinese word for city and wall is the same, *cheng*); the imperial Forbidden City is contained within an encircling wall; and individual private household compounds, large or small, are bounded by a high closed wall. The *Kaogong ji* indicates that a capital city should be a square 4,000 feet to a side, oriented to the cardinal directions, with three gates on each side. The main gate should face south, with the principal street running north-south from that gate, leading to the governmental complex in the center of the city. In the imperial Forbidden City, Beijing, that central position is occupied by the Hall of Supreme Harmony, and the palace itself is at the center of the orthogonal plan of Beijing. There, in the center of the space inside the Hall of Supreme Harmony, facing southward, sat the emperor at the center of all things, in the kingdom still called *Zhongguo*—the "central nation."

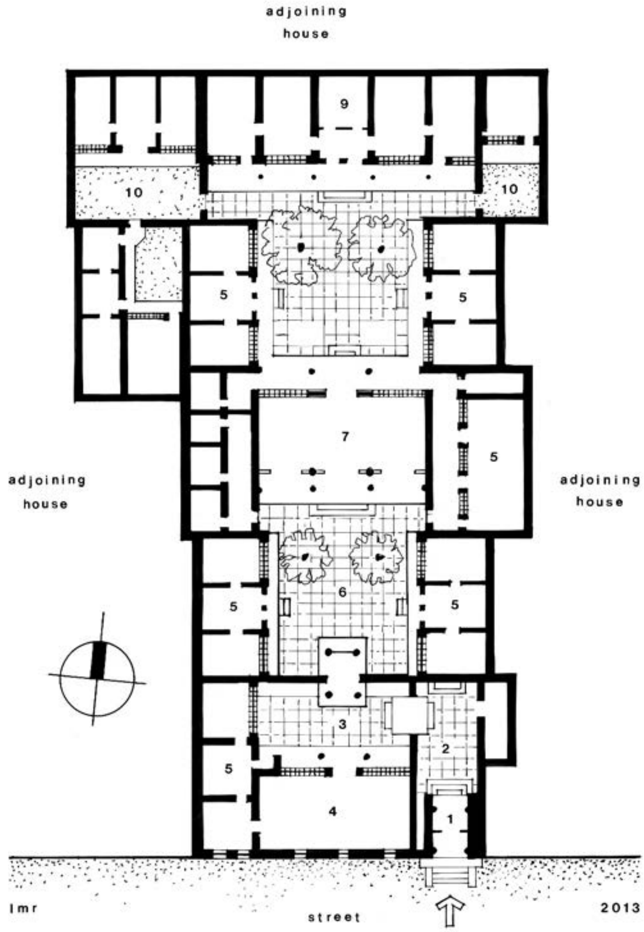
Moreover, each of the cardinal axes and directions, whether at the scale of a city or the small scale of a private house, is associated with one of the Five Elements, with attributes and colors, in turn, associated with each of the cardinal directions. East is linked with spring, wood, and the color blue-green (pictorially represented by the Blue Dragon). South is associated with summer, fire, and red (pictorially represented by the Red Phoenix). West is associated with autumn, harvest, metal (gold in particular), also weapons, and the color white (frequently depicted as the White Tiger). North is associated with winter, night, and black (sometimes represented by the *xuanwu* figure, a coiling snake).[3] The ruler's residence and place of administration were located

CH-3. Nanchan Buddhist Temple at Mt. Wutai, Shanxi Province, China, 782. The oldest wood temple in China, this shows the wood bracketing (dougong) *construction that carried roofs cantilevered well beyond the walls. Photo: Christopher Liu, Chinastock.*

where the axes of the city intersect in the center, or *zhong.* The emperor's compound also was associated with a central vertical *axis mundi* (in addition to the cardinal axes), which connects Heaven to Earth; the associated color of the vertical axis is the royal yellow. Only imperial roofs in the city were covered with yellow glazed roof tiles.

The other ancient method of ordering space and making correct planning decisions is observing correct *fengshui,* or geomancy (literally translated as "wind-water"). The objective of *fengshui* is to ensure the openness to positive *qi* ("breath"), life energy or energy flow, a concept closely related to the *Dao;* correct *fengshui* also provides measures to redirect or block negative energy flow. When undertaking a building, the patron would engage a *fengshui* consultant to determine the most auspicious orientation of the proposed structure.[4]

Just as cities were walled enclosures, so too were residences walled family compounds, the wall defining the edge of the street. Under Confucianism, the house is ruled by the eldest male family member with, ideally, three generations living as one household. The walled house was made up of a series of inward-focused courtyards with only a simple door opening to the narrow street. As it typically had no windows onto the street (restricting access to intruders), light from the internal courtyards lit the interior rooms. The street entry door was most often placed to one side so that the entry path into the house required two turns, avoiding a straight line due to the belief that evil forces, *Sha,* move in straight lines [CH-4]. Once inside the compound, a visitor could perceive the central axis on which the entry court was placed. In a large house this was a service court, lined by kitchen and service rooms to the south, with children's and guest rooms east and west. A door in the northern wall of this court led to a second larger inner court, lined with consorts or children's suites east and west. Flanking the axis on the north side of this court would be the parent's and sons' rooms, with the parent's chamber to the left and the sons' to the right. Daughters generally slept in the rear of the compound, farthest from the point of entry to the house. In the very center, on the axis and against the north wall, was the largest chamber; this served as a reception room and the ancestral hall, housing an altar table for veneration of the family's ancestors.



CH-4. Plan of a typical Beijing siheyuan *or northern-style walled courtyard house, nineteenth century. The plan shows the offset entry, requiring several turns as a person enters, the strong axial alignment, and the succession of courts that lead to the ancestral hall.* **1** *= entry hall;* **2** *= entry court;* **3** *= second court;* **4** *= servants' rooms;* **5** *= side halls or children's rooms;* **6** *= main courtyard;* **7** *= ancestral or main hall;* **8** *= inner family courtyard;* **9** *= master suite flanked with wives' rooms;* **10** *= service space connecting to other chambers. Drawing: L. M. Roth, after L. Liu,* Chinese Architecture *(New York, 1989).*

Still surviving in Beijing is the expansive Gongwangfu residential complex, built in 1777 for imperial minister He Shen but later confiscated and passed through several owners until finally being given in 1851 by Emperor Xianfeng to his brother, Prince Gong. Known by that name today (and open to the public as a museum), the Gong Mansion is considered one of the largest and most sumptuous private garden residences in Beijing in the old northern style.

Somewhat more typical of the southern residences of prosperous merchants is the Lin An Tai residence, Taipei, Taiwan, begun about 1783–1785 (with side additions built in 1822–1823). The house was built by Lin Chin-Neng, a successful merchant who had come from Fujian Province with his father and family around 1754. The house in Taiwan was built in the Fujian style, and it was named Lin An Tai by its builder to allude both to the family name and to the Rong Tai company that he operated.[5] The plan exemplifies moderate-sized homes, with an entry "gate hall" with two doors on either side to avoid a straight line axial entry (today, there is a central door for visitors since the house is a museum open to the public). Beyond the entry is an internal court with small secondary family bedchambers left and right. On the central axis toward the rear wall of the house is the ancestral hall, flanked on either side by bedchambers for the elders. Thicker masonry walls separate the center block from the added *hulong* "wings" left and right; these wings were built to provide ancillary bedchambers in the front and servants' rooms in the back, including a kitchen. Small open courts in the four *hulong* sections provide additional light and air as well as rainwater for small indoor ponds.

While the Lin An Tai house is generous in space by Chinese Qing dynasty standards, other successful merchants found ways of providing comparable living space in much more compact arrangements. An exceptional example—a house for the Huang family, which traces its lineage back through thirty-six generations—was built about 1790–1800 in the village of Huangcun in southern Anhui Province, about 224 miles (350 km) west of Shanghai. Though the house, named Yin Yu Tang ("Hall of Plentiful Shelter"), had been occupied by the same family for two hundred years, by 1996 it stood empty and suffered some vandalism before being acquired by the Peabody Essex Institute of Salem, Massachusetts.[6] Once all the necessary clearances had been obtained, the Huang house was methodically disassembled, the parts transported, and the house meticulously reconstructed in Salem, next to the Institute. The house has the additional advantage of being exceptionally thoroughly documented, with detailed interpretive presentations now available online.[7]

Because the Huangcun village is squeezed between a river and a mountain, building space was limited, so the footprint of the two-story Huang house was compressed; it has a single wide but narrow rectangular court rising through the center of the two stories of the house, the *tianjing,* "skywell." The presence of the mountain and the river also caused Yin Yu Tang to be oriented completely opposite to orthodox *fengshui:* it faces north instead of south. Since a mountain rose directly behind the house—a most auspicious condition—and since flowing water is associated with wealth flowing into a house, Yin Yu Tang was oriented facing north, the mountain to the back and the river to the front, although in all respects the house was considered by its residents as facing south with all the interior rooms disposed according to traditional placements.

In marked contrast to the ordered structure and symmetrical axiality of the Confucian-based house is the studied and felicitous irregularity of the Chinese garden. Contrary to the yin (feminine) and yang (male) balance within the house, the garden was considered to be the province of the *Dao,* exhibiting the unexpectedness and spontaneous variability of nature, achieved in studied asymmetrical plantings, irregular bodies of water, winding or zig-zag paths, and a strategically positioned ornamental pavilion called a *ting* from which, under the shelter of its dramatically upturned roof, one could meditate on the carefully designed views. Some gardens were large, such as those of the Gong Mansion. Others, such as the highly esteemed gardens in Suzhou, Jiangsu Province, built by retired imperial officials from the eleventh through the nineteenth centuries, are less ostentatious and more studied in design. Of the nine principal Suzhou gardens, all of which have been placed on the UNESCO World Heritage List, one appropriate representative is the Garden of the Humble Administrator, begun by Wang Xiancheng in 1510 [CH-5].[8] But size is not critical, for through the adroit design of a small lagoon or pond, a few selected trees, and perhaps a carefully chosen unusually irregular rock, even a small garden could be made the alternate of nature. Gardens were considered more difficult to design than houses, as they were intended to look as if they had grown out of nature though they were clearly a work of human artifice. Hence, the intellectual study of garden design and the making of gardens was a discipline associated with highly educated poets, philosophers, and those who had distinguished themselves in government service. In the evening, in the garden, away from the cares of the daily world, a scholar could escape the structured Confucian confinement of the house, relax within the *ting,* sip rice wine, and, in the light of the full moon, write or contemplate a reflective poem. In such moments, the rigorous discipline of Confucian order could be set aside while the mind opened itself to the infinite expansiveness of the *Dao* [Plate 23].

As the poet Bai Juyi wrote in the ninth century: "There is one thing and one alone I never tire of watching—The spring river as it trickles over the stones and babbles past the rocks."[9]

CH-5. Garden of the Humble Administrator, Suzhou, southern China, begun 1510. Plan. Artfully crafted to combine water, a variety of plants, covered walkways in zigzag paths, and strategically placed pavilions, such gardens as this provided places for officials to contemplate natural beauty in its manifold forms. **E** *= entrance;* **1** *= The Secluded Ting (pavilion) of the Chinese Parasol Tree and Bamboo;* **2** *= The Green Ripple Ting;* **3** *= The Orange Ting;* **4** *= The Snow-Like Fragrant Chinese Plum Tree Pavilion;* **5** *= The Lotus Breezes Ting;* **6** *= The Mountain-in-View Tower;* **7** *= The Tower of Reflection;* **8** *= The Floating Green Tower;* **9** *= The With-Whom-Shall-I-Sit Ting;* **10** *= The Keep and Listen Pavilion;* **11** *= The Pagoda Reflection Ting;* **12** *= The Hall of 36 Pairs of Mandarin Ducks, with the Hall of 18 Camellias;* **13** *= The Good-for-Both-Families Ting;* **14** *= The Magnolia Hall;* **15** *= The Fragrant Isle Pavilion;* **16** *= The True Nature Pavilion, leading to the Small Flying Rainbow Bridge;* **17** *= The Bamboo Pavilion;* **18** *= The Hall of Distant Fragrance;* **19** *= The Flowering Loquat Ting;* **20** *= The Tree Peony Ting;* **21** *= The Hall of Elegance;* **22** *= The Listening-to-the Sound-of-Rain Pavilion;* **23** *= The Chinese Flowering Apple Court. Drawing: L. M. Roth, after L. Liu,* Chinese Architecture *(New York, 1989).*

17.6. Jacques-Germain Soufflot, Church of Sainte-Geneviève ("Le Panthéon"), Paris, France, 1755–1790. Interior. The vaults are true structural shells of cut stone, not plaster illusions; their weight is poised directly over the structural Corinthian columns. Photo: Bridgeman-Giraudon/Art Resource, NY.

Chapter 17

The Origins of Modernism

Architecture in the Age of Enlightenment, 1720–1790

> Modern architecture is a product of Western Civilization. It began to take shape during the later eighteenth century, with the democratic and industrial revolutions that formed the modern age. Like all architecture, it has attempted to create a special environment for human life and to image the thoughts and actions of human beings as they have wished to believe themselves to be. In these two fundamental attempts the modern man has faced psychic difficulties unparalleled in the West since the time of the breakup of Rome. The old, Christian preindustrial, predemocratic way of life has progressively broken away around him so that he has come to stand in a place no human beings have ever quite occupied.
>
> —*Vincent Scully,* Modern Architecture*, 1961*

The modern age, our age, began in the eighteenth century, it could be argued. In 1700 kings ruled in Europe with supreme authority, especially in France. By 1800, a century later, there was no longer a French monarchy, for it had been abolished by the citizenry. In 1700 the dispersed British colonists along the Atlantic seacoast of North America considered themselves, for the greater part, loyal subjects of a distant king. But a hundred years later, by 1800, they had successfully beaten the most powerful military force then existing in the Western world to obtain their freedom and then had formed a union of states, creating for themselves a representative republic that operated according to a written constitutional agreement. The former British subjects now governed themselves, the first men to do so since the early Roman Republic nearly eighteen hundred years earlier. The Americans' example of self-governance set off a passion for similar self-governance that, more than two hundred years later, still inspires other peoples who live under the thumb of despots. During the eighteenth century a new age had begun to take shape.

The modern epoch is characterized by several encompassing trends, beginning with representative democratic republics. Another important trend has been a growth in the power of business corporations, and a comparative decrease in the political power of the established church compared to that prior to the sixteenth century. The modern era also is characterized by a rise in philosophical pragmatism and empiricism, together with a strong reliance on scientific enquiry and its industrial application. As this list of characteristics suggests, it has little to do with any particular architectural style, even though a style was later created in the early twentieth century that came to be called Modernism. With these concepts in mind, we can say that the modern epoch begins in the eighteenth century, in what has come to be called "The Age of Enlightenment." What precipitated these fundamental social changes was a cycle of interrelated sweeping reorganizations and upheavals that collectively can be labeled "revolutions."

These revolutions are so interconnected that they can be thought of as operating almost in a circle, each feeding the next. We might start with the demographic revolution, for around the mid-eighteenth century there occurred a major change in the growth rate of populations, not just in Europe but in Asia as well. The shift in Europe and its colonies was caused in part by the agricultural revolution beginning in the Netherlands and England, based on increased yields from fields due to crop rotation as advocated by Charles Viscount Townsend. In addition, Townsend promoted turnip production for feeding livestock through the winter so that animals would not need to be slaughtered each autumn. This resulted in the retention of more breeding stock, in turn producing more offspring, and an increase in meat being added to the general diet. In England Jethro Tull developed the use of a seed drill for planting, replacing the ancient practice of broadcasting seed by hand; this produced greater rates of successful germination. The improved diet, along with earlier marriages of couples, produced more children, leading to a population expansion. Moreover, during the century various steps were taken to improve hygiene and disease survival, most notably Edward Jenner's introduction of vaccines against smallpox in 1796, so mortality rates were lowered. The end result of these combined changes was a significant increase in the rate of population growth. What had been a long and gradual arithmetic growth curve in population increase for the preceding eons shifted around 1750 to a more logarithmic curve that has increased ever since.[1]

In Europe the overall total population is calculated to have been about 110 million in 1700, growing to 190 million by 1800. The demographic revolution resulting from the growth of population in general was intensified in Great Britain by new "enclosure laws," which reallocated land and other natural resources formerly used by communities for raising sheep and other farming and subsistence activities. The yeoman farmers being forced off the land fed a migration to the cities' proliferating factories, causing rapid urban growth. This urban in-migration was felt first and most dramatically in London, whose population ballooned to nearly a million people by the end of the century. Other cities such as Paris and Vienna had comparable growth rates, although the absolute numbers were lower. The sheer increase in the number of gathered people meant that activities that had been housed in adapted older buildings by the end of the century required wholly new purpose-built structures—banking houses, hospitals, orphanages, insane asylums, and prisons, to name a few. Soon the expanding impact of industry led to the creation of entirely new building types, most notably railroad passenger terminals in the early nineteenth century.

Other closely related cultural revolutions concerned business and industry, including a financial revolution. One aspect of this financial revolution involved the creation of modern banking and the introduction of printed bank notes and letters of credit. Another was the expanding sale of stock and the growth of stock exchanges. This trading of paper made possible the expansion of industry and business, although for a time in the mid-eighteenth century this expansion was still funded in large measure by private family fortunes.

The single most sweeping change was the move away from small-scale cottage production of goods to large-scale factory production—first of thread and woven textiles and, then, of many other goods. The one industrial enterprise that proved crucial to many others was the great expansion of iron production, beginning with cast iron in the western counties, where coal and iron ore deposits were found near each other. Another facet of this industrial revolution was the mechanized production of goods, particularly the use of machines to make other machines using standardized parts.

The movement of ore and grain, as well as the distribution of manufactured products, was greatly facilitated by what could be called the transportation revolution brought about by the rapid expansion of canals and all-weather roads, in some cases toll roads. Roads that had been little more than dirt tracks since the Middle Ages were now being designed by English engineers such as John Metcalf and John Loudon McAdam; they were higher at their center for drainage and made of layers of hard-packed gravel.[2]

Taken together, these changes in population growth, industrial production, and transportation produced a growing middle class the likes of which had never existed before. This social class would become significant patrons of architecture in the next two centuries.

Coupled with the growth of industry was the expansion of scientific inquiry in physics, inspired by the slightly earlier work of Isaac Newton and capped in large degree by the demonstration by Benjamin Franklin that lightning was a form of electricity that could be safely conducted to the ground through the installation of lightning rods. Also highly significant were the advances in chemistry such as the work of Joseph Priestly, who identified the element oxygen, as well as that of Antoine Lavoisier, who identified twenty-three additional basic chemical elements.

Equal perhaps to the growth of industrial production in the fundamental reshaping of social values was the deepening impact of the political theories of John Locke, Baron de Montesquieu, and Jean-Jacques Rousseau, among others, coupled with a close reading of early republican Roman history. This led to a questioning of the acceptability of monarchical rule, particularly on the part of English American colonists who came to view rule by Britain as an illogical denial of what they considered their fundamental political rights. After 1776, the stirring words of their Declaration of Independence—that all men are created equal and that they possess

17.1. Richard Boyle, Third Earl of Burlington, Chiswick House, Chiswick, outside London, England, 1725. The English in the early eighteenth century developed a new appreciation for the proportional clarity of Palladio's architecture, resulting in several country houses such as this based on the Villa Capra. Photo: © Wayne Andrews/Esto. All rights reserved.

inalienable rights to life, liberty, and the pursuit of happiness—resounded around the globe, beginning in France in 1789 and then throughout Europe in the following century.

From before the time of the Egyptians up to about 1750, monumental Western architecture, in any given time or particular region, was relatively uniform—one stylistic character or expression for each relatively homogeneous culture. This homogeneity had just begun to change during the Renaissance as the new humanist architecture spread outside Italy and mixed for a time with regional and national (i.e., Gothic) architectural traditions. During the eighteenth century, however, there began to appear a multiplicity of architectural options.

This multiplicity is evident in the contrast between two important churches both under construction in mid-century, one an expression of Rococo visual illusion and the other a celebration of stark structural fact. Vierzehnheiligen, begun in 1742, was still being decorated as the 1770s began, its stucco carving and scagliola work the product of the most accomplished skills of Baroque and Rococo artisanship. Meanwhile, a very different view concerning architecture was being embodied in the church of Sainte-Geneviève, Paris, begun in 1755 and built midway to completion when the decorative stuccowork of Vierzehnheiligen was being finished. Austerely pure Classical elements were employed in Sainte-Geneviève, but they were no longer decorative and painted to look like marble; the columns in Sainte-Geneviève serve a vital structural function, and the vaults are solid stone, not artificial suspended plaster shells. Whereas Vierzehnheiligen is an illusion, Sainte Geneviève is "real." Yet another way in which Sainte Geneviève serves as an effective symbol of the modern age is that, as it was being finished, it was de-consecrated and converted into a mausoleum commemorating the great heroes of French cultural and military achievement, becoming the "Panthéon."

The portico of Sainte Geneviève (Panthéon) was particularly Roman in spirit, an early indication of the growing push for a return to the clear forms and proportional relationships of ancient architecture. Another alternative manifestation of this desire can be seen in the revival of Palladian architecture in England, brought on by the appearance of the first English translation of Palladio's *Four Books of Architecture* in 1715. The strongest English promoter of Palladian ideals was Richard Boyle, Third Earl of Burlington (1694–1753), together with his architect, William Kent (1685–1748). Lord Burlington designed Chiswick Villa in 1725 as a wing to his family residence, Chiswick House, clearly inspired by Palladio's Villa Capra but incorporating other elements as well [17.1]. Kent and also Robert Adam designed a number of other country houses early in the eighteenth century, exploiting the proportioned geometries of Palladio's designs. To Burlington and his followers this simplified "un-Baroque" architecture embodied the ideals of the ruling Whig oligarchy.

By the middle of the eighteenth century in France, the artifice of Rococo art and architecture came to be viewed as symptomatic of the affectation and corruption of what was called the *ancien régime,* the times of the reigns of kings Louis XV and Louis XVI. As social critics such as Denis Diderot (1713–1784) viewed lascivious images of cavorting plump pink nudes, such as shown by François Boucher at the annual painting exhibitions, they felt the need for a new purer art and architecture, which served not to pander but to instruct and uplift. Diderot intended to write a book on the subject of art criticism (it would have been one of the very first), and his notes for this book reveal deep misgivings concerning the visual arts with respect to the social values of his period. One finds among his notes such comments as this:

> Every work of sculpture or painting must be the expression of a great principle, a lesson for the spectators. I am no Capuchin [a monk—that is, a prude], but I confess that I should gladly sacrifice the pleasure of seeing attractive nudities, if I could hasten the moment when painting and sculpture, having become more decent and moral, will compete with the other arts in inspiring virtue and purifying manners. It seems to me that I have seen enough tits and behinds. These seductive things interfere with the soul's emotions by troubling the senses.[3]

He could easily have made comparable observations concerning the Rococo seductive deceit of hiding a building's structure while emphasizing overt sensual display in Rococo interiors.

Diderot was a champion of the *philosophes,* the moral and social philosophers in France who advocated radical change in society; he edited and published the *Encyclopédie,* a richly illustrated summation of knowledge that also advanced new social ideas.[4] The *philosophes,* and also progressive-minded members of the growing middle class, believed it was imperative to strip away the corrupting influence of the *ancien régime* to arrive at what they believed to be the natural condition of humankind, and to create through deliberate and rational design a new social order, and with it a new, purer, more functionally and structurally expressive architecture. The *philosophes* had an implicit faith in human reason, which, pursued to its logical ends, they believed would result in social enlightenment. They rejected the idea of supernatural religion and the notion of a divine plan directed toward some preordained human end. Instead they believed in the power and potential of rational human reason.

The *philosophes* believed that knowledge was derived solely from direct observation of the natural world. Since human understanding would always be incomplete, even though humans could be certain of no absolute truth, there was a necessity to constantly investigate. Such a view tended to foster tolerance, something that religious dogma—whether Catholic, Protestant, Jewish, or Islamic—has tended to make impossible. The *philosophes* emulated the critical objectivity of Ionian Greek scientists, adding to Greek disciplined observation the modern idea of proof through experimentation. The only knowledge one could be certain of was what one could demonstrate by scientific observation and measurement, and out of this emerged modern notions of science and the mathematical model of the universe. Sir Isaac Newton's explanation of celestial movements, published in 1687, exerted an enormous influence on the *philosophes,* who envisioned the universe as a giant clock, perfectly made and operating without fault since the time of creation according to rational and knowable mathematical principles. Inspired by Newton's model, scientists in the eighteenth century endeavored to explain other natural phenomena in an effort to make the whole observable world the result of rational processes.

The Emergence of Art and Architectural History

The *philosophes* attributed to primitive nature an almost sacred power, searching for qualities of the primitive, the pure, and the uncorrupted in art and architecture. In architectural terms this meant that the purest architecture, that most suited to fundamental human needs and to basic human society, was what had appeared at the dawn of civilization. But with the *philosophes'* insistence on knowledge based on direct observation, it was now apparent that very little was truly scientifically known about ancient architecture. It was possible to read Vitruvius, but as to what the Roman houses of his time really looked like no one in the 1700s was positive. From what Vitruvius wrote, however, it was clear that in antiquity it had been the column that was the basis of architectural structure, not the wall, with proportions of entire buildings determined by the diameter of each respective columnar order. This was where Alberti had made a fundamental error, basing his system of Renaissance architecture on the wall, embellished with engaged columns or pilasters, whereas it was from the orders themselves

17.2. Frontispiece of Marc-Antoine Laugier, Essai sur l'architecture, *2nd edition (Paris, 1755). This engraving, the only illustration in this slender book, shows the Muse of Architecture pointing out what true architecture is. Photo: From* Essai sur l'architecture.

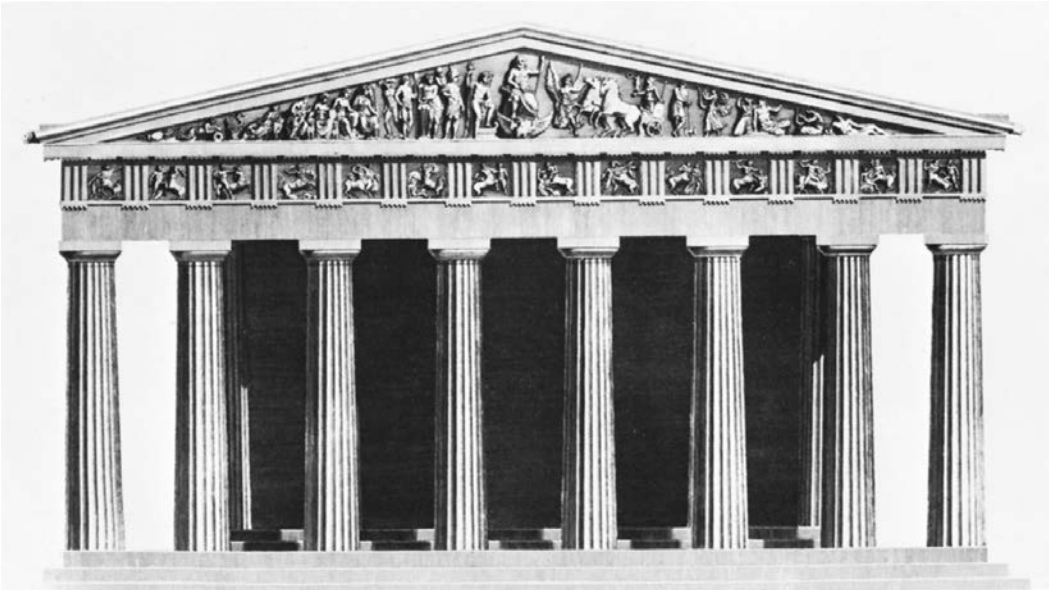
that the entire system of proportion derived according to Vitruvius. Yet when early-eighteenth-century critics looked about them at recent contemporary late-Baroque architecture, what they saw were walls that swelled inward and outward, plaster masquerading as stone, and ornament so elaborate it obscured the structure. This deceptive ornament had to be stripped away; architecture had to get back to essentials.

This radical view was first expressed by Jean-Louis de Cordemoy in 1706 and then further elaborated in a little book, the *Essai sur l'architecture* (Paris, 1753), by Marc-Antoine Laugier (1713–1769), which gave instant form to the feelings of many architects of the period. The frontispiece of the second edition of the book [17.2], the book's only illustration, shows the muse of architecture pointing out to a human infant (the first of his race) the mythical "primitive hut," a pure structure of columns and beams in which, in fact, the columns are the trunks of living trees. That, according to Laugier, was the beginning of architecture (and, unknowingly, he was not so very far from describing the hut of *Homo erectus* at Terra Amata, Nice). Architecture, Laugier asserted, in contrast to Rococo embellishment, was the art of pure structure, the essential elements of which are column, architrave, and pediment, serving their original structural functions and not applied as ornament. Yet he also appreciated the structural directness of Gothic vault construction (he was, after all, a Frenchman). In many ways his little book was the first manifesto on modern architecture, for it sparked lively discussion and a search for a pure architecture, freed of deceptive ornamental overlay. An even more extreme position was taken by the Italian theorist Carlo Lodoli (1690–1761), who insisted that architecture be determined solely by its internal function or use.

The first civilized people, so the *philosophes* reasoned, had been closer to the natural state, and hence their architecture had been purer, but (as noted) the precise appearance of ancient domestic architecture was still a mystery. At least, that is, until 1748, when workmen digging a canal near Naples came upon the remains of Pompeii. The destruction of Pompeii in 79 CE was far from being unknown, for it was described at length in writings by Pliny the Younger, who watched it from the safety of a ship at sea. But it was indicative of the theoretical bias of Renaissance architects that they had never bothered to locate Pompeii and uncover it. In 1721 the Viennese architect Johann Fischer von Erlach had published a remarkable book, *Entwürf einer historischen Architektur* (A Study of Historical Architecture), presenting the great buildings of antiquity in large engraved plates. Although the plates revealed a new interest in the successive phases of architectural history, the images were largely Fischer von Erlach's artistic invention. What was needed instead was hard evidence concerning ancient architecture, and that literally began to come to light in the mid-eighteenth century. Through the excavations of Pompeii and its neighboring towns, actual Roman homes, furniture, garden ornaments, jewelry, and other objects of everyday use were revealed, put on display, and eventually published.

To this new physical evidence was added a critical philosophical structure in the writing of the German art historian Johann Joachim Winckelmann (1717–1768). Winckelmann visited the diggings at Herculaneum and Pompeii to observe operations, but what he saw prompted him to write a series of open letters protesting the looting of the precious artifacts. Winckelmann's objections resulted in the expulsion of amateur treasure hunters, putting the excavations in more competent hands. For this he is credited as the father of archaeology. His study of Greek sculpture (though pursued unknowingly through his study of Roman copies of Greek statuary) resulted in two epochal works, *Gedanken über die Nachahmung der Greichischen Werke . . .* (Reflections on the Painting and Sculpture of the Greeks . . .) (1755) and the more sweeping *Geschichte der Kunst des Alterthums* (History of the Art of the Ancients) (1764). In the first work appeared Winckelmann's famous characterization of Greek art as being suffused with "noble simplicity and calm grandeur." His history, though imperfect, was the first to outline the organic growth of art, passing from a period of youth to maturity of expression and then to a period of decline; in addition, he attributed such natural, social, and cultural factors as climate and politics to the development of art. Because of this he is also credited as the father of art history. While Winckelmann helped to establish the strong affinity of Germans for Greek art, even more important was the stress he placed on the ennobling moral impact of the study of Classical art, suggesting that making such works of art available to the public would improve the moral consciousness of the nation—an idea many German rulers readily embraced, leading to the opening of royal art collections to the public and to the housing of them in specially designed art museums.

As archaeological evidence began to accumulate, and with perceptions reshaped through Winckelmann's writings, a new sense of the successive phases of history began to be formulated. Although the concept of the distinct phases of Classical art—Greek, Hellenistic, and Roman—was not yet fully developed, there were those like Winckelmann who argued that Greek architecture was superior because it was older and purer than Roman. Since ancient Greek architecture was even more imperfectly understood than Roman, expeditions of architects and natural scientists soon set out for remote sites around the Mediterranean to record in an objective way the appearance, dimensions, and proportions of Greek buildings. The first expedition to Greece itself was led by James Stuart and Nicholas Revett of England. During 1751–1755 they traveled across Greece, visiting Corinth, Delos, and Delphi, but the focus of their attention was Athens and the surrounding region of Attica. In 1761 there appeared the first of their four engraved volumes, *The Antiquities of Athens,* presenting the buildings of the Akropolis in crisp engravings [17.3].[5] In 1750–1751 Madame du Pompadour, mistress of Louis XV, spon-



17.3. James Stuart and Nicholas Revett, restoration drawing of the Parthenon, Athens, c. 1755–1785. Engraving published in the second volume of their The Antiquities of Athens *(London, 1787), following intensive archaeological study in Athens; this was the first truly accurate representation of the Parthenon and introduced the austere beauty of Greek architecture in Europe. Photo: From* The Antiquities of Athens, *vol. 1.*

sored a team that visited the ruins of the Greek settlement at Paestum in Italy; one member of this party was the young architect Jacques-Germain Soufflot (1713–1780). The published result of this expedition was *Ruines de Paestum* (Paris, 1764).

Roman sites also began to receive similar scrutiny. An English expedition to Yugoslavia resulted in Robert Adam's *Ruins of the Palace of the Emperor Diocletian at Spalato . . .* (London, 1764), and Adam's fellow Briton, Robert Wood, traveled extensively, producing *Ruins of Palmyra* (London, 1753) as well as *Ruins of Baalbec* (London, 1757). In England such investigations helped support a revival of Roman forms and spatial configurations in interior design, of which Robert Adam (1728–1792) was the leader. His column-screened library in Kenwood House, London, 1767–1768 [17.4], is based on similar Roman rooms. Even Adam's delicate decoration is inspired by Pompeian prototypes, but with the flat painted Roman designs being translated into low-relief carved plaster, and the atmosphere of the whole room elevated by lighter, pastel colors.

A Rational Architecture: Sainte-Geneviève, Paris

How the study of antiquity might contribute to an original new architecture was demonstrated in the design of the church of Sainte-Geneviève, Paris, designed in 1755 by Soufflot, who just four years earlier had studied the Greek temples at Paestum. There he had seen Greek columns boldly silhouetted against the sky, powerfully demonstrating the properties of load and support. Where the roof of the temple of Poseidon had been supported, there were superimposed columns, one atop the other. For the plan of Sainte-Geneviève, Soufflot used a Greek cross [17.5], but it was like a temple turned inside out. The external walls were opened up with numerous windows (later filled in), and its internal structure was a colonnade (Corinthian in this case—Soufflot was not yet prepared to use the more massive and austere Greek Doric he had seen and sketched at Paestum). The internal columns of the church would in turn support the domical vaults over the arms of the church; each dome would be carried by pendentives that come down in points precisely over the columns [17.6, p. 462; 17.7]. The vaults are exactly what they appear to be—structural shells of solid cut stone, and not a false shell of plaster suspended from some hidden armature. It was this structural realism, combining the best expression of load and support, Classical post and lintel with medieval arch and vault systems, that prompted Laugier to praise Sainte-Geneviève as "the premier model of perfect architecture."[6]

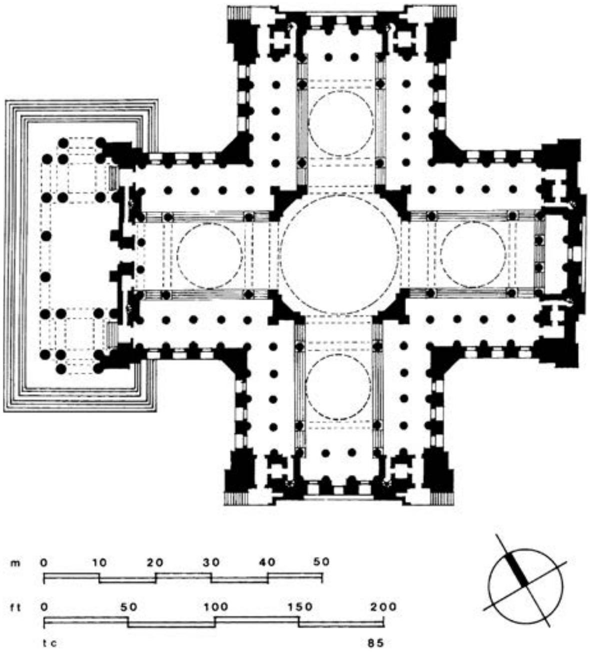
17.4. Robert Adam, library, Kenwood House, London, England, 1767–1768. Such interiors as this resulted from Adam's own study of ancient Roman architecture, such as the Palace of Diocletian at Spalato (Split), on the Dalmationa coast (now Croatia), which he visited and published. Photo: Edwin Smith, London.

Over the central crossing was to be a dome carried on four slender piers, while across the front would be a Classical temple portico of Corinthian columns [17.8].

The entire building was designed by Soufflot with the new mathematics of architectural statics, allowing him to calculate pressure and thrust; there was no stone that was superfluous. During construction in 1776, however, cracks appeared in the crossing piers, precipitating an onslaught of attacks by those who felt the design was too minimal in its use of stone. After detailed examination by several structural theorists, including Jean-Baptiste Rondelet, Soufflot was vindicated. However, he did restudy the design of the dome, which originally incorporated two shells, giving it three shells and making it taller, and wrapping it in a continuous external circular colonnade. Furthermore, in the portico he incorporated a complex system of iron bar reinforcements in the flat arches of what appears to be the entablature (it was not possible to find single stone blocks to span the distance between columns). In its clarity of form and structural expression, Sainte-Geneviève seemed to its generation to announce a new era in architecture.

"Speaking Architecture"

Some French architects endeavored to push Soufflot's ideas to their inevitable conclusion, creating an architecture of pure elemental form symbolically expressing function. What these architects proposed was later called an architectural "revolution," although politically these architects were actually



17.5. Jacques-Germain Soufflot, Church of Sainte-Geneviève ("Le Panthéon"), Paris, France, 1755–1790. Plan. The Greek cross plan, with four arms of equal length, was popular with academically trained French architects, but the use of freestanding structural colonnades internally was new. Drawing: T. Cheun.

quite conservative; indeed, Claude-Nicolas Ledoux (1736–1806) nearly went to the guillotine for building royal tax-collecting stations in a ring around Paris. Yet those tax tollhouse stations had a bold severity of form and a simplicity of detail that was radically new. Few survive, as many were ripped apart when the French Revolution erupted. One of the tollhouses that did survive is the Barrière de la Villette, 1784–1789, composed of a square base and a cylindrical upper section [17.9]. Windows, doors, and arched openings are completely free of embellishing frames, and the entry porticoes are made up of massive square Doric piers. None of the columns or piers are fluted.

Ledoux's contemporary, Étienne-Louis Boullée (1728–1799), built several private hôtels (all destroyed) but his principal impact came through his teaching at the Royal Academy of Architecture. Like Ledoux, he proposed a boldly scaled and austere architecture whose symbolic forms would evoke a sense of function. Such architecture was intended to communicate its purpose directly to the observer, to be *l'architecture parlent,* or literally, "speaking architecture." Boullée's most expressive designs were funerary monuments of enormous scale, and his best known is a cenotaph for Isaac Newton designed about 1784 [17.10]. Deriving its basic form from the round tumulus mausoleums of the Romans, the Newton cenotaph was to have a vast cylindrical base supporting a pure hemispherical dome. Reached by means of a tunnel passing through the base of the building was an enormous spherical interior chamber, with a massive symbolic sarcophagus at its base. The upper masonry shell was to be penetrated by tiny apertures that admitted pinpricks of daylight; these points of light, viewed against the black interior of the dome, recreated the vault of the heavens, whose planetary mechanics Newton had explained. Considering the state of building technology of the late eighteenth century, these vast projects were clearly unbuildable, but even if never intended for construction, the Newton cenotaph and church exemplified a new scale and a new simplicity of form, and were challenging exemplars for Boullée's students.

In his drawings and projects Ledoux was freer than in his tollhouses to create an architecture of pure volumes declaring functional use. The best known of these idealistic designs is his house for a river surveyor, done about 1785–1790 [17.11]. The house is a hollow cylinder lying in a cradling base; through the hollow of the cylinder the river flows, as dramatic an expression of control of the water as Ledoux was able to make. The boldness of this new architecture is contrasted to the old mills and their water wheels visible in the shadows in the foreground.

Another of Ledoux's royal commissions was a saltworks, begun in 1775 between the small villages of Arc and Senans in eastern France, not far from

17.7. Sainte-Geneviève. Interior view. One can see in this interior detail how the church was designed like a Greek temple turned inside out, with the walls on the exterior and the columns inside, carrying the weight of the vaults and everything above; the internal structure was so designed that the weight of the vaults is collected and focused on the point loads of the pendentives. In the spirit of the Enlightenment, nothing is hidden, false, or an illusion concerning the structure. Photo: L. M. Roth.

the Swiss border. This, too, had caused him political trouble at the time of the French Revolution, but while in prison he redesigned the town, creating an ideal industrial community. After the Revolution he published engravings of his ideal town, now called the Saline de Chaux (Saltworks at Chaux), along with other designs, in a volume entitled *L'Architecture considerée sous le rapport de l'art, des moeurs et de la legislation* (Architecture Considered in Relation to Art, Habits [or Morals], and Legislation) (Paris, 1804). The buildings were arranged to enclose an oval, a form that Ledoux used because, as he wrote, it was "as pure as that of the sun in its course" [17.12]. At the center of the oval plan are the first buildings actually to be constructed: the house of the administrator, flanked by the reduction buildings where the brine pumped up from the salt mines was boiled down to obtain the salt. The stark geometry of the administrator's house was emphasized by overscaled details, particularly the columns of the portico built up of alternated cylindrical and square blocks of stone. The only ornaments in the otherwise stark walls of the reduction buildings are openings from which protrude carvings of a thick fluid, the sculpted representation of the brine. The carvings thus expressed the buildings' function—*l'architecture parlent*. Around the workshops in the oval ring and framing a communal park were to be the residential apartments for the workers, with gardens in rear yards. Beyond the ring were to be public facilities, markets, and more gardens and open farmland forming a green belt.

Designing the City

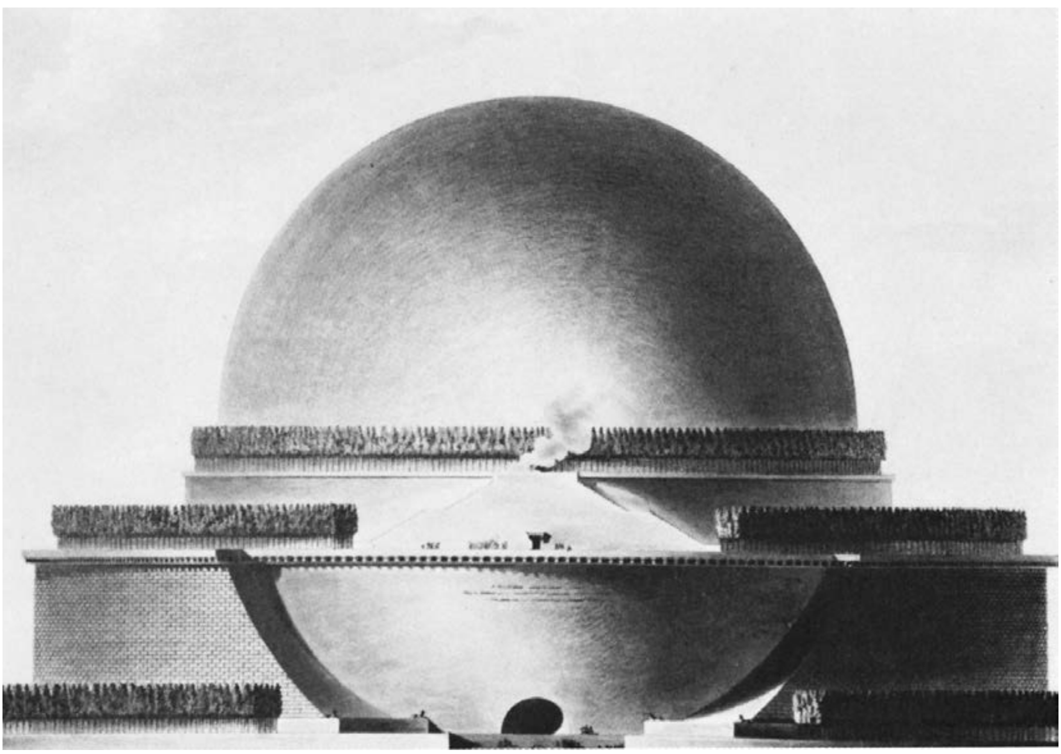
The planning of ever-larger building complexes eventually resulted in architects planning entire cities, but city design was an undertaking that re-

17.8. Sainte-Geneviève. The facade incorporates a Roman temple portico. Photo: Giraudon/Art Resource, NY.

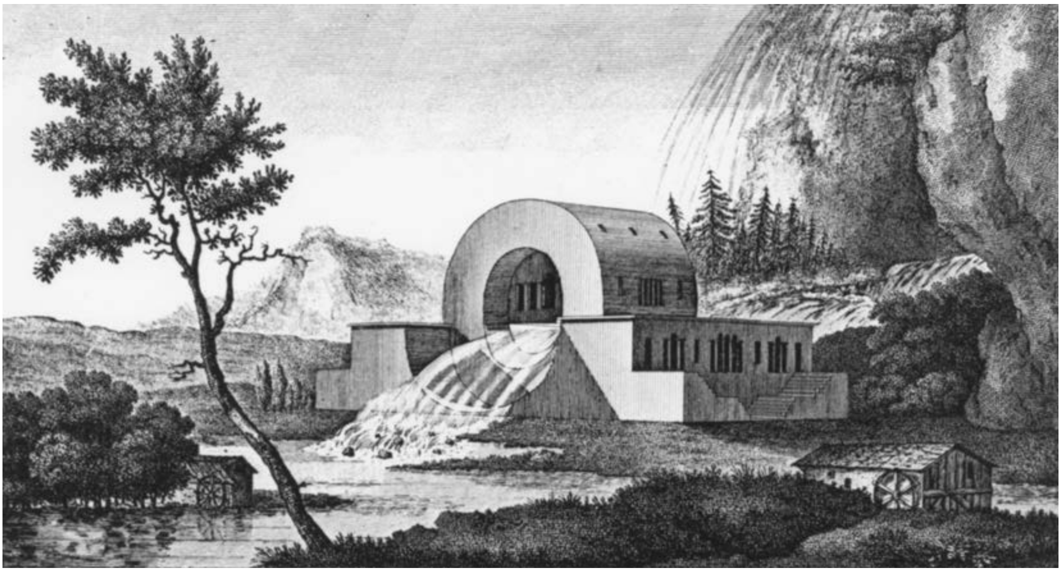
lied almost entirely on patrons with significant power and influence (unless the design was to remain on paper). This may be one reason why the history of urban design was so closely connected with France, where the monarch and his ministers had overwhelming control, and where powerful aristocrats often preferred to live in cities. Perhaps a word at the outset regarding urban design and urban planning would be helpful. *Urban design* might be defined as dealing with shaping the relationship of numerous individual buildings within a city so as to create harmonious groupings, often arranged around open spaces. *Urban planning,* in contrast, is done at a larger scale, embracing the whole of an urban complex. The topic of urban planning has been touched on in preceding chapters dealing with Greek and Roman architecture. With the renewed interest in the Classical world during the Renaissance, interest in designing cities was reawakened as well. This scale of urban design increased still further in the sixteenth and seventeenth centuries, most notably in the city of Paris, which established itself as the arbiter of taste and design.

The process could be said to have begun with the creation of the Place Dauphine, at the far northwestern tip of the Île de la Cité, Paris, coincident with the building there of the Pont Neuf ("the new bridge"), which crossed the tip of the island allowing for easy passage from the north side of Paris (where the Louvre Palace was) to the southern half of Paris (where schools and universities were located). The Pont Neuf was proposed as early as 1550 as a royally sponsored project. The first stones for the multiarch bridge were not laid until 1578; it was finished in 1607 by King Henri IV, who also started the project for the adjoining Place Dauphine, 1607–1610 [17.13]. This was a residential "square" located

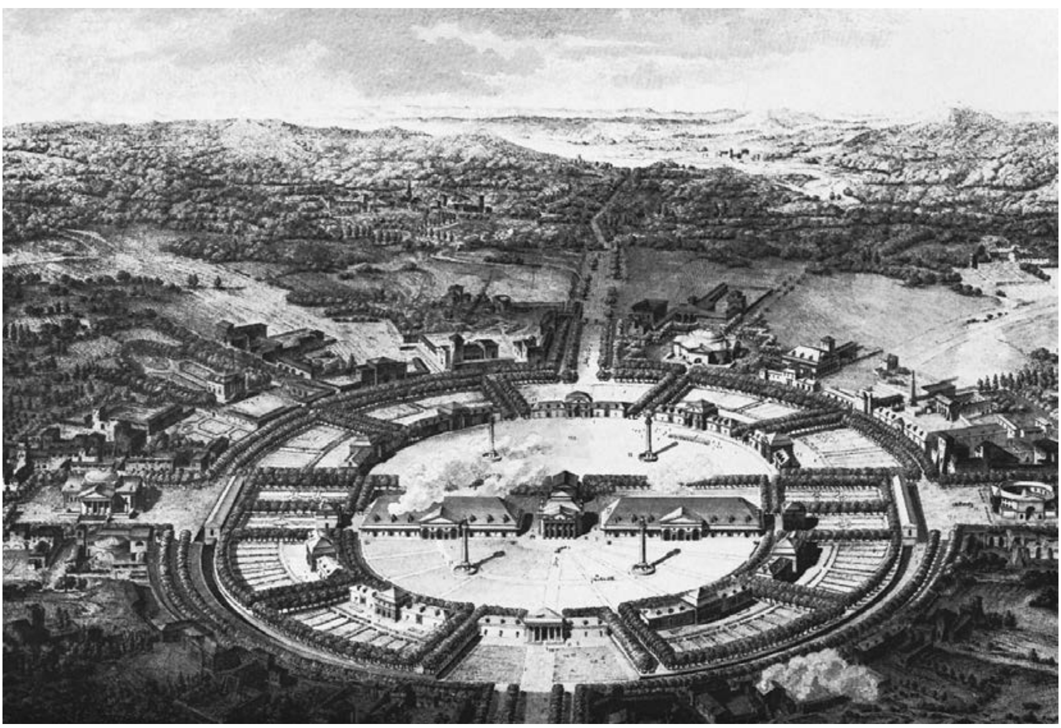
17.9. Claude-Nicolas Ledoux, Barrière de la Villette, Paris, France, 1784–1789. Ledoux's consciously modern architecture was reduced to the simplest possible geometries in the tax-collecting gate houses around Paris. Photo: L. M. Roth, 2003.



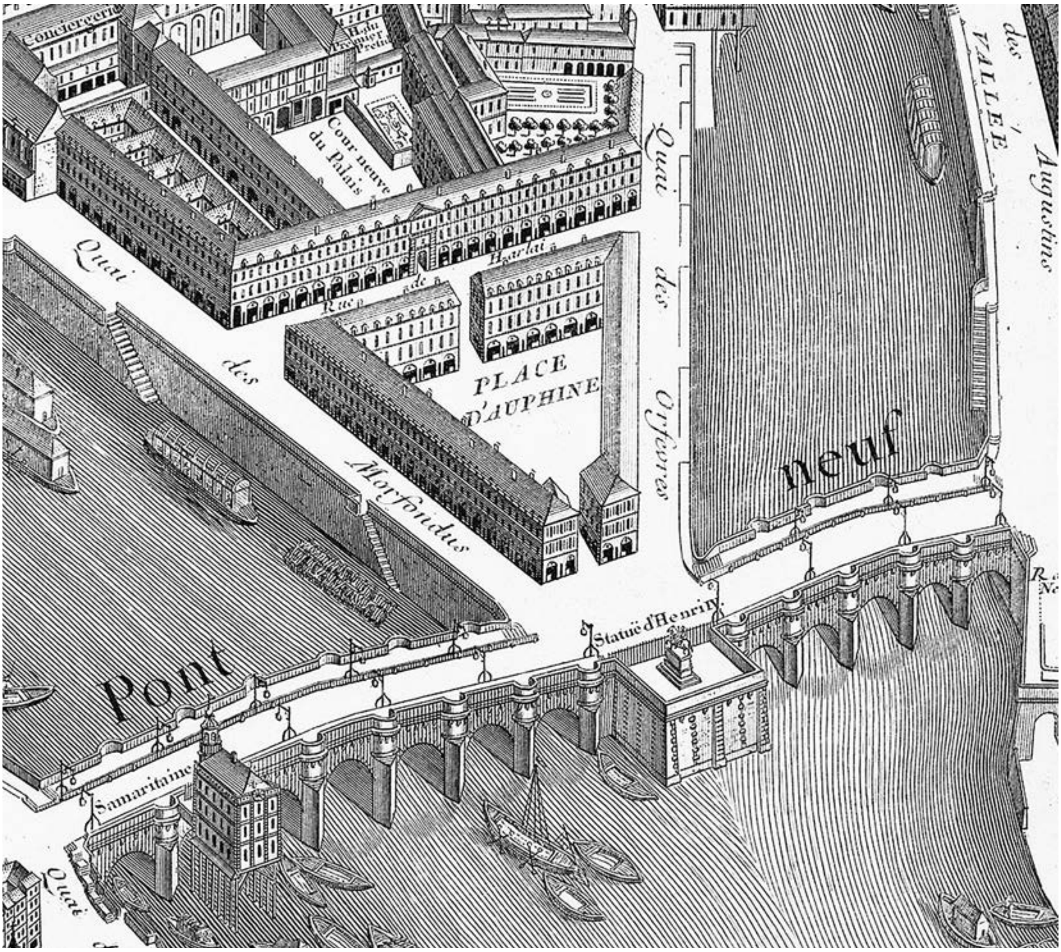
17.10. Étienne-Louis Boullée, cenotaph for Isaac Newton, project, c. 1784. This idealized monument to Newton (theoretically impossible to build at that time) was a study in the expressive possibilities of pure geometry at enormous scale. Photo: Bibliothèque Nationale, Paris.



17.11. Claude-Nicolas Ledoux, house for a river surveyor, project, c. 1785–1790. The new architecture envisioned by Ledoux and Boullée was to speak directly of its function—in this case, providing residence for a hydraulic engineer in charge of controlling the flow of a river. Photo: From C.-N. Ledoux, L'Architecture considerée . . . *(Paris, 1804).*



17.12. Claude-Nicolas Ledoux, Royal Saltworks at Chaux (Saline de Chaux), Arc-et-Senans, near Besançon, France, begun c. 1775. Begun as a royal saltworks, this was later redesigned by Ledoux as an ideal industrial town with the saltworks and housing in the center oval, other civic buildings around that, and all surrounded by an agricultural green belt. Photo: From C.-N. Ledoux, L'Architecture considerée . . . *(Paris, 1804).*

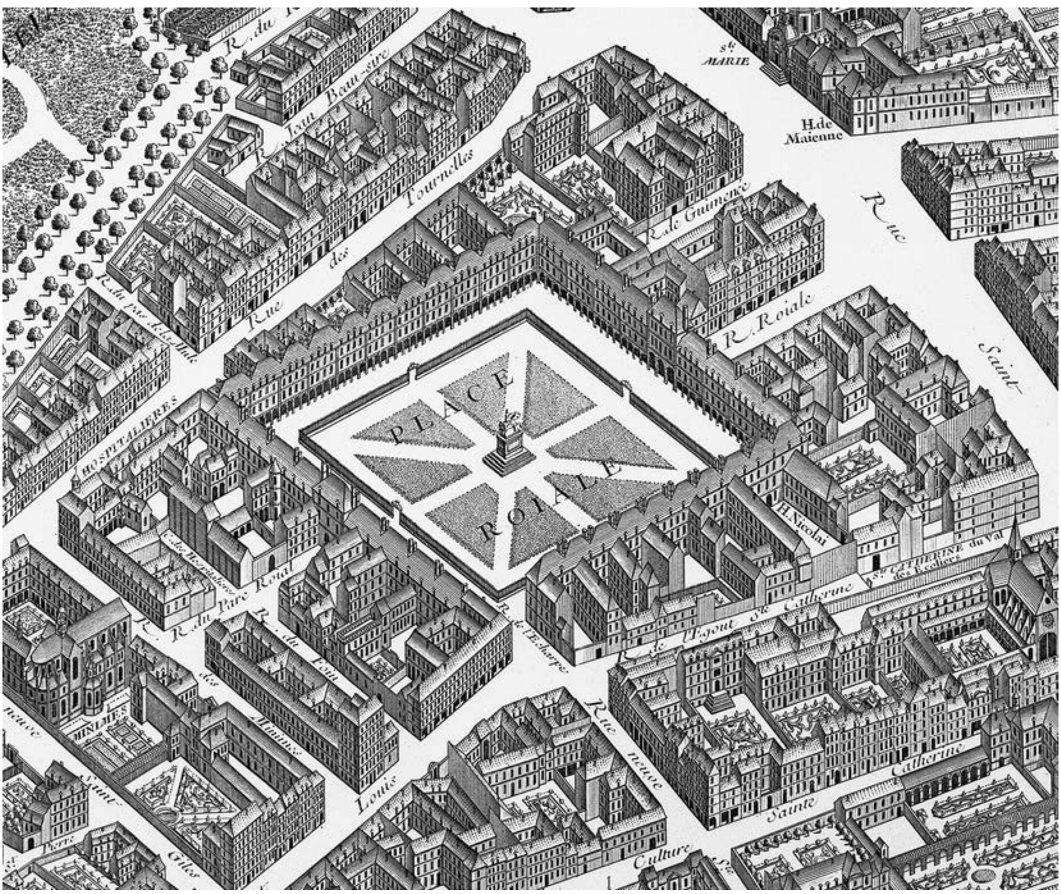


17.13. Place Dauphine, Ile-de-la-Cité, Paris, 1607–1610. This urban space was created to complement the newly built Pont Neuf and to provide an elegant setting for townhouse residences. From the Plan of Paris commissioned by M.-E. Turgot, 1734–1739, published in twenty plates in 1739.

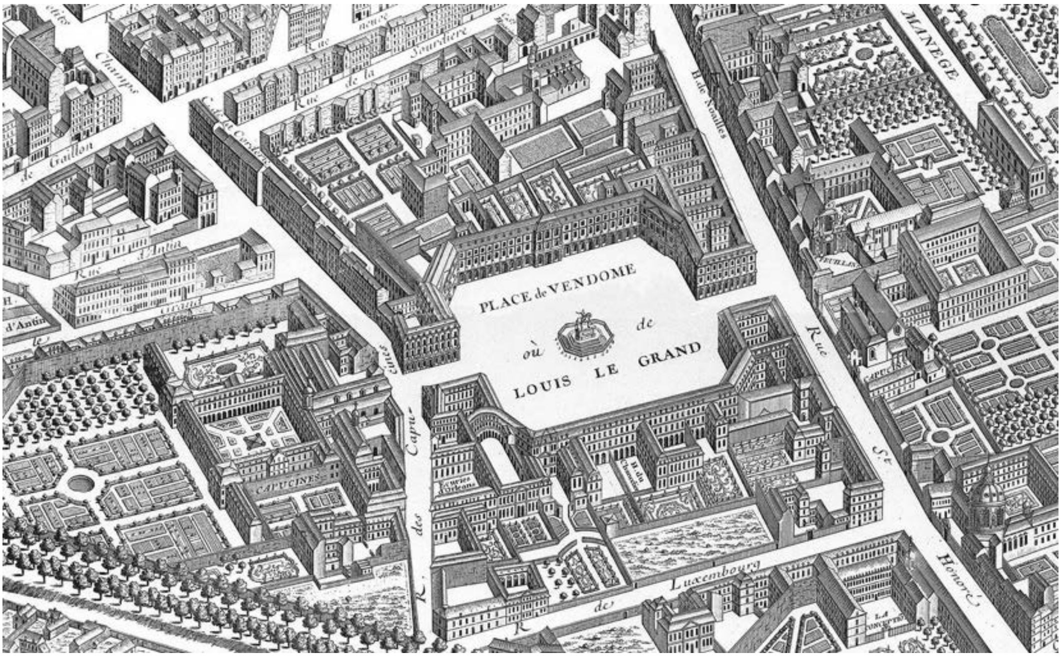
immediately against the new bridge's southern edge. Technically the Place Dauphine is a triangle of individual contiguous residential townhouses built of brick with stone trim elements. The continuous aligned houses read as a larger united group, giving the Place Dauphine a sense of identity and singularity. The prototype was the larger, truly square Places des Vosges (Place Royale), which was also begun by Henri IV, two years earlier in 1605; it took five years to complete [17.14]. In this square the houses are opened up with stone arcades below the individual townhouses. The same combination of brick with stone trim was used for this complex as well, but the Place des Vosges is located in the eastern half of old Paris whereas the Place Dauphine was closer to the very center of things.

In the second half of the seventeenth century two more royal square projects were undertaken by Louis XIV, and these were created in the developing northwest quarter of the city. Both were designed by the king's favored architect, Jules Hardouin Mansart. First was the Place des Victoires, 1685–1692, started by Count d'Aubusson but transferred to the King's Building Works program under Mansart's direction. In this case, the Place was in the form of a circle, eventually opened by six streets that radiate from it. Individual residential units comprise the defining enclosure. Now the facade building material was a uniform limestone. The grandest of the residential squares designed by J. H. Mansart is the Place Vendôme, 1702–1720, begun as a speculative venture by Mansart, taken over by the king's minister of finance, the Marquis de Louvois, and then finished under the direction of financier John Law. Louvois had intended to pattern the square on the Place des Vosges, and the Place Vendôme is nearly the same size, with some differences: it is somewhat rectangular, had two wide streets opening out of its north and south faces, and had distinctive chamfered corners, giving it the sense of being an octagon. At the Place Vendôme, just as at the Place des Victoires, the uniformity of material, the strong arcades at the street level, the pediment accenting the angled corners, and the two-story pilasters pulling together the upper floors—together with the continuous mansard roof, plus the large scale—give a strong presence to this urban space [17.15].

All these Parisian spaces are shown, with scores more proposed to honor Louis XV in the 1750s, in a large map engraved and published by Pierre Patte in 1765. Only one of these was accomplished, but it was by far the largest one, on the undeveloped northwestern edge of the City [17.16]. This was an enormous defined open space, originally called the Place Louis XV, larger than the Place Vendôme and the Place des Vosges combined. This public project was designed by architect Ange-Jacques Gabriel in 1755. The large new Place was to be placed directly west of the Gardens of the Tuilleries Palace, extending its northeasterly axis. But the new Place Louis XV also helped to define a major new cross axis running to the northeast and terminating in a proposed new Church of the Madeleine (dedicated to Saint Mary Magdalene). The aerial view of the Place shown in 17.17 is looking along this new northeasterly axis, over the Seine River and across the Place Louis XV toward the proposed church. This new square was not significantly residential but largely ceremonial, and was strongly defined by dry moats that ringed it (with entrances on both axes as well



17.14. Place des Vosges (Place Royale), Paris, France, 1605–1610. In the eastern edge of the city, this large residential square was landscaped as a pleasure park. From the Turgot Plan of Paris, 1739.



17.15. Jules Hardouin Mansart, Place Vendôme, Paris, France, 1702–1720. This large urban square, with its street-level arcade, its uninterrupted facade design, and its unique canted corners, set the pattern for Parisian urban spaces. From the Turgot Plan of Paris, 1739.

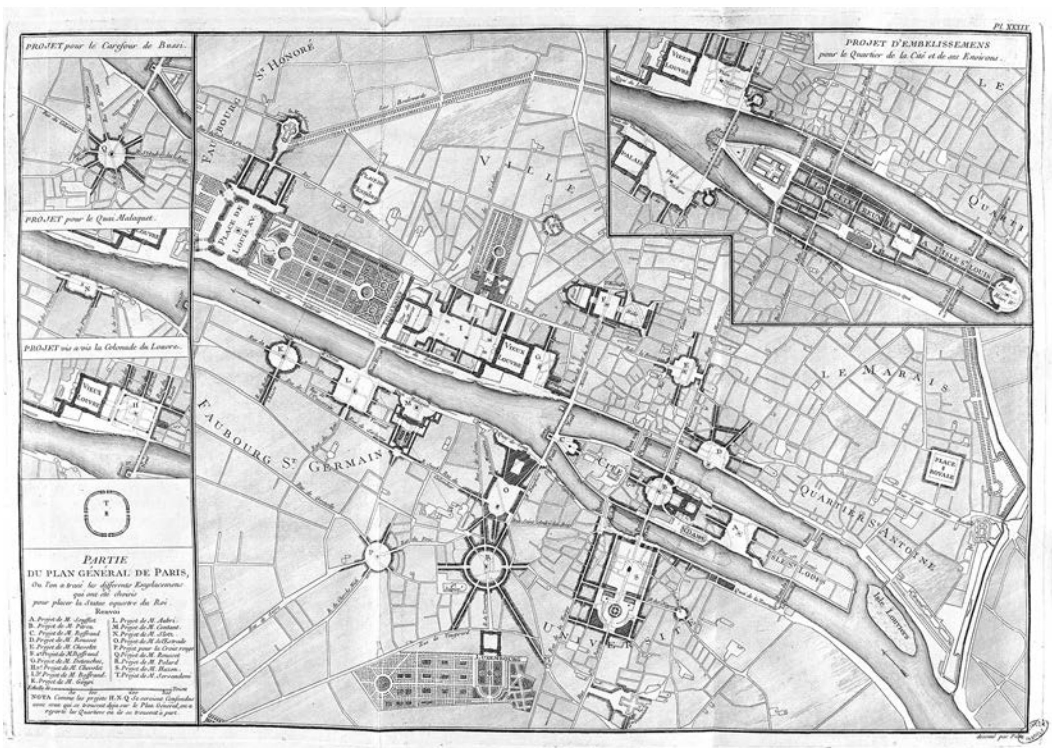
at each of the corners). The edges of these dry moats (long since filled in) were marked with elaborated balconies and sculptural groups (these sculptural masses still stand). In the center was a bronze equestrian statue of the king. North of the Place Louis XV were two new imposing buildings defining this edge, also designed by Gabriel, the east one housing the Ministry of the French Navy and the west one becoming the urban palace of the Duc d'Aumont. During the bloody French Revolution, 1789–1795, the king's statue was soon pulled down and the square became the location of the new mechanized execution device, the guillotine. Here, during the length of the Revolution, perhaps as many as forty thousand people met their swift deaths, including King Louis XVI and Queen Marie Antoinette. In one month alone, during the summer of 1794, thirteen hundred people were executed. By 1795, however, the public guillotine had been removed, and as if to expunge the memory of this bloodbath the square was renamed the Place de la Concorde.

Idealistic city plans were developed during the eighteenth century, including Ledoux's project for the Saline de Chaux, an example of the increasing attention that some architects were giving to the form of the city. Ledoux's Chaux is especially noteworthy since it was an example of an ideal industrial community. In hindsight, it can be viewed as prophetic, as it depicts a town of predetermined size, composed of idealized buildings, set in a green countryside. This appears to foreshadow the idea of the Garden City suburb that was developed at the end of the nineteenth century, when increasing industrialization and the concentration of population in cities were beginning to show their ill effects; this Garden City model continued to be rejuvenated throughout the twentieth century and remains a planning objective.

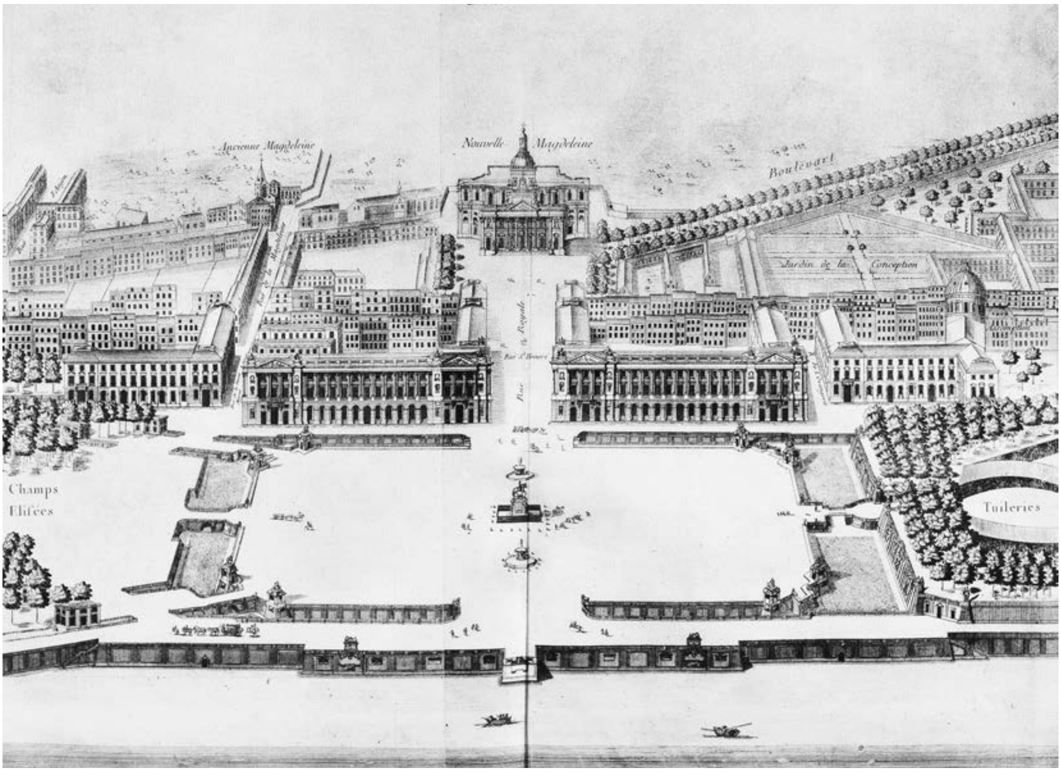
In England in the eighteenth century, the most coherent demonstration of urban design was in the small spa town of Bath, which increasingly began to attract London society during the summer months. John Wood (1704–1754) undertook to remake the town, designing clusters of town houses shaping urban spaces, beginning with Queen Square in 1729–1736 and adding the Circus in 1754, a circle of thirty-three residences facing inward toward a common park. His son, John (1728–1781), continued this work, adding the Assembly Rooms, 1769–1771, and the majestic Royal Crescent, 1767–1775, a group of thirty houses in a broad half-ellipse. In the case of Bath, the various housing clusters by the two Woods were adapted to existing streets and also to the topography [17.18].

Urban squares were designed in Paris, Bordeaux, Copenhagen, and other cities, all of them royal projects, but perhaps the most intriguing case of urban design in France is Nancy, the administrative capital of Lorraine in northwestern France. The duchy of Lorraine was given by Louis XV to Stanisłas Leszczyński, father of Marie, queen of France, and former king of Poland. A king without a country, Stanisłas set out to make Nancy his own capital city, befitting his station.[7] With the financial aid of Louis XV, he engaged the architect Emmanuel Héré de Corny (1705–1763) to design a series of linked urban squares, with his residence at one end and a major urban space at the other, connected by a tree-lined boulevard framed with rows of identical houses [17.19]. This new town center was built during 1741–1753. Nancy brought together both a hint of what was to come as well as the summation of what was then ending. At the end of the boulevard (the Place de la Carrière) is a Roman triumphal arch, foreshadowing the emerging Neoclassicism that would become a major movement in another quarter-century, while the large Place Royale (now the Place Stanislas) was embellished with gilded wrought iron gates and lamps that epitomize Rococo delicacy. It was fitting, perhaps, that one of the last such royally sponsored urban rebuilding projects should have been so well done. Nancy survives with virtually no change.

The argument could be made that Ledoux's ideal Saline de Chaux was not a real community, for it never prospered and, in fact, was closed down by the new revolutionary French government in 1790. Solidly built, however, it still stands. And Nancy, in Lorraine, as well, was based on a false premise: the creation of an artificial though beautiful "capitol" for an ousted monarch. But then, at the very end of the eighteenth century, a puzzling highly idealized design was proposed for a wholly new governmental center that would prosper beyond all expectation to become one of the greatest centers of political power during the twentieth century: the Capitol of



17.16. Pierre Patte, Part of a General Plan of Paris Marking Out the Different Placements Selected for [Proposed] Equestrian Statue of Louis XV, *Paris, France, 1765. Engraving showing the numerous plazas and squares built as well as proposed to honor Louis XV. On the far right is the Place des Vosges; in the upper center is the small round Place des Victoires; and left of it, the octagonal Place Vendôme. At the far left, then at the very edge of the city, is the Place Louis XV (later renamed the Place de la Concorde), in the process of being built in the 1760s when the map was published. Photo: © RMN-Grand Palais/Art Resource, NY.*

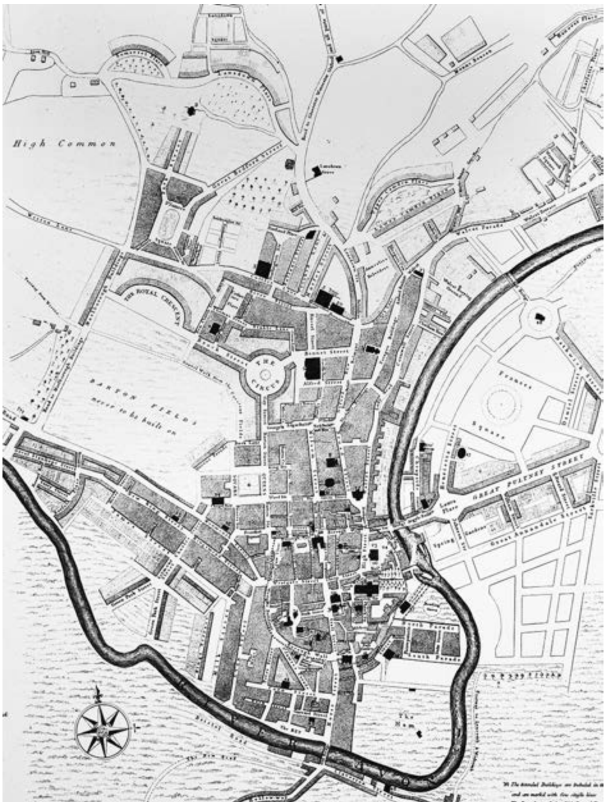


17.17. Ange-Jacques Gabriel, Place Louis XV (later renamed the Place de la Concorde), Paris, France, 1755–1772. Vast in scale and defined by the Seine along its south side and a pair of twin buildings by Gabriel along its north edge, the square was further defined by dry moats around its perimeter. This view from over the Seine River toward the proposed Church of the Madeleine in the distance (shown in the Patte plan) shows the dry moats (since filled in and paved). Engraving by Le Rouge, from E. Comte de Fels, Ange-Jacques Gabriel *(Paris, 1912).*

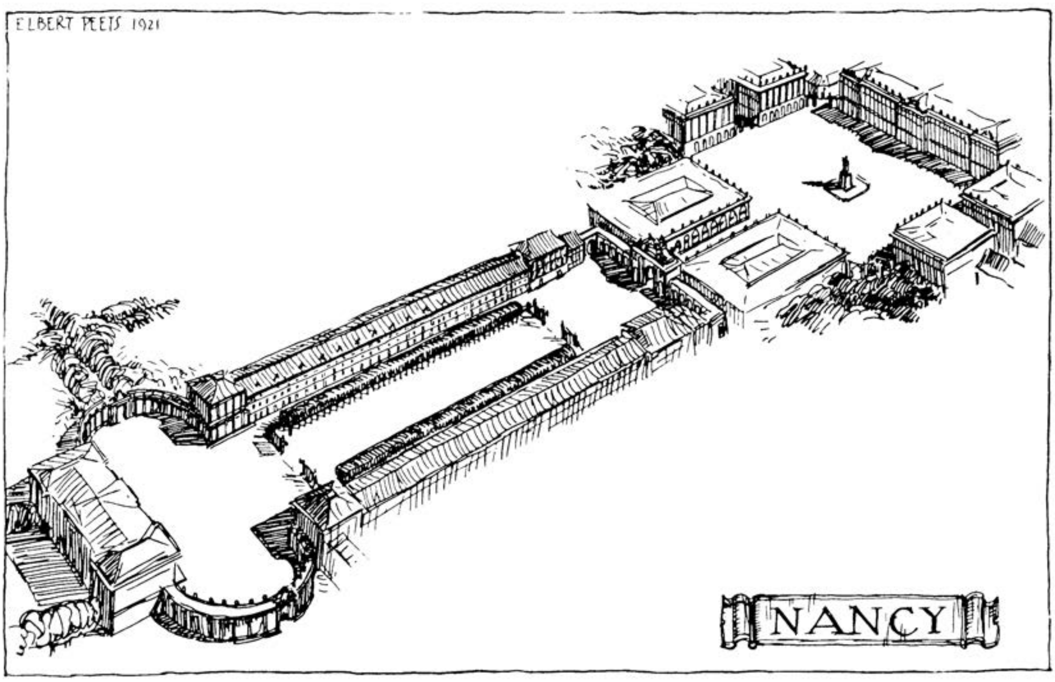
the new United States of America that came to called by its popular name of "Washington's city" or Washington, District of Columbia.

The fractious confederation of American states had to rewrite its governmental structure in 1787, just six years after the winning of independence. The product was the Constitution, a secure but flexible document that was achieved as the result of a multitude of compromises. One of those compromises concerned the location of the seat of the federal government. Northern, more commercially oriented states wanted it in the North. Southern, more agriculturally based states wanted it in the South. Finally the deal was reached that it should be nearly dead center, on the banks of the Potomac, a river that promised access to the interior of the new nation. However, it was to be placed not in any one particular state, where local politics might exert too much influence, but in its own separate District of Columbia, a square ten miles on each side. Ultimately the decision was made to leave the precise location of the "District" to the new president, George Washington. As it happened, in 1791 Washington selected a fairly open area just eleven miles north by carriage ride from his plantation, Mount Vernon, on the Potomac, and appointed three commissioners to see to the development of the capitol city.

Obtaining the plan design was left in Washington's care as well, and he turned this task over to a young Frenchman who had volunteered to serve in the Colonial army fighting against the British. This was Charles Pierre L'Enfant, one of Washington's closest aides in the army, the son of a French court painter who had lived as a boy with his family at Versailles. The curious aspect of the city plan that L'Enfant invented was that it so strongly resembled Versailles: in short, the seat of government of a freely elected democratic republic was based on the design of the residence of the most absolute monarch in Europe. But L'Enfant adapted the French plan uniquely to his site [17.20]. On inspecting the open



17.18. John Wood (the elder), and John Wood (the younger), Plan of Bath, England, 1720–1803. With a relaxed grace, new streets lined with town houses were built during the eighteenth century from the central hot springs bath area to the round "circus" and from there to the wide half "crescent" defined by town houses along its northern edge. A New and Accurate Plan of the City of Bath to the Present Year, 1799 *(Bath 1799; Historic Urban Plans, Inc., Ithaca, New York, USA).*



17.19. Emmanuel Héré de Corny, aerial view of Place Stanislas and Hemicycle, Nancy, France, 1741–1753. This small town in Lorraine was replanned at its center to become a fitting seat for the French queen's father, formerly the king of Poland. From Werner Hegemann and Elbert Peets, American Vitruvius *(New York, 1922).*

17.20. Charles Pierre L'Enfant, Plan for the City of Washington in the Territory of Columbia*, designed in 1791, shown as slightly adjusted by surveyor Andrew Ellicott and published in 1792. Placing the two most important government buildings on low hills, L'Enfant connected them with a diagonal street, generating comparable radiating streets focusing on the two focal points, and then overlaying an orthogonal grid of streets. From* Plan for the City of Washington in the Territory of Columbia *(Philadelphia, 1792; Historic Urban Plans, Inc., Ithaca, New York, USA).*

ground, he wrote, he had observed two slight rises, the largest of them seeming to be a pedestal waiting for a monument. On these two elevations he would place the two major government buildings, the House of the Legislature on the highest and the House of the Executive (the president) on the lower one. Between the two focal points he ran a broad roadway, so that the two agencies could, in a quite literal way (as he wrote to George Washington), keep an eye on each other—or, as he expressed it, so that there might forever be "reciprocity of sight."[8] In preparation for working out his plan, L'Enfant was given the loan of several engravings of city plans from Thomas Jefferson's collection, but whether Wren's 1666 plan for London was among them is not clear. Yet there are a number of commonalities between those two plans as well. Then, L'Enfant laid out a series of radiating principal avenues extending out from these two focal points, thirteen in all, naming each one for one of the original colonies. Finally he laid over this arrangement of diagonals a regular grid of streets oriented true north to south, east to west. Where the two street systems created major intersections, he proposed that there be monuments and centers for each of the states.

Unfortunately, L'Enfant conducted himself as though he was a high government official operating on the orders of a superior officer (as Washington had been during the time that L'Enfant served in the army). He repeatedly ran afoul of the three commissioners, for he assumed the professional position that any Frenchman would have enjoyed, given the training he had received in Paris. He thought of himself as an artistic planner whereas American citizens had never heard of anything of the sort (and wouldn't understand this concept until 1893). L'Enfant was seen as merely an insubordinate employee of the commissioners and was dismissed. Nonetheless, his plan for the city was slowly realized, although his name and his role in creating it were largely forgotten. Meanwhile, the commissioners were successful in getting the city started, and Congress sponsored two architectural competitions to obtain designs for the president's residence and the House of the Congress (the Capitol Building), both of which were successfully concluded and the buildings started. With this beginning, and with everything very much in a state of unfinished commencement, the government of the United States officially relocated from Philadelphia, Pennsylvania, to Washington, DC, at the turn of the new century in 1800. In 1900, at the time of the centennial of relocation of the government to Washington, L'Enfant's primary role in creating the plan of the American capitol was reestablished and its beautiful logic restored.

The English Garden: "Consult the *Genius* of the *Place*"

The arrangement of Ledoux's industrial city of Salines de Chaux on the landscape was exceedingly formal, in the best French tradition of Le Nôtre, but it is significant that so much open space was set aside around it in a green belt. Around the edges of formal Chaux, however, Ledoux was reflecting the new sensitivity to nature that arose in the Age of Reason. Whereas in the seventeenth century (and especially in France) nature was seen as something to be mastered, tamed, controlled, and geometrically reshaped, having no inherent or worthy form or beauty in its own right, early in the eighteenth century that perception radically changed in England. The English aristocracy and gentry began to develop an entirely new approach to planning the grounds around their country houses. Instead of imposing an arbitrary geometric pattern of parterres, they set out to enhance and augment the natural contours of the land, following the advice that poet Alexander Pope gave in *An Epistle to Lord Burlington* (1731), advising designers to determine where

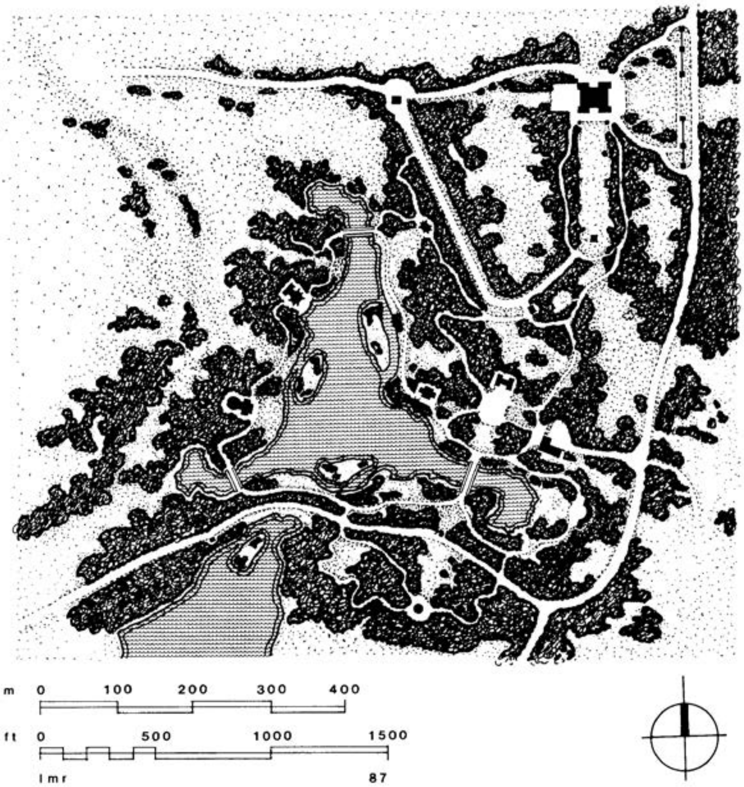
> To swell the Terras, or to sink the Grot;
> In all, let *Nature* never be forgot. . . .
> Consult the *Genius* of the *Place* in all,
> That tells the Waters or to rise, or fall. . . .

As Pope had said, "all gardening is landscape-painting."[9] In actuality, taking their inspiration directly from the seventeenth-century landscape paintings of Nicolas Poussin and Claude Lorrain, numerous English aristocrats and wealthy gentry reshaped the grounds of their country estates in the manner of these paintings, damming streams to create irregular lakes and planting groups of trees so as to frame asymmetrical vistas of meadowland across the landscape, dotted with Classical pavilions. Of the scores of such garden parks, one of the best preserved is the house and garden at Stourhead, England, adorned with a neo-Palladian house in 1720–1721 (by Colin Campbell) and then re-landscaped following the designs of its owner, Sir Henry Hoare, from 1741 to 1781 [17.21, 17.22]. Hoare collected such paintings, and in his collection was a copy of the famous Claude painting, *Coast View of Delos with Aeneas.* What these Englishmen were trying to do was to re-create in real materials, in soil, water, and carefully arranged masses of trees and plants, the pastoral Classical landscapes described by the Roman author Virgil. Not content with viewing the painted versions of such pastoral landscapes, they sculpted the earth itself to re-create those admired landscapes. The result was the creation of the English garden park with its new aesthetic of the Picturesque that prized irregularity, roughness, asymmetry, and the surprise of unexpected vistas as one moved through the landscape. Again, Pope provided a concise summation:

> He gains all Ends, who pleasingly confounds,
> Surprises, varies, and conceals the Bounds.[10]

Building such landscapes could be ruinously expensive, requiring teams of workmen and gardeners working year after year. For the landowners, building such a garden was a life's work, and shaping Stourhead was Hoare's passion for more than forty years. And we must remember that the builder did this in the full knowledge that he himself would never see the result; it would become a legacy for his heirs and their descendants. Such gardens were understood to be investments in the future.

Artfully placed in these carefully crafted "natural" landscapes were representations of historic or exotic buildings intended to induce reflection, or even, as at Stourhead, the re-creation of the places described in Virgil's *Aeneid*. Hoare had his architect, Henry Flitcroft, place several Classical pavilions in his garden: the Temple of Flora in 1745, an evocation of the Roman Pantheon (inspired by Claude) in 1754, and the Temple of Apollo in 1765. Besides taking in the re-created pastoral environment, the visitor to the park could sit on a bench, facing the Pantheon across the lake, and reflect on Virgil's pastoral *Georgics,* or perhaps even consider the implications of Edward Gibbon's newly published history of the decline and fall of the Roman Empire. Other buildings in different settings might evoke different



17.21. Sir Henry Hoare, English Garden, Stourhead, Wiltshire, England, 1741–1781. The picturesque English garden, looking deceptively "natural," is totally a product of human design and careful planting, imitating the paintings of Claude Lorrain and the nature writing of ancient authors. Drawing: L. M. Roth, after F. M. Piper, 1779.

17.22. Henry Flitcroft, Pantheon garden pavilion, Stourhead, Wiltshire. Positioned at strategic points in this English garden are buildings depicting episodes from Aeneas's descent into the underworld, meant to serve as objects of contemplation. Photo: © Wayne Andrews/Esto. All rights reserved.

17.23. James Stuart, "Doric Portico," Hagley Park, Worcestershire, England, 1758. Stuart based this garden pavilion on the Parthenon in Athens, which he had just returned from measuring. Photo: Country Life, London.

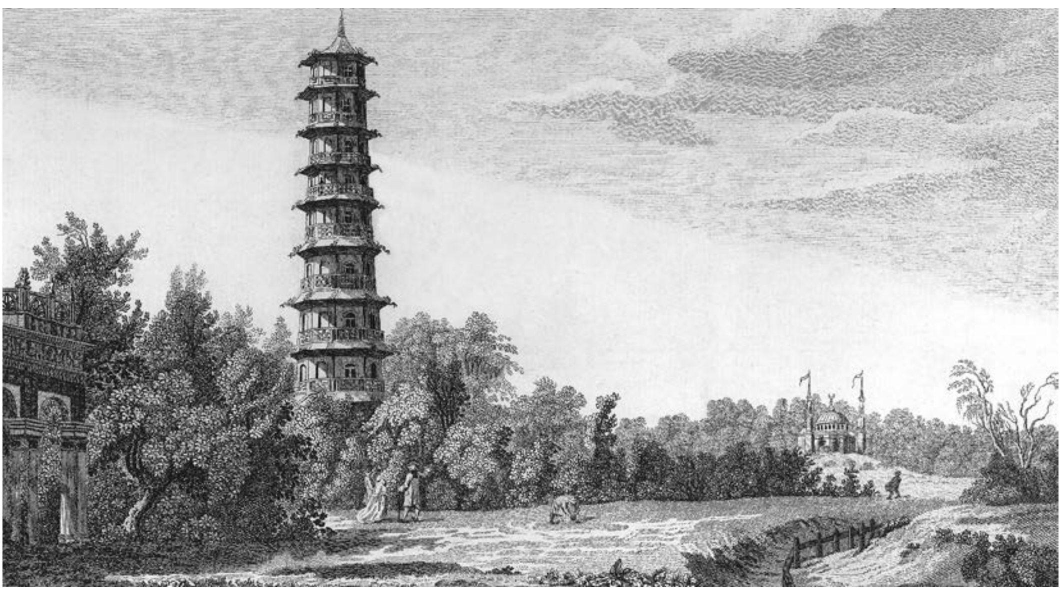
associations with different historical periods; for example, an allusion to ancient Greece was made at Hagley Park in Worcestershire, where in 1758 James Stuart built a Doric garden pavilion with a facade adapted from the Parthenon, which he had just returned from measuring in Athens [17.23].

Or the intent might be to induce reflections on local history by showing medieval architecture, an idea that had first emerged about thirty years earlier. In 1705, when Sir John Vanbrugh inspected the Woodstock royal estate where he had been commissioned to build Blenheim Palace, he discovered on the grounds the ruins of the medieval Woodstock Manor, which Sarah Churchill insisted be removed. For a time Vanbrugh strongly argued against this, writing in a letter of 1709 that such ruins "move lively and pleasing reflections . . . on the persons who have inhabited them [and] on the remarkable things which have been transacted in them." If the ruins were planted, he advised, "with trees (principally fine yews and hollys), promiscuously set to grow up in a wild thicket, so that all the buildings left . . . might appear in two risings amongst them, it would make one of the most agreeable objects that the best of landscape painters can invent."[11] As Vanbrugh clearly suggested, it was the associations the mind made with the old buildings and their stylistic qualities that were important. And if real ruins did not exist, faux medieval buildings could be built and then knocked down to create instant ruins. In 1747 at Hagley, a mock ruin of a Gothic building was built in the park by Sanderson Miller [17.24].

Aside from the allusions to the pastoral Roman and Greek past in garden pavilions, as in Flitcroft's Pantheon at Stourhead or Stuart's Doric pavilion at Hagley, and the references to England's own medieval past, all manner of associations were made to places and times far away in time and space. One newly fashionable style was Chinese—or, more correctly, what eighteenth-century architects and landowners imagined as Chinese. This interest in things Chinese lasted from about 1715 through the end of the century and manifested itself in country house interiors and garden ornaments. Sir William Chambers published a book entitled *Designs of Chinese Buildings . . .* (London, 1757) that provides suggestions for garden buildings, and he also designed the tall pagoda added to Kew Gardens outside London in 1761–1762 [17.25]. In addition, he designed a Turkish mosque at Kew, visible in the distance in 17.25.

In France a sensitivity to nature was awakened by the philosopher Jean-Jacques Rousseau. In his *Discourses* (1750–1754) he made an eloquent plea

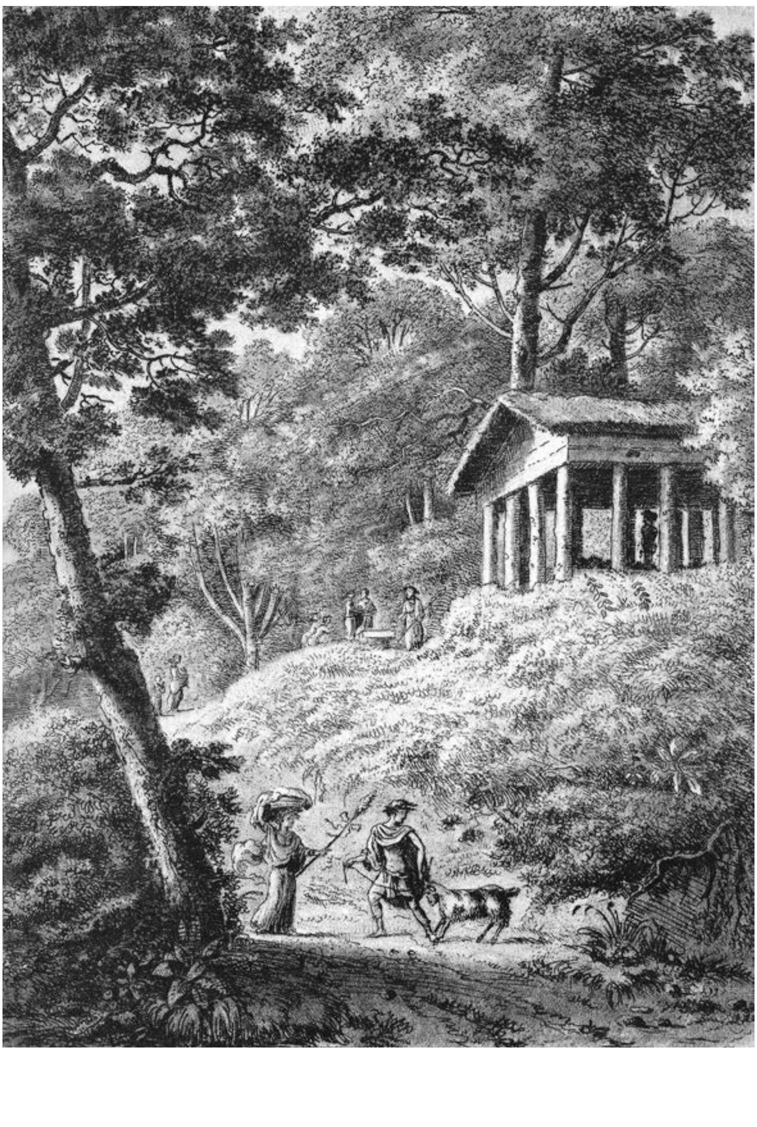
17.24. Sanderson Miller, sham Gothic ruin, Hagley Park, Worcestershire, England, 1747. If no real medieval ruins existed on the grounds of English garden parks, imitation ruins such as this were sometimes built. Photo: A. F. Kersting, London.



17.25. Sir William Chambers, Chinese Pagoda, Kew Gardens, London, England, 1761–1762. This engraved view of the pagoda at the royal gardens at Kew (then outside London) shows well the mix of exotic architectural styles used for picturesque effect. Note the Moorish pavilion (portion to the left) and the Turkish mosque (in the distance on the right). Photo: From Plans, Elevations, Sections and Perspective Views of the Gardens and Buildings at Kew *(London, 1763); author's collection.*

for the natural man, writing that human beings were essentially free, virtuous, and happy but became corrupted by society and urban ills. A friend of Rousseau, the Marquis de Girardin, resolved to create at his estate at Ermenonville, outside Paris, the kind of landscape in which the natural man could rediscover himself. Assisted by J.-M. Morel and the painter Hubert Robert, the marquis had the park constructed in 1754 to 1778, with a variety of open or wooded landscapes dotted with the sort of picturesque buildings, all permeated with the pastoral and n atmosphere of Rousseau's book *Julie ou la Nouvelle Héloïse* [17.26]. Even at Versailles, at the far northern edge of the grounds of the Petite Trianon, and well away from Le Nôtre's unrelenting geometries, in 1778–1782, Marie Antoinette had built a *Jardain Anglais.* In the garden, encircling an irregular lily pond, designer Richard Mique created a mock *hameau,* or rustic farm hamlet, where the queen tried desperately to recapture the simple life of a milkmaid [17.27].

The picturesque English garden park, in its embrace of nature in all its untidiness and planned irregularity, was one of the first expressions of another view of the world that eventually would challenge Enlightenment rationality; this would become Romanticism. Named after the literary "romances" of mystery and suspense that writers modeled after medieval stories, Romanticism was a reaction against the constricted mathematical models of the *philosophes,* which the Romantics felt limited feeling and imagination. Early Gothic novels, such as Horace Walpole's *Castle of Otranto* (1765) and Ann Radcliffe's *Mysteries of Udolpho* (1794),



17.26. Rustic Temple, gardens at Ermenonville, France, c. 1764–1778. In the Rustic Temple actual living tree trunks are shown being used as columns, suggesting the primitive house described by Vitruvius. Photo: From S. Girardin, Promenade . . . des jardins d'Ermenonville *(1788), in* Transformations in Late Eighteenth Century Art*, by Robert Rosenblum (Princeton, NJ, 1967).*

17.27. Richard Miqué, Antoine Richard, and Hubert Robert, Hameau (Hamlet), Versailles, France, 1778–1782. In this mock rural village tucked into a corner of the forest of Versailles re-landscaped as an English garden, Marie Antoinette liked to play at being a peasant. This photograph made in 1953 shows the ancient surrounding trees before many were destroyed in a wind storm in 1999. Photo: Marvin Wit, 1953, courtesy of the Visual Resources Collection, Architecture & Allied Arts Library, University of Oregon.

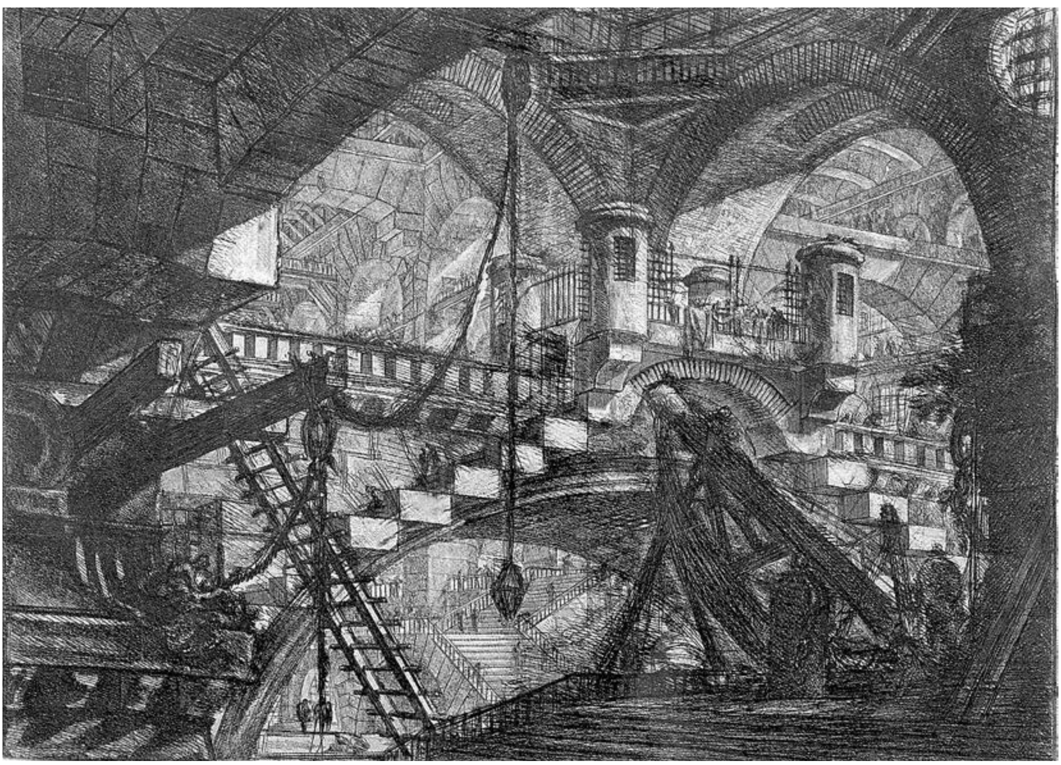
were set in dark, mysterious, ancient houses in which the single governing principle of their rambling design seems to have been irregularity and asymmetry. As in the gardens, it was irregularity and roughness that were prized. Another literary foundation for the emerging Romanticism was provided by Edmund Burke's essay *A Philosophical Inquiry into the Origin of Our Ideas of the Sublime and Beautiful*, 1756. Contradicting the *philosophes* at every turn, Burke discussed the heightening of the senses caused by darkness, danger, and great forces of nature, such as roaring waterfalls, storms, and volcanic eruptions. So, in addition to the refined symmetry and proportion of the Enlightenment, and the irregular roughness of the Picturesque aesthetic, there was the awe-inspiring danger of the Sublime.

The Romanticists' vivid imagination and something of their sense of awe were expressed in the engravings of Giovanni Battista Piranesi (1720–1778). An Italian architect who actually built very little, he nonetheless had an enormous impact on architects in the last half of the eighteenth century through the various series of engravings he produced. In his *Veduta* (Views of Rome), he presented fanciful visions of Roman ruins and recent buildings, suggesting a scale that absolutely dwarfed ant-sized humans. Piranesi's creative invention reached its zenith in his *Carceri* (Prisons), about 1750, which presented visions of endless spaces, delineated by broken architectural fragments of overpowering scale [17.28]. Appearing in thirty-one different series or titles, his thousands of etchings were enormously popular; one estimate is that by the end of his life over a million of his prints were circulating in Europe, and they continued to be printed in Paris until about 1838, sixty years after his death.[12] Like Boullée, Piranesi proposed an architecture whose scope far outreached the building technology of the time but that soon became the prototype for the building needs of the nineteenth century.

Eclecticism and the Architecture of Revolutions

The impacts of the carefully positioned pavilions in English garden parks were twofold. One was the suggestion that architecture derived its value in direct proportion to its literary associations—that is, to the degree the historical references were in accord with the building's function. The other impact was reinforcement of the concept of experientialism or sensationalism as developed in John Locke's *Essay Concerning Human Understanding* (1689). This essay proposed that all human understanding came through direct experience based on sensation, rather than through received or inherited knowledge. Thomas Jefferson (1743–1826) believed similarly and used this idea not only to inculcate in his American countrymen a taste for good architecture but also to visually reinforce the nature of republican government. There were no Classical ruins in the New World from which Americans could learn something of what made for good design, or to remind them of the virtues of the people of republican Rome. Moreover, the republican forms of government that had just been re-created following the American Revolution in the new American federal government (and in each of the individual state governments) were the first true republican governments since early Roman times. What sort of building would a modern democratic republican government require? What sort of image should it project? Those were the questions that Jefferson faced when he was asked by his fellow Virginians to provide them a design for the new Virginia State Capitol. What he wanted was a building that would provide the appropriate associations and experiential links in the minds of his colleagues.

As a result of designing his own home, Monticello, which he began building in 1770, Jefferson had become well known among Virginians for his abilities in architectural design. At the time that Jefferson received the request for the Virginia capitol design in 1785, he was serving as the first ambassador of the United States to the court of France. By then he had moved beyond his youthful admiration for the proportioned Renaissance architecture of Palladio; he now was an ardent admirer of Palladio's own inspiration, Roman Classical architecture.



17.28. Giovanni Battista Piranesi, Plate XI from the Carceri *series, c. 1745–1761. In these visions of boundless spaces, of ramparts connected by bridges stretching away in vistas beyond comprehension, Piranesi gave form to a uniquely modern view of architecture on a vast scale. Photo: Print courtesy The British Museum, London, England.*

17.29. Thomas Jefferson, Virginia State Capitol, Richmond, Virginia, 1785–1789. Jefferson specifically selected a Roman temple, the Maison Carrée, in Nîmes, southern France, as his model, since he believed it to be an example of superior Roman Republican architecture and therefore symbolic of republican self-government. See also 12.2. Photo: L. M. Roth.

Working in association with the Parisian architect Charles-Louis Clérisseau, who had recently published measured drawings of the Maison Carrée in Nîmes, Jefferson took the Maison Carrée as his model [17.29, 12.2]. He prepared sets of drawings, using the new printed graph paper then being used by French engineers, putting the various state governmental functions into rooms fitted into the shell of a Roman temple, and had a plaster model made in Paris for shipment to Richmond, Virginia. Jefferson did make some departures from his Roman model. In place of the Corinthian columns of the Maison Carrée, Jefferson called for the somewhat simpler Ionic. The side walls of Jefferson's building were punctuated by two stories of windows, lighting the various chambers inside. He wrote to his colleagues in Virginia that because the prototype in Nîmes was "noble beyond expression" he was dismayed to hear that major changes were being considered in his plans. He implored his friends to follow his designs, for "how is a taste in this beautiful art to be formed in our countrymen unless we avail ourselves of every occasion, when public buildings are to be erected, of presenting to them models for their study and imitation?"[13] Persuaded by his arguments, the Virginia committee suspended the work and then, when the drawings and model reached them, had the building erected with only minor deviations from Jefferson's drawings. As a result, on the bluff overlooking the James River rose a white Roman temple.

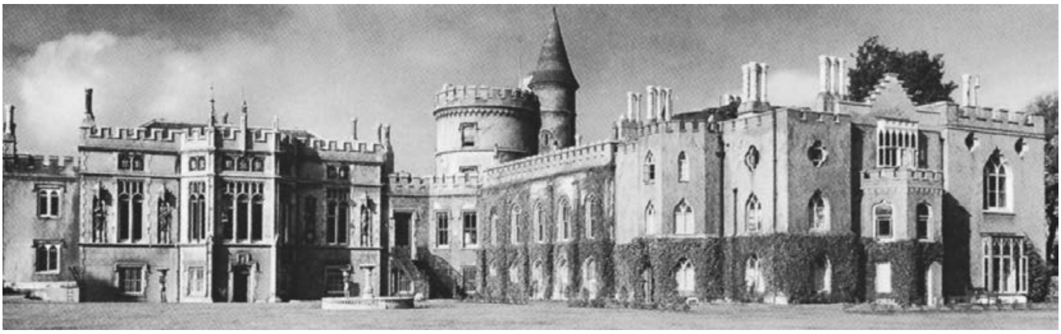
Jefferson's Virginia capitol was the first functionally habitable building, on either side of the Atlantic, whose form was based on a specific historical model. Since that form was meant to exemplify the architecture of people governing themselves in a republic, it was an example of ***associational eclecticism***.[14] But Jefferson's adaptation of a specific ancient building also gave authoritative approval to the idea that a new building could successfully duplicate an ancient model; this would soon lead to an outright Roman and Greek Revival. By the beginning of the nineteenth century, architects were turning increasingly to specific source models, in a wide variety of historical styles, resulting in revivals of Greek and Roman Classicism, medieval and Gothic architecture, as well as Egyptian and even more exotic re-creations. (These developments are discussed in the following chapter.) Book publishers obligingly provided architects with increasing numbers of folios with engravings of historical ancient buildings. The measured drawings by Stuart and Revett were just the beginning of such architectural publications.

With Jefferson, eclecticism was established as a basis for architectural design. Fundamental to this approach was the associational connection between the form or ornamental detail of a contemporary building with another architecture, distant either in time or location. This initial phase of associational eclecticism lasted from roughly 1740 to 1785 and formed the basis of historic associational eclecticism that continued through the nineteenth and twentieth and even the early-twenty-first centuries. The fact that the eighteenth-century garden pavilions were meant to be seen from a distance meant that they did not need costly building materials painstakingly detailed, nor did the historical references need to be especially precise (and in any case, archaeological knowledge in the mid-eighteenth century regarding the specifics of Greek or Gothic architecture was just emerging). So, for instance, although the columns of Stuart's Greek Doric pavilion at Hagley are true Greek Doric, heavily proportioned and devoid of a base, the corner columns are not thicker, nor do any of the columns have true ***entasis***.

This initial associational phase of eclecticism gradually changed to a ***synthetic eclecticism***, lasting roughly from 1755 through 1820. Synthetic eclecticism advocated using various historical styles from a range of historical periods combined in a single structure. This method sounds as though it would result in jumbled confusion, and in the hands of ill-trained architects it sometimes did. But Soufflot's Sainte Geneviève in Paris is a good example of synthetic eclecticism employed at its best. The Corinthian columns are used as structural supports in the sense that the Greeks used them (although they are inside the building); the entrance portico is Roman in detail and scale; the plan form is contemporary; the saucer domes on pendentives in the arms of the church are Byzantine in concept; and the cut stone construction of the domes and the resolution of structural forces are Gothic in spirit, even to the extent of using hidden flying buttresses. Moreover, the dome, as finally completed, was inspired by Wren's contemporaneous dome on Saint Paul's, London. Yet these various references are fused so as to create an organic whole, not a collection of ill-fitting parts.

The Baltimore Cathedral in the United States, designed in 1804 by Benjamin Henry Latrobe (1764–1820), is a similar synthesis of various elements. It has a plan inspired largely by Byzantine examples, covered with cut stone vaults [7.16], with an entry portico supported by some of the most beautifully carved Grecian Ionic columns of the period. When Latrobe was first asked to develop a design for the diocese, he drew up two completely different and independent proposals. One was a version of a Gothic church (although not very accurate in detail), since Latrobe recognized that Gothic architecture had been developed by the medieval church and he thought it might have symbolic meaning for the diocese. His alternative design, the one finally selected and built, was the Classical domed scheme. The fact that Latrobe was able to provide his client with two completely different alternative designs, however, is a measure of his extensive professional training.

Synthetic eclecticism was employed by the early Romantics just as it was by the early Neoclassicists, as is evident in Strawberry Hill, the country house Horace Walpole designed as his own personal Castle of Otranto, the stage set for his life as a literary romance [17.30]. Walpole began Strawberry Hill, outside London at Twickenham, in 1748, and construction continued for almost forty years, as section after section was added, supervised by various architects with parts designed by various of his friends who shared his enthusiasm for the medieval English



17.30. Horace Walpole and others, Strawberry Hill, Twickenham, near London, begun 1748. For his own home, the author Horace Walpole and his friends designed a mix of miscellaneous medieval details to create an evocative and romantic setting. Photo: A. F. Kersting, London.

past. It is a mixture of every conceivable expression from the Middle Ages, ranging from twelfth-century battlements to sixteenth-century Tudor moldings; it even was given a library in a new "Gothick" style greatly influenced by the contemporary craze for intricate and exotic Chinese design.[15]

The Industrial Revolution

As displaced farmers relocated to the burgeoning cities, and the urban populations swelled, people were employed in proliferating shops and factories. This change in production of goods radically restructured the European economy, for it meant replacing traditional economic practices with new procedures that fostered ever-expanding production of goods for general consumers. This increase in production began in Great Britain in the textile industry. The first step in the transformation of the textile industry was the mechanical spinning of thread in 1765 and then Richard Awkright's invention of the water-powered loom in 1769. With these inventions, soon powered by the steam engine perfected by Watt and Boulton in 1769–1776, the production of cloth in Britain increased by 800 percent by the end of the eighteenth century.

The most important change in industry, perhaps, was using machines in place of skilled labor to make other machines, first done in 1799 by Marc Brunel, who designed machines in England to make pulley blocks for ships' rigging. A cube of wood went into the shop at one end and came out the other as a finished piece of block and tackle. Brunel's simple apparatus was surpassed in 1798–1801, when the American Eli Whitney used the division of labor, together with standardized machine jigs, to enable workers to produce identical musket components; finished firearms could then be rapidly assembled from the standardized parts by anyone. With the application of simple machines to perform repetitive tasks, mass production of consumer goods began. The result was a dramatic increase in production and a lowering of production costs, meaning that goods formerly available only to the aristocracy became available to the growing middle class and even eventually to the workers themselves.

Cast Iron

The increased manufacture of consumer goods was dependent on the production of less expensive component materials, and of these the most important was iron. Iron was not a new material, but the smelting of iron ore had been hampered from the beginning by the use of charcoal for fuel. At the very time that the need for iron began to rise, the English forests were fast disappearing into the charcoal furnaces. Abraham Darby devised a system of heating mineral coal to drive off its sulfur content, creating coke; this carbon material could then be used to fuel iron furnaces. Darby began to use this process in his works at Coalbrookdale, England, in 1709. Not only did coke allow for larger furnaces with hotter smelting temperatures, it also produced a better grade of molten iron, which could be cast into thin-walled pots and other everyday items in great demand. Darby's son and grandson continued to develop the iron industry and worked with Boulton and Watt to perfect precision boring of the pistons of steam engines. As the technique of iron smelting was improved by the Darbys, the cost per ton gradually dropped, so that ***cast iron*** and its tension-resisting derivative, ***wrought iron***, became the basic materials for industrial growth.

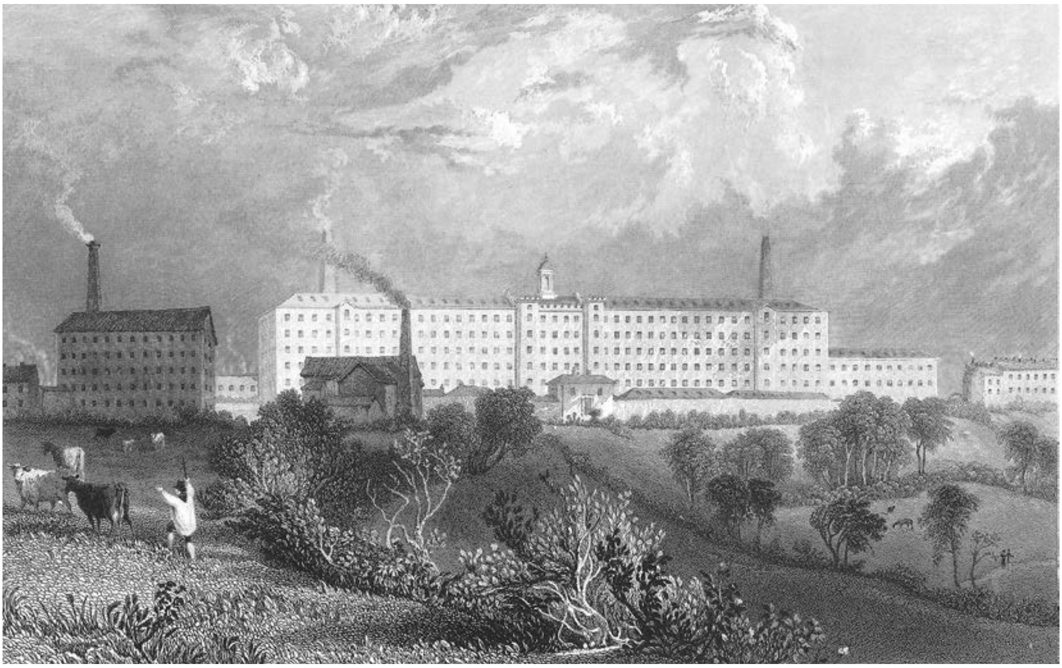
17.31. John Wilkinson, Thomas F. Pritchard, and Abraham Darby III, Coalbrookdale Bridge, Coalbrookdale (Ironbridge), England, 1777–1779. One of the first demonstrations of the dramatic potential of cast iron as a structural material, this bridge was cast in 50-foot-long half sections. Photo: British Museum, London; Courtesy, the Trustees.

One of the landmarks in the emergence of iron as a new building material was the construction of a cast-iron bridge over the Severn River near Coalbrookdale in 1777–1779, based on an idea of John Wilkinson after designs by Thomas F. Pritchard and manufactured by Abraham Darby III [17.31]. Traditional in its arch form, it was made of five half arches on each side (ten pieces in all), with a total clear span of 100 feet (30.5 meters). It was intended as a dramatic demonstration piece. Each half-arch was cast as a single piece, a formidable job of iron casting. Soon other bridges of cast-iron voussoir-like sections were proposed, as were suspension bridges using wrought iron chains. Cast iron was also being exploited for thin structural columns needed in textile factories during the 1780s, and in 1786 the architect Victor Louis designed a light iron truss for the roof of his Théâtre-Français in Paris. By the end of the eighteenth century, iron was a major building material, although its full potential was just beginning to be understood.

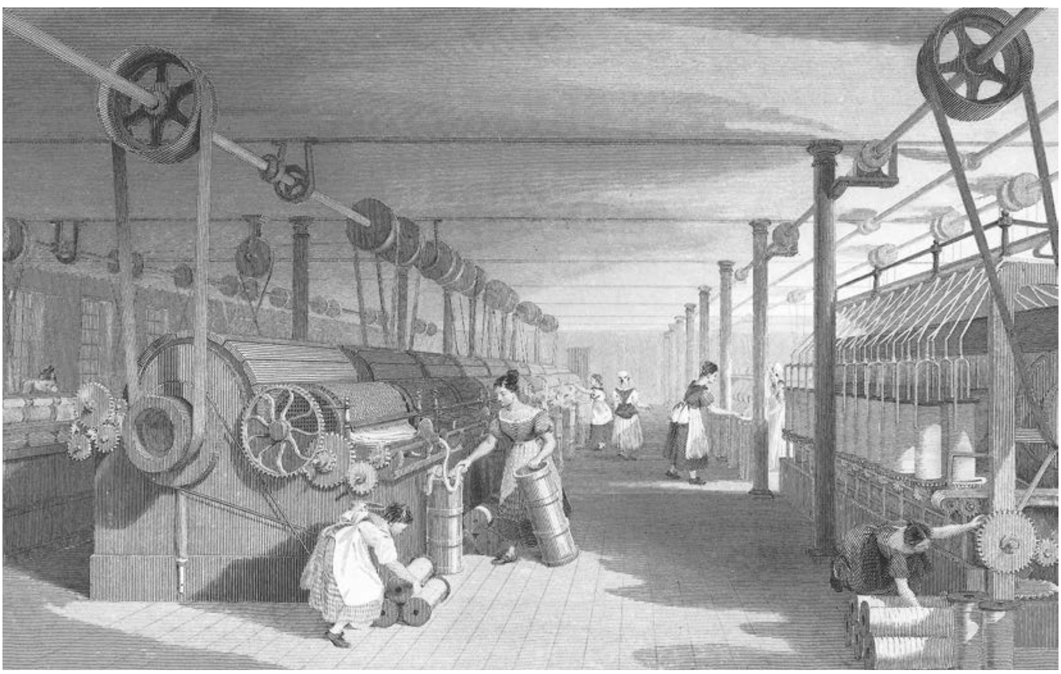
With their intensive production, whether it was grinding grain into flour or spinning and weaving cotton thread, mills and factories generated large amounts of flammable particles, and fire was a constant threat in the ever-larger facilities. A disastrous fire in the Albion Grain Mill, London, in 1791 prompted public debate and design reforms, resulting in such new factory designs as the new textile mill at Derby, England, in 1792. This calico mill, designed by William Strutt, employed slender cast-iron columns supporting floors constructed of shallow ceramic "flower pot" arches that spanned between iron floor beams.[16] The power driving all the machinery in the mill was supplied by a large water wheel as well as a Boulton & Watt steam engine. Typically in these mills, the rotary power was distributed to the many spinning jennies and power looms by a system of belts and pulleys, with long shafts running the length of the mill and numerous wheels and leather belts transferring the power to individual machines. Hence, the basic plan of such mills was long and narrow, not only to facilitate the shaft, belt, and pulley system but also to provide banks on windows along the sides of the mill to provide light for the machinery and workers inside. Although built slightly later, between 1800 and 1810, the Swainson, Birley and Co. cotton mill near Preston, Lancashire, England, exemplifies the building type and machinery that transformed England at the turn of the seventeenth century [17.32, 17.33].

An Architecture of Rationality

Guided by the *philosophes,* European architects by the mid-eighteenth century began to reject the visual excesses of Rococo architecture in favor of a structural discipline shorn of extraneous ornament; the generative basis of architecture was transformed. Increasingly architects were faced with devising solutions and using new building materials for the new buildings needed by the exploding urban populations. The church, splintering now into ever more numerous factions, was no longer the most important patron of architectural innovation. It says much about the times that during the French Revolution, Soufflot's Sainte-Geneviève ceased to be a church and was secularized as the Panthéon, a political monument. The architectural corollary to the late-eighteenth-century processes of industrialization coupled with economic and political theory was this: the building tasks that soon were the most pressing were those that provided the greatest use for the



17.32. Swainson, Birley and Co. cotton mill, near Preston, Lancashire, England, c. 1800. This rather idyllic view shows the long narrow shape of early factories reliant on extended belt and pulley systems for power transmission. Photo: From E. Baines, History of the Cotton Manufacture in Great Britain *(London, c. 1835).*



17.33. View of cotton weaving (carding, drawing, and roving), unidentified British factory, c. 1828. Although showing a factory interior of the very early nineteenth century, this view depicts technology closely resembling that used with the introduction of full internal cast-iron frames around 1799. Note the shafts, pulleys, and leather belts employed to transmit power to the individual powered looms. Photo: From E. Baines, History of the Cotton Manufacture in Great Britain *(London, c. 1835).*

greatest number, the greatest public service to the community. The most important commissions very shortly were no longer great aristocratic palaces but legislative halls, courts, museums, galleries; the new patrons of architecture were industrialists and governmental bodies. As the eighteenth century came to a close, the basis of the bourgeois middle-class culture of the nineteenth century, clothed and supplied by means of mass-produced goods, was being firmly established. The dramatic effect of this expanding bourgeois middle class was a new secular culture and an architecture inspired by egalitarian ideals and industrial enterprise. The old religious and aristocratic architectural models would no longer suffice.

JP-1. Pagoda, Hōryū-ji Monastery, Hōryū-ji, Japan, c. 607. Inspired by Chinese pagodas, the Japanese pagoda tends to have far more extended, cantilevered roofs encircling the central shaft. This is the oldest wood pagoda in Japan. Photo: © Ivan Vdovin/Alamy.

Japanese Architecture

Traditional Japanese architecture and its modern influence presents an intriguing conundrum: it is based on a design aesthetic that, until the 1850s, was basically unknown outside Japan because of the *Sakoku,* or "locked country" policy begun in 1633. *Sakoku* rigorously closed the country to all foreigners and therefore to Japan's art and architecture, as well as to the subtle beauty of its landscape gardening, which was largely unknown to Europe and America. In 1853, Commodore Mathew Perry, acting on behalf of the US government, sailed his fleet of "black ships" into Edo (now Tokyo) harbor and forced Japan to open the country to foreigners and to trade. Interest in Japanese culture, architecture, and landscape design then became almost insatiable, particularly for early-twentieth-century architects such as Frank Lloyd Wright, Bruno Taut, and Walter Gropius. Over the next century, the influence of the Japanese arts on the West, particularly its architecture and garden design, was perhaps greater than that of any other.

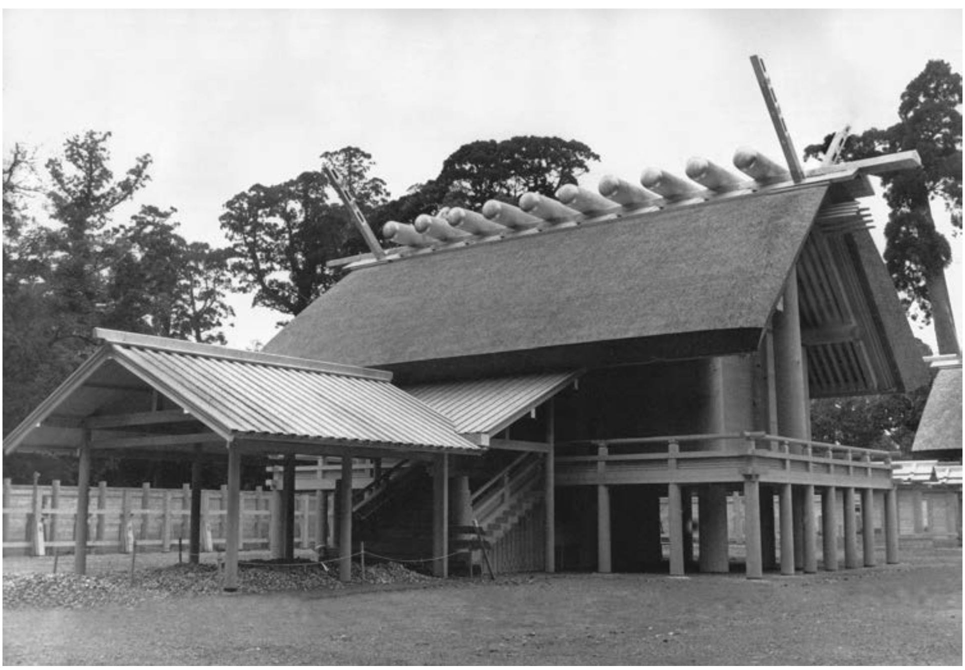
To prevent social disruption, Japan had been closed to the outside world by the Shoguns, the military leaders given control of the empire on behalf of the Japanese emperors (who for more than two hundred years had been unable to exercise political control in the empire). Once the gates of Japan were open, however, and the shogunate ended with the ascendency of the Meiji emperors in 1868 (termed the Meiji Restoration), Japan began an active program of embracing aspects of Western culture and technology considered compatible with Japanese culture, particularly Western manufacturing and military technology. In less than two generations, Japan went from being a late-feudal society to becoming a fully industrialized modern power, adopting Western dress and forming a parliamentary government. Japan was determined not to be humiliated by being colonized by Western powers, in the way that China had been forced to cede coastal ports and make other concessions to European powers during the nineteenth century. And though it was Japanese governmental policy to embrace aspects of the modern Western world with enthusiasm, the Japanese people never abandoned the essence of their ancient culture, particularly its foundation in Shinto, their indigenous spirituality.

While Japanese architecture, like its culture, is distinct and unique, it was influenced by Korean and Chinese architecture as well as by its particular geography and climate. Japan is an island nation. It has four main islands but more than twenty-five hundred smaller ones, with its northernmost island at the same latitude as the northern border of New Hampshire (and Venice, Italy) and the southernmost at the same latitude as the lower tip of Florida (and the Canary Islands in the Atlantic). Because the Japanese island chain is in the path of the warm North Pacific ocean currents, Tokyo receives more rainfall than typical for similar latitudes—more than 60 inches (153 cm) of rain a year, whereas New York City receives just under 50 inches and Seattle less than that. Moreover, the summer temperatures in Tokyo are sufficiently elevated that, coupled with the high humidity, the buildings must be well ventilated.

Although Japan later assimilated Buddhism (introduced via Korea from China), as well as Buddhist architectural forms introduced from China, the nation's roots are founded in Shinto, the indigenous animist religion. Shinto has fundamentally shaped Japanese architecture. The "way of the gods" (the literal meaning of *Shinto*) is based on deep reverence and respect for *kami* ("spiritual essence"), the innate supernatural force or eternal super-consciousness believed to be inherent throughout nature, most strongly present in ancient or unusual gnarled trees, in remarkable boulders, in streams, waterfalls, and other natural manifestations. Reverence before *kami* produces profound awe. This fundamental veneration of *kami*, and the perception of it as a form of nature's idealization, was largely responsible (some scholars have suggested) for Japan's being able to retain a distinct cultural identity in the face of strong Chinese cultural influence. Though the Japanese embraced Buddhism once it was introduced, officially dated at 552 CE, the Japanese found ways of integrating Shinto concepts with certain Buddhist practices.

Shinto is thought to have been formulated during the Yayoi period (c. 300 BCE to c. 300 CE), though apparently it was observed and practiced for several thousand years before that. Shinto, quite unlike other formalized religions, has neither doctrinal dogma, established scriptures, nor the degree of ritual religious forms associated with Buddhism or Christianity. The purity and essence of Shinto is made visible in the form, material, and construction of objects, including architecture. The spiritual force of *kami* is also considered present in human constructions of utmost simplicity of form and purity, as when beautiful wood is left unpainted so that the texture of its grain is gradually intensified through natural weathering. Though Buddhist precepts seem at odds with those of Shinto, the two religions were fused in Japanese life, with Shinto rituals being employed for civil life and social events (such as birth and marriage) while Buddhist practices are relied upon in life transition events (such as funerals).

The clearest demonstration of *kami* embodied in architecture can be found in the most ancient Shinto shrines, particularly at the dual temple site at Ise Jing on the eastern coast in Mie Prefecture (in all, the Ise area contains 123 related Shinto shrines). Established according to mythological accounts about two thousand years ago, the present shrine complex was built under Emperor Temmu (reigned 672–686) [JP-2 Ise]. To ensure that the Ise shrine is forever rooted in Japan's ancient past, but also forever new, the structure is meticulously duplicated every twenty years on alternate adjacent sites using trees from sacred forests reserved especially for the rebuilding. The *hinoki* Japanese cypress wood exposed by the chisels and planes of the workmen starts out a bright golden honey color but weathers over the years to a silver sheen. Raised up on stout wood posts placed directly in the ground, the shrine building is encircled by an elevated



JP-2. Ise Jingū Inner Shrine (the Kotai Jingū), Uji-tachi, south of central Ise City, Mie Prefecture, Japan. Begun in the seventh century, the complex is ritually rebuilt every twenty years (most recently in 2013). The most sacred Shinto shrine, this both represents the rarefied essence of ancient architectural forms and manifests the place where the goddess Amaterasu-ōmikami dwells. Photo: ASSOCIATED PRESS.

terrace covered by a massively thick but fastidiously trimmed thatch gable roof through which, at each end, jut out the crossed ends of stylized roof rafters. On the adjacent cleared twin site, ready for the next shrine rebirth, a sacred central pole is raised, awaiting the next shrine reiteration. Rebuilt in 1993, the complex was rebuilt again in 2013, its sixty-second re-creation.[1]

The remains of the earliest discovered Japanese houses, dating from the Yayoi period, were pit dwellings with a slightly excavated floor and four internal wood posts carrying beams and rafter poles; the whole was covered with a gable thatched roof. A dwelling of this period, based on excavated remains, has been reconstructed at the Toro site, Shizuoka. Also found at this site were the remains of several elevated platform structures, believed to have been grain storehouses, also covered with large thatch roofs protecting the side walls. These platform buildings recall the archetypal shrines at Ise and other Shinto sites, though the oldest surviving platform granaries had walls of triangular logs laid with one side forming a smooth vertical surface inside, as seen in the log storehouse building elevated on stout wood posts (the Shōsōin, built in c. 756, is part of the Tōdaiji temple precinct).[2]

During the following Kofun period (250–538 CE) a major new architectural form—the tumulus tomb—was added to the range of building types, likely inspired initially by natural land forms but then purpose-built with a raised earth mound joined with a trapezoidal extension, often described as having a keyhole-shaped plan. This type of tomb building culminated in the construction of the *Daisen-kofun* tumulus tomb, Osaka (fifth century), for Emperor Nintoku. Covering a total of 79 acres (32 hectares), it has the distinctive keyhole shape and is surrounded by three moats. After the fifth century, however, earth tomb building declined as the practice of Buddhist cremation gained favor.

Given the area's abundant rainfall, wood was originally plentiful throughout the chain of islands and was the dominant building material for millennia. Particularly favored for its natural resistance to decay was old-growth Japanese cedar and cypress wood, used especially for religious, ceremonial, and imperial buildings. There was little stone construction because experience demonstrated that the tensile strength of intricately interlocked wood frame members resisted earthquakes far better than masonry.[3] Frequent fires have meant that few old wood frame buildings survive, but the oldest today is believed to be the pagoda in the compound of the Hōryū-ji Buddhist monastery, built about 607 [JP-1]. The enormous central mast pole, or "heart pillar," rising through the five-story pagoda has been dated to 594 through dendrochronology (analysis of annual tree-ring growth). The temple buildings in the monastic compound, though they have been rebuilt due to fires, have portions that date from 670.

Buddhism may have come to Japan in 467 or earlier, but the official date of introduction is 552, when a contingent of monks arrived from Korea. Once Buddhism was embraced by Empress Suiko (554–628) and Prince Sōtoku (or Shōtoku, 574–622), Buddhism spread throughout Japan. Prince Sōtoku was a significant patron of building the Hōryū-ji monastery complex begun in 607 (Nara Prefecture). The somewhat earlier Japanese Buddhist temple compounds, such as Shitennō-ji, had a multi-tiered front gate as part of a surrounding roofed wall, with a pagoda, a *kondō* (statuary hall), and a *kodō* (lecture hall) all aligned on a single axis extending from the front gate. Though consumed by fire long ago, the foundations of Shitennō-ji make this arrangement very clear. It is the classic Chinese Buddhist temple complex transported to Japan. Analogous is the axial linearity of the Asukadera monastery (588), also in Nara, which again has an absolutely symmetrical plan, with the pagoda on the center axis placed between twin *kondō* worship halls.

At Hōryū-ji, however, the Japanese aversion to rigid axial alignment (so at odds with Shinto) asserted itself [JP-3]. As at Shitennō-ji, within a rectangular walled enclosure generally about 289 feet (88 m) wide and 328 feet (100 m) deep, and behind the centered *chūmon* gatehouse, is a five-tiered pagoda and a two-level *kondō* hall. A *kodō* lecture hall is incorporated in the center of the rear wall of the enclosure; flanking the lecture hall, and integrated into the side passageways, are a sutra repository and the belfry. But, significantly, at Hōryū-ji the pagoda and the *kondō* hall are positioned *on either side* of the central axis running back to the lecture hall. Instead of the rigid fixed balance of axial symmetry, the Japanese concept of dynamic balance through calculated asymmetry was introduced.

The earliest Japanese Buddhist temple buildings drew heavily on Chinese and Korean models, but Japanese builders quickly adapted the Chinese bracketing system and adapted wood framing

JP-3. Hōryū-ji temple complex, Hōryū-ji, Nara Prefecture, Japan, begun c. 607. This aerial view shows the contrast with Chinese Buddhist temple compounds, for the Japanese tend to avoid straight-line axial symmetry; here the axis runs between *the five-story Gojū-no-Tō pagoda and the Kondō or Main Hall toward the Daikōdō or Great Lecture Hall on the north perimeter. Photo: © amana images inc./Alamy.*

techniques to create specifically Japanese prototypes[4] [JP-1 Hōryū-ji pagoda]. One particularly noticeable example is the adjustment of roof construction to emphasize the cantilevering of roof projections in wood-framed pagodas, halls, and other buildings. Japanese builders employed the Chinese sequence of cantilevered brackets supporting beams, but they extended the bracket-supported principal rafter out much farther. Although Japanese pagodas were vertical towers (very much like Chinese prototypes), the Japanese pagoda roofs were cantilevered out so far as to cast the center pagoda shaft into deep shadow, making the strongly horizontal roofs appear to float in ascending diminishing stages. The proportional ratios in the middle region of the Hōryū-ji pagoda are revealing. If the rise between the roof levels is used as a module unit of 1, then the width of the pagoda core measures 1.5, whereas the total width of the extended roof is 3.6, for a height-to-width ratio of 1 to 3.6.

Increasingly, Japanese builders tried to avoid the customary Chinese practice of painting temple structural supports vermillion red; they favored unfinished wood, a good example of a Buddhist practice being modified through the influence of Shinto aesthetics favoring natural finishes for construction materials.[5] Other larger temple and monastery compounds were built elsewhere, as in the large Tōdaiji monastery compound built at Nara (743–752), the Imperial capital of Japan in the Nara period.

One Japanese Buddhist temple long considered particularly special was created for the worship of the Amida Buddha, the Buddha of Boundless Light. It was built during the Heian period (704–1185), when the capital was in Heian-kyō (modern Kyōto) [Plate 24]. The temple was built in a private residential compound owned by Fujiwara Yorimichi to embody the realization of the Pure Land Buddhist Paradise as illustrated in the Taima Mandala brought from China in the late ninth century. Built in 1053 in Uji, near Kyoto, the Byōdōin temple contains the regent's private chapel, the Amida Hall, called the Hōōdō (Phoenix Hall) because of its plan with central tail and outstretched wings that suggest a phoenix, and also because of the ceramic phoenix images crowning its roof. Reflected in the waters of the lake, the outstretched wings also suggest flight. Inside sits a gilded wooden image of the Amida Buddha seated on an open lotus, his resting hands serenely folded in meditation.

An exceptionally ascetic form of Buddhism—Chan Buddhism in China but translated as Zen Buddhism in Japan—was introduced from China around 1190 and melded well with Shinto aims of utmost simplicity. This form of Mahayana Buddhism shunned elaborate formal external rituals and the memorization of sutras while stressing intensely focused meditation to achieve a personal direct insight into Buddhist teachings. Zen Buddhism held strong appeal for the ruling samurai warriors during the shogunate, when direct political control by the emperor was lessened and replaced by the strong regional lords (*diamyo*). Emphasizing asceticism and stern personal self-discipline, Zen Buddhism proposed a different path to enlightenment. This reduction to pure essence is well illustrated by the austere meditative rock gardens of Zen monasteries, most notably in the rock garden at the Rōanji temple, likely built between 1450 and 1550 [JP-4]. The confined temple courtyard is bounded by a roofed wall that is gradually lowered by 20 inches (50 cm) at the far corner to make the space seem larger. Within the courtyard and set in a bed of meticulously raked white stone pebbles are fifteen carefully chosen rocks arranged in five groups, judiciously placed with some set vertically like miniature mountains; each group is surrounded by a small irregular border of moss. The rocks might suggest islands in a shimmering, rippling sea, or perhaps mountains rising out of a blanket of fog. The worshipper-practitioner sits on the raised

JP-4. Rōanji Zen Buddhist Temple, Rōanji, near Kyoto, Japan, c. 1450–1550. In the Zen garden, everything is reduced to essence to focus contemplation. Photo: © Ei Katsumata/Alamy.

wood temple veranda floor to focus attention on the rocks, not deliberately calling up formed thoughts but clearing the mind and waiting for perception to emerge, perhaps in a flash of insight.

Perhaps the purest expression of the Japanese house as a philosophical ideal, embodying the Zen Buddhist focus on essentials and exquisite refinement of detail, is found in the Katsura Detached Palace (or Villa, c. 1616–1660), built in stages by Prince Hachijo Toshihito and his son Noritada on the Katsura River southwest of Kyoto. Rather than being a single large rectangular mass, the house was laid out as a series of offset L-shaped units joined together so that the view from a veranda presents a series of receding corners from one building section to the next. Returning to ancient prototypes, Katsura is raised off the ground on slender posts. Because it was intended as a place of meditation and withdrawal from the press of day-to-day affairs, Katsura was not designed to make a dramatic frontal impression of power from the outside; rather, it was created primarily to be used from the inside, as a place of utmost simplicity devoid of distracting elements, providing locations from which to view the enveloping garden in which the house sits [Plate 25]. As were all typical Japanese houses, the villa was designed on the basis of the module of the *tatami* floor mat, very nearly 3 by 6 feet. Hence the various spaces of the Katsura villa can be described as simply being an eight-tatami or a ten-tatami room. A pervasive sense of serenity is achieved by the clear order created through the use of the tatami module, but to say "room" is misleading, since the "walls" of these spaces are temporary, defined by sliding screens set in grooves in the *shikii* or wood rail in the floor (the corresponding upper rail is the *kamoi*).[6] These screens, found both internally and along the house perimeter, include sliding opaque panels (*fusuma*) or sliding translucent rice-paper-covered screens (*shōji*) that can be pushed aside to create extended open spaces or pulled together to form multiple enclosed rooms. Along the perimeter, the panels can be moved to shape an infinite number of openings to frame varying views of the garden landscape. As with a Chinese garden, designing the classic Japanese garden requires perhaps more attentive design than creating the architecture of the house itself.

Katsura—with its unfinished, age-darkened cedar frame contrasting with its white plastered exterior panels and paper shōji screens, with the studied angles of its gentle gable roofs, and its uncluttered internal spaces defined by the patterns of the *tatami* floor mats—perfectly projects Zen ideals. But in the grounds of the villa complex itself, attention to exceptional detail is found in each of five dispersed teahouses [Plate 1 and 1.9, 1.10].

Zen monks drank tea as a way of staying awake for their meditations, but offering and taking tea eventually became a rigorously prescribed ritual, practiced initially by court members and then by ordinary people. The purpose of the choreographed tea ritual was not for ceremony's sake but as a way of clearing the mind to focus on the essential qualities of life, as a means of reflecting on the concepts of *wabi-sabi* (roughly equivalent to "quietness in rustic beauty" plus "serene beauty found in patina and wear")—that is, on the acceptance of transience and the imperfection of life. As Richard Power has put it, *wabi-sabi* can be encapsulated as: nothing lasts, nothing is finished, nothing is perfect.

To aim for this state of mind, the guest at a tea ceremony was to attentively examine the elements of the garden while approaching the teahouse, carefully stepping from stone to stone set in moss or gravel, focusing with deliberation on the coolness of the water lifted from a stone bowl and drunk as an act of purification just before reaching the teahouse. On arriving at the small veranda, the guest would remove his or her sandals and, bending low as a gesture of humility, would crawl through the small square door into the teahouse chamber. Even more than the residence itself, the teahouse was reduced to pure essence, with perhaps one carefully selected ink painting and a simple asymmetrical arrangement of a few flowers (*ikebana*) placed in the *tokonoma* recess built for that purpose. The tea master host would prepare the tea slowly and deliberately and present it to the guest in a rough, seemingly crude bowl, specially made for this ceremony. The irregular form, rough texture, and serendipitous accidents in the glaze of the bowl are meant to represent the unpredictability of life, just as the delicate pink petals from the cherry tree in the garden, as they flutter to the ground like snow, are meant to be reminders of the shortness of life. The guest would slowly rotate the tea bowl to take in the fortuitous accidents of its making and the interesting random patterns in its glazing, perhaps commenting on all these ruminations. In the same way, the architecture of the teahouse, like the tea ceremony in its earliest manifestation, is intended to remind those coming to it of the Zen principles of frugality, simplicity, and restraint, to impart a sense of grace, in the anticipation that all of these qualities might be carried back into everyday life. Perhaps it is not a fanciful exaggeration to say that the purpose of the austere simplicity of a Zen residence, its garden and humble teahouse, as at Katsura, is to make us aware that the focused examination of beauty in tea bowl, teahouse, and garden landscape is directed at making life more satisfying through reflection on the evanescence of beauty.

With the start of the Meiji Restoration in 1868 and the rush to westernize Japanese industry and related areas, ancestral architecture was temporarily ignored and even denigrated by some Japanese progressives. In fact, many of the castles that had once been the *daimyo* lords' strongholds were demolished, while temples and traditional structures fell into disuse and decay. Then, through the efforts of Japanese scholar Ernest Fenellosa and his Japanese assistant Okakura Kakuzo, a renewed appreciation developed.[7] By 1897, the first Japanese legislation was created for the preservation of historic architecture and art—the beginning of the National Treasures listing that has saved a broad range of tangible cultural properties, as well as providing support for living individuals who practice ancestral skills at risk of being lost.

Arguably the person in Japan initially most visible in affecting this change in saving and preserving the nation's heritage was Okakura Kakuzo, perhaps best known in the West through his slender book published in English in 1906, *The Book of Tea,* which uses a discussion of the tea ceremony as a focus for explaining aspects of Japanese culture. Frank Lloyd Wright later read this book and was struck by the passage in which Kakuzo notes that the ancient Chinese philosopher Laozi (Lao-Tse) asserted the Daoist view that the reality of a room lies not in its floors, ceiling, and walls but in the space enclosed by those external elements, just as the reality of a pitcher is found not in the clay from which it is made but in the enclosed volume that can be filled with water.[8] Wright perceived immediately that this was how he thought of space within his buildings. He was one of the earliest American architects to find in traditional Japanese architecture a source of continuing inspiration, particularly the idea of open, interwoven interior spaces such as are possible through the moving of the shōji. It is through the impact of Wright's work, particularly his residential designs, that Japanese influence has been doubly felt around the world.

18.17. Charles Garnier, Paris Opéra. Grand staircase,1861–1875. In the generous staircase, Garnier provided a place for Parisians to promenade—to see and be seen. Photo: Bridgeman-Giraudon/Art Resource, NY.

Chapter 18

The Roots of Modernism

The Nineteenth Century

It is very important for architects, engineers, both civil and military, painters of both historical and landscape scenes, sculptors, draftsmen, theatrical decorators, in a word, for all those who build or depict buildings and monuments, to study and know all the most interesting things that have been done in architecture in every country throughout the ages.

—*Jean-Nicolas-Louis Durand,* Recueil et parallèle des édifices en tout genre, anciens at modernes, *1801*

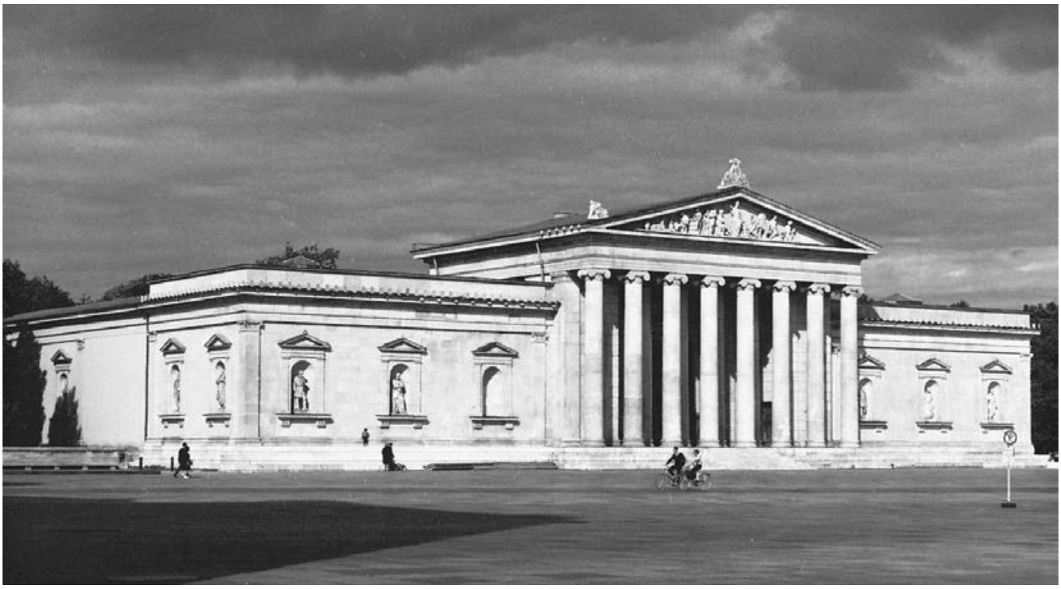
Must the nineteenth century, then, come to a close without ever possessing an architecture of its own? Is this epoch, so fertile in discoveries, so abounding in vital force, to transmit to posterity nothing better in art than imitations, hybrid works without character and impossible to classify?

—*Eugène-Emmanuel Viollet-le-Duc,* Entretiens sur l'architecture, *1863–1872*

It is nonsensical, of course, to speak of nineteenth-century architecture as if it suddenly appeared in 1800 and ceased or was redirected with equal abruptness in 1900. The building programs and the available building materials did indeed change enormously during the nineteenth century, but to a large degree the outward appearance of nineteenth-century architecture developed fairly logically from what was being done in the 1780s and '90s, and continued with only modest changes until 1914 and the outbreak of World War I—with the dramatic exception of Art Nouveau. And even after the war, certain aspects of the conservative branch of design theory and practice continued through the 1920s and into the 1930s. What did change in the nineteenth century was the need to design for building functions that had never existed through the entire course of previous human history: large covered public markets, railroad stations, public and charitable institutions, hospitals, insane asylums, and housing for workers being drawn to rapidly expanding industrial cities, to mention only a few of the new building tasks. Moreover, these buildings had to be larger than any had been since Roman times. Architects were also presented with new building materials, cast and wrought iron as well as glass, in quantities never available before thanks to improvements in mass production.

These logistical and technical problems were perplexing enough in themselves, but architects also found themselves in an awkward position. Architects at the dawn of the nineteenth century now *knew* the history of architecture better than any designers before their generation, and they could never again have the innocence of *not* knowing history. Once the evolutionary stages of the history of civilization had been sketched out, the historical development of architecture and its successive styles had begun to be codified. Intoxicated with this new knowledge, architects wanted to make buildings like those they were learning about. Furthermore, the growing nationalistic fervor, particularly in those countries overrun by Napoleon and now seeking to reestablish their unique national identities, impelled architects to use historical references to establish recognizable national architectural styles.

Architects inherited Romantic literary associationalism from the eighteenth century, causing them to ask what the appropriate images of these new building types should be. For buildings such as churches and residences it was possible to look to native vernacular models for appropriate expression, as Augustus Pugin and William Morris would do in England in the design of churches and houses. But for other new building types, the temptation to draw analogies and to think of contemporary buildings in terms of similar ancient examples was very seductive.



18.1. Leo von Klenze, Glyptothek (Sculpture Gallery), Munich, Germany, 1816–1830. Designed as part of the campaign to embellish Munich as capital of Bavaria, this public museum was designed by von Klenze especially to house the Greek sculpture recently discovered at the Temple of Aphaia on the island of Aegina, Greece. Photo: © Wayne Andrews/Esto. All rights reserved.

Moreover, all too readily available were proliferating portfolios of engravings of measured drawings, first of Classical buildings, then of Gothic churches, and even of exotic non-European architecture, such as the views of Egypt that excited so much interest after Napoleon's campaign there in 1797–1798. During the Renaissance, architects had had to visit Rome and other ancient sites to make sketches of Classical ruins, an arduous undertaking, and then to abstract their own principles of composition and proportion. Although nineteenth-century architects were able to travel even more easily, now they could also purchase engravings and photographs, and they became deluged with information as to the accuracy of details. And by mid-century there was photography to make detailed records such as no artist or sketcher could make.

Soon after the start of the century, the major objective of eclecticism in design now became archaeological accuracy, making sure the entasis of a column was exactly like that of its prototype, the curve of a capital was correct, the number of cusps on a Gothic finial was accurate, the arrangement of tracery of a Perpendicular Gothic window was authentic, or the inclination of the battered wall of an Egyptian pylon was right. Eclecticism thus entered a third phase, growing out of general historical and literary associationalism and synthetic accretions—***revivalism***—lasting from roughly 1800 to around 1850, in which two criteria determined the success of a design: how appropriate the historical allusion in conveying the image of the internal function was, and how archaeologically correct the form of the building and its details were. Jefferson's Virginia capitol would have been only a qualified success in this respect, for its side walls had been punctured by un-Roman (but functionally necessary) windows.

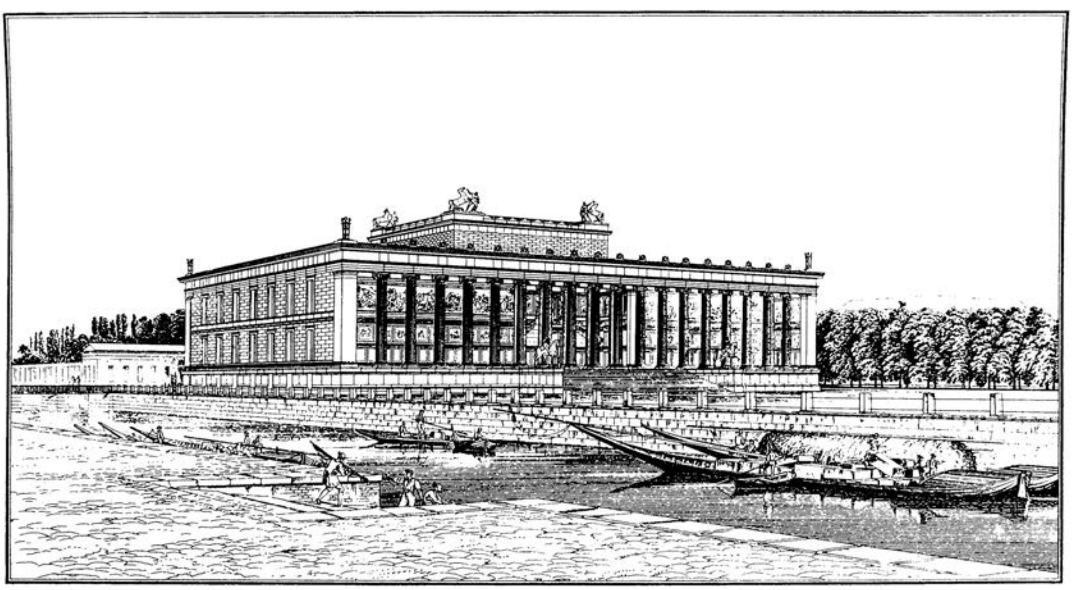
Neoclassicism

The image of Classical order came to be strongly associated with public buildings and the role of public buildings in elevating public virtue. One early example was Leo von Klenze's sculpture gallery built in Munich, 1816–1830, for Ludwig of Bavaria [18.1]. Bavaria had just achieved the status of an independent kingdom, having allied itself with Napoleon, and its king, Ludwig, an ardent patron of architecture and a firm believer in the public function of architecture, quickly set about rebuilding Munich as a royal capital and a symbol to the entire German people. Leo von Klenze (1784–1864) faced the dual problem of developing a new building type and of giving it a recognizable and appropriate image. This was to be the first major public sculpture museum, presenting for public study the remarkable early Classical Greek pediment sculpture from the temple of Aphaia on the island of Aegina that had been excavated in 1811. The newly recovered sculpture had just been purchased by the Bavarian king and its missing fragments restored by the Danish Neoclassical sculptor Bertel Thorvaldsen. The creation of this public museum was the logical extension of practice in the preceding century, when, under the influence of the *philosophes,* enlightened European monarchs and princes had been opening their residences to the public so their collections of painting and sculpture could be viewed by their subjects. As Diderot and Winckelmann suggested, if Classical art could be viewed by the general public it would have an uplifting and moralizing impact. Starting with von Klenze's building, other buildings began to be built solely for this purpose, the museum becoming an extension of the art being housed in it, enhancing its educational function.

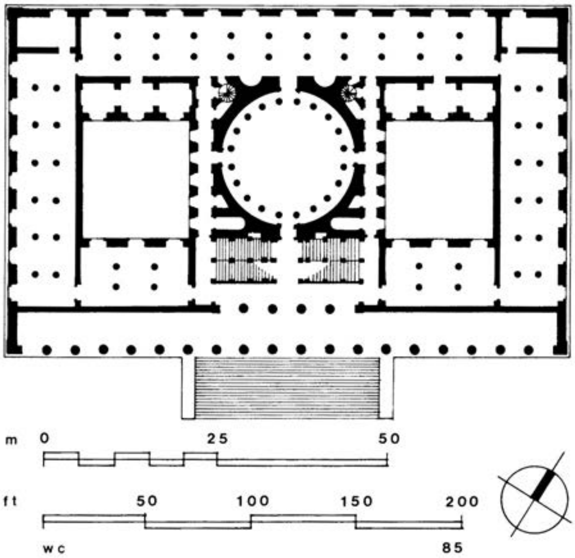
Because of this view, and because of what von Klenze's building was designed to contain, it was given the Greek name Glyptothek, "sculpture gallery." And because this museum was to present Greek sculpture, von Klenze made his Glyptothek Grecian Classical in its details. The plan, however, was contemporary and not Greek, composed of identical square cubicles, each capped by a dome, based directly on a plan for a public gallery published by Jean-Nicolas-Louis Durand (1760–1834) in his *Précis de leçons données à l'École Royale Polytechnique* (Paris, 1802–1805). Durand had been von Klenze's teacher in Paris. The exterior of the Glyptothek has no windows but, rather, blind aedicules containing sculpture (another announcement of what one will find inside), and at the center of the building is a Greco-Roman Ionic temple block serving as the entrance portico, its careful details inspired by Greek sources.

Since 1798 much the same concern for making the royal collections available to the public had been on the mind of Friedrich Wilhelm II, King of Prussia, and his curator of art, Alois Hirt. Their resolve was further strengthened by the ideas of Alexander von Humboldt on the role that cultural institutions played in public education. As early as 1800 the architect Karl Friedrich Schinkel (1781–1841) prepared schemes for a museum to hold the Prussian royal collections of painting and sculpture, but it was not until Napoleon had been defeated in 1815 and the art he had carried off to Paris had been returned to Berlin that final plans for the Altes (Old) Museum were undertaken (the name was adopted after a new museum was built in 1841–1855).

The Altes Museum, designed by Schinkel in 1822 and built 1824–1830, is a large rectangular block on an island in the Spree River in central Berlin [18.2, 18.3, 18.4]. Its broad front closes off the end of the old royal pleasure garden and faces the Baroque royal palace. Perhaps it was because it was intended to define and enclose a major public space that Schinkel gave his museum the generic form of a Greek stoa; its long Ionic colonnade continues the average cornice height of surrounding



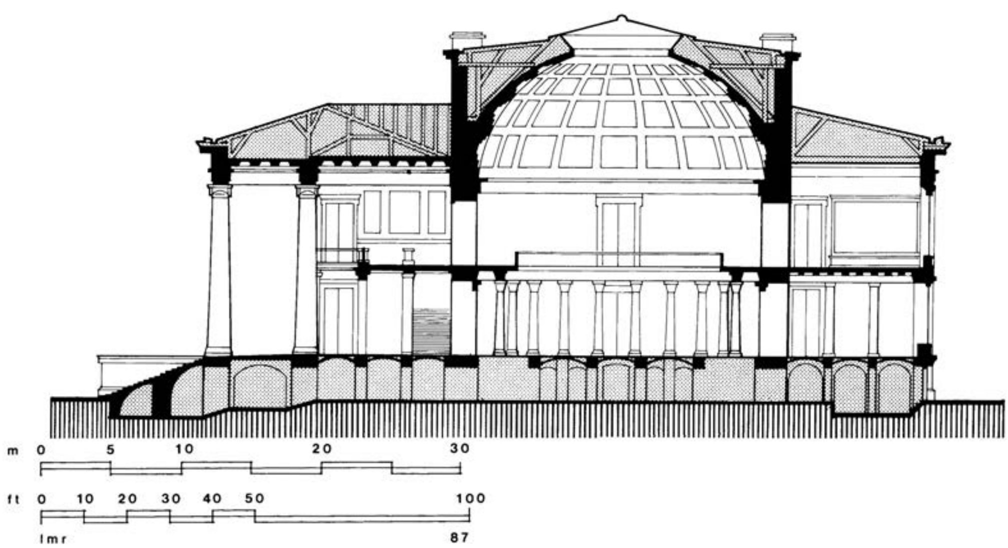
18.2. Karl Friedrich Schinkel, Altes Museum, Berlin, Prussia, Germany, 1822–1830. This major public art museum was built as part of the redevelopment of the capitol of Prussia; its novel plan was carefully designed by Schinkel to provide ease of circulation and good light, and to promote the educational function of the building. From K. F. Schinkel, Sammlung architektonischer Entwürfe *(Berlin, 1865).*



18.3. Altes Museum. Plan of the main floor. Drawing: N. Nguyen, after Schinkel, Sammlung architektonischer Entwürfe *(Berlin, 1865).*

Baroque buildings. The art works to be displayed inside included both sculpture and painting so the building was divided into two zones, with a central Pantheon-like rotunda to house the sculpture, and surrounding galleries for the paintings. Illuminating the paintings was of paramount concern to Schinkel, so he devised a system of galleries arranged around light courts. The court and the outer walls are opened up with tall windows, and perpendicular to these are spur walls or panels on which the paintings could be hung, thus eliminating glare on the varnished surfaces of the paintings.

In the Altes Museum, Schinkel devised a logical plan and a circulation pattern based on a thorough study of the building's function of displaying works of art as an educational task, creating around it a crisply and accurately detailed Greek envelope. It was designed as the ancient Greek architects them-



18.4. Altes Museum. Cross section. The central, domed rotunda was designed to house the sculpture collection. Drawing: L. M. Roth, after Schinkel, Sammlung architektonischer Entwürfe *(Berlin, 1865).*

selves might have done if they had been required to design such a large public museum. In buildings such as this, Neoclassicism became firmly linked with public service and educational aspirations; this museum and Schinkel's other buildings also helped to establish Berlin as the preeminent German cultural and architectural center.

Both von Klenze's and Schinkel's galleries used Greek details selectively, in buildings whose plans were evolved almost solely with a view to solving contemporary functional requirements. They can be called Revivalist because of the fidelity to Greek and Roman source material in their details. In other instances, however, architects duplicated whole Greek temples, in form as well as in detail. Von Klenze himself did this in his memorial temple Walhalla, 1821–1842, a Germanic pantheon commissioned by Ludwig of Bavaria to commemorate the great figures in German literature and history, built atop an immense ziggurat podium high on a bluff overlooking the Danube near Regensburg, Germany. Although the building was given the name of the Norse paradise, it is nevertheless a faithful replica of a Doric Greek temple.

American architects faced a similar need to make buildings express a national character. Following the example provided by Jefferson in his Virginia State Capitol, they built a number of state capitols in the early years of the nineteenth century. Like Jefferson they wanted to give these governmental buildings the image of democracy, and so they attempted to fit all the requirements of state government into building shells patterned after Greek temples. One particularly well-detailed example is the old Kentucky capitol at Frankfort, Kentucky, 1827–1830, by Gideon Shryock, built of white marble. Nearly all these early state capitols were soon outgrown and replaced, but one that was built on an ample scale and continues to house state government is the Tennessee State Capitol Building at Nashville, designed by William Strickland and built 1845–1859.

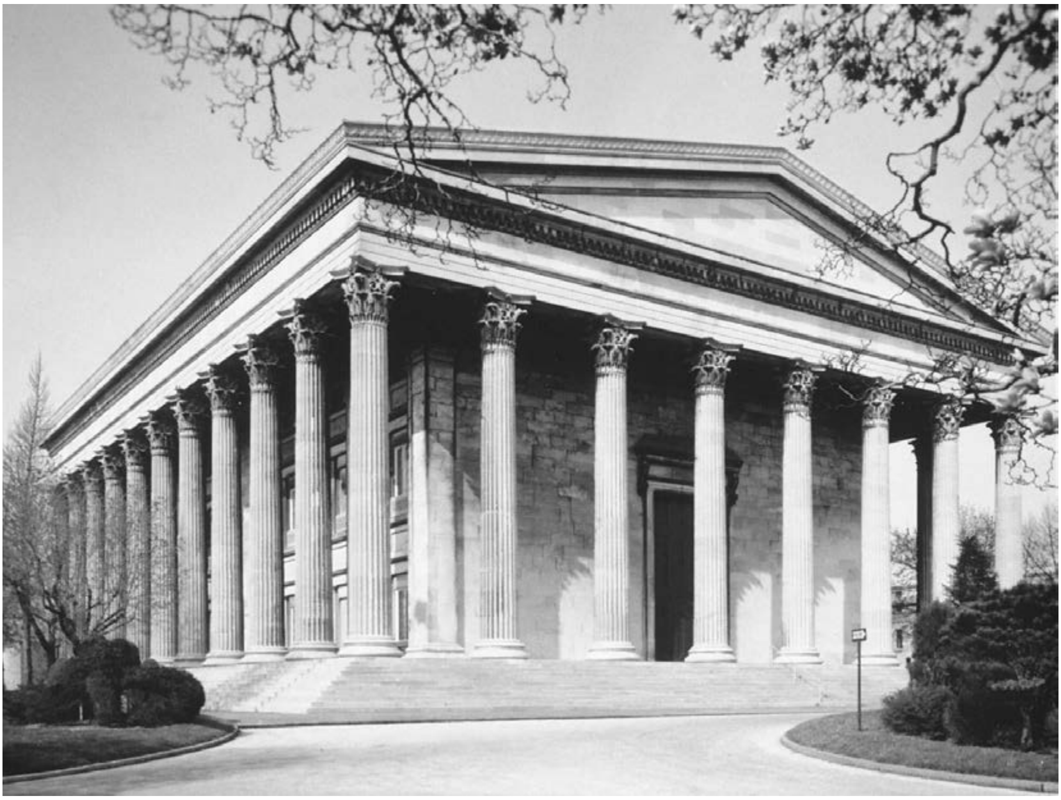
Perhaps the most elaborate of all the American examples is Thomas Ustick Walter's Greek Corinthian temple designed to house Girard College in Philadelphia, 1833–1847. Built entirely of cut stone, it has beautifully and authentically detailed Greek Corinthian columns completely surrounding the temple block, although at the insistence of donor Steven Girard the building does not have the canonical number of columns on the long sides [18.5]. The problem that all Revivalists faced, however, especially those trying to fit modern public functions inside a Classical temple, was that it was not possible to make changes in the established model to allow for modern needs without violating the image. The American sculptor Horatio Greenough recognized this problem and, in 1843, said that his countrymen were going about architecture in a backward manner, trying to bend the Greek temple to contemporary needs. If, he suggested, Americans would only design buildings the way they built their ships, with lean economy of form dictated by function, they would soon create buildings "superior to the Parthenon."[1]

The Gothic Revival

Neoclassicism was only one manifestation of how the interest in history influenced design, for medieval, Egyptian, Asian Indian, and other exotic styles were also being re-created with increasingly correct details. The major alternative to Neoclassicism in public architecture was the Gothic style. Religious and educational activities had been housed in Gothic structures since the earliest colleges and universities had been developed by the Church in the Middle Ages. The use of Gothic forms also corresponded to the more romantic side of eclecticism; for just as the trabeated Neoclassical orders suggested enlightened logic and ennobling probity, so craggy and dark Gothic architecture corresponded to the Romanticists' desire for mystery and irregularity of form.

The Houses of Parliament, London

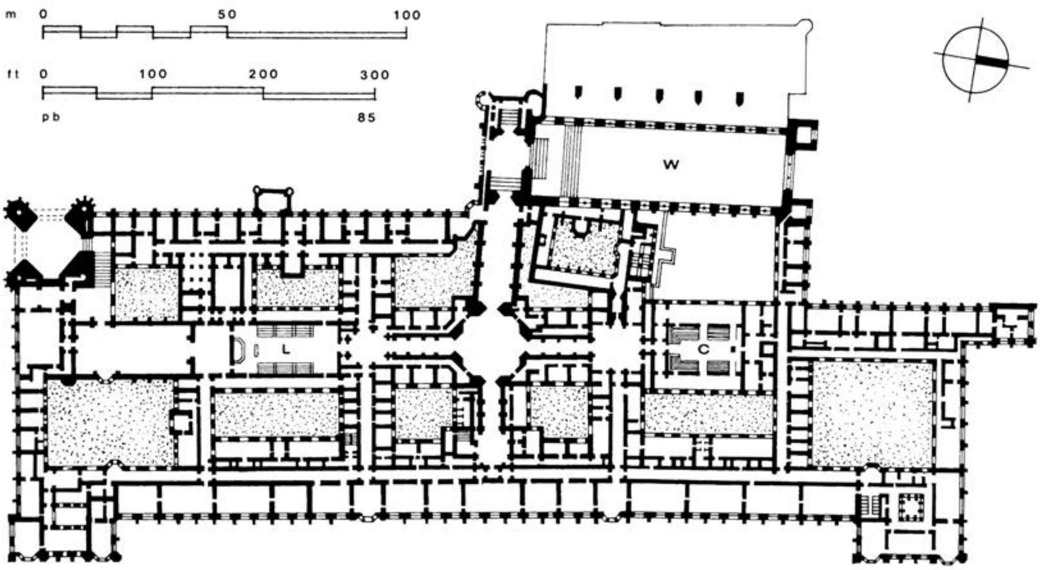
In northern Europe, especially, Gothic architecture was viewed as inherently national in expression, the French and Germans also seeing it as embodying their particular national character, but the English had an affinity for Gothic architecture. This became evident in 1834 following a catastrophic fire that consumed the medieval palace of Westminster, where Parliament had been assembling since the thirteenth century. In 1052 an abbey had been established there by Edward the Confessor, and next to it a royal palace was built and enlarged over the centuries. One major addition was Westminster Hall, in 1397, the great public room with its hammerbeam wooden trusses [see 14.46]. Another was the mid-twelfth-century palace chapel of Saint Stephen. Because subsequent monarchs came to prefer other residences, the palace at Westminster was made available to Parliament, and in Saint Stephen's chapel the upper and lower houses of Parliament alternately sat for debate. It was not an arrangement specifically designed for this parliamentary function, but over the years Parliament adjusted its mode of operation to the spaces provided.



18.5. Thomas Ustick Walter, Girard College, Philadelphia, Pennsylvania, 1833–1847. Required by the donor to be Neoclassical in style, the building was designed by Walter to present extremely accurate Grecian details so as to enhance its educational mission. Photo: Sandak, University of Georgia.

In 1834 royal tax records that had accumulated over eight centuries were burned to make room in the government vaults. The incineration went on nonstop in the palace furnaces for days, and finally one night the heat buildup ignited the wooden structure near the furnaces; by the time the blaze was discovered it was impossible to contain the fire. The ancient houses of Parliament were almost totally consumed, in a great conflagration stirringly depicted in the bold color sketches of the landscape painter Joseph Mallord William Turner.

After the fire was extinguished it was quickly decided that the houses of Parliament should be rebuilt on the same spot. It was also decided that the general style of the new buildings should be medieval, so as to better accommodate the surviving portions of the original buildings, especially Westminster Hall. A competition held to procure the best design was won by the team of Charles Barry (1795–1860), working with the young designer Augustus Welby Northmore Pugin (1812–1852). Barry had already established his reputation as a designer of sensible and elegant Classical buildings, while Pugin and his father had been among the leading advocates of Gothic architecture and had already published several books presenting measured details of thirteenth- and fourteenth-century churches (something like the Gothic equivalent of Stuart and Revett for Greek Classicism). The symmetrically Classical and rationally efficient plan of the new Houses of Parliament was devised by Barry, with two wings balanced about a central circulation corridor and rotunda [18.6]. At the center of each wing was the principal chamber, for the Lords and for the Commons, each surrounded by associated committee rooms, offices, and libraries, all arranged around light courts. On the Lords' side were additional robing rooms and special preparation chambers for the monarch when opening parliamentary sessions. All of this was clothed in the most accurate late English Perpendicular Gothic detail. This style made possible the repetition of many identical small bay units (thereby permitting repetitive cutting of ornamental detail) and also provided for large banks of glass [18.7]. To



*18.6. Sir Charles Barry and Augustus Welby Northmore Pugin, New Palace of Westminster (Houses of Parliament), London, England, 1836–1870. Plan. Although the new Houses of Parliament were designed in the Perpendicular Gothic style to better incorporate portions of medieval Westminster Hall (***W***), the strictly symmetrical plan was based purely on functional needs, reflecting the two governing bodies—the House of Lords (***L***) and the House of Commons (***C***). The stippled areas are internal light courts. Drawing: P. Boundy.*

18.7. Houses of Parliament, London, England. Elevated eastern river facade. Photo: © Royalty-free/Corbis.

provide for better ventilation (poor ventilation being one of the great faults of the original buildings), large plenum chambers were created over the meeting halls into which the warm, stale air rose and was passed to large iron ventilators on the roof. Iron was used for the framing of the roof trusses as well, so as to eliminate combustible material that might contribute to future fires.

Thus the new Houses of Parliament combined a rational plan, carefully devised to enhance functional use, with a new structural material exploited to improve mechanical services and fire safety, and with historical references in the detailing that enhanced the functional meaning of the building in three ways. First, the Gothic details of the new work allowed it to join with the surviving medieval portions in such a way that the line between the two is nearly indiscernible. Second, Perpendicular Gothic, in particular, was viewed by the mid-nineteenth-century Englishman as being an inherently English architecture. And third, because of the long association of Parliament with the medieval palace of Westminster, the Gothic style was viewed as being connected with the parliamentary form of government. In fact, when designing the new chambers for the Lords and Commons [1.5, Plate 26], Barry and Pugin were careful to retain the medieval chapel seating arrangement. Hence, it could be argued that the Gothic style was perhaps the only one that could have been used in building the Houses of Parliament.[2]

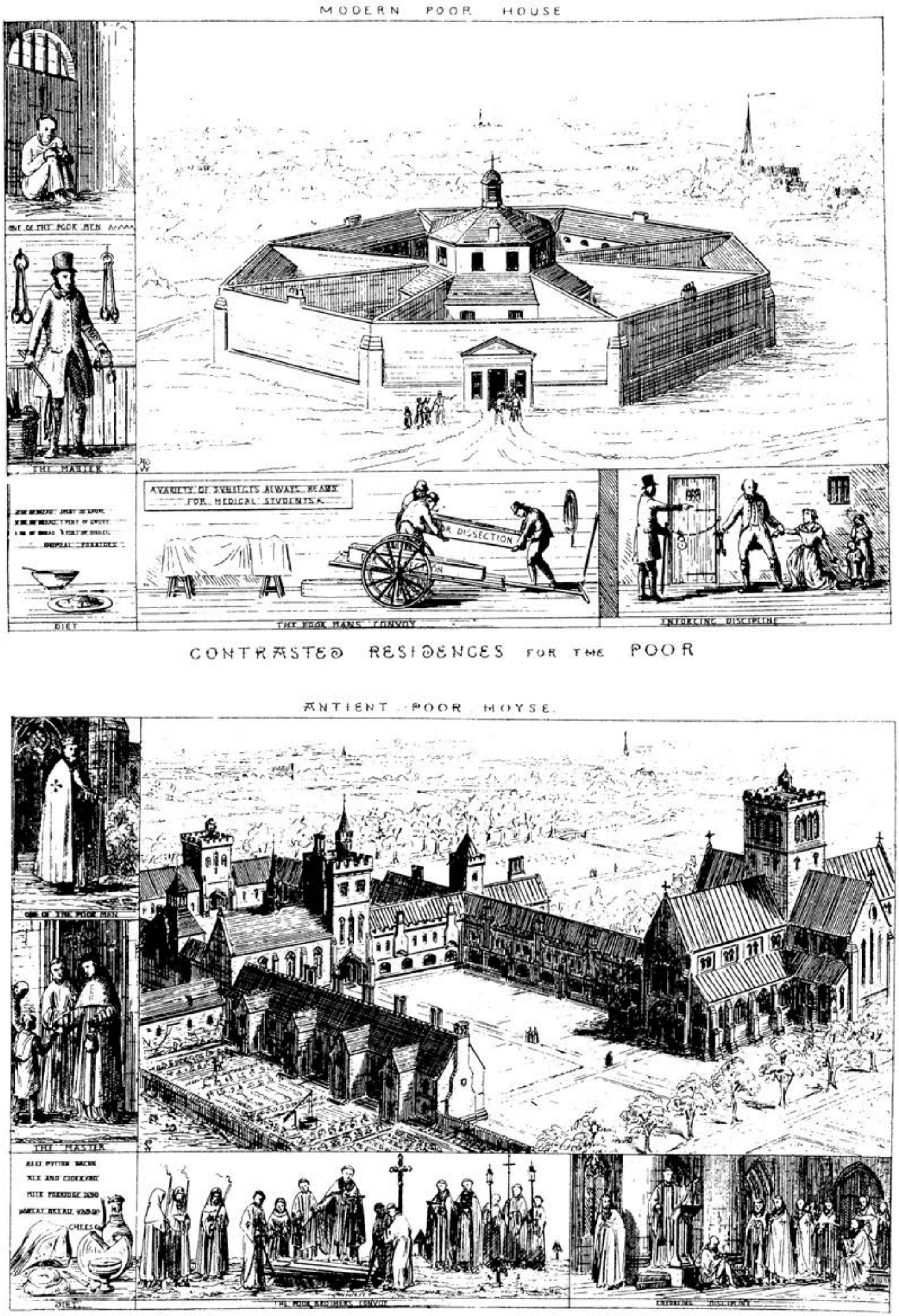
Saint Giles, Cheadle

The revival of the Gothic style coincided with and gave support to the resurgence of mysticism in religion in the Church of England that grew out of Romanticism. The Gothic Revival phase of eclecticism that emerged in the 1840s in England was linked with a liturgical reform movement within the English Anglican Church. Impassioned students at Oxford and Cambridge began a movement to return to the pre-Reformation English liturgy, and this could be best accomplished by a return to the church architecture of that period. The acknowledged arbiter of taste in this revival of archaeologically correct Gothic church architecture was Pugin. In 1836 he had published a highly propagandistic and persuasive book called *Contrasts,* in which he presented side-by-side drawings of fifteenth-century buildings with their nineteenth-century counterparts, which unvaryingly lacked a humane spirit and convincing architectural form [18.8]. Quite obviously, according to Pugin, Gothic architecture had been far better.

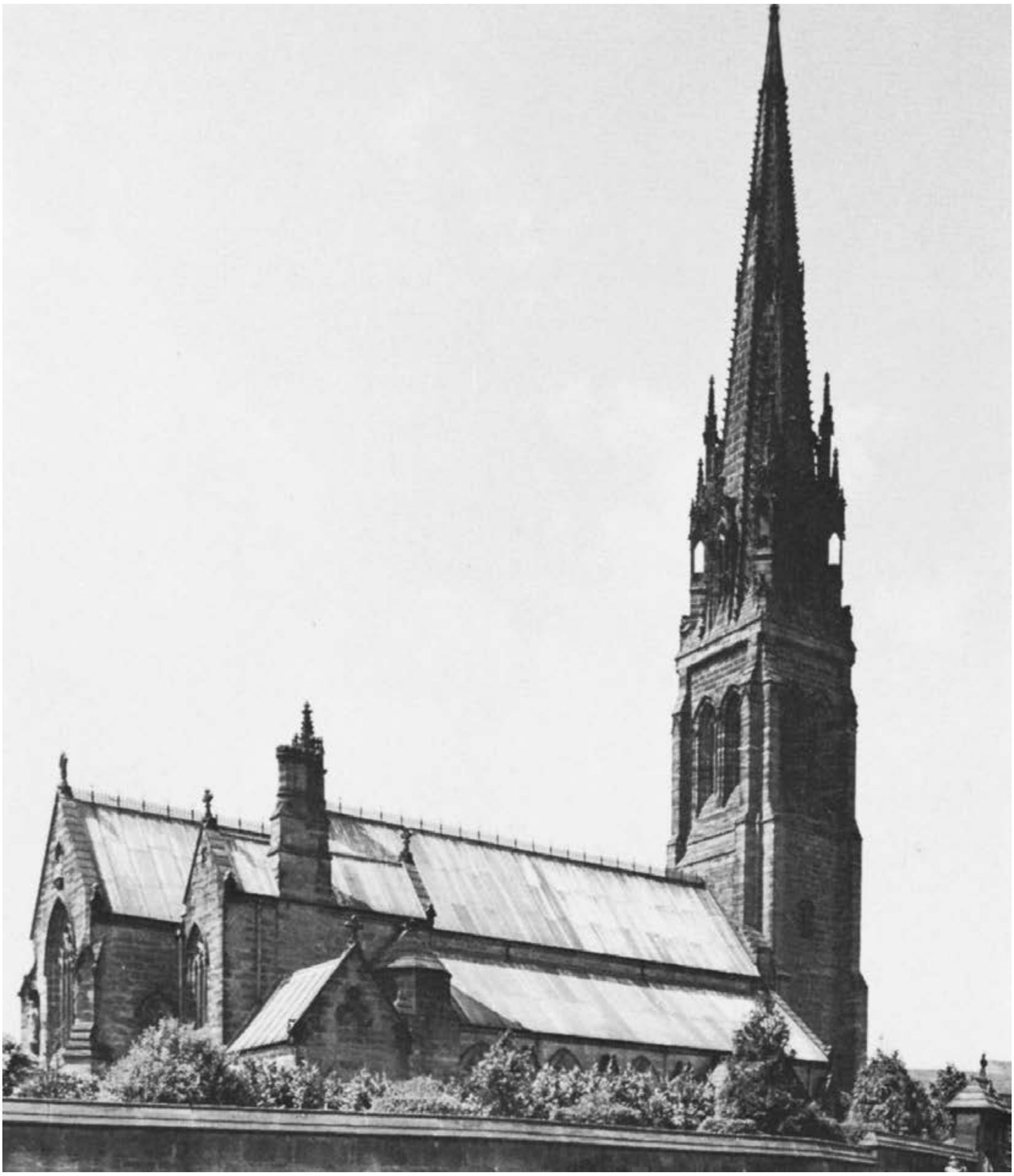
For Anglican churches, the Gothic Revival worked very well, for the reinvigorated architecture fitted perfectly with the building's renewed function. One of the best examples of Pugin's adaptation of fourteenth- and fifteenth-century parish church models is his church of Saint Giles in Cheadle, Staffordshire, 1840–1846 [18.9, 18.10]. The compact plan of the church, with a separately articulated chancel, side porch, and tower, recalls such prototypes as Saint Andrew's, Heckington, Lincolnshire, 1345–1380. In building Saint Giles, Pugin had the fortunate patronage of the Earl of Shrewsbury, who provided ample funds for the building so that Pugin was able to realize the intense and highly colored interior ornamentation he desired. Following Pugin's example, in England and in the United States Gothic architecture was used extensively for churches and collegiate buildings, although few were as richly embellished as Saint Giles.

Egyptian Revival

The two major stylistic categories just described—Greek and Roman Classicism, and the Gothic Revival—were employed because of strong associational ties: Classicism with governmental and commercial buildings, and Gothic with religious and educational (and in some cases governmental as well because of nationalistic links). Other historic styles were also called upon for specialized uses. One that had not been employed for almost two thousand years was Egyptian architecture. Intensive scholarly interest in Egyptian art and architecture had been stimulated by various individuals, including Piranesi, but especially by the French publication by the Compte de Caylus, *Recueil d'antiquités égyptiennes, étrusques, grecques et romaines* (Paris) in seven volumes, 1752 to 1767. It should be kept in mind, however, that for centuries few Europeans had traveled to Egypt. What truly constituted the art and architecture of Egypt was very imperfectly understood. Nor could anyone make sense of the carving covering Egyptian monuments, clearly some sort of writing. Interest in Egypt remained especially high in France, providing some basis for the adventurous scheme devised by Napoleon in 1798 to invade Egypt and cut off England's route to India, its most valuable colony. The Egypt campaign of 1798–1799 was in military terms a failure, but the intensive contact with the ancient culture of Egypt resulted in a series of publications, including the huge production of the official *Commission des Sciences et Arts d'Égypte*, the twenty-one-volume, illustrated *Description de l'Égypte* produced from 1809 to 1828.[3]

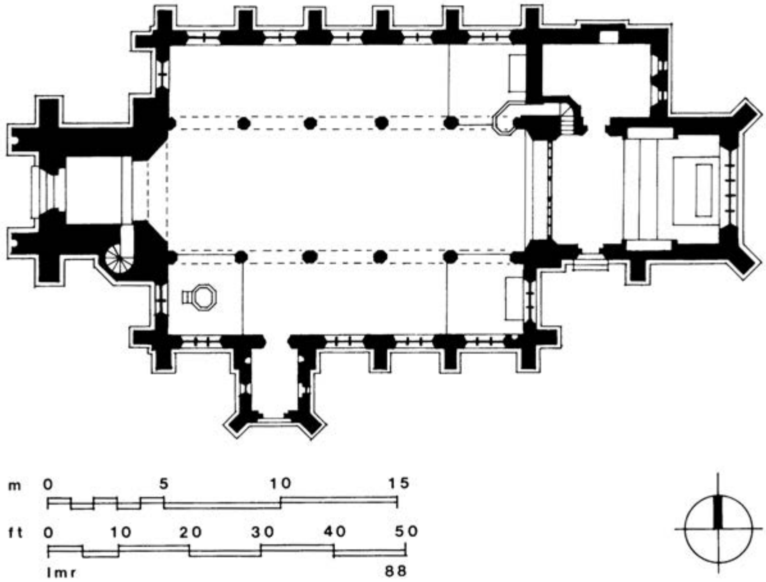


18.8. A.W.N. Pugin, plate from his Contrasts *(London, 1836). This pair of views contrasts the generous care of the poor in the fifteenth century in a Christian almshouse with the impoverished provisions of a nineteenth-century English poorhouse. Pugin suggested that the character of architecture reflected the quality of social concern and interaction. Photo: Courtesy, Avery Library, Columbia University.*



18.9. A.W.N. Pugin, Church of Saint Giles, Cheadle, Staffordshire, England, 1840–1846. For his revitalized church architecture, Pugin drew from English parish churches of the fourteenth and fifteenth centuries. Photo: National Monuments Record.

The Egyptian Revival style was likewise used for buildings with strong associational links and, hence, came to be used for funerary buildings, gates to cemeteries, medical schools, and jails and prisons due to the massiveness of construction. One particularly interesting application is found in the small library for the small town of Devonport, England, not far from Plymouth, designed by John Foulston in 1823 [18.11]. The small building is all the more interesting since Foulston published a small book on *The Public Buildings Erected in the West of England* (London, 1838), explaining the rationale behind the cluster of buildings in various historic styles he created for Devonport. While appreciating, he wrote, the "grandeur and exquisite proportions of the Grecian orders, the author has



18.10. Saint Giles, Cheadle. Plan. Just as in medieval churches, the chancel area containing the altar is a separate smaller space. Drawing: L. M. Roth.

18.11. Devonport Town Hall, Ker Street, by John Foulston. Watercolour. Devonport, Plymouth, England, 1823. Foulston designed a new town center for Devonport, combining Greek, Egyptian, and other exotic historic styles to achieve a "picturesque effect." Photo: Plymouth City Council (Arts & Heritage).

never been insensible to the distinguishing beauties of the other original styles; and it occurred to him that if a series of edifices, exhibiting the *various features of the architectural world* were erected in conjunction, and *skillfully grouped,* a happy result might be obtained. Under this impression, he was induced to try an experiment (never before attempted) for producing a *picturesque effect,* by combining, in one view, the Grecian, Egyptian, and a variety of the Oriental [styles]."[4] Hence, Foulston's reasons were both for picturesque effect and for educational impact.

Creative Eclecticism

There were limits to the literal reuse of established architectural forms, as the many ill-formed variations on the Greek temple made clear by mid-century. For five decades such replication was feasible, but by 1850 it was no longer possible to fit the ever-expanding needs of the nineteenth century into predetermined fifth-century BCE building envelopes. The alternative was a new approach to building design in which historically derived details were inventively manipulated in buildings planned strictly in accord with contemporary functional requirements. At first, the historical references were employed in highly personal, creative, and often idiosyncratic ways, but by the 1880s, due to more extensive and better-informed education, creative eclectic designs had greater restraint and archaeological accuracy in proportion and detail. The term ***creative eclecticism*** was developed in the 1950s to describe this late-nineteenth-century mode of design by historian Carroll L. V. Meeks, growing out of his detailed study of European nineteenth-century train stations; it was the best way he could describe the architects' inventive use of traditional details and forms.

Second Empire Baroque

For public buildings the Classical alternative was developed in Paris by the French architects Louis Visconti and Hector-Martin Lefuel in the extensive additions they made to the Louvre, Paris, 1852–1857 [18.12]. What they created was a lavishly embellished variation on the French Baroque in what came to be called Second Empire Baroque, since their patron was Louis-Napoleon, who declared himself emperor of the Second Empire, inspired by the empire of his more famous uncle, Napoleon Bonaparte. The Louvre additions housed, in separate sections, residential quarters, government ministries, and portions of the palace converted to an art museum.

The richly embellished character of Second Empire Baroque was even further elaborated in the sumptuous new opera for Paris built in 1861–1875 by Charles Garnier (1825–1898) [18.13, 18.14, 18.15, 18.16]. During the mid-twentieth century this building was considered by knowledgeable modernist architects and critics to represent the

18.12. Louis Visconti and Hector-Martin Lefuel, the new Louvre, Paris, France, 1852–1857. The richly embellished French Neo-Baroque style was developed by Visconti and Lefuel to integrate the new additions to the building with the original portions of the Louvre, built in the sixteenth and seventeenth centuries. Photo: Giraudon/Art Resource, NY.

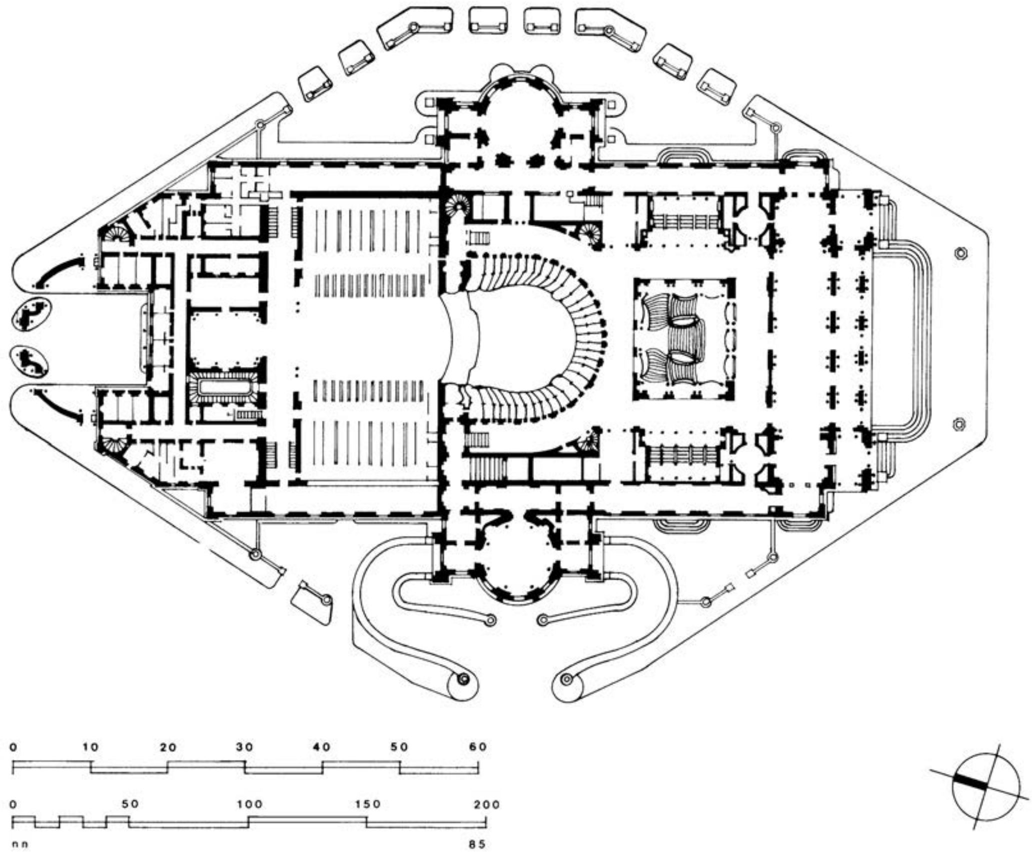
18.13. Charles Garnier, Paris Opéra (Opéra Garnier), Paris, France, 1861–1875. Garnier designed the exterior to accomplish several public functions, including expressing each of the three major sections of the building, providing a fitting terminus to the new Avenue de l'Opéra, and celebrating the act of going to the opera. Photo: Art Resource, NY.

lowest point of rationality in design, but in fact Garnier had made a careful study of how the opera functioned in Paris. Hence, he developed a carefully plotted circulation pattern for each of the four types of opera-goers he identified: those arriving by carriage, those on foot, those who already had tickets, and those who bought them at the box office. But above all, he perceived that late-nineteenth-century Parisians went to the opera principally for social reasons, rather than to hear the music—they went "to see and be seen." Accordingly, Garnier used a traditional horseshoe auditorium with layered galleries around the auditorium so opera-goers could better see each other. But most important, by far the greatest proportion of space in the building is devoted to circulation spaces and lobbies, focused on the elaborate staircase, which provides the perfect stage on which the opera-goers can parade and exchange greetings [18.16, 18.17, p. 504]. Garnier carefully studied the personal space maintained by walking couples passing each other while promenading, and these spatial modules he employed in designing the width of the major lobbies. In many ways, on reaching the auditorium after having passed through the staircase and the successive lobbies, an opera-goer may have experienced something of an anticlimax.[5]

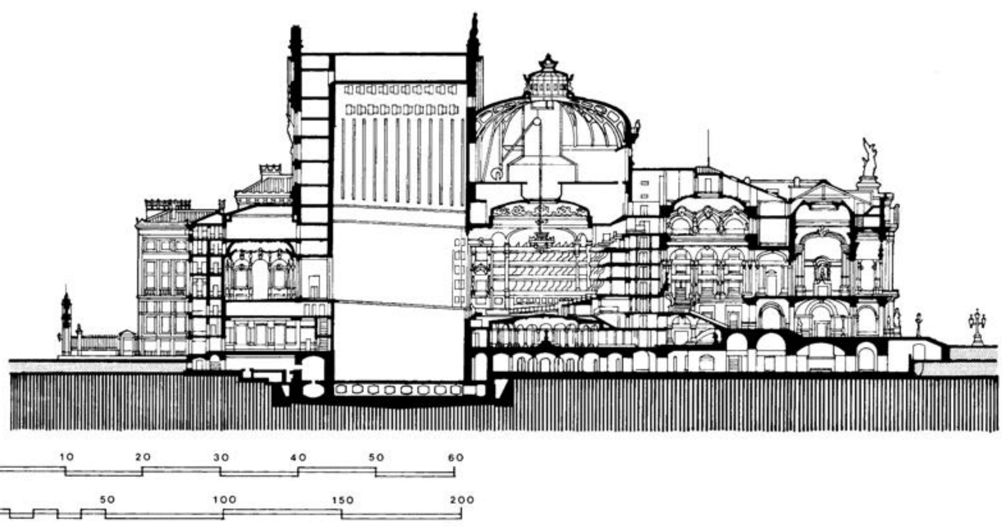
High Victorian Gothic

The Gothic alternative in this more creative phase of nineteenth-century eclecticism has come to be called High Victorian Gothic, because of its elaborate character, its development in England during Victoria's reign, and its creative and colorful use of Gothic forms. It likewise appeared about 1850, and is well illustrated by the Midland Grand Hotel designed by Sir George Gilbert Scott (1811–1878) as the head house for the Saint Pancras Railroad Station, London, 1868–1874 [18.18, 18.19, Plate 11]. Now converted to new uses, it is a long J-shaped building fitted to its irregular site, originally not only providing facilities for ticket offices, waiting rooms, and baggage handling for the station but also serving as a terminus hotel for travelers, with lounges, dining rooms, and private rooms on the upper floors. Its skyline is among the most picturesque in London, with a variety of clock towers, dormers, chimneys, ventilators, and miscellaneous projections. The colorful character of the profile is enriched by the multiple colors of the building materials, including red brick, stone, slate, and marble of various hues in the polished columns.

This external representation of internal function through varied building masses, and the expressive



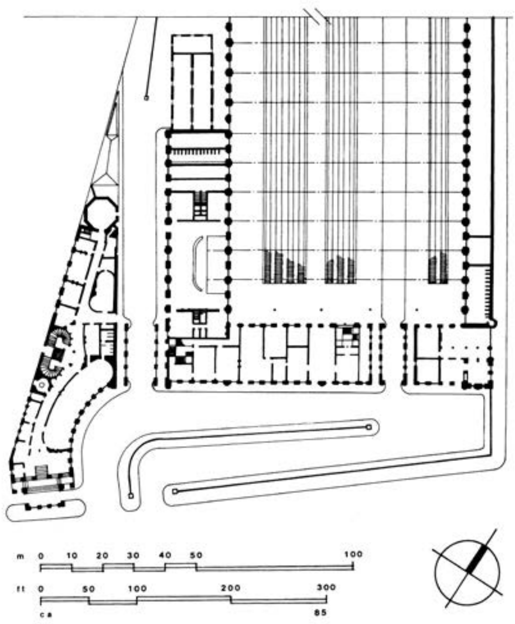
18.14. Paris Opéra. Plan. Drawing: N. Nguyen, after Garnier.



18.15. Paris Opéra. Section. Drawing: N. Nguyen, after Garnier.

18.16. Paris Opéra. Staircase. Revealing the important social aspect of opera attendance in Paris, the staircase space and the promenade gallery next to it represent the largest area in the building, greater than the auditorium. Musée de la Ville de Paris, Musée Carnavalet, Paris, France. Photo: Scala/Art Resource, NY.

18.18. *Sir George Gilbert Scott, Saint Pancras Station and Midland Grand Hotel, London, England, 1868–1874. Built of multicolored stone, brick, and other materials, this vigorously modeled building celebrated the power and status of the railroad. Photo: National Monuments Record.*



18.19. *Saint Pancras Station and Midland Grand Hotel. Behind the hotel rises the great train shed covering all the tracks. Drawing: C. Amberson.*

use of various building materials in their natural colors, derived from the writings of the architectural critic John Ruskin (1819–1900). Although not an architect, Ruskin exerted a profound influence on architectural development, primarily through two books. In *The Seven Lamps of Architecture* (London, 1849), he argued in favor of seven criteria: the use of functionally expressive ornament, truth in expression of building materials and structure, expressive massing, beauty derived from observation of nature, bold and irregular forms, durable construction, and adherence to traditional Christian architectural forms (that is, Gothic architecture). In his other highly influential work, *The Stones of Venice* (London, 1851, 1853), he extolled the architecture of Venice, suggesting that it provided the perfect point of departure for developing a modern Gothic architecture suited to a capitalist, mercantile culture. It was also a highly colored architecture. In the Midland Grand Hotel, Scott showed how Ruskin's arguments could be applied to real situations.

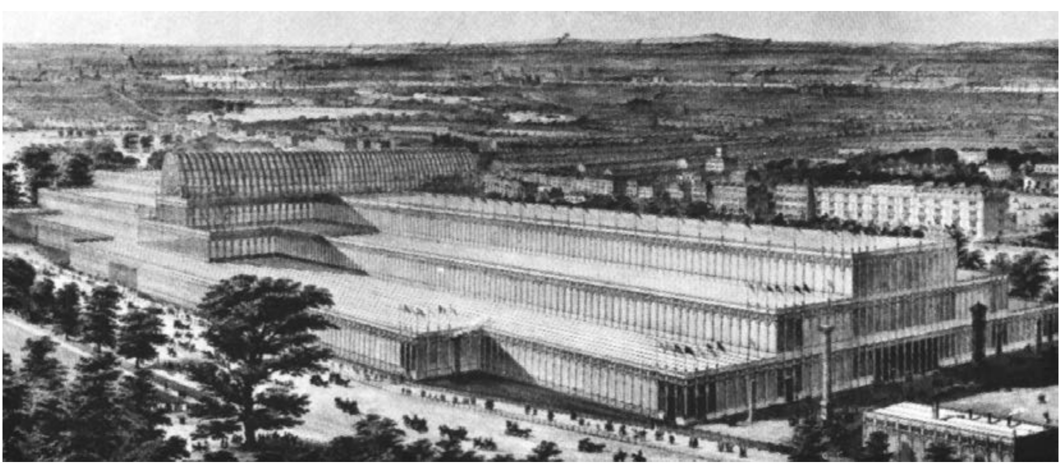
The Architecture of the New Industrialism

The Impact of Industry

In the nineteenth century there arose building needs that had never existed before, leaving architects perplexed as to how to design the required structures. At the turn of the eighteenth century, one new building type that appeared was the factory, but in most cases it was designed not by architects but by company engineers; only in some rare cases were architects called up to design the administrative offices of companies. One striking instance is John Marshall's Flax Mill in Leeds, 1838–1841, designed by Joseph Bononi in a massive Egyptian style. For the most part these early textile mills were long, rectangular masonry shell buildings with walls opened up with windows as large as possible [see 17.32]. Internal space was optimized by using the slenderest cast-iron columns to carry cast- or wrought-iron beams. In the best construction, the floors were supported by narrow brick segmental vaults spanning between the beams, covered by a light concrete floor slab, resulting in a structure that was fully fire resistant. In less expensive construction, thick wood posts and floor girders made up the internal frame. The long rectangular reach of these factories was necessitated by the belt and pulley system used to transmit rotary power from the water wheels (and, later, steam engines) to all the internal machinery. So the final building form was dictated by what worked best for the layout and operation of the machinery.

Another result of this factory building system was the de-facto standardization of prefabricated parts in the cast-iron columns and wrought-iron beams. The same technique also was employed for the production of building parts used in putting up garden greenhouses to protect and nurture the exotic tropical plants being brought to England and other areas of northern Europe.

It was at mid-century that the worlds of industrial building component manufacture, garden greenhouse building, and public architecture intersected. Seeking to highlight industrial manufactures (especially English manufacturing), in 1850 Prince Albert and his supporters conceived of mounting a comprehensive international exhibition of industrial products, the first world's fair. Various executives and architectural committees were set up and the exhibition was scheduled for 1851. The most notable English architects of the day submitted designs for the exhibition building. Not only were none found satisfactory in design, none could be built in the time remaining before the exhibition was to open. The solution to this problem was provided not by an architect but by Joseph Paxton (1801–1865), a horticulturalist and a builder of greenhouses. He proposed a large building, essentially a grandly oversized greenhouse, to be assembled of identical modular cast-iron columns and beams, with a wall membrane fabricated almost entirely of standardized panes of glass [18.20]. His initial sketch was drawn on June 11, 1850; in eight days he prepared the necessary drawings for approval; in July a contract for construction was accepted; and within nine months all



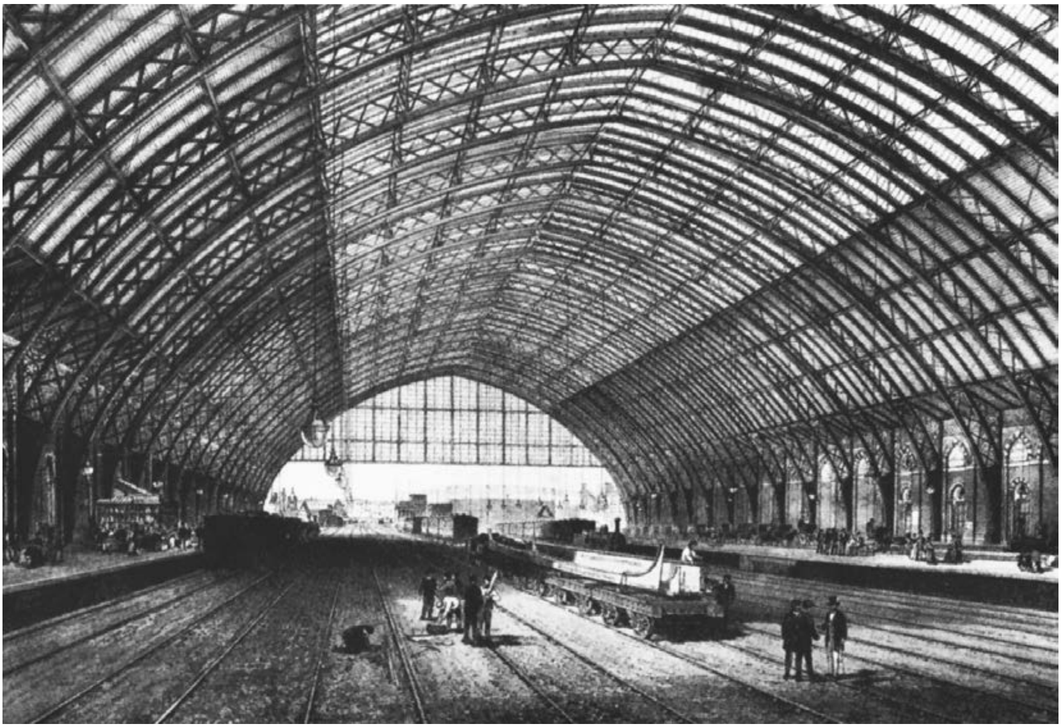
18.20. Sir Joseph Paxton, Crystal Palace, London, England, 1851 (destroyed 1936). Elevated view. Photo: Victoria and Albert Museum, London; Crown Copyright.

parts had been manufactured and shipped to Hyde Park, London, ready for assembly. On May 1, 1851, the building was opened with great fanfare by Queen Victoria. It was almost immediately dubbed the Crystal Palace by the London magazine *Punch*.

Paxton made full use of all that the English had learned of metal building technology in the construction of train stations and greenhouses in the preceding two decades, but his innovations produced a giant leap in building scale, in the prefabrication of standardized building parts in factories across England, and in methodical organization of the building process. The Crystal Palace covered an enormous area, 1,848 by 408 feet (563.3 by 124.4 m), with cast-iron columns set 48 feet (14.6 m) apart. As in no building before, Paxton had created a building in which the volume enclosed far surpassed the mass of the building. Compared to all prior buildings, it was like a bubble, and so Paxton introduced cross bracing in wrought-iron diagonal rods in the upper parts of the structure to resist lateral wind pressures [18.21]. But he also created a transparent building without visual limits. Its cast-iron members were painted predominantly blue, so they tended to merge with the sky. Even better, it was a demountable building, and when the exhibition was over the parts were disassembled and removed to Sydenham, where an enlarged Crystal Palace was re-erected and served as a cultural center for London until destroyed by fire in 1936.

The greatest limitation of historical styles was in meeting the growing demand for such large public

18.21. Crystal Palace. Interior view of the central transept, May Day 1851, showing how the building incorporated entire ancient trees already existing on the building site in Hyde Park. From: B. Dunlop and D. Hector, eds., Lost Masterpieces *(London, 1999).*



18.22. W. H. Barlow and R. M. Ordish, engineers, Saint Pancras Station Train Shed, London, England, 1863–1865. Behind the hotel rises the great train shed covering all the tracks of the station; the clear span of this metal and glass roof is 234 feet (71.3 m). Photo: Science Museum, London.

buildings as train stations. Boulton and Watt's steam engine was put on wheels in 1804 to move mining cars, and in 1825 the first passenger railway began operation between Darlington and Stockton, England. During the following decade other passenger rail systems were set up in England, with small depot buildings erected by the sides of the tracks, sometimes with the roofs extended toward the tracks to provide cover for passengers. Within thirty years the technology of rail transport was fully developed and several different types of rail stations had been defined. Perhaps never before in human history had a building need arisen, been solved, and pushed to its limits so quickly as in the invention of the railroad station.[6] (In a few years the same rapidity in invention and perfection would occur in the development of the high-rise office building in the United States.)

Since Roman times, buildings covering large spans had been built with wooden trusses, but the railroad buildings posed a particular challenge. What was required were buildings for locomotive roundhouses and passenger depots that could cover the tracks and yet not be susceptible to fire caused by embers blown from the smokestacks. The rapidly developing technology in building in iron provided the answer, allowing extremely light trusses to be made of wrought-iron bars and rods. The railroad station reached a culmination in the vast arching metal shed built at the Saint Pancras station in London, 1863–1865, by the Midland Railway Company, designed by the engineers W. H. Barlow and R. M. Ordish [18.22]. Barlow, who was the engineer of the Midland Railway Company, had earlier helped Paxton in the design of the Crystal Palace. Like the Crystal Palace, this train shed is a great bubble of vast Piranesian dimensions but little building mass—a structure in which, compared to the massive masonry of Roman and even Gothic construction, the greatest possible work is done by the least amount of material. The arch of the shed spans 234 feet (71.3 m) and rises 100 feet (30.5 m) with a slightly pointed profile; its length is 689 feet (210 m). In actuality the shed was built first and the head-house hotel built afterward, but it would be a mistake to assume that Barlow or other nineteenth-century observers saw in this juxtaposition of dissimilar elements any profound discordance. Only mid-twentieth-century observers felt that the shed was superior to the hotel, because it openly exploited metal structure. To nineteenth-century users each part of the building was well designed to serve its distinct appointed function—the shed to protect passengers and baggage handlers from the weather, and the head-house hotel to advertise the railroad and provide the most commodious and luxuriant accommodations for travelers. Because the symbolic connotation, the meaning, of each section was quite different, the forms and structures correspondingly differed.

Few train sheds exceeded Saint Pancras in size, and the only structures that did were temporary buildings for exhibitions, the lineal descendants of Paxton's Crystal Palace. The best known was the cavernous Palais des Machines, built to house the large industrial exhibits at the World's Fair in Paris, 1889, celebrating the centennial of the French Revolution[7] [18.23]. Designed by the architect Ferdinand Dutert in 1886, in collaboration with the engineers Contanmin, Pierron, and Charton, it was an enormous pointed barrel vault 1,407½ feet (429 m) long, with a clear span of 377¼ feet (115 m), rising to a height of 142½ feet (43.5 m). Twenty transverse trussed arches supported the roof. As never before, the forces of nature pulled on this building, for its huge wrought-iron and steel structure expanded and contracted over the course of the day as the sun passed from one side to the other, during the changes in temperature from midday to the cold of night, and during the changes in temperature from summer to the dead of winter. Accordingly, the trusses were hinged at their bases and at the crown, so that they might bend and flex at those points and not tear themselves apart. There seemed to be a denial of weight as well, for there were no massive stone or concrete buttresses to resist the lateral thrust at the bottom of the arch. Instead the huge trussed arches came to rest on the pins of large hinges, the lateral forces taken up by tensile rods running under the floor. Like the Crystal Palace, the Palais des Machines was translucent, with glazed roof and end walls, and this apparent openness (particularly in photographs taken before the exhibits were installed) accentuated the already vast scale. Such buildings as this and the great mid-

18.23. Charles-Louis-Ferdinand Dutert, with Contanmin, Pierron, and Charton, Palais des Machines, Paris, France, 1886–1889. Designed to house all the major machinery exhibits of the Paris World's Fair of 1889 and marking the centennial of the French Revolution, this vast shed had a span of 377.3 feet (115 m). It is shown here just after construction ended and before the exhibits were installed. From N. Ponente, The Structures of the Modern World, 1850–1900 *(New York, 1965).*

nineteenth-century train sheds, all of them nearly pure structure, were the logical extension of the insistence on rationalism in design begun by Laugier and Lodoli in the eighteenth century.

One objective of the Palais des Machines was to cover the largest horizontal area possible for exhibition display, without any interfering supports, while another was to celebrate the abilities of French engineers and industrial production. Unfortunately the vast horizontal structure was temporary, and the iron was recycled for later reuse. There was, however, another equally ambitious and awe-inspiring structure proposed for the Paris fair, also proposed to be temporary, or at least to stand for only twenty years. Events would take a different direction, however. This second, even more daring demonstration of French scientific and industrial prowess was a soaring tower proposed by the engineer Gustave Eiffel, consisting of four curved truss-framed legs of iron latticework rising to join into one shaft and reaching the almost unimaginable height of 986 feet (300 m) [18.24]. The design was prepared beginning in 1884 by the chief engineers in Eiffel's office as a dramatic centerpiece for the upcoming revolutionary centennial exposition. Eiffel was already well known, a most successful engineer entrepreneur who, with his engineering firm, had built many celebrated railroad bridges in France and elsewhere. The overall design was then modified by Eiffel himself and publically presented, only to prompt an outcry among the literary and artistic community in Paris. Prominent cultural luminaries such as Charles Garnier, Adolphe Bouguereau, Guy de Maupassant, Charles Gounod, and Jules Massenet petitioned to stop construction of "this useless and monstrous Eiffel Tower," as they called it, fearing that they would forever "see stretching like a blot of ink the hateful shadow of the hateful column of bolted sheet metal." Others, particularly Eiffel himself, responded, extolling the tower as a symbol of French industrial progress so that the protest had no effect. When the tower opened in May 1889, and visitors were able to ascend to the upper terraces or even to the very top, attitudes changed. Writer Guy de Maupassant, however, reportedly had lunch at the restaurant incorporated on the first terrace every day during the fair because, he said perhaps sardonically, it was the only place in Paris where he was not forced to see the structure.

The tower was constructed of a form of very pure wrought iron; steel in such large quantities was not yet available in France, but perhaps the wrought iron was selected for its flexibility. As Eiffel knew well from his early large bridges over deep valleys, lateral wind forces were sometimes more significant than the vertical weight of the structure or even its dynamic load when trains crossed over. Hence, the widely spaced feet of the tower were necessary. (The large semicircular arches springing from and connecting the four feet are largely decorative.) Because the tower was built of open lattices there is little surface area to catch the wind, so that horizontal movement is only about 4.7 inches (12 cm). As Eiffel also knew well, exposure to the sun during the day, and changes in temperature over the course of the year, would cause the tower to expand and contract; its height varies during the course of the year by 6 inches (15 cm). The open latticework structure means that the tower's weight is not nearly as great as people imagine. The square column of air up to the stratosphere over the tower's base weighs more than the structure itself. Aside from its worldwide popularity with tourists (reportedly, it is the most visited monument in the world), there was some thought of dismantling the Eiffel Tower in 1909, but by that time its importance as a transmission tower resulted in its preservation. Now the tower has become the instantly recognized symbol of Paris and is dearly loved so that no one complains that it must be repainted, top to bottom, every seven years. Nor does anyone complain about the "blot of ink" shadow that daily sweeps over Paris rooftops.

Industry and Urban Growth

The relocation of the population that had begun in the eighteenth century, first in England and then across Europe, expanded and accelerated as the nineteenth century began. Old cities such as London grew from just under a million inhabitants in 1800 to nearly 4.3 million by 1900. Paris expanded from over a half-million in 1800 to 2.5 million in 1900. Industrial cities in Great Britain—such as Manchester, Birmingham, Liverpool, and Glasgow—which all had populations of about 70,000 to 80,000 at the beginning of the century, grew to almost three-quarters of a million each by the end of the century. In the United States the rate of urban growth was even greater, for New York, which had 63,000 people in 1800, was second only to London in 1900, with 2.8 million. Even more dramatic was the explosive growth of Chicago, which had fewer than 30 permanent residents in 1833, when it was formally established; by 1900 Chicago had more than a million inhabitants and was the sixth-largest city in the world.[8]

The results, most especially in those cities spawned by the proliferating factories, tended to be

18.24. Gustave Eiffel, Eiffel Tower for the World's Fair, Paris, France, 1884–1889. At 300 m (986 ft), this wrought-iron structure was for decades the tallest structure in the world. Photo: © nobleIMAGES/Alamy.

grim indeed. The English author Charles Dickens (1812–1870), whose sense of public moral responsibility was especially keen, sketched a revealing caricature of the mid-nineteenth-century no-nonsense industrial city Coketown in his novel *Hard Times* (1845). Coketown, he wrote, was a creation of economic determinism.

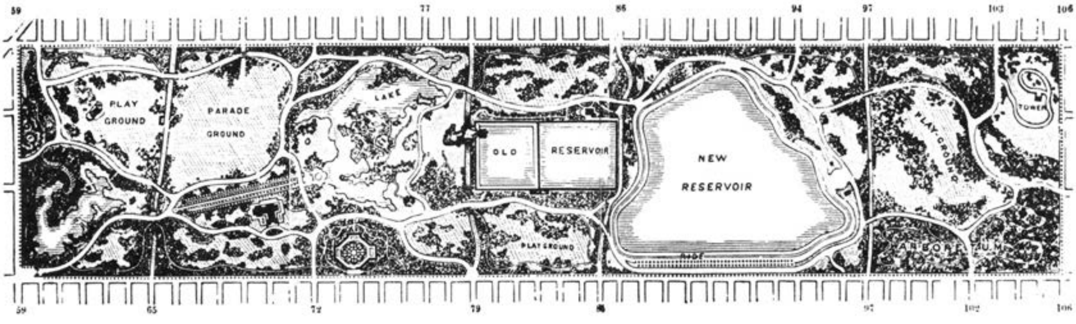
> It was a town of machinery and tall chimneys, out of which interminable serpents of smoke trailed themselves forever and ever, and never got uncoiled. It had a black canal in it, and a river that ran purple with ill-smelling dye, and vast piles of building full of windows where there was a rattling and a trembling all day long, and where the piston of the steam-engine worked monotonously up and down like the head of an elephant in a state of melancholy madness. . . . You saw nothing in Coketown but what was severely workful . . . everything was fact between the lying-in hospital and the cemetery, and what you couldn't state in figures, or show to be purchasable in the cheapest market and saleable in the dearest, was not, and never should be, world without end. Amen.

The Restorative Power of Nature: Frederick Law Olmsted and Public Parks

When the Industrial Age (c. 1750–1850) was well under way, Charles Dickens realized that, without intervention, its dehumanized workers would continue to be isolated from any connection with the natural world. The American landscape architect Frederick Law Olmsted (1822–1903) also perceived this disconnection and came to realize that landscaped public parks could be an antidote. Olmsted is often considered the father of the modern profession of landscape architect, but only through long and arduous work experience did he learn what a socially beneficial endeavor it could be. After abandoning college studies due to eye-damaging sumac poisoning, he farmed on Staten Island, New York, where he closely studied horticulture and experimental gardening and cultivation; these activities eventually brought him into close contact with pioneering landscape gardener and author Andrew Jackson Downing (1815–1852). Olmsted also worked as a seaman, merchant, and journalist; chief among his early journalistic accomplishments was a series of essays commissioned by the *New York Daily Times,* published 1852–1857, on the impact of slavery in the American South. From that experience arose a passion to improve the lot of the poor, and from travel experiences came his idea for how that might be done through landscape design.

In 1850, Olmsted, then age twenty-eight, visited England to study public gardens. In Birkenhead Park (near Liverpool), he was deeply impressed by the many ordinary people using and enjoying "their" new park, built with public tax funds. Designed and built in 1843–1847 by English landscape architect and gardener Joseph Paxton (soon to design the Crystal Palace in London), the 125-acre park had been sculpted with the excavation of two lakes and the laying of winding carriage drives and public walkways; artistically designed bridges crossed the lakes, and row-houses lined the irregular perimeter. Olmsted was astonished, both by the successful social purpose of the park and by its design, especially the rock-work, the plantings of shrubs and ferns, the beds of flowering plants, the carefully tended lawns, the ornamental pavilions, and the walks and drives. "And all this magnificent pleasure ground is entirely, unreservedly, and for ever, the people's own. The poorest British peasant is as free to enjoy it in all its parts as the British queen."[9]

The United States had nothing like it, but a movement was gradually gaining momentum to create a public park in New York City, then busily filling up every square foot of its constricted island with businesses and houses. Landscape gardener Andrew Jackson Downing had already begun promoting this proposal and would likely have been its designer had he not died. An open competition for the park plan, held in 1857, was won by the team of Frederick Law Olmsted and Calvert Vaux, a transplanted Englishman who had come to New York to be Downing's architectural partner. It was a most unpromising site—a long, rigidly squared rectangle running down the center of Manhattan Island, filled with rough ridges of schist rock erupting through the soil (the lands closer to the flanking rivers had been held back by business owners unwilling to yield such valuable riparian real estate for a project they then considered totally pointless). Moreover, to maintain communication across the park, every seven blocks or so was to be a major cross-town thoroughfare. To separate this cross-town traffic from the carriage drives, bridle paths, and pedestrian walkways, the streets were pushed somewhat down, using bridges and tunnels to carry the drives and walks within the park. Masses of trees were planted to define large meadows for recreation, while the slightly lower areas of the original landscape were dredged to create several irregular lakes for pleasure boating, with artistic bridges to accommodate the crossing drives and walks that meandered through the trees [18.25]. While the



18.25. Frederick Law Olmsted and Calvert Vaux, Central Park, New York, NY, designed 1857, built over the decades following. Within an awkward long rectangular site, Olmsted and Vaux designed a recreational landscape with open meadows framed by trees, placing the cross-town streets below grade so that walkways and carriage drives could pass over them. From J. G. Fabos, G. T. Milde, and V. M. Weinmayr, Frederick Law Olmsted, Sr. *(Amherst, MA, 1968).*

southern half of the park had a tamer, gentler natural character, the northern half was deliberately landscaped to appear more rustic and wilderness-like. The imprint of Paxton's Birkenhead Park was clearly evident, and "Central Park" became beloved as "the people's park," filled with picnickers, strollers, bicycle and horse riders, ice skaters, carriages in summer, sleighs in winter—all manner of people of all ages from every station in life enjoying their park.

Even before it was finished, neighboring Brooklyn engaged Olmsted and Vaux, now instantly acclaimed the masters of such landscape shaping, to design Prospect Park. Other cities hired them to do likewise. Before Olmsted's retirement in 1895, he and Vaux had designed urban parks for more than thirty-five cities; an interconnected park system for Boston with eighteen separate elements; landscape plans for ten institutions including hospitals, insane asylums, and the US Capitol; campus and landscape plans for fourteen colleges and universities; landscape plans for numerous private estates; and the overall plan for an ideal landscaped suburb in Riverside, Illinois. Started in 1868, Riverside was the model for scores of later suburbs: its paved streets followed the flow of the topography, with lots and streets planted with trees so that, in time, a leafy canopy would shelter everything. Every landscape Olmsted designed demonstrated that he understood precisely what Alexander Pope had advised those who wish to design a landscape: that they first "consult the genius of the place," using the term *genius* in its ancient Latin sense, the spirit dwelling in a particular location. Olmsted's work looks as though it always was there, rather than appearing as a conscious imposition of human will on the earth.

The last project in which Olmsted participated—the Columbian Exposition held in Chicago in 1893—helped initiate another field of design activity. As a major contributor to this first large-scale world's fair, Olmsted persuaded the other participants to build on the shore of Lake Michigan, advising them that the many individual buildings should be integrated not just in character and style but also through the spaces that knitted them together. The impact of the plan and architectural spectacle of the Columbian Exposition inaugurated the profession of city planning, as scores of American cities endeavored to bring sensible order to the jerry-built chaos of their centers that had resulted from expediency rather than conscious planning.

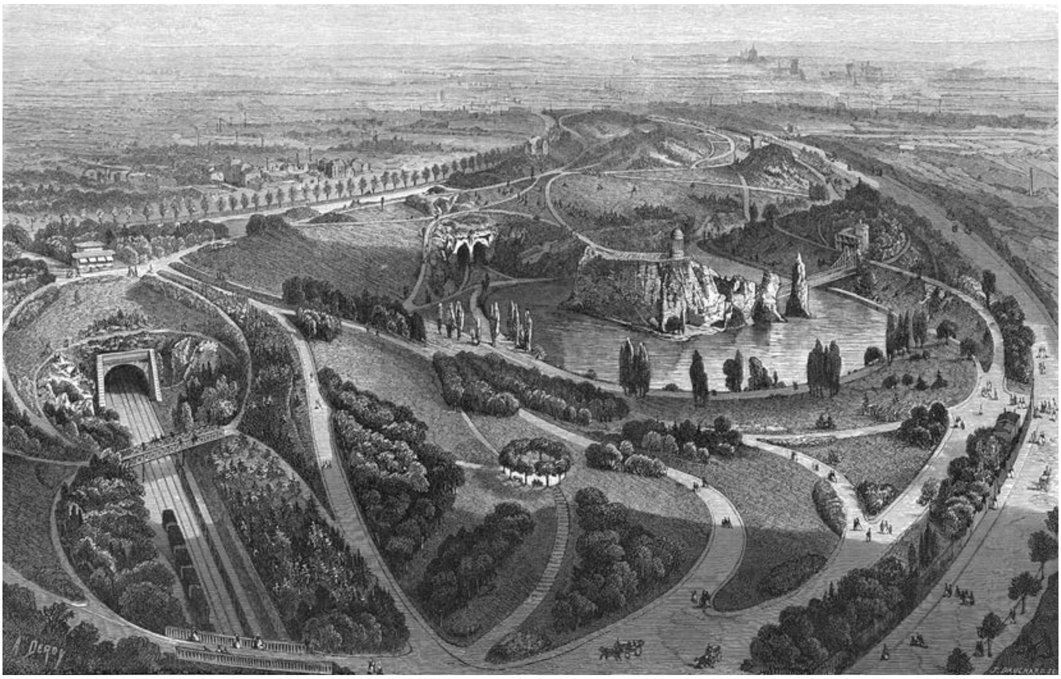
The Replanning of Paris

In the United States, where laissez-faire capitalism controlled business as well as politics, no direction was given to urban growth, but in Europe, where governmental and bureaucratic control was more customary, steps were taken to shape urban growth in a few places, as illustrated in the replanning of Paris from 1852 to 1870. The growth of Paris was due only in part to the influx of rural immigrants, for the city also grew through the annexation of adjacent suburbs. The water and sewer systems of the city were a patchwork of seventeenth- and eighteenth-century additions. Cholera was an annual epidemic, since drinking water was drawn from the Seine almost directly *downriver* from where major sewers emptied into the river. In addition to these health concerns, the twisted, narrow streets of the medieval part of the city were repeatedly blocked by barricades during uprisings that convulsed the capital city almost every twenty years.

When Louis-Napoleon declared himself emperor in 1852, he embarked on a rebuilding of the city of Paris following the designs of his chief engineer of the Department of the Seine, Baron Georges-Eugène Haussmann (1809–1891) [18.26]. To connect the railway stations scattered around the periphery of the city, Haussmann cut new streets through the heart of the city and had entire sections of the medieval core demolished. It was also believed that the broad new tree-lined boulevards would make civil insurrection impossible (a hope that was dashed in the uprising of 1870). New aqueducts were built, extending thirty miles to the tributaries of the Seine, and the fabled sewers of Paris were laid under the new street system to carry the effluent of the city several miles downstream, thus eliminating the summer outbreaks of cholera. Two enormous park preserves were created from royal hunting grounds at the west and east edges of the city; these Haussmann called "the lungs of the city." In the north of Paris an abandoned open limestone quarry, with a railroad now running through it, was transformed by the landscape architect and designer of all the parks in Louis-Napoleon's new Paris, Adolphe Alphand. The bare rock terraces were thickly covered with soil and planted, the deep excavations were allowed to fill with water, and walkways and bridges were installed, so that what had been a noxious eyesore was transformed into a vision of bucolic loveliness [18.27]. Not even Sixtus V had dreamed of an urban rebuilding scheme so vast as this.

Although there was criticism concerning the historical medieval architecture in Paris wantonly destroyed during the process, Napoleon III's and Haussmann's determination to restructure the city was a challenge to planners in other cities, who likewise attempted to reshape jumbled medieval cities, transforming them into modern metropolises. Since the Turks had been so decisively defeated in 1683 and pushed back well south and east of Vienna, it seemed certain that this threat had been removed. Yet, as conservative reassurance, the fortifications and battlements encircling the old part of the city had never been removed. Meanwhile, numerous suburban communities had arisen and circled the city, standing outside the smooth *glacis,* left as an open field of cannon fire. In the uprisings of 1848 that swept across Europe, citizens demanding reform even used the old ramparts to defend themselves against government forces. Extreme conservatives then pushed for further improvement on the old battlements to prevent a repeat of such uprisings. But in 1857 the Austrian emperor Franz Joseph decreed that the city's fortifications be removed and a boulevard, lined with public buildings and parks, built in its place, uniting the medieval core of the city with the suburbs that

18.26. Baron Georges-Eugène Haussmann, plan for Paris, 1852. At the direction of Emperor Louis-Napoleon, Haussmann undertook the rebuilding of the city, cutting major new streets, laying new water and sewer systems, and adding new parks. From J. Alphand, Les Promenades de Paris *(Paris, 1867–1873).*



18.27. Jean-Charles Adolphe Alphand, landscape designer, Parc des Buttes Chaumont, Paris, France, 1860–1864. Starting with an abandoned limestone quarry, Alphand transformed it into a wooded landscape of ponds and hills. (In the Paris plan, 18.26, it is the kidney-shaped park in the northeast quadrant.) Photo: From A. Alphand, Les Promenades de Paris *(Paris, 1867–1873).*

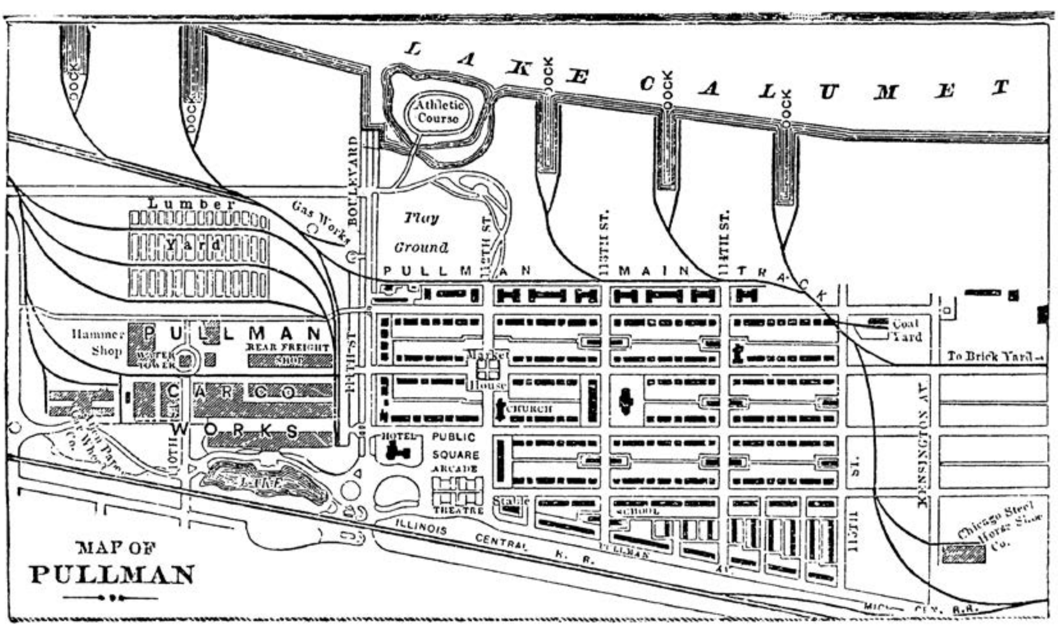
had grown up outside the walls, making numerous individual communities into one united city. The result was the Ringstrasse, designed by Ludwig Förster and carried to completion, with major public buildings by various architects still being completed up to the time of World War I, in 1914.

A new problem that architects and planners faced was creating new industrial towns on open land, including all necessary civil amenities and housing for the workers. One of the first of the planned industrial communities was the textile factory town of Saltaire, outside Bradford, England, begun in 1852 by Titus Salt. Subsequently, in 1879 the Cadbury family began construction of Bournville outside Birmingham, as the site of the Cadbury chocolate factory, with rows of housing and communal facilities set on winding landscaped roads. Even more picturesquely idyllic was Port Sunlight, built by the Lever family beginning in 1888, in which the houses were specially designed and arranged on winding landscaped streets so as to suggest the quaint atmosphere of a preindustrial English village. In the United States several similar industrial towns were planned and built, of which perhaps the most elaborate architecturally (if not the most progressive socially) was Pullman, 12 miles (19.3 km) south of Chicago, designed by landscape architect Nathan F. Barrett and architect Solon S. Beman, and built largely from 1879 to 1895 to house workers making the luxurious Pullman sleeper railroad cars[10] [18.28].

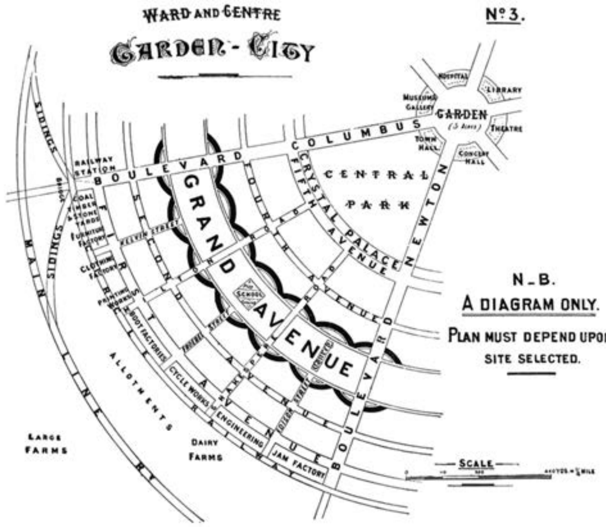
Constructing a single idealized model worker's community here or there was all very well, but English urban reformer Ebenezer Howard foresaw that such isolated piecemeal solutions could not be sufficient for the future. He realized that large metropolises would expand outward indefinitely, ultimately producing unlivable cities. Even with late-nineteenth-century improvements in rail and streetcar transportation, urban residents would face long uncomfortable commutes through dense urban construction. There had to be a way to provide the multiple social opportunities of a true urban center combined with the restorative power of the open countryside. This better way, it seemed to him—as he wrote in his revised book, *Garden Cities of To-Morrow,* 1902—was for municipal public planning bodies to limit the expansion of large cities while creating satellite communities, also limited in their optimum size. Strong links to the center metropolis by efficient rail lines would permit easy connections from center to satellite while simultaneously ensuring that the open land remain farm or woodland in perpetuity as a "green belt." Howard, who wrote well before the age of automobiles and freeways, envisioned outlying self-supporting "Garden Cities" whose outer ring was filled with industries surrounding an inner core of housing, shops, and parks [18.29]. As a result, Garden Cities would possess both the advantages of employment opportunity and the intellectual stimulation of the city, while also providing ready access to recreational opportunities in the nearby open countryside—the best of all worlds. As one Garden City satellite would fill up to its design limit, another would be started nearby. Howard had already set up the Garden Cities Association in 1899, which advocated these objectives, and advised on the creation of two such Garden Cities outside London (Letchworth begun in 1903, and Welwyn Garden City in Hertfordshire, in 1919). The houses designed for both new towns were created by architects affiliated with the English Arts and Crafts movement. Moreover, Howard's ideas were taken up in Germany and also in the United States, resulting in the building of several new towns, though seldom were they as independent as Howard had hoped. Other new Garden City communities were undertaken after World War II in England, and more recently much of what Howard advocated was incorporated in what has been called the New Urbanism with its deemphasis on the private automobile and emphasis on building with better human scale. Howard's advice is difficult to implement, however, for it requires applying controls on unbridled commercial and private development.

Reaction to the Machine

The Palais des Machines of 1889, and the earlier Crystal Palace that had inspired it, were made possible by the growth of industry in producing iron and steel, as well as by the application of mathematical statics to determine the forces at work in such large structures. They were manifestations of the impact of the machine on architecture. The Crystal Palace had been created, in fact, specifically to showcase the products of mechanized industry, the kinds of mass-produced goods that made nineteenth-century middle-class culture possible—pianos, rugs, chairs, pitchers, goblets, scissors, and thousands of other objects. To the English artist and designer William Morris (1834–1896), however, it seemed also an exhibition of the worst possible design, in which bad variations on Classical and medieval forms were adapted to mechanized



18.28. Nathan F. Barrett, landscape architect, and Solon S. Beman, architect, general plan of Pullman, Illinois (now incorporated in Chicago), 1879–1895. Barrett designed the street and park system, and Beman designed the public buildings and houses of this ideal American industrial village. From Harper's Magazine, *February 1885.*



18.29. Ebenezer Howard. Diagram showing a portion of a satellite garden city, proposed adjacent to a large urban center. Not a plan for a specific landscape location, this diagram was meant to illustrate the relationship between the various areas in the city. From E. Howard, Garden Cities of To-morrow *(London, 1902).*

reproduction. The results were pitchers with handles so contorted as to be impossible to hold and chairs in which no person could sit at ease. How could the taste of the middle class be improved, Morris pondered, if such was the poor quality of design in the objects offered for sale to them?

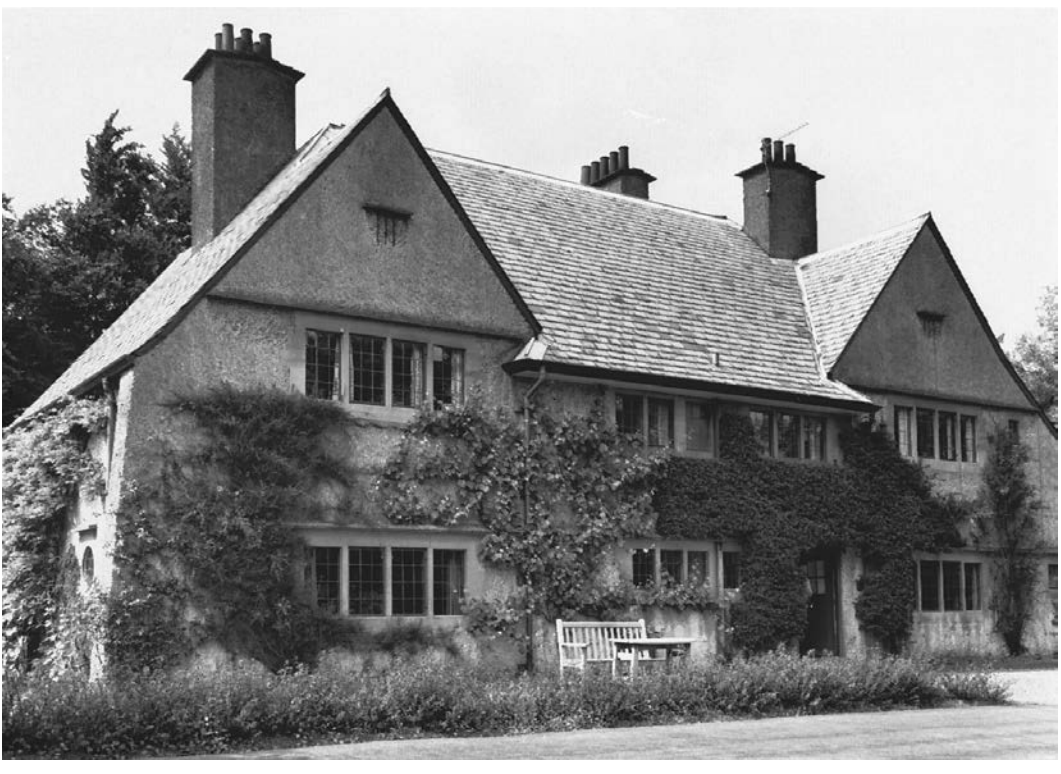
The Arts and Crafts Movement

Taking a theme first proposed by Pugin and then Ruskin, that Gothic architecture was good because it was handmade, by workmen who took joy in their work, Morris set about to reform standards in design. He began by designing, with the architect Philip Webb, a house for himself—simple in design and based on medieval vernacular prototypes, yet free of any attempt at deliberate copying [18.30]. His house, at Bexley Heath in Kent, built in 1859–1860 of exposed common red brick without a coat of fashionable stucco, came to be called Red House. Inside, the rooms were finished in simple moldings of stained wood, with some built-in pieces of wooden furniture, and freestanding pieces inspired by medieval models but designed to facilitate use and handmade with an emphasis on making evident the constructive process. If wallpaper or rugs were required, Morris designed them with comparatively simple, flat curvilinear foliate patterns, instead of the illusionistic three-dimensional-looking flowers and landscapes that were then fashionable. Morris then began to gather about him artisans who made furniture, tableware, and other objects used in domestic interiors. Although their designs were deliberately kept uncomplicated, the objects they produced could never be made cheaply enough to appeal to a broad audience. In the end, the Arts and Crafts Movement that Morris initiated in the 1860s, and that continued up through 1920, was able to attract (and still attracts) the interest of a few devoted affluent followers. Morris's greatest impact on design, however, was to be made by later disciples such as Charles Francis Annesley Voysey in England and Frank Lloyd Wright in the United States.

Reinvigorating an English vernacular tradition became the very essence of the domestic architecture of Charles Francis Annesley Voysey (1857–1941) from the time he designed his first house in 1885 through 1914 when his practice began to decline. His houses employed tight plans, often fitted into clear rectangles, with long unbroken wall surfaces punctuated by repeated steep sharp roof gables. The basic type is well illustrated in Voysey's own house, The Orchard, at Chorleywood, a suburb of London, 1899–1900 [18.31]. The walls were built of solid random ashlar stone, the masonry carefully dressed only around the windows and doors, with the broad surfaces between openings covered with rough stucco painted white. The result was a traditional design rendered with abstract clarity. A simultaneous parallel approach was taken by the Scottish architect Charles Rennie Mackintosh (1868–1928), who drew on Scottish baronial architectural tradition but reduced his architecture to a careful study of abstracted planes.

The formal clarity of Voysey's houses, based on functional use and highlighted by crisp, white stuccoed wall surfaces, began to interest German architects and theorists in the 1920s. Later, when

18.30. William Morris with Philip Webb, Red House, Bexley Heath, near London, England, 1859–1860. In his own house, Morris returned to English vernacular architectural traditions, exposing the materials and revealing the method of construction. Photo: © Wayne Andrews/Esto. All rights reserved.



18.31. Charles Francis Annesley Voysey, The Orchard, Chorleywood, near London, England, 1899–1900. Inspired by plastered, late-medieval vernacular houses, Voysey developed a modernized vernacular with steep roofs and abstracted wall planes accentuated by rough stuccoed surfaces. Photo: © Wayne Andrews/Esto. All rights reserved.

18.32. Sir Edwin L. Lutyens, The Deanery, Sonning Berkshire, 1900–1902. Lutyens established himself with the design of country houses, drawing freely from English medieval vernacular inspiration. Photo: Lucinda Lambton/arcaid.co.uk.

Nikolaus Pevsner praised him for being the grandfather of the emerging International Modernism, Voysey vigorously objected, saying he never had any intention of spawning a new architecture but, rather, had set about improving the old. Mackintosh was lauded by the few ardent modernists in Vienna, and even Voysey had an influence on the Continent, for during the early years of the new century the ideals of English Arts and Crafts architecture, particularly the insistence on excellence in design and extreme care in craftsmanship, were carried to Germany and Austria by writers such as Hermann Muthesius. Muthesius then helped establish the Deutscher Werkbund in Germany to promote these design ideals. (This thread of development will be returned to later.)

Voysey's and Mackintosh's houses, for all their nostalgic reminiscences of medieval traditions, were planned around contemporary use and needs. The same was true, in the early years, of the houses of Edwin Lutyens (1869–1944). His country house, The Deanery, at Sonning, Berkshire, 1900–1901, is a good example of the extension of William Morris's theories in Arts and Crafts architecture [18.32]. Built of red brick, with a red tile roof, it is set against an old brick wall, facing an orchard and a series of garden terraces designed by the landscape architect Gertrude Jekyll (1843–1932). Although derived ultimately from medieval sources that determined such things as the two-story living hall at the center of the garden facade, The Deanery nonetheless has a carefully studied functional plan and deliberate artful geometries in the arrangement of windows, masses, and planes. By 1906, however, Lutyens had turned by stages to a weighty Neoclassicism reminiscent of the English Baroque architecture of Hawksmoor and Vanbrugh, perhaps because he saw this as a more fitting cultural expression of the self-secure British Edwardian Imperialism.

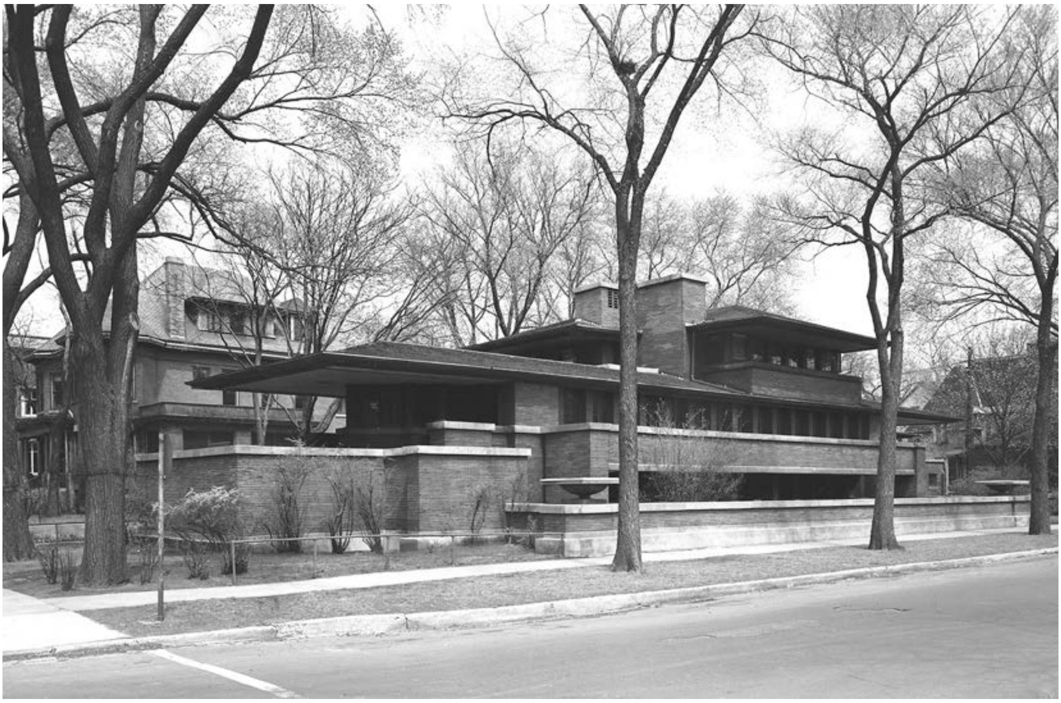
Frank Lloyd Wright

Strongly linked to Morris's English Arts and Crafts movement was the early work of Frank Lloyd Wright. Although he was loath to admit to any outside influences, he did acknowledge Morris's design philosophy, and in the early years of the twentieth century he was closely connected to the American Arts and Crafts movement. Where he deviated from the established Arts and Crafts view was in embracing the machine to facilitate production. As he correctly perceived in his address of 1901, "The Art and Craft of the Machine," the architecture of the future would be built of machine-formed elements; the modern architect would of necessity need to embrace the machine in every aspect of design.[11] Where Wright held fast to the Arts and Crafts ideal, however, was in the firm belief that all parts of the modern house had to germinate from a single design idea, that there be unity throughout the whole. Despite the one note of disagreement with English Arts and Crafts leaders (concerning mechanized production), he received their approval. When C. R. Ashbee—one of the preeminent Arts and Crafts practitioners in England—visited the United States, he made a pilgrimage to visit Wright and see his architecture. It is no surprise that when Wright had his early designs published by the Wasmuth Company of Berlin, he arranged for Ashbee to write the commentary in one of the volumes.[12] Wright's earliest work, such as his own residence in Oak Park, Illinois, 1889, was greatly indebted as well to the American Shingle Style that had been developed on the Eastern seaboard during the 1880s. Wright, who had been the principal assistant in Adler & Sullivan's Chicago office during 1888–1893, shared with Sullivan the belief that American architecture ought to evolve its own forms, derived from unique American circumstances.

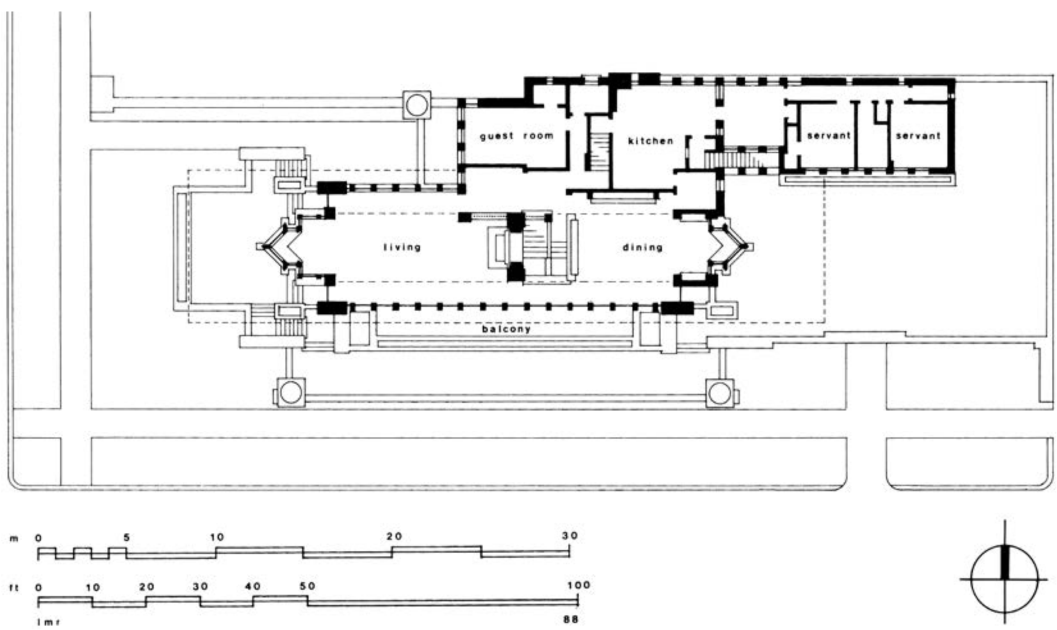
As Wright built suburban residences in the flat prairie land around Chicago, he began to stretch them out into the landscape and to emphasize their horizontal lines in his designs. The first fully developed expression of what he called the Prairie House was the Ward Willits residence [18.33]. In designing this house Wright had the advantage of working on a large lot, so that the house could expand outward from the chimney mass at the center in four wings accommodating separate functional sections. On the ground floor (aside from the servants' quarters), the public rooms of the house—the entry, living room, and dining room—are connected spaces, teasingly screened from each other by lattice panels. Inspired by Japanese architecture, the exterior of the wood-frame house is reduced to a stark pattern of dark-stained wooden members contrasting with the white stucco of the walls.

In 1906 Wright began work on what has generally been regarded as the finest of the Prairie Houses, the Frederick C. Robie house on the South Side of Chicago, 1908–1909 [18.34, 18.35]. Wright pulled the house up out of the damp clay of the prairie, so that the main living level is on the upper level, with three bedrooms in the cupola on the third level. At every point the horizontal line is stretched and emphasized, internally as well as externally. The main living level is one long space, divided into living room and dining room by a

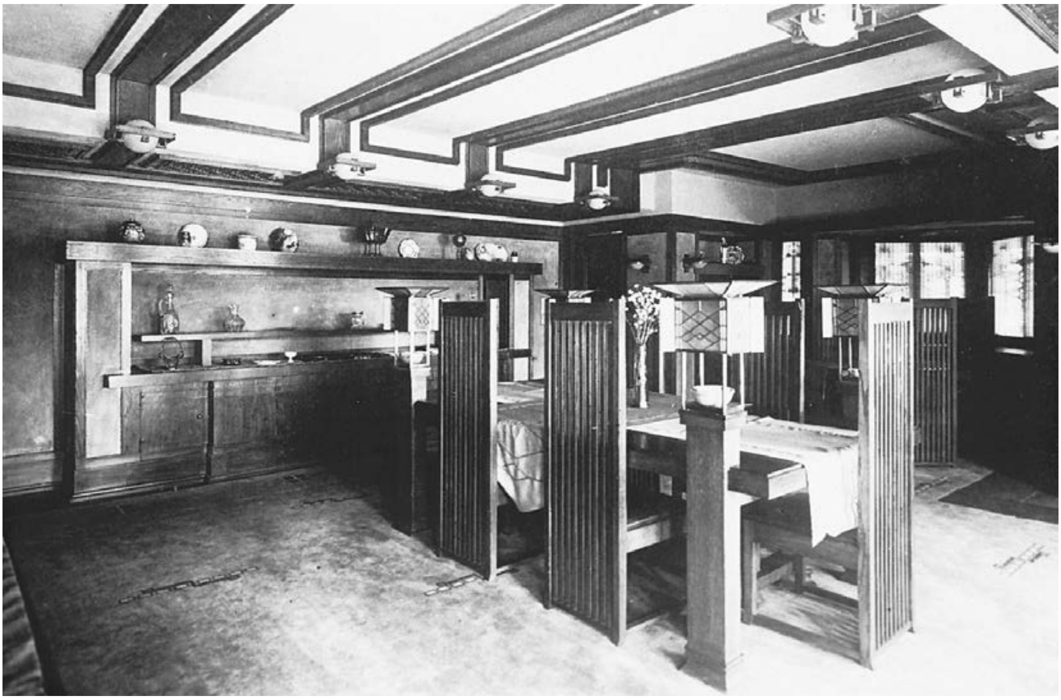
18.33. Frank Lloyd Wright, Ward Willits House, Highland Park, Illinois, 1900–1902. Wright's houses, superficially similar to those of Voysey and Mackintosh, were partly inspired by Japanese architecture but were shaped by Wright's unique conception of expanding, open, interwoven spaces. Photo: Rosenthal Collection, Department of Art History, Northwestern University.



18.34. Frank Lloyd Wright, Frederick C. Robie House, Chicago, Illinois, 1908–1909. Wright exaggerated the horizontal lines to integrate his houses with their prairie settings, creating a strong connection with the earth. Photo: Sandak, University of Georgia.



18.35. Frederick C. Robie House. Plan of the living level. For privacy the living level is lifted to the second story; here is a single living space divided into two parts by the freestanding fireplace. Drawing: L. M. Roth, after HABS drawings and Wright.



18.36. Frederick C. Robie House. Dining room. This view shows the interior fixtures and furniture specially designed by Wright as an integral part of the house's architecture. Photo: Rosenthal Collection, Department of Art History, Northwestern University.

freestanding fireplace. To achieve the long internal spans, and to support the long cantilever where the roof to the west covers the porch, Wright had to use hidden steel beams inside the roof. Wright also integrated the lighting and heating into the ceiling and floor, and designed nearly all the furniture, using machine-cut oak components given only a dark stain[13] [18.36]. Wright's early work was well published and became widely known. Although European architects in search of an architecture appropriate to the new century paid little notice to Wright's exploitation of wood and his expansive house plans that exploited large American suburban building lots, they were inspired by his rejection of traditional forms and building methods.

Academic Eclecticism and the École des Beaux-Arts

As the multiplicity of building types increased in the nineteenth century, and as those buildings became larger in size and more complex, the sheer scale of building activity meant that the apprentice method of training architects and engineers in the offices of practitioners was no longer adequate. The French had long before confronted this problem in the 1660s in royal building projects, resulting in the creation of the Royal Academy of Architecture in 1671 to train architects. The Royal Academy was then transformed during the French Revolution, becoming the École des Beaux-Arts ("School of Fine Arts"). It quickly established itself as the largest and most comprehensive school of architecture during the nineteenth century. One important but less internationally influential school was the Prussian Bauakademie in Berlin, under the direction of Karl Friedrich Schinkel. By the end of the nineteenth century, there were also schools of architecture at numerous American universities patterned after these two.

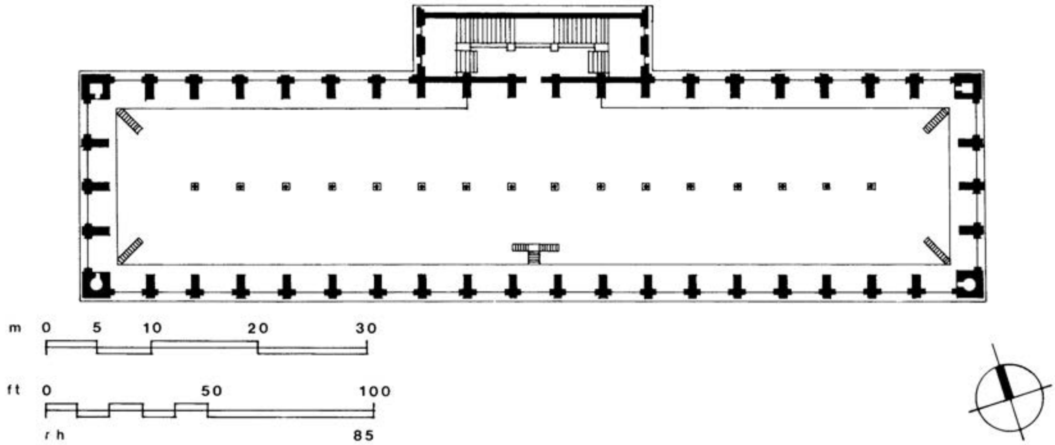
Alongside the architectural students at the École des Beaux-Arts were students of painting and sculpture (in the tradition of the Renaissance), whereas those who wished to study the various branches of mechanics and engineering were taught in the completely separate École Polytechnique, unfortunately encouraging a split between architects and structural engineers. While it is true that students at the École des Beaux-Arts were taught structural design and construction techniques, design instruction there focused strongly on plan organization, with a view to achieving the simplest possible circulation into and through a building, as well as emphasizing that students give expression to the character of the function being housed.

Henri Labrouste

The architect who has come to best represent École des Beaux-Arts precepts of functional planning and character expression is Henri Labrouste (1801–1875).[14] He entered the École in 1819 at the age of eighteen, progressed through the successive levels of instruction, and won various design competitions, which culminated in his winning first prize in the Prix de Rome competition in 1824. This allowed him to live in Rome for the next five years, where he prepared the required series of restoration drawings of Roman buildings. For his last project, however, Labrouste chose to study not an ancient Roman building but the ancient Greek temples at Paestum. In the course of working on these drawings, Labrouste came to a new understanding of the relationship between form and expressive structural function in Greek architecture, which determined the development of his own subsequent design. He scandalized his teachers in Paris when he sent back detailed drawings showing the temples in use rather than as remote austere Classical ideals, suggesting that buildings arise as expressions of unique functional and social environments and not as universal prototypes. So upset were École officials that they prevented Labrouste from getting any government commissions for ten years.

Finally, however, in 1838, Labrouste was given the commission for a large new reference library on the Place du Panthéon, the Bibliothèque Sainte-Geneviève (1838–1850), north of Soufflot's church-now-museum. One of the civic functions of the new library was to define this edge of the Place around the Panthéon. Internally, the building had to provide a large reading room, for books were not to be taken from the library [18.37]. Accordingly, Labrouste placed the reading room on the upper level. Even though the building was to be the first library in Paris illuminated with gas, and hence the first library to have regular hours irrespective of the amount of daylight, the need for daylight was still great. Labrouste opened up the upper level by creating an arcade running completely around the building so that sunlight

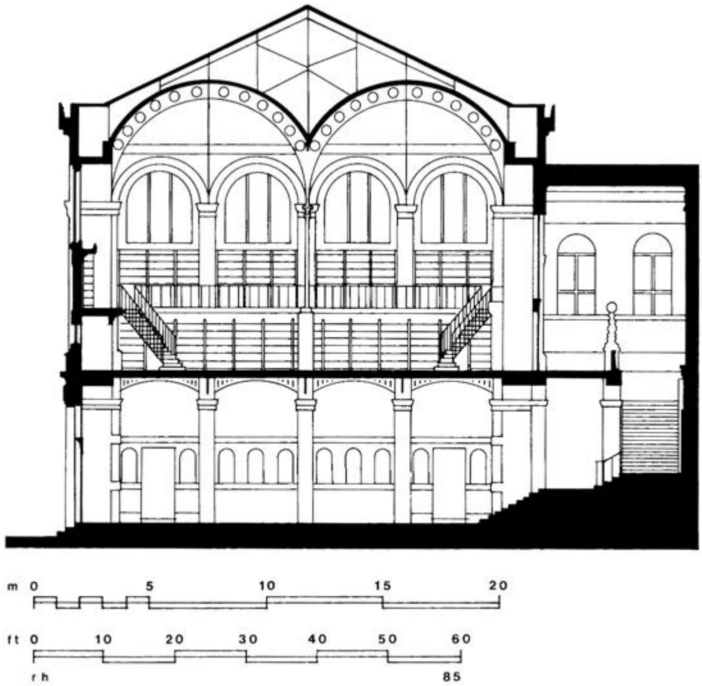
18.37. Henri Labrouste, Bibliothèque Sainte-Geneviève, Paris, France, 1838–1850. In this public reference library, framed in iron, Labrouste took care to define urban space and to let the external form and details of the building speak of its internal function by means of the glazed arcade and the inscribed authors' names. Photo: L. M. Roth, 2003.



18.38. Bibliothèque Sainte-Geneviève. Plan at the upper reading-room level. Drawing: B. Huxley.

could stream through its broad glazed openings [18.38]. The lower portion of the arcade corresponded to the two levels of bookshelves around the perimeter of the reading room, so there Labrouste inserted stone panels inscribed with the names of authors, symbolic of the books housed just on the other side of the stone panels. Covering the reading room are two parallel barrel vaults carried by delicate open web transverse arches of cast iron [18.39, 18.40]. These are fastened to the stone piers of the perimeter walls, but down the center of the room they are carried by the slenderest of cast-iron columns. What Labrouste achieved in the library was the combination of clarity of functional arrangement and directness of

18.39. Bibliothèque Sainte-Geneviève. View of the reading room. From R. Middleton and D. Watkin, Neoclassical and 19th Century Architecture *(New York, 1987), v. 2, pl. XXIX.*



18.40. Bibliothèque Sainte-Geneviève. Section. Drawing: B. Huxley.

circulation with a structure that exploited new building materials and expressed in a straightforward way just what the building was used for. Moreover, he had done all this without applying superfluous Classical ornament. Understandably, among students and progressive architects, the Bibliothèque Sainte-Geneviève quickly became a model of what a modern library ought to be.

The basic principles of architectural design taught at the École des Beaux-Arts were codified by the school's theorist, Julien Guadet (1834–1908), in 1901. He summarized the instruction given there during the last half of the nineteenth century, when so many young Americans attended the École. Guadet wrote that the first requirement in design is to understand the function of the building and to accommodate it fully, but that secondly the building site and the prevailing climate will necessarily modify the way function is accommodated. Third, a good design must be easily buildable and should not rely on complicated and costly structural gymnastics. Fourth, truth in architectural expression must be maintained. Fifth, a building must look strong as well as be structurally sound. Sixth, a good design must have easy and inevitable patterns of circulation for the movement of people, for admitting light, and for carrying away rainwater. And seventh, he wrote: "Composition proceeds by necessary sacrifices. Composition must be good first, but it must be beautiful as well. You must therefore compose a building with a view towards its usefulness and its beauty. You will seek character, which contributes to beauty by creating variety."[15] This triple goal (based on Vitruvius) of clear structural expression and functional composition in beautiful designs was the goal of American architects who studied at the École des Beaux-Arts in the late nineteenth century. When these students returned from Paris, they were asked by businessmen to design large commercial blocks of offices or warehouses, a building type that had seldom engaged the attention of architects before. For these Paris-trained American architects, the idea of wrapping a functionally designed commercial building in an appliqué of unrelated Second Empire Baroque or High Victorian Gothic details was considered inappropriate. The external character of the building had to result from the inside function projected to the outside.

Henry Hobson Richardson

Henry Hobson Richardson (1838–1886), the second American to study at the École, during 1860–1865, tackled this problem of finding an appropriate expression for modern buildings. He created for himself a personalized and simplified Romanesque style that used masses of masonry in strongly expressive ways to accentuate points of entry into a building, bands of windows, and solid structural supports. His last two buildings, designed in 1885 as nephritis was gradually killing him, summarized his views concerning the expression of character in large urban buildings. His Allegheny County Courthouse and Jail in Pittsburgh, Pennsylvania, basically is divided into two parts [18.41]. The courthouse section focuses on a massive tower that serves as a civic symbol; its external walls are modeled with projecting towers that correspond to the alternation of courtrooms and private judges' chambers inside. To the rear, however, is the county jail, enclosed in a wall of gigantic granite blocks and unadorned with any of the delicate Romanesque details that grace the public areas of the courthouse.

Richardson's Marshall Field Wholesale Store, Chicago, 1885–1887, was also austere [18.42]. Field had asked for a huge building, occupying an entire city block, on the west side of Chicago's warehouse district. It was to contain showrooms for the wholesale branch of Field's department store. Field's wholesale building was the largest single business building then in the city, and Richardson expressed this by a unity of massing and a singularity of effect, superimposing masonry arcades in the exterior wall. Since it was to be a strictly utilitarian commercial building, it was stripped of almost all historical ornament, employing only the roughness of the stones themselves to provide visual texture. The Marshall Field Wholesale Store had a most dramatic impact on Chicago architects, showing them how to express the scale of the increasingly large commercial blocks without falling into the pitfall of overusing ornament.

The Chicago School: Adler & Sullivan

Richardson's Marshall Field Wholesale Store was structurally quite traditional, with thick heavy outer masonry walls that carried their own weight

18.41. Henry Hobson Richardson, Allegheny County Courthouse, Pittsburgh, Pennsylvania, 1885–1887. Richardson attempted to suggest permanency in American buildings by the massiveness and roughness of his Romanesque masonry, devising plans driven by internal functional requirements. Photo: Carnegie Collection.

18.42. Henry Hobson Richardson, Marshall Field Wholesale Store, Chicago, Illinois, 1885–1887 (demolished 1930). For this utilitarian building, Richardson simplified his masonry, unifying this massive commercial block by the repetition of window arcades. Photo: Charles Allgeier, Chicago, c. 1887; author's collection.

and that of adjacent floor loads, and an interior structural skeleton of heavy wooden timbers. Almost at the moment Richardson began designing the Field store, however, there appeared in Chicago a radically new technique for supporting office blocks. In 1883 the architect William Le Baron Jenney (1832–1907) had begun construction of the Home Insurance Building in Chicago, with outer walls of solid brick piers, when a bricklayers' strike brought work to a halt [18.43]. Wishing to finish the building, Jenney decided to use a metal iron skeletal frame, not only on the inside but in the exterior walls as well. When the bricklayers came back to work, the metal skeleton was wrapped with protective masonry cladding attached to the metal skeleton instead of supporting its own weight.[16] Within five years Chicago architects had almost completely changed over to using metal frames, composed of every form of iron available, first of cast and wrought iron and some steel, and soon of steel entirely. Such wrought-iron and steel frames reduced the total weight of these business and office blocks by a half or more (and consequently reduced settlement in the soft subsoil of Chicago), and the metal frame eliminated the thick supporting walls at the ground floor and in the basement.

As business buildings got higher and higher, the movement of people within these buildings was mechanized by the introduction of the passenger elevator. This stimulated architects and the clients to build even higher office blocks, going from five to ten, to sixteen, and finally to twenty stories and more. And yet, while the various technological advances making possible this height were being perfected, few architects were seriously considering how this new verticality might affect design. What Chicago architects and structural engineers had done in the space of five years was to invent a wholly new building type, and yet architects were still thinking of the vertical office towers as composed of stacked sections of two- and three-story units.

It was the architect Louis H. Sullivan (1856–1924), a student at the École during 1874–1875, who first analyzed this new design problem in his essay of 1896, "The Tall Office Building Artistically Considered." He insisted that "form follows function," and he correctly perceived that the tall office block was a totally new building type, requiring completely new thinking, and made up of four principal visible functional zones. The Guaranty Building in Buffalo, New York, which he and his partner, Dankmar Adler, had designed the year before, embodied all the points Sullivan expressed in his essay [18.44]. Below sidewalk level is a basement area filled largely with mechanical equipment and utilities, but this had little bearing on the external expression since it was not visible. Above this is the first principal visible area, a street-level zone made up of a mix of street-oriented shops around the perimeter, with public entrances leading to a central elevator lobby; above this is a related mezzanine level of offices reached by stairs from the internal lobbies. Above this, in turn, is the third major visible zone, the stacked identical office cells grouped along corridors that branch out from the central elevator spine. Atop all of this is the fourth, terminating visible zone, with some offices, elevator machinery, and other utilities. Sullivan proposed that the new office blocks were decidedly vertical buildings and ought, therefore, to emphasize and celebrate that character. Moreover, since they were a cage of thin steel columns and beams, the external protective skin should not appear to be heavy supporting masonry. In the Guaranty Building, Sullivan used protective blocks of terra cotta embellished with his own unique foliate ornamental patterns stressing the different character of the three visible zones and indicating that this skin was clearly not the structural support. Above all, Sullivan gave expression to his definition of the modern commercial skyscraper: "It must be every inch a proud and soaring thing, rising in sheer exultation that from bottom to top it is a unit without a single dissenting line."[17]

Academic Eclecticism: McKim, Mead & White

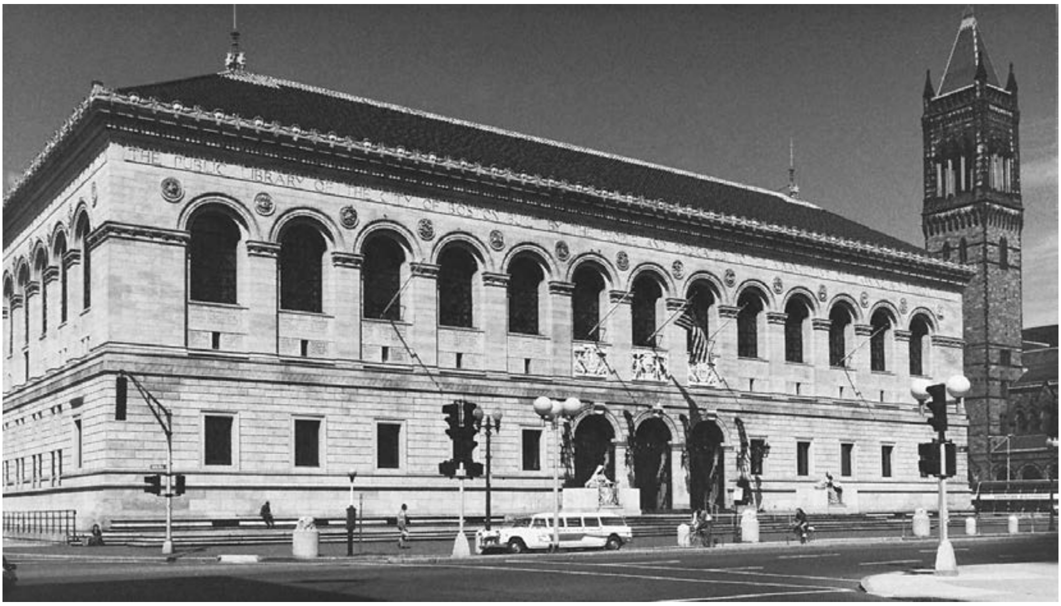
Sullivan's rational analysis of the modern office tower, applying the essence of his École training, laid the basis for the modern architectural movement, as early apologists of Modernism later recognized. What Sullivan did in applying École principles to the design of the new commercial high-rise office building, the architects McKim, Mead & White accomplished in the design of urban public buildings, with this difference: they did not reject the use of traditional Classical ornamental details in favor of a personal invented ornamental language such as Sullivan devised. McKim had been a student at the École during 1867–1870 and, hence, was trained to

18.43. William Le Baron Jenney, Home Insurance Office Building, Chicago, Illinois, 1883–1886 (demolished 1931). When a bricklayers' strike interrupted progress in construction, Jenney substituted a full metal structural skeleton to allow work to continue; later, the outer masonry veneer was attached to the standing skeleton. This was the first constructed metal frame skyscraper. From A. T. Andreas, History of Chicago *(Chicago, 1884–1886).*

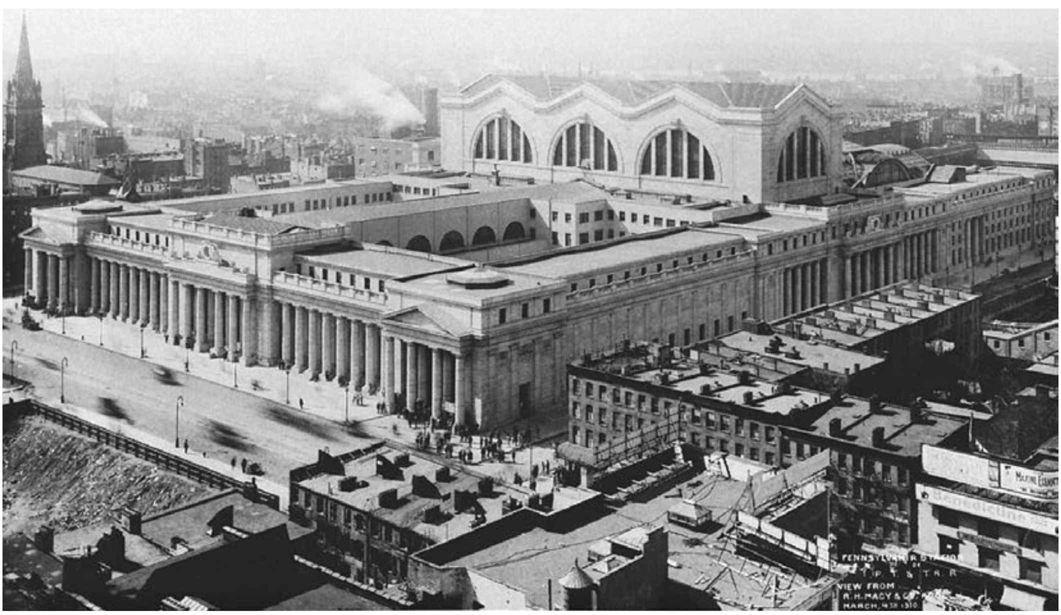
18.44. Adler & Sullivan, Guaranty Building, Buffalo, New York, 1895. Sullivan gave clear expression on the exterior of three major functional zones of the modern office skyscraper. Photo: Rosenthal Collection, Department of Art History, Northwestern University.

think of the Classical tradition as something still applicable to the late nineteenth century. One of his and his firm's earliest successes was the Boston Public Library, 1887–1895 [18.45]. Forming a defining wall along the southwest side of Copley Square (a major open space in a newly developed portion of Boston), the library was inspired by Labrouste's Bibliothèque in Paris. Although its internal plan arrangement was not as forthright as Labrouste's—for the Boston library officials kept changing their minds as to what they wanted, even as the walls were being built—it was richly embellished inside and out with painting and sculpture as a way of inviting the populace into the building, for this was the first large urban public lending library. The entrance doors were tripled, for example, and the stair to the upper reading room was much larger than Labrouste's.

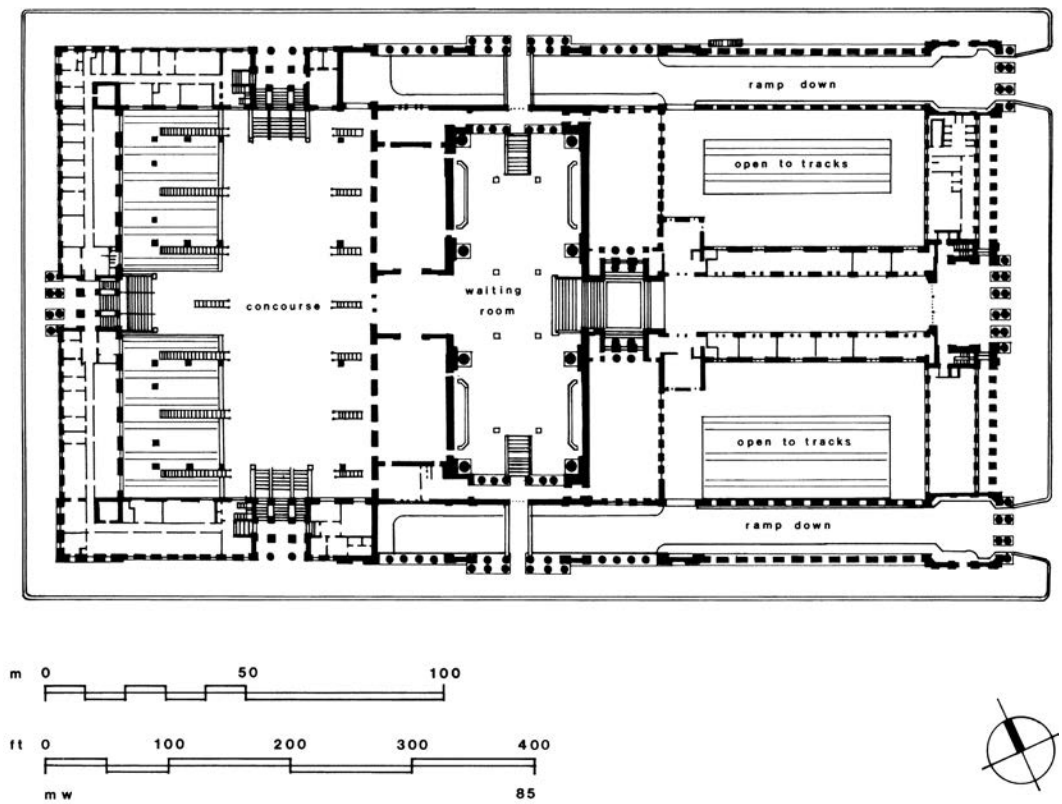
The most commanding example of McKim, Mead & White's attempt to merge functional clarity with expressive form was their Pennsylvania Station in New York, designed in conjunction with engineers for the Pennsylvania Railroad during 1902–1905, built in 1905–1910, and demolished in 1963 [18.46, 18.47]. Hoping to draw off some of the transcontinental business of the rival New York Central Railroad, the Pennsylvania Railroad built this new station over tunnels that brought the trains under the Hudson River from New Jersey, under Manhattan Island, and continuing under the East River out to Long Island. The station had a double function, providing for crowds of commuters who poured into



18.45. McKim, Mead & White, Boston Public Library, Boston, Massachusetts, 1887–1895. Like Labrouste, McKim, Mead & White defined an urban space while at the same time expressing the fact that this was a library generously open to the public. Photo: L. M. Roth.



18.46. McKim, Mead & White, Pennsylvania Station, New York City, 1902–1910 (demolished 1963–1965). As had G. G. Scott in the St. Pancras Station in London, McKim, Mead & White wanted to celebrate the power of the railroad and create a magisterial gateway for the city. Photo: Dreyer photo, c. 1909; courtesy of Avery Library, Columbia University.



18.47. Pennsylvania Station. Plan. The main working floor was below street level and was reached by stairs and ramps for vehicles; from the Concourse area additional stairs led down to the train tracks, about 45 feet below the street, as they still do. Drawing: M. Waterman and L. M. Roth.

the city from Long Island in the morning and funneled back through the station in the afternoon on their return home, while at the same time accommodating the different needs of long-distance travelers, with their more extensive baggage. The paths of these two groups of users were carefully studied so that they would not cross; commuters could exit the station going in any direction or connect directly with subterranean mass-transit subways.

At the heart of the building, which filled two entire blocks in the heart of Manhattan, was the soaring General Waiting Room [18.48], modeled after the huge public spaces of the Roman baths, specifically the Baths of Caracalla [12.25]. Beyond the Waiting Room was the Concourse, in which stairs descended to the nineteen parallel-track platforms below the station; the Concourse was covered by a glazed system of groin vaults, recalling the form of the Roman groin vaults of the Waiting Room but constructed of exposed steel columns, steel arches, and glass. The Waiting Room was designed as a great gate to the city, a monumental termination of a long journey, whereas the Concourse was a calculated transition from the monumental Classical architecture of the Waiting Room to the twentieth-century mechanical utilitarianism of the trains themselves. In short, the Waiting Room and Concourse were an envelope molded to evoke historical forms but built of twentieth-century materials.[18]

Architects such as McKim, Mead & White set out to design wholly modern buildings, drawing on the full capacity of contemporary building science but using traditional forms based on studiously informed knowledge of specific periods of past architecture. Nearly all these late-nineteenth-century architects had extensive academic training, as well as ready access to huge libraries of photographs, monographs, and illustrated portfolios covering the rich panoply of past architectures. They used an eclectic approach to design, but one based on academic knowledge and restraint.

18.48. McKim, Mead & White, Pennsylvania Station. Interior of the Waiting Room, once one of the grandest public spaces in the United States. Photo: Avery Library, Columbia University, New York.

AF-1. Great Mosque at Timbuktu, Mali, Africa, fourteenth century. The oldest mosque south of the Sahara, built of rounded adobe bricks and stone rubble with a clay stucco finish. Photo: Werner Forman/Art Resource, NY.

African Architecture

Africa is a huge continent containing more than 20 percent of the earth's land area. It extends roughly 5,000 miles (8,000 km) south from Tunis on the Mediterranean to the Cape of Good Hope and is nearly as wide as it is long. Climatically the continent is divided into broad horizontal bands ranging from moderate Mediterranean seasons to extremely arid desert. Such a profound range of temperatures, the varying amounts of rainfall, and the many kinds of vegetation over this vast expanse has led to a variety of building solutions over the centuries.

The human species originated in Africa, with early hominids appearing about 4 million years ago; ironically, it is the last of the major areas of the world to develop its own regionally generated modern architecture. For millennia, the continent was populated by myriad tribal societies, but starting in the early Renaissance period, region after region was colonized by European nations, first the Portuguese in search of India and the Far East, soon followed by others.

Architecture in Africa can be thought of in two ways: as the architecture *of* Africa, with emphasis on indigenous vernacular or tribal building, and as architecture *in* Africa, including introduced colonial European architecture in the nineteenth century in addition to the work of recent native-born black Africans, particularly those who focus on building for their own people. The earliest African buildings began within tribal social communities with clear disposition of customary structures (headman's residence, wives' residences, women's shelters, granaries, animal corrals, and so on). Early African structures exploited whatever organic materials were easily available—branches, saplings, grasses—with adobe plaster or stucco formed of clayish soils blended with water and grass, straw fibers, or desiccated animal dung. Blocks of this adobe mortar could be formed and baked in the sun to make adobe brick. A good example of distinctive sapling-framed but completely stucco-covered dwellings are the tall, egg-shaped houses built by the Musgum people in Cameroon [AF-2].

But that is just one of thousands of ways in which these traditional houses "out in the bush" were constructed. Even within the borders of one modern African nation, Kenya, tribal housing types vary from one region to another, with the general form being a round enclosure covered with a conical thatch roof.[1] Some houses, as among the Luo people, might be ringed with free-standing posts supporting an extended thatch roof gallery providing shade for the walls at any time of the day. Some, as among the Galla people, might have saplings bent in the form of large hoops as framing members, forming a dome-shaped round dwelling covered with thatch; others, as among the Pokot people, might have vertical posts set close in a ring like a palisade, supporting a conical thatch roof. Still other houses, as among the Maasai, might have spaced vertical posts placed in a ring (with the intervals between filled with interwoven sticks and branches), but with a rounded flattened roof covered with adobe plaster mixed with cattle dung as a hard roof shell. In the various conical houses, the way the thatch materials are pulled together and bound and finished at the top varied from tribe to tribe. Among the Pokomo people the thatch is attached in thick batches to encircling inside sapling stringers, creating the external appearance of concentric thatch rings around their domed houses. The Kishi and other tribes cover the inside and outside of the round walls of their sapling-framed dwellings with smoothed adobe plaster.

Western observers in the nineteenth and early twentieth centuries all too often referred to such structures, whether architectonically simple or complex, as "mud huts"—a designation that placed the buildings in the lowest architectural status and, in the European view, made them

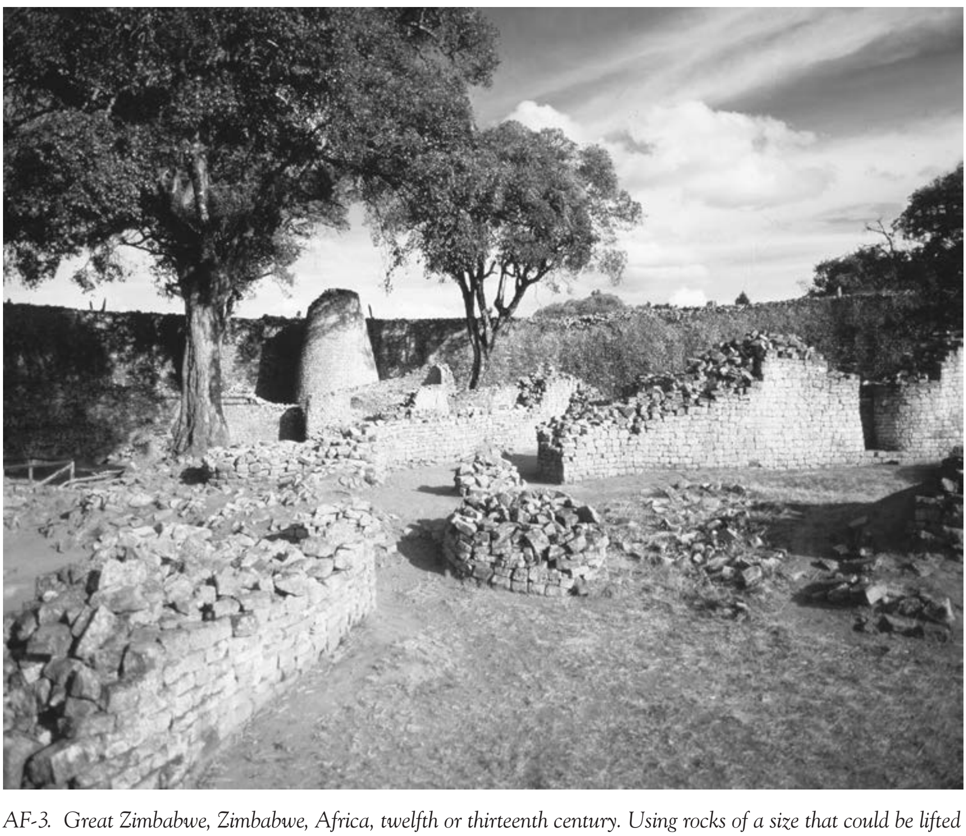
AF-2. Musgum house, in Cameroon, Africa, late twentieth century. Over a light sapling frame, layers of a clay-adobe are applied forming slightly projecting oval forms; once dried, these forms serve as foot rests for those applying the upper layers of the adobe shell until the top is reached. These houses can reach heights of over 35 feet (30.7 m). Photo: © Anthony Asael/Art in All of Us/Corbis.

hardly worth considering.[2] This dismissive nomenclature overlooked the fact that the materials were perhaps the only ones readily available, that their cost was minimal, and, more important, that these materials responded well to the nature of the local climate. They still retain these advantages; in villages in the back country, some dwellings continue to be built in these ancient traditional ways.

Conversely, larger and more socially structured African kingdoms produced permanent architecture at a time when Egypt was well into its decline. Although the Egyptians had conquered and controlled the kingdom of Nubia in the Kushite region south of Egypt along the Nile, by 760 BCE Nubians took control of Egypt, establishing the twenty-fifth Pharonic Dynasty until it in turn was conquered by the Assyrians around 656 BCE. It is architecturally significant that the Kushites took on some of the architectural traditions of ancient Egypt, wrote in hieroglyphs, and, by around 750 BCE and continuing up to about 330 BCE, built stone pyramid tombs with associated funerary temples for their rulers. Far smaller than the pyramids of Gisa, the Nubian pyramids rose perhaps 30 feet (10 meters) and had very steep slopes covered in smooth plaster. Some 223 of these small pyramids were built at three sites in Nubia—more pyramids, in fact, than were built in ancient Egypt itself.

Other cultures that left lasting architectural legacies were the Shona kingdom in Zimbabwe, active from the eleventh to the fourteenth centuries CE, and the Ethiopian kingdom of Fasilides and his successors, who established their capitol within the fortress-city of Fasil Ghebbi in the sixteenth and seventeenth centuries CE. The Shona people built the Great Zimbabwe complex near Masvingo, Zimbabwe, composed of large stone buildings of dry masonry.[3] It is estimated that these structures could have housed eighteen thousand people, including a palace to house the ruler of the kingdom (now in ruins), and an oval enclosure with curving stone walls of dry masonry 13 feet (4 m) thick at the base and rising as much as 26 feet (8 m) (with sections still standing), as well as a round tower 33 feet (10 m) high [AF-3]. Evidence suggests that within the enclosure, set inside smaller curving stone walls, sapling-framed and thatched-roof individual houses were built, probably very much like the houses today in the Shona villages near Great Zimbabwe. Even more accomplished in its masonry is the fortified town of Fasil Ghebbi near Gondar, Ethiopia, built in the mid-seventeenth century. The seat of Ethiopian Emperor Fasilides (who ruled from 1630 to 1632), this permanent stone-built city consisted of at least eight buildings plus three churches. The castellated buildings suggest European counterparts and very likely were influenced by the presence of Portuguese in the kingdom.

Of all the kingdoms arising in Africa, Ethiopia (a colony for only a short time) has the longest history of organized self-governance. Its history is extraordinarily deep, for in the Awash Valley of Ethiopia's Afar region, the skeleton of an *Australopithecus afarensis* female calculated to be 3.2 million years old was found in 1974. (She was named "Lucy" by her discoverer.) The recorded history of Ethiopia includes biblical references, and the legendary Queen of Sheba is believed to have been Ethiopian. The son she reportedly conceived with King Solomon is said to have returned to Ethiopia from his travels to Israel with a replica of the Ark of the Covenant, discovering only later that he had the actual Ark, with the replica being left in Jerusalem. According to Ethiopian tradition, the true Ark of the Covenant is still preserved in a small church in the town of Axum. Long isolated from the rest of Christianity after being surrounded by territories converted to Islam, Ethiopia has been predominantly Christian since the religion was first introduced about 330 CE. Though now separate with its own Patriarch since 1959, the Ethiopian Orthodox Church was once a branch of the Coptic Church. This long history of a unique form of Christianity in Ethiopia is important for understanding the thirteen dramatic rock-cut churches in the



AF-3. Great Zimbabwe, Zimbabwe, Africa, twelfth or thirteenth century. Using rocks of a size that could be lifted by hand, walls and enclosures were raised to protect smaller dwellings very much like those built by the Shona in Zimbabwe today. Photo: Werner Forman/Art Resource, NY.

AF-4. Djenné Mosque, Djenné, Mali, Africa, 1906–1907. Though rebuilt after extended neglect, the form and building material continue a centuries-old local tradition; the protecting bundles of rodier palm are used for periodic adobe plaster maintenance. Photo: AFP/Getty Images.

area of Lalibela, such as the Church of St. George, carved perhaps sometime in the twelfth or thirteenth century [Plate 27].

Northern Africa was swept by the spread of Islam, beginning, it is said, when Muhammad himself briefly took refuge across the Red Sea in Zeila in the Axumite kingdom (Ethiopia). In the century following the death of Muhammad in 632 and the end of the Umayyad Caliphate in 750, Islam spread through either conquest or conversion across the length of North Africa, carrying with it the architectural forms of mosque, minaret, and madrassa ("school") and associated decorative features such as brightly colored glazed tile, which shaped the architecture of North Africa. Numerous embellished gates, such as that of the Sultan's Palace at Meknes, Morocco, built about 1700, exemplify Muslim architecture, with its many-lobed horseshoe arch, recessed geometric panels filled with colored tile, and strong geometric patterning.

As Islam was carried southward, the associated building types became merged with local construction methods, resulting in mosques and madrassas such as those around Timbuktu in Mali. The Sankore mosque was built about 1325, and the Sidi Yahya mosque and school were built about 1400 using stucco-covered adobe brick (later partially reconstructed). Perhaps best known is the Djenné mosque, today the largest remaining adobe brick structure in the world [AF-4]. First built between 1200 and 1330, it was wholly reconstructed in 1906–1907 with the support of the French colonial government, leading to the suggestion that the early-twentieth-century design was heavily influenced by a French architect. Regrettably, there seem to be no photographs or drawings of the original mosque, which had been allowed to dissolve into ruins. Félix Dubois visited the site and published a book on Timbuktu in 1896. When he returned on a subsequent visit, he was shocked by the appearance of the rebuilt mosque, particularly the formality of the three symmetrical minaret towers on the *qibla* wall facing Mecca. He also thought the new pointed "finials" atop each of the wall buttresses were rather strange. Adding to the curious effect are the many protruding beams, the *toron,* but these projecting bundles of rodier palm sticks are essential supports used for the annual adobe replastering. The Djenné mosque and nearby old adobe buildings were designated as a World Heritage Site by UNESCO in 1988.

The rebuilding of the Djenné mosque illustrates well the profound impact of colonial governments on areas that they claimed and controlled. The creation of colonies in Africa began with the first landing of European explorers during the fifteenth century as they sought an ocean passage around Africa to India. During the seventeenth and eighteenth centuries, the creation of coastal European colonies had increased, driven by the almost unfathomable wealth amassed by European brokers who paid Africans to capture and sell their own people as slaves. By the end of the nineteenth century, the two European nations that controlled the largest portions of Africa were France (holding colonies across North Africa), and Great Britain (holding several colonies along the Ivory Coast as well as an almost uninterrupted band of colonies in the eastern half of Africa stretching from Egypt to South Africa). Portugal retained Angola on the western coast and Mozambique on the east, and Spain had a few small holdings; Belgium profited greatly through its large central colony of the Congo; Germany seized Cameroon, Namibia, and Tanzania; and Italy took over Libya and the coastal areas of Eritrea and Somalia. The last colonization occurred with the Italian invasion of Ethiopia in 1936, a cynical effort by Mussolini's Fascist government to re-create a new Roman Empire; it lasted only five years but resulted in some transplanted Italian modernist architecture in Asmara, Eritrea (then part of Ethiopia), such as the Cinema Impero, an Art Deco movie house built in 1937.

Each of the European nations imposed their own language, culture, and laws, as well as aspects of their national architectures, such as the Neoclassical buildings in the British colonies (see the domed Cairo University, 1910). Not only did Europeans—most notably the British—posted to these colonial stations create for themselves enclosed enclaves away from home, replete with cricket teams, afternoon high tea, and other amenities, but they also put up buildings that brought a little of their England to areas "back of the beyond." Among many other examples is the Edwardian-Classical Town Hall of Durban, South Africa, but perhaps the most impressive (or oppressive?) are the Union Buildings at Pretoria, South Africa (1910–1913), the seat of the South African colonial government designed by British architect Sir Herbert Baker. The broad encircling colonnade was considered a symbol of a united African people, while the two towers were seen as representing the two major languages used in the colony, English and Afrikaans. To the expatriates, the two domed towers would have been comfortingly familiar, since they strongly recall Sir Christopher Wren's twin cupolas flanking the open quadrangle space of the Royal Naval Hospital, Greenwich (1696–1714). Expatriates see what they want to see.

After World War II, one after another of the colonial possessions were granted their freedom. Most were ill equipped to assume their new nation's responsibilities, since their indigenous citizens had typically not been trained for administrative positions; nor did the new countries have well-developed industries, since the valuable raw materials had previously been stripped and shipped back to the governing European nations. The architectural situation was analogous, with major new postwar buildings being designed by European or American architects, including the schools designed by Maxwell Fry and Jane Drew in Ghana and other locations in West Africa, or the parliament building for Guinea designed by Frenchmen Michel Andraut and Pierre Parat (not built). In North Africa (Morocco, Algeria, and Tunisia), architects of Euro-African descent began designing new buildings in the 1960s, including the African-born, French-trained Jean-François Zevaco, who designed numerous schools and civic buildings. Though using large smooth planes derived from the International Style aesthetic, Zevaco employed substantial roof overhangs to create deep shadows and prevent solar heat gain. Clearly aware of contemporary developments in 1960s Europe, Zevaco and Elie Azagury also used concrete poured into deliberately rough board lumber formwork, leaving carefully controlled patterns in the finished building, as Zevaco did in his Post Office for Agadir, Morocco (1966). Brutalism, as it was being contemporaneously defined in Britain, France, and Switzerland, was brought immediately to North Africa.

At the same time, native Africans were leaving their homeland to be educated in universities in their former ruling countries, then obtaining valuable work experience with established European architects before returning home to reformulate what they had been taught to fit the social and climatic conditions. One representative is Oluwole Olumuyiwa, born in Nigeria, West Africa, who studied architecture and city planning at the University of Manchester, England (1949–1954). After graduation, he worked in architectural offices in Britain, Holland, and Switzerland, and in 1958 he returned to Nigeria and opened a practice in Lagos. His Nigerian buildings employed free ground plans (derived from International Modernism) but were coupled with "breathing walls" to facilitate traditional cross-ventilation, as well as doubled roofs to provide an "air cushion." In a 1968 house in Lagos, protected under a broad sheltering roof, Olumuyiwa used floor-to-ceiling glass doors that pivoted in the middle to allow the wall to virtually disappear and permit the full flow of air.[4]

As the twenty-first century began, architecture in Africa demonstrated the widest possible range of form and material, though for certain highly specialized buildings such as colossal sports arenas, European and local Euro-African architects have been the designers of choice. In the far north along the Mediterranean, as well as at the other end of the continent in the Republic of South Africa, strikingly contemporary buildings and high-end residences have been built.[5] Nearly all large urban centers in Africa—Cairo, Casablanca, Lagos, Harare, Kampala, Nairobi, and others—are becoming filled with high-rise office buildings so that, from a distance, they seem indistinguishable from European or North America major cities, at least at their core; beyond that cluster of modern central office towers may spread sprawling slums.

Among the more customary expressions of modern architecture, particularly in South Africa, have appeared monumental structures as well as parks and interpretive centers celebrating the end of apartheid in 1991. Particularly intriguing are two buildings designed by GAPP Architects/Urban Designers (based in Capetown), the interpretive centers for the Cradle of Mankind World Heritage Site where, in limestone caves, more than five hundred hominid remains some 2 million years old have been identified in the last half-century. The visitors' center at Sterkfontein (Afrikaans for "strong spring") is a long, low linear building lifted on a number of short posts so that it seems to hover over the undulating veld below; the center at Maropeng is a taller, sloped tear-shaped building that rises on its high side as a tall earth- and grass-covered tumulus.

A few young black African architects, educated in places like Great Britain, are establishing themselves as "starchitects." Best known, perhaps, is David Adjaye, born in Tanzania, the son of a Ghanaian diplomat, educated from the age of nine in England and earning his professional degrees there. Among his celebrated accomplishments are the design of the Skolkovo Management School outside Moscow, Russia; his consulting participation in the design of the National Museum of African American History and Culture, Washington, DC; and the translucent glass cube he designed for the Museum of Contemporary Art Denver (MCA Denver) (2007), a serene counterstatement to Daniel Libeskind's explosively angular titanium Hamilton wing of the Denver Art Museum (DAM) (2006).[6]

Another approach being pursued by native-born aspiring architects is to complete their education outside of Africa but then focus on building for the marginalized peoples in their home countries. Of these less-privileged African architects, one example is Diébédo Francis Kéré, son of the headman in Gando, a village of about three thousand people in Burkina Faso in sub-Saharan west-central Africa. As son of the headman, he was able to attend local schools; when he showed promise, he was awarded a scholarship to study woodworking in Germany. Kéré has observed with amused irony that he was being trained as a carpenter for a country devoid of wood. He earned the equivalent of a high-school diploma in Germany and graduated from the Technical University of Berlin in 2004. Meanwhile, he learned that the village school in Gando where he had started his education was near collapse, so he developed a design that exploited local materials, then raised funds and devised methods for building the new school using local volunteer labor. The resulting primary school at Gando (2004) was awarded a number of international prizes [AF-5]. This design, and a subsequent one for the Dano village high school (2007), both exploit raised and extended double roofs of galvanized sheet steel to promote natural ventilation and cooling; both also use locally produced earth blocks, a type of adobe material mixed with roughly 10 percent cement and molded in hand-operated presses, to make brick units that withstand the occasional rains.

In the early twenty-first century, the combination of urban building on a grand scale (locally produced, but European inspired) with unpretentious modern architecture for rural villages (inspired by ancient indigenous building practices) suggests a most promising future for the modern architecture both of and in Africa.

AF-5. Diébédo Francis Kéré, Primary School, Gando, Burkina Faso, Africa, 2004. Drawing on inexpensive modern materials (galvanized sheet metal) and traditionally based materials (hand-molded adobe brick), Kéré designed this school to be built largely using village workers. Photo: © Siméon Douchoud of the Aga Khan Award for Architecture.

19.14. Hans Scharoun, Schminke house, Löbzu, Saxony, Germany, 1933. Hans Scharoun suggested in this house that modernism was not limited to flat-sided square box shapes. Photo: Achim Bednorz, Architekturfotografie, Achim Bednorz, Siemensstrasse 29, D-50825 Cologne, Germany.

Chapter 19

Versions of Modern Architecture, 1914–1970

Architecture is the will of the epoch translated into space. Until this simple truth is clearly recognized, the new architecture will be uncertain and tentative. Until then it must remain a chaos of undirected forces. The question as to the nature of architecture is of decisive importance. It must be understood that all architecture is bound up with its own time, that it can only be manifested in living tasks and in the medium of its epoch. In no age has it been otherwise.

—Ludwig Mies van der Rohe,
"Baukunst und Zeitwille," 1924

We have had enough and to spare of the arbitrary reproduction of historic styles. In the progress of our advance from the vagaries of mere architectural caprice to the dictates of structural logic, we have learned to seek concrete expression of the life of our epoch in clear and crisply simplified forms.

—Walter Gropius,
The New Architecture and the Bauhaus, *1935*

Modern architecture, especially as indicated by such phrases as International Modernism or Canonical Modernism, has come to mean the lean, crisp, sharp-edged, boxy buildings, exploiting industrial building materials such as concrete, steel, and glass, designed in Europe in the 1920s and '30s. This design type came to be epitomized by the glass boxes designed by Ludwig Mies van der Rohe and the architectural firm Skidmore, Owings & Merrill in the 1950s and '60s in the Unites States. Yet this use of the word *modern* wholly ignores other forms of modernism evident in a far wider range of buildings in the developed West, including examples representing Expressionism, Classicism, and national vernacular or national romanticism during the twentieth century. All these idioms or styles need to be understood if we are to appreciate the complex intermix of multiple "moderns" that developed in the twentieth century.

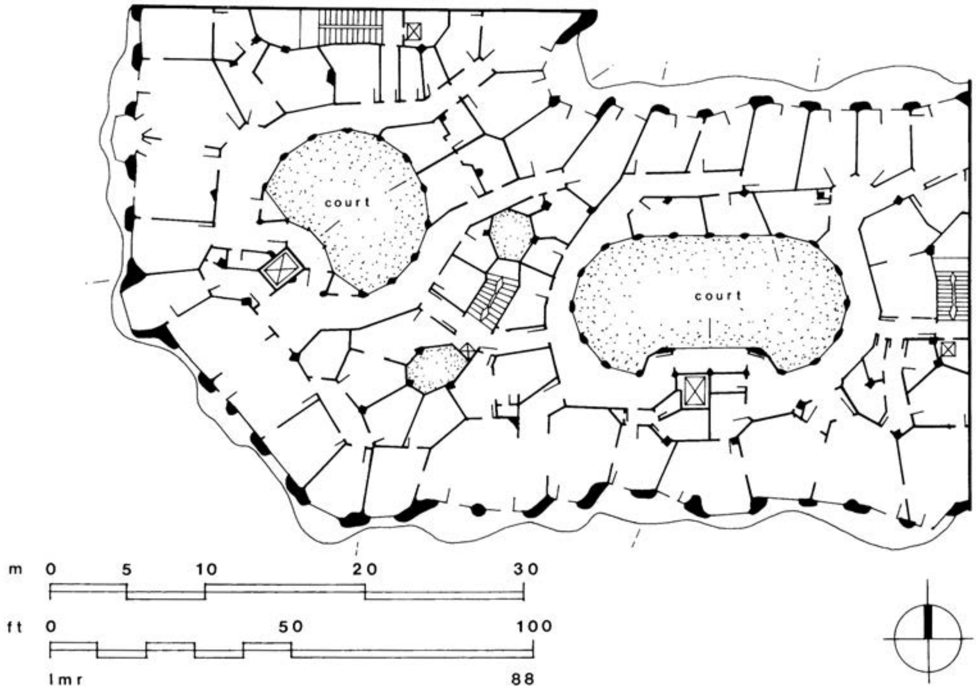
The situation in the twentieth century was further complicated by two global conflicts that have customarily been called World War I in 1914–1918 and World War II in 1939–1945. The issues left unresolved after the first conflict led almost inevitably to the second, so perhaps in future years historians and others may speak of the twentieth century as a hundred-year period torn by nearly constant warfare in at least some part of the globe.

An Architecture of Its Own Time

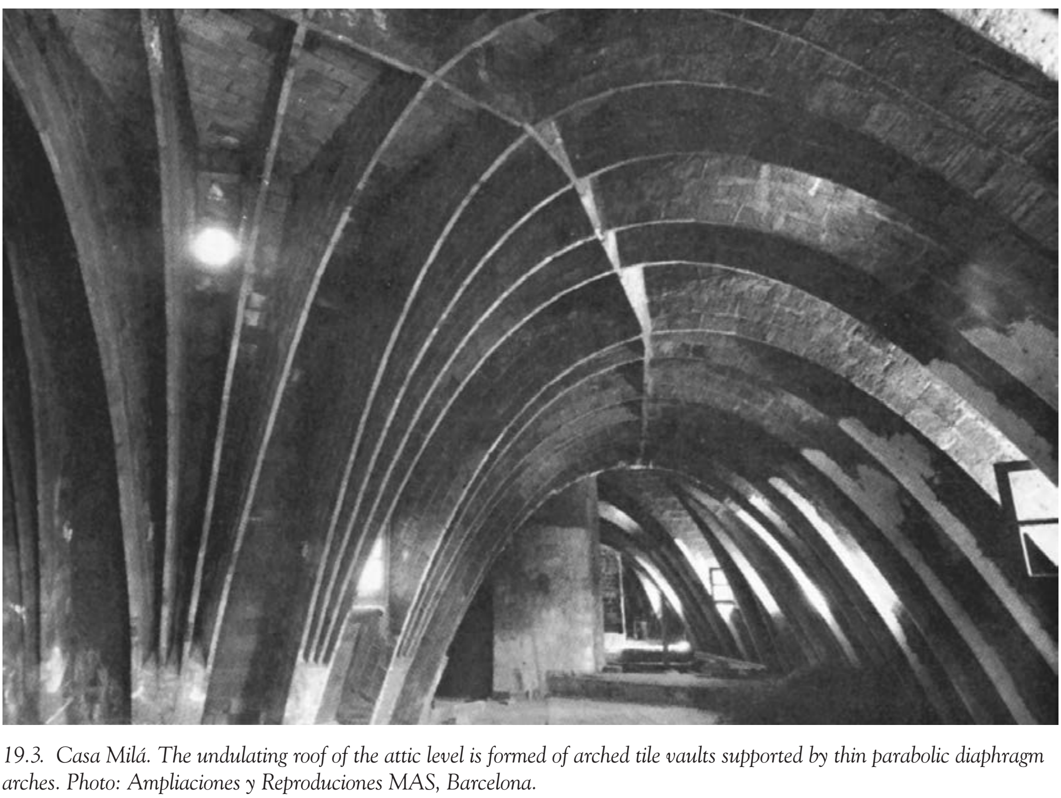
Critics and architects in the nineteenth century were consumed with an interest in historic style. As they studied Greek, Roman, and Gothic architecture, they came to understand by the end of the nineteenth century that these ways of building had begun first as vernacular expressions, which then had been clarified and stylized, becoming cultural expressions rich in meaning. As Ruskin put it in the Preface to *St. Mark's Rest* (1877), great nations write their autobiographies in the "books" of their literature, their political histories, and their art, and "of the three," he insisted, "the only quite trustworthy one is the last."[1] What then, as Viollet-le-Duc asked in the 1860s, was the nineteenth-century architectural expression that summarized its culture; what style was it creating that embodied the spirit of adventurousness of the age? This was the question that Louis Sullivan struggled with as well. Although Sullivan attempted to develop an American approach to design broad enough to be applied to any building task, his most notable successes were largely limited to commercial and office buildings, rather than churches and residences of which he designed relatively few. Sullivan rejected the literal reuse of styles and historical architecture, while at the same time observing the crucial lesson of history that the best designs always grow out of a cultural response to function.

Other architects responded in their own ways in developing a method of building unique to their own place and time. Some put the emphasis on exploiting local vernacular traditions, as was the case in the Red House designed for William Morris. Perhaps the most unusual of such architects was Antoni Gaudí (1852–1926), of Barcelona, Spain, who developed an architecture of brilliant color inspired by Moorish ceramic tiles and molded forms based on curved structural walls and thin masonry vaults. Catalonia, the Spanish province of which Barcelona is the chief city, has continually chafed under the rule of Madrid, and at the end of the nineteenth century the province witnessed a resurgence of separatist sentiment. Gaudí created an architecture rooted in Catalonia's Moorish and medieval past, ablaze with colored tile, exploiting the thin, curved tile vault construction for which Catalonia had long been famous. Hence, it could be said that Gaudí's extremely personal architecture was also an expression of "critical regionalist" design. Moreover, his architecture was closely studied from nature, as well as being carefully analyzed mathematically, so that supporting columns were inclined and vaults were twisted and ramped to follow the lines of structural action. As a result, he was able to eliminate all external flying buttresses in the immense church of the Sagrada Familia, on which he began work in 1884 and which remained incomplete at his death.[2] His fusion of organic naturalism and the structural logic of curved vaults is demonstrated in the large apartment block, the Casa Milá, that he designed for Dona Rosario Milá on the Paseo de Gracia, Barcelona, 1905–1910 [19.1, 19.2]. Its plan of irregular walls, looking like a microscopic enlargement of the cross section of a plant stem, provides for four apartments per floor, grouped around interior light courts. On the exterior the massive walls of cut stone give the appearance of a weathered cliff (closely resembling the sea cliffs outside Barcelona), with balcony balustrades of wrought iron fashioned in the likeness of tangled kelp seaweed. The attic roof, whose undulations, ventilators, and mechanical houses create a surreal roof garden, is supported by diaphragm tile arches and thin parabolic vaults [19.3]. It is a unique vision of a functional, structurally utilitarian, organic architecture that could have been created only in Barcelona.

19.1. Antoni Gaudí, Casa Milá (La Pedrera, "The Quarry"), Barcelona, Spain, 1905–1910. Gaudí sought to create an architecture that was modern yet inspired by Moorish traditions, as well as uniquely identified with Barcelona and Catalonia. Photo: MAS, Barcelona.



19.2. Casa Milá. The plan of a typical apartment floor reveals few traditional straight lines. Four apartments (their party walls are indicated by the dotted lines extending from the periphery) are arranged around internal light courts. Drawing: L. M. Roth, after Martinel and Gaudí.



19.3. Casa Milá. The undulating roof of the attic level is formed of arched tile vaults supported by thin parabolic diaphragm arches. Photo: Ampliaciones y Reproduciones MAS, Barcelona.

19.4. Victor Horta, Tassel House, Brussels, Belgium, 1892–1893. Stair hall. Horta's modernity came from the use of metal for both structural and decorative elements and the artistic assimilation of electric incandescent lighting fixtures, all woven together in a continuous curvilinear pattern. Photo: Ch. Bastin & J. Evrard Photographes, Bruxelles, Belgique.

An altogether different approach in creating a new design language was taken in Brussels, Belgium, by architect Victor Horta (1861–1947). Horta deliberately rejected historical styles and invented a new architectural idiom for his progressive, wealthy industrialist clients, using ornamental motifs in metal and glass derived from plant forms. As with Rococo architecture, whose delicacy and irregularity in detail it resembled, this "new art"—or as the Parisian collectors called it, *l'Art Nouveau*—was employed largely for interiors. It appeared fully developed in the interiors of the Tassel house, Brussels, that Horta designed in 1893 [19.4]. The Tassel house staircase, with its integration of pattern and line in floor mosaic, foliate column with bud-like capital, wall painting, tendril-like gas lighting fixture, and curvilinear stair balustrade, was the prototype for the other houses Horta designed in Brussels.

Horta's inventiveness in Brussels was matched in Paris by the work of Hector Guimard at the turn of the century, in residences and especially the commission that Guimard was given to design scores of stations for the new electrified underground Paris mass-transit railroad, the Métropolitain or Métro. Devising a kit of basically identical parts in cast iron, glazed block, glazed terra cotta panels, and glass, and incorporating the new incandescent electric illumination, Guimard built stations both small and large in variations on a theme throughout the city during 1900–1913, many of them still prized and in use today [19.5]. In this instance, Guimard demonstrated that the new art was not always or by definition costly and therefore inaccessible by ordinary citizens. Not only was Guimard's work intimately connected to the newest transportation technology, but it was unquestionably a deliberate attempt to ex-

19.5. Hector Guimard, Metro Station (Les Abbesses stop) in Montmartre, Paris, France, 1900–1913. Using forms inspired by plants, Guimard devised a system of identical cast iron and ceramic parts to create entry gates for the new electrically powered underground mass-transit system. Photo: L. M. Roth, 2003.

press the architect's own time. It was decidedly new. And whereas Guimard was able to exploit industrial production of building parts for the Métro sufficiently to make it reasonably cost-effective, the private houses that Horta and Guimard designed and built, and the comparable work of other *Art Nouveau* architects, with their many hand-crafted elements, were too costly to be the start of a universal modern architecture.

Creative Eclecticism (Redux)

For many building users and architects alike, simply building something in the early twentieth century automatically made it modern, even if the stylistic character was strongly based on past expressions. The railroad engineers as well as architects McKim, Mead & White, in planning Pennsylvania Station, exploited the very latest and most advanced transportation and electrical innovations, so the station was considered modern even if the architectural details were inspired by ancient and Renaissance Rome. The same was true of the equivalent and contemporaneous new railroad station built by the New York Central company in New York City, 1902–1910, Grand Central Terminal, by architects Warren & Wetmore and Reed & Stem, working with Wilbur Wilgus and his staff of railroad engineers of the New York Central Railroad [Plate 28]. Here, too, the building and transportation technology was the most advanced (even better in some technical aspects than Penn Station), even though the stone envelope of the station drew heavily on Classical design motifs taught in Paris at the École des Beaux-Arts. In 2013, a century after it opened, Grand Central still functions efficiently as the railroad and commuter hub of New York, a testament to its modernity.[3]

19.6. John Russell Pope, Thomas Jefferson Memorial, Washington, DC, 1937–1943. Forming a gesture of homage to Jefferson, who first introduced the classical revival to the United States, Pope is here emulating the Roman domed library for the University of Virginia designed by Jefferson. Photo: © idp eastern USA collection/Alamy.

The use of Classicism continued well into the twentieth century for certain building functions. In the United States, governmental buildings were somehow considered inappropriate if not done in traditional Greco-Roman Classicism. Two good examples from well into the twentieth century are the Washington State Capitol Building in Olympia, Washington, by architects Wilder & White and built in 1911–1928, strongly patterned on the United States Capitol though made more compact since offices and other chambers were housed in separate flanking buildings creating a capitol campus. While the Washington State Capitol building was completed just before the Great Depression halted most such construction, a bit later, and in some ways even more decidedly Roman Classical in style, was John Russell Pope's Thomas Jefferson Memorial on the Tidal Basin in Washington, DC, designed as early as 1925 but not built until 1937–1943, so that this monument to pure Roman Classicism was finished almost at the midpoint of the twentieth century [19.6]. Pope's simple domed design is meant to recall Jefferson's own domed library for the University of Virginia.

Classicism of a more British character was championed by Sir Edwin Lutyens, who had been designing in the Arts and Crafts mode, as indicated in his country house, The Deanery, Sonning, of 1901, set in gardens by Gertrude Jekyll (see Chapter 18). Lutyens's shift to an English Classicism was declared in another country house designed in 1905, Heathcote, in Yorkshire, England, where the references to Van Brugh in the massing and detailing of the garden front are unmistakable. Lutyens rose to the pinnacle of his profession, being called upon to produce designs for British structures outside of England itself, including World War I memorials in Flanders, a new British ambassadorial compound in Washington, DC, 1928–1931, and a large residence for the British viceroy in New Delhi, India, a protracted undertaking that extended from 1912 to 1931 [19.7]. For the ambassador's residential compound in Washington, Lutyens produced a Wren-like building of accomplished massing that hinted at what the colonial plantation owners might have built had they possessed the education and budget of Lutyens. For the Viceroy's House in Delhi, Lutyens devised a sprawling structure, set in formal gardens, with the palace itself built of red sandstone below and cream-colored stone above. In particular, he incorporated references to local building traditions, as in the extended horizontal shelves of the cornices creating deep shadows, and especially in the small Mugul *chattra* pavilions atop the roof. For the expansive porticoes, Lutyens developed a column capital composed of Indian motifs but which, when viewed at a distance, suggests the Classical Corinthian capital. The commanding central dome (built of concrete), while also making reference to long-established European Classical models, is in fact proportioned and detailed to recall the ancient rounded Buddhist stupa at Sanchi, begun in the third century BCE, particularly in the distinctive banded base or drum stage that references the stylized fence surrounding the Great Stupa at Sanchi.[4] Hence, Lutyens fuses the architecture of both ruled and ruling peoples so as to convey the image of familiar Western forms in a composition that, in its component parts and details, draws on ancient Indian traditions.

National Romanticism

Another form of modernism in the early twentieth century was the creation of well-articulated expressions drawn from national vernacular architectural traditions, sometimes called national romanticism. This was particularly evident in the northern European Scandinavian countries in the years between 1890 and 1940, and especially in the case of Finland this was directly connected to its having gained its freedom in 1917 after a century of Russian dominance. The subtle regional differences in this resurgent vernacular nationalism were analogous to how Renaissance architecture had been modified in the Scandinavian countries several centuries earlier.

Particularly celebrated is the City Hall for Stockholm, Sweden, the design for which was won in competition by Ragnar Östberg in 1908, with construction occurring 1911–1923 [Plate 29]. With a beautiful waterfront setting on Kungsholmen island, the building's construction was protracted because of the extraordinary level of skill among the many artisans who contributed to the building, and in many ways this set the standard for the national romanticism that was embraced in the larger Scandinavian region.

In Denmark, a particularly good example of this national regionalism can be seen in the new housing development in the midst of which stands Grundtvig's Church in Copenhagen, initiated by a

19.7. Sir Edwin Lutyens, The Viceroy's House, New Delhi, India, 1912–1931. Drawing on generalized traditional European classicism, Lutyens nonetheless used ancient Indian models for the columns and the dome, and particularly the parasol-like chattra *embellishments. Photo: Country Life Picture Library, London.*

19.8. Marinus Jan Granpré Molière, Town Hall, Waalwijk, The Netherlands, 1939. In this example built just prior to the outbreak of World War II, well into the twentieth century, Granpré Molière makes clear reference to Netherlandish Renaissance traditions as seen in the Vleeshal ("meat market"), Haarlem, of 1602–1603. Photo: M. M. Minderhoud.

competition in 1913 but then built after World War I during 1921–1926. The architect was P. V. Jensen-Klint, and the church is often described as being part of Expressionist postwar reaction, but in fact Jensen-Klint was drawing inspiration from small rural parish churches, such as St. Jørgensberg in Roskilde or the twelfth-century Falster Church in Astrup. Perhaps the architect was attempting to soften the cultural shock of rural folk moving into the densest city in Copenhagen, putting them around a church type that they would have been familiar with back home.

A perfect example of this national vernacular resurgence can be found in the Netherlands, a northern country (though not Scandinavian), in the town hall built for the little town of Waalwijk as late as 1939 by architect Marinus Jan Granpré Molière. What he created was a simplified version of the familiar traditional brick stepped-gable models found in Deventer, or seen in the Renaissance Vleeshal (meat market) in Haarlem [19.8].

A later phase of reductivist classicism was practiced by Swedish architect Gunnar Asplund, perhaps best known for his dramatically simple Stockholm Public Library, 1924–1928. One of his most attractive works was a cemetery on the outskirts of Stockholm designed with Sigurd Lewerentz, built on the basis of a competition they won in 1917. (A classically severe crematorium built in 1940 for the cemetery was one of Asplund's last works.) Built in a grove of small evergreen trees that had established itself in an old gravel quarry, the Woodland Cemetery, as it came to be called in English, had burials marked with small headstones grouped around a chapel that, like Laugier's primitive hut, is architecture reduced to its essence [19.9]. A plain hip roof is placed directly on slender archaic Doric-like columns, the roof dark and the walls and columns painted white strongly contrasting with each other. The suggested heaviness of the roof is lifted lightly by the grid of columns, creating a deep, protected "porch" that prepares visitors for passage through the door into the intimate internal space.

Perhaps the most accomplished architect in this group was Eliel Saarinen of Finland, who began as a proponent of national romanticism but then reworked and rethought that approach to create a unique modernism that appeared in his celebrated design in the global competition for the new Chicago Tribune office tower in Chicago, 1922. As it turned out, although Saarinen's design was awarded second place, it proved far more influential in later skyscraper design than the winning Gothic Revival design by Howells & Hood.[5] The roots of Saarinen's Chicago entry can be seen in his Helsinki Railroad Station, 1904–1909, particularly in the step-backs of the copper-clad tower top. Shortly after, Saarinen designed the city hall for the town of Lahti in southern Finland, a good example of his mature national romanticism leading to his Chicago success.

Fascist Architecture

The darker side of this national romanticism was how a search for an identity through architecture became a nationalistic assertion of the primacy of the state through architecture. Some of the same basic stylistic forms were used, but for very different ends. In Spain, Generalissimo Francisco Franco emerged victorious during the Spanish Civil War of 1936–1939 as dictator of Spain, exercising a hard-handed rule he held until his death in 1975. While it is not easy to isolate a Franco Fascist architectural stylistic character, what was achieved during his rule was the absence of creativity and the stifling of a genuine modern architecture in Spain during the mid-twentieth century. The tight clamp that the Franco regime had over imaginative artistic and architectural life was made evident by the explosion of creativity that emerged from Spain almost immediately after his death in 1975.

In Italy, Benito Mussolini leading the Fascist Party took over control of the country in the political unrest following World War I. The Fascists looked back to the glory and power of ancient Rome, lamenting the emasculated Italy following the war. Hence, rebuilding Italy in the style of ancient Rome became a goal, even to the extent of rebuilding a modern Italian (that is, Roman) empire by seizing the African countries of Eritrea,

19.9. Gunnar Asplund with Sigurd Lewerentz, Woodland Cemetery chapel, outside Stockholm, Sweden, 1917. Seeming to go back to Laugier's basic primeval building, Asplund here created a kind of classicism that was pure essence. Photo: © Arcaid Images/Alamy.

Libya, Somalia, and Ethiopia. The emblem of the party was the *fasces,* the ancient Roman ceremonial axe that served as an symbol of strength through unity: a thin weak metal axe with bundles of light sticks placed around it and bound with tight leather bands. It is, in fact, an official emblem of the United States House of Representatives, but the political and subsequent military outrages of the Italian Fascist Party have caused the ancient Roman *fasces* to fall into public disgrace. One of Mussolini's particular interests was encouraging archaeological excavations in Italy, to better bring to light ancient Roman accomplishments in the arts and architecture. One achievement, among many others, was the excavation of the parts of the *Ara Pacis,* an altar covered with sculptural reliefs originally built to honor the Emperor Augustus in 13–9 BCE. The sections were unearthed over the years, beginning in 1937, and the altar reassembled. For public display, as a way of promoting a new Rome as glorious as ancient Rome, Mussolini had a protective shelter built over the reconstructed altar (in 2006 a totally new sheltering glass building was built for it from designs by Richard Meier). In an even more ambitious project, Mussolini had tunnels cut to drain Lake Nemi to expose the sunken wood frames of two huge, fabled pleasure boats built for Caligula. After 40 million cubic meters of water were drained during 1927–1932, the boats were recovered and housed in museums built on site, but regrettably the boats were largely destroyed by fire due to allied military shelling in World War II. These two examples illustrate the importance that Mussolini placed on recovering as much as possible of the ancient Roman era.

Italian Fascist architecture attempted to emulate Roman greatness, but sadly its graceless brutalism is all too visible today in the surviving Palazzo della Civilita Italiana located in the EUR district in Rome (the initials coming from Exposition Universal of Rome, which Mussolini had hoped to host in 1942 to celebrate forty years of Fascist rule). The Palazzo was to be featured in the grounds of the EUR fair. Another building strongly associated with Italian Fascism is the Casa del Fascio in Como, Italy, the work of Giuseppe Terragni. Conceived as a stylish "set piece" for the large local Fascist rallies held there, it is a severe, cubic palazzo centered on a glass atrium [19.10]. However, Terragni's Casa del Fascio possesses a degree of lightness and subtlety not normally thought of as qualities associated with Fascist policies, and shows Terragni's connection to the Modernist movement.

Architecture by and for the National Socialist Party (Nazi Party) in Germany was of a heaviness and inhuman scale that Mussolini did not achieve. To Adolf Hitler, architecture was extremely important as an expression of Nazi ideals. Indeed, Hitler believed he had the makings of an architect himself and considered architecture to be, as he put it in a speech of 1938, "the word in stone." Party officials spoke of him, with exaggeration, as being a great builder, and he imagined undertaking grandiose building projects. A willing collaborator in these schemes was the young German architect Albert Speer. Hitler, along with Nazi officials who took up his architectural views, developed an architectural program of building styles considered appropriate for particular uses. Residences could be either chalet-like in southern Germany or steep-roofed with half timbering for the north, and factories could have exposed, or at least expressed, steel frames with glass and brick panel walls (these factories looked much like what Gropius and Mies van der Rohe had been designing before they fled Germany and relocated to the United States). But for civic and government buildings a sort of severe classicism was required. This was not the graceful Greek Classicism of Karl Friedrich Schinkel of a century earlier. Schinkel, most ironically promoted by the Nazis as a supreme cultural hero, had produced elegant buildings comprehensible in their human scale; his Altes Museum incorporated delicate Ionic columns whose slight *entasis* and sensuously curling volutes softened the rigor of the broad colonnade. In contrast, official Nazi Classicism was hard-edged and superhuman in scale, utterly dwarfing human beings. The Nazis built what could be called "colonnades," but these were endless rows of hard, straight-sided square piers, standing stiff like soldiers at attention. We see this in the huge Zeppelin Field stadium that Speer designed for party rallies held at Nuremburg, capable of holding 100,000 people [19.11]. Fed by Hitler's megalomania, Speer's designs became ever larger and scaleless—architecture to crush the human spirit.

Modernism: Phase One, 1914–1940

Since the dawn of human symbolic thinking, architecture has not only provided utilitarian shelter but has also silently expressed how humans view themselves in relation to the cosmos, to their gods, and to each other. It has given formal expression to their whole social and religious natures. This has been the foundation of symbolic architecture from the Paleolithic period up to the present, and provided the basis for the secular philosophies of empiricism, utilitarianism, and positivism in the eighteenth and nineteenth centuries. By the mid-nineteenth century, architecture had lost much of

19.10. Giuseppe Terragni, Casa del Fascio, Como, Italy, 1932–1936. Although working in Fascist Italy with its strong association with the ancient Roman empire, Terragni shunned historicism and attempted to create a unique Italian modernist idiom. Photo: Scala/Art Resource, NY.

19.11 Albert Speer, Zeppelin Field Stadium, Nuremburg, Germany, 1934–1935. Encouraged by Hitler, Speer readily devised a form of austere Classicism, massive in scale, that was rigidly stiff, suggesting masses of soldiers snapped at attention. Photo: © CORBIS.

its age-old cosmological significance and had become instead a literary symbolic vehicle, conveying historic traditions. Then, during the early twentieth century, architecture was reduced by Modernists to being simply a utilitarian vessel for housing human activity.

During the nineteenth century, philosophers and art historians such as Hegel and Jakob Burckhardt developed the concept that history evolves as the result of an inner spiritual necessity, and that each period in history is shaped by its unique *zeitgeist,* the spirit of the age. The art historian Heinrich Wölfflin then extended this idea to the interpretation of architecture, writing in 1888 that "architecture expresses the attitude to life of an epoch."[6] Thus, it was up to architects at the end of the nineteenth century to express the character of their time, but precisely what that character was proved difficult to define. Further complicating the issue was the fact that a new millennium was beginning. Clearly, for those promoting this *zeitgeist* idea, the architecture of the twentieth century ought to declare its uniqueness, to celebrate the advances made possible by electric illumination, radio communications, the automobile, and (by 1904) the airplane. The dawning century was to be the era of the machine, of greater speed, and of unprecedented mobility, and the architecture of the new epoch must surely manifest this mechanization.

The forces of change in the eighteenth and nineteenth centuries had dramatically changed Western society from monarchy to democracy, from religious certitude to a broader secular focus, and from an aristocratic taste in the arts to one dominated by industrial entrepreneurs and the rising middle class. To achieve a sense of order in this apparent chaos, architects could turn to one of several design alternatives: eclecticism, vernacular national traditionalism, personal invention, or functional/structural determinism. The design concepts of academic eclecticism and vernacular traditionalism (or national romanticism), formulated in the late nineteenth century, continued well into the twentieth. The architects who put themselves in one or the other of these theoretical camps seem not to have shifted in their design approach markedly in the opening years of the twentieth century, but for countless others—architects, patrons, the public—the unfolding of World War I had a most profound and disturbing effect. The general attitude before 1914—that things were gradually getting better and better, that applied logic could solve all problems—was shattered beyond all recovery by the horrors of the war and the deaths in the trenches. The finest generation of European and American youth disappeared in the trenches, never to reappear.

The young architects who did survive took one of two diametrically opposed positions. Either they turned to an even more obsessively logical and radical functionalism, a new objectivity or *Neue Sachlichkeit* (literally "fact-like-ness" that later was given the label ***International Style***), or they absolutely threw off the restraints of logical formalism and struck out in new directions, following personal and subjective visions that favored irregular, dynamic, contrasting forms commonly gathered under the label ***Expressionism***. These two fundamentally opposed philosophies of functional/structural determinism and dynamic personal invention manifested themselves early in the twentieth century. What they held in common, as a result of the experience of World War I, was a driving passion to sweep away the Old Europe and to build a new utopian world, a new social and moral order. For this reason, many of the younger architects embraced socialism or communism, with the doctrines' emphases on uplifting and improving the lot of the working class.

A Counter-Architecture to Rationalism: German Expressionism in the 1920s

There were architects in the 1920s who believed that architecture—far from being simply a utilitarian appliance—could and should be primarily a vehicle for evoking emotional, even mystical states of experience achievable in no other way. The essence of the modern idiom developed by Gropius, Mies, and Le Corbusier (discussed in the latter part of this chapter) was an absolute reliance on rational analysis. An adjective Le Corbusier often used with respect to his designs was *Cartesian,* referring to the logical, analytical thought of philosopher René Descartes. Yet in the wake of the waste and utter madness manifested in the "Great War" (and no one could yet imagine the even more horrific repetition in a *second* world war), this reliance on rationality seemed to make no sense to some architects, particularly in Germany. What quickly emerged among them was an architecture that turned its back on Cartesian logical analysis in favor of the suggestive and emotive power of architectural form as pure sculpture.

One building that may serve to illustrate the intent of the German Expressionists is the Einstein Tower, built in Potsdam, outside Berlin. The work of the architect Erich Mendelsohn (1887–1953), it was designed in 1917–1919 and built in 1919–1921. Mendelsohn had been educated for a career

19.12. Erich Mendelsohn, sketch for an optical instrument factory, project, 1917. This sketch, one of many done in the trenches during World War I, was the inspiration for the Einstein Tower commission. From Zevi, Erich Mendelsohn *(New York, 1985).*

in architecture in Munich, then the center for Expressionism championed by Wassily Kandinsky.[7] From this school of architectural thought, Mendelsohn learned to think of the function of architecture as the symbolic expression of inner human emotions realized in physical form. He had just set up a practice in Berlin when World War I interrupted his career. In the trenches, he began to write out his theory of architecture and to make small sketches, some of them no bigger than postage stamps. The small size enabled him to concentrate on a few bold, energetic lines conveying a sense of mass and motion. Some of the visionary projects were for garden pavilions and great public halls, and some of the abstract designs were done in response to hearing pieces of music; but many were hypothetical sketches for industrial buildings, railway stations, automobile plants, and foundries. One in particular was a design sketch for a factory of optical instruments [19.12]. This sketch would lead to Mendelsohn's first major commission—the Einstein Observatory Tower—built immediately after the war.

Mendelsohn had become a friend of Erwin Freundlich, a research associate of Albert Einstein, and immersed himself in studying their scientific investigations concerning relativity. Once the war was over, Mendelsohn was invited to redraw his thumbnail sketches for exhibition in Berlin. Consequently, he came to the attention of a group of supporters who were proposing to build an observatory/laboratory where Einstein's theories about the relationship between energy and matter could be proven. Mendelsohn's hypothetical observatory project of 1917–1919 was converted into detailed drawings for a boldly molded building, to be built of reinforced concrete, the material that for Mendelsohn symbolized the potential of the new century [19.13]. However, when it came time to build the tower in Potsdam, outside Berlin, the postwar German economy was collapsing and the necessary concrete could not be found. So the structure was built of concrete foundations, with a tower of brick covered in concrete stucco.

Such a substitution of material would have been unthinkable to Gropius or Mies without changing the form, but for Mendelsohn, the form was paramount and the substitution posed no significant problem. In the rotating dome atop the tower was a system of lenses and mirrors that reflected starlight to another mirror at the base of the tower, which in turn reflected it to various instruments in the laboratory base of the structure. Instead of encasing this mechanism in a light framework of industrial steel (which would not have given the necessary thermal insulation nor provided the mass necessary to prevent vibrations from disturbing the delicate instruments), Mendelsohn sculpted a heavy mass that was not so much a direct expression of the mechanics of the scientific and technological age as it was a symbol of Promethean power. Mendelsohn's gesture was prophetic, for in 1917 only a few scientists could imagine how Einstein had put the immeasurable and terrible atomic "fire of the gods" into the hands of humankind with the simple formula of $E = mc^2$.

The claim that Expressionism was a reaction to the perceived failure of rationalism in World War I is, in truth, not wholly correct. One of the leading

19.13. Erich Mendelsohn, Einstein Tower, Potsdam, near Berlin, 1917–1921. Designed especially to house equipment to test Einstein's theory of relativity, this also was meant to suggest an image of modern Promethean power. Photo: © Wayne Andrews/Esto.

polemical writers and architects of the movement was Bruno Taut, whose base was Berlin. In February 1914 (before war broke out), he published an essay, "A Necessity," in the magazine *Der Sturm.* In this essay he advocated a new structural intensity achieved through the expression of rhythm and dynamics, built using steel, concrete, and glass. At nearly the same time, another essay appeared in *Der Sturm;* this second piece was written by Paul Scheerbart and entitled "Glass Architecture." Scheerbart made the connection between the built environment and its influence on culture, noting that people live and work for the most part in spaces enclosed by opaque materials:

> If we wish to raise our culture to a higher level, we are forced . . . to transform our architecture. And this will be possible only if we remove the enclosed quality from the spaces within which we live. This can be done only through the introduction of glass architecture that lets the sunlight and the light of the moon and stars

> into our rooms . . . simultaneously through the greatest possible number of walls that are made entirely of glass—colored glass. The new environment that we shall thereby create must bring with it a new culture.

Scheerbart envisioned an architect's dream of light, crystal-clear, colorful, mobile, floating, and soaring constructions that would transform "Old Europe's habits of thought and feeling."[8] This idea of the reforming power of glass architecture, conceived as crystalline structures, reappeared more forcefully after the war, as in the books published by Bruno Taut. For example, in *Die Stadtkrone* (Jena, 1919), Taut described the "city crown," the central communal public structure, as "a crystal building of colored glass" that would "shine like a sparkling diamond."

After 1919, however, the emotionally evocative power of strongly modeled form was taken up by several German architects for the design of churches. For them the avoidance of rationally dictated box-like forms seemed to promote a sense of mysticism and made possible allusions to medieval architecture with its pointed arch forms. Among these architects who exploited sculptural architectural form were Dominicus Böhm and Otto Bartning, whose best work consisted of several churches. In these buildings the strongly molded architectural forms manipulated light in ways that paralleled what had been done by Baroque architects, who also aimed at shaping human psychological experience.

Striking angular crystalline qualities dominate the sketches made by Hans Scharoun in the years immediately after the war, but by the mid-1920s he had shifted his design ideology to include form as an expression of function.[9] For him, however, this never meant restricting building form to reductive, box-like forms, as was clearly demonstrated in his Schminke House in Löbzu, Saxony, built in 1933 [19.14, p. 556]. Two axes at an acute angle, suggested by the site, determine an open house plan divided by movable partitions. Projecting, triangular exterior balconies create a series of stacked angles, with rounded corners, not the sharp right angles favored by his Modernist peers. The materials used—steel columns, large sheets of glass, smooth stuccoed surfaces—make a connection to the rationalists, but the sharp, angular forms retain a connection with the dynamics of Expressionism.

Functional Utilitarianism and the Rise of International Modernism

Turning away from Expressionism as well as national romanticism, designers holding a purely pragmatic and utilitarian view opted to let functional requirements and structural solutions determine their designs. To an extent, Louis Sullivan had appeared to do this at the close of the nineteenth century, using ornament to delineate the four visible zones of internal function in his skyscrapers. But Sullivan was no strict structural determinist, for to emphasize the verticality of his skyscrapers, he had used *twice* the number of required vertical piers. This had the practical advantage of reducing the size of windowpanes, but it also made the building look much higher than it actually was, emphasizing its vertical nature [see 2.5, p. 20, and 18.44]. Because he was trained in the principles of Beaux-Arts theory and composition, Sullivan made his primary objective the definition and expression of *character* (a concept fundamental to the Beaux-Arts) appropriate to the modern high-rise office tower.

For designers seeking a purely utilitarian architecture, the form could be (or at least could appear to be) absolutely determined by internal function and necessary structure. The American buildings that particularly fascinated European observers in the opening years of the twentieth century were the bold, cylindrical concrete grain elevators and the bare, utilitarian concrete-frame American factories, with their structural bays filled with panels of brick and steel sash windows. These appeared to be building forms wholly determined in every part by internal functional necessity. Architects like Charles-Édouard Jeanneret (Le Corbusier) saw in photographs of such strictly utilitarian structures a hint of what twentieth-century architecture might become.

How the machine might inspire a new architecture was demonstrated first in Berlin, in a Germany just beginning at the turn of the century to develop its potential as a political and industrial power. The creation of a new architecture to express the aspirations of industrialism in the rising German empire was strongly encouraged by German industrial leaders. Its originator was Peter Behrens.

Peter Behrens (1868–1940)

Behrens, who received training in Karlsruhe and Munich as an artist and a designer, quickly became a central figure in the progressive art movement in Munich, a center for the German equivalent of Art Nouveau, *jugendstil* ("Youthful Style").[10] He trained himself as an architect-designer, a provider of the appropriate forms for the new social order. Meanwhile, he taught and practiced design in a wide variety of fields, becoming well known for his graphic and typographical design. Whereas his early architectural leanings had been toward an austere,

19.15. Peter Behrens, AEG Large Assembly Building, Berlin, Germany, 1911–1912. As in his Turbine Factory for the AEG [2.1], in this even larger assembly building Behrens offered another archetype of industrially based architecture elevated to the status of high-art architecture. Photo: bpk, Berlin/Art Resource, NY.

simplified Greek Classicism, he gradually turned to more purely abstract circular and square shapes as he became interested in the mystical-symbolic suggestion of geometry.

In 1907, Behrens was appointed industrial designer for the Allgemeine Elektrizitäts Gesellschaft (AEG, or German General Electric Company), first designing some of its lamps, and then all of its electrical appliances, their trade catalogs and other publications, as well as the various buildings in which AEG products were assembled. Behrens was also one of the founders of the Deutscher Werkbund, an organization of architects, artists, designers, craftsmen, political economists, and industrialists who pursued educational and industrial reform in various ways. The organization sought to encourage a reconciliation of fine and applied arts, the elevation of the artist's position in an industrial society, the improvement of architecture and interior design, and especially the expansion of German industrial and economic strength in the wor1d.[11] Behrens saw that his position as designer for the AEG allowed him an unusual opportunity to advance these causes, to advance the ennobling effect of art on technology.

In the following year, 1908, Behrens worked with the company engineer Karl Bernhard, designing the first major assembly building for the AEG, the turbine factory, where large turbines were being manufactured for ships. As Alan Colquhoun has put it, Behrens set out "to spiritualize the power of modern industry in terms of an eternal classicism."[12] Since Germany was rapidly expanding its maritime trade and its navy, the demand for these turbines was high and new facilities were urgently needed. Behrens viewed this situation as an excellent opportunity to create a factory building that, like the machinery built inside it, was determined by its primary mechanical functions. In this way, the factory was elevated to the higher realm of architecture [2.1, 19.15].

First, the technical requirements were provided for in the turbine factory, with two gantry cranes riding on rails in the walls of a long, rectangular block. These cranes had to be able to lift loads of 50 tons to a height of 49 feet (15 m). The basic frame of the building was 123 feet (37.5 m) across by 402 feet (122.5 m) in length. Twenty-two girder frames supported the rails for the gantries as well as the glazed roof. Since the box-section columns of these frames had to be thicker at the top, the outer surface was kept perfectly vertical while the inner face slanted inward. Rising between the columns along the inclined inner edge were walls of windows, so the steel columns were openly revealed to the street. At the end of the building, the faceted profile of the inner roof girders determined the line of the gable. Below this hangs a curtain-wall of windows. Enclosing the corner is an inclined concrete membrane (its inclination matching that of the side window-walls) striped with bands of steel. Ironically, this corner, originally intended by Behrens to suggest the thinness and nonsupportive function of the corner, has often been misinterpreted as representing containment and support.

What Behrens set out to create was a compelling symbol for electricity, and his work for the AEG, beginning with this building, was soon lauded for its clarity of form determined by function.[13] Subsequent buildings by Behrens for the AEG included the small motors factory, 1909–1913, and the high-tension material factory of 1908.

Walter Gropius (1883–1969)

Behrens's conception of the architect as the shaper of form and taste, as exemplified in his buildings for the AEG, attracted a number of young architects to his Berlin office. One was Walter Gropius, the son of a family of teachers, civil servants, and architects prominent through the nineteenth century (his grand-uncle, Martin Gropius, had been the architect of the Neues Gewandhaus in Leipzig).[14] Walter Gropius was trained in Berlin to become an architect in the noble tradition of Schinkel. During 1907–1908 Gropius was Behrens's chief assistant, but by 1909 the young man had set up his own practice with Adolf Meyer. He received his first major commission, the Fagus Shoe Last Factory, from company owner Carl Benscheidt, who shared Gropius's progressive social ideals [19.16]. In the administrative wing of the factory, Gropius created an austere block inspired by Behrens's turbine factory. Here, too, the structural supports taper inward as they rise to a flat roof, with the glass curtain walls seemingly hung from the roof. The building appears to be reduced to sheets of glass (with the window panes at the floor lines replaced by opaque metal panels), but here, significantly, the corners are not solid masses but the merging of transparent glass planes; the corner as a visible, significant support has been erased. In the yellow brick walls, the grid of the windows is repeated in recessed courses of dark brick, recalling the banding of Behrens's corners in the turbine factory. As in Behrens's factory, here is the image of a mechanized architecture.

Gropius's career was then interrupted by World War I (he served in the German army), and after the conflict, like so many other artists, he joined revolutionary groups seeking to replace the old social order with one that was more socially progressive and responsive to modern needs in industrial design and housing. In 1919, he was invited to take over the direction of the School of Arts and Crafts at Weimar, originally established by the Grand Duke of Sachsen-Weimar. Gropius merged this school with the Weimar Academy of Fine Arts, forming an institute of design he called the Bauhaus. He reorganized the curriculum to stress basic principles of design. His objectives were proclaimed in numerous manifestoes and publications. In the Bauhaus manifesto of 1919 he wrote rhapsodically:

> The ultimate aim of all visual arts is the complete building. . . . Together let us desire, conceive, and create the new structure of the future, which will embrace architecture and sculpture and painting in one unity and which will one day rise toward heaven from the hands of a million workers like the crystal symbol of a new faith.[15]

In these early years, the character of the Bauhaus was strongly influenced by Johannes Itten (1888–1967), who taught the *Vorkurs,* the basic introductory course in design. After Lazzlo Moholy-Nagy took his place in 1923, and following the arrival of the Dutch architect Theo van Doesburg, the focus on crafts diminished in favor of an emphasis on industrial production and the development of normative industrial standards.

Gropius's concept of the Bauhaus changed as the school gained new teachers, and when the Bauhaus relocated in 1926 to new buildings in Dessau (designed by Gropius and Meyer), Gropius summarized the emphasis of the modified curriculum:

> Modern man, who no longer dresses in historical garments but wears modern clothes, also needs a modern house appropriate to him and his time, equipped with all the modern devices of daily use.

19.16. Walter Gropius and Adolf Meyer, Fagus Factory, administrative wing, Alfeld-an-der-Leine, Germany, 1911–1912. Gropius pursued the lead provided by his teacher Behrens in using an industrial expression for the administrative office wing of the factory. Photo: Vanni Archive/Art Resource, NY. © 2013 Artists Rights Society (ARS), New York/VG Bild-Kunst, Bonn.

> The nature of an object is determined by what is does. Before a container, a chair, or a house can function properly its nature must first be studied, for it must perfectly serve its purpose; in other words, it must fulfill its function practically, must be cheap, durable, and "beautiful."[16]

It is significant that Gropius should have used the word *beautiful,* for by what standard was something to be considered beautiful in this new functionally ordered world? The architect Bruno Taut, a contemporary of Gropius's then working in Berlin, held similar views and believed that beauty and total adaptation to function were inextricably intertwined. As he wrote in his book *Modern Architecture,* "The aim of architecture is the creation of the perfect, and therefore also beautiful, efficiency."[17]

Gropius continued to refine his theory of Bauhaus principles, writing in 1926:

> The creation of standard types for all practical commodities of everyday use is a social necessity. On the whole, the necessities of life are the same for the majority of people. The home and its furnishing are mass consumer goods, and their design is more a matter of reason than a matter of passion. . . . The Bauhaus workshops are essentially laboratories in which prototypes of products suitable for mass production and typical of our time are carefully developed and constantly improved.[18]

In another description of the program, Gropius wrote, "The Bauhaus believes the machine to be our modern medium of design and seeks to come to terms with it." An architecture generated by this principle, he was certain, would be clear and organic, "whose inner logic will be radiant and naked, unencumbered by lying facades and trickeries." Gropius further asserted that if modern designers were to understand the role of the machine in design and production, their education "must include a thorough, practical manual training in workshops, actively engaged in production, coupled with sound theoretical instruction in the laws of design."[19]

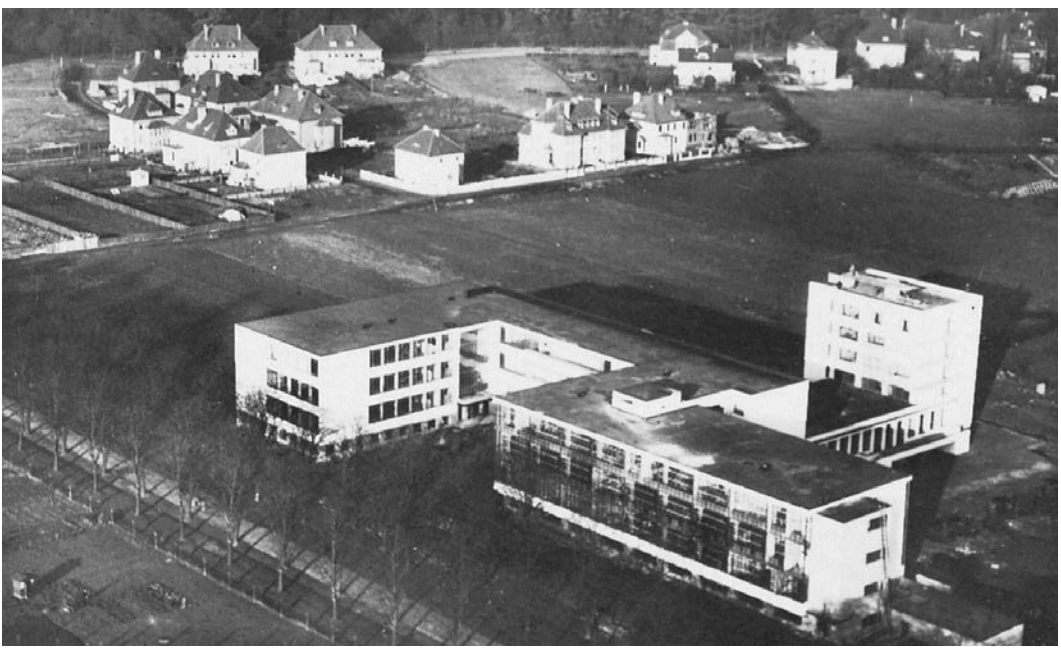
These ideas were perfectly realized in the architecture of the new Bauhaus at Dessau designed by Gropius and Meyer [19.17]. The school building had a pinwheel plan straddling a street. Faculty offices formed a bridge over the street, linking the classrooms, dining hall, and student housing to the workshop wing, in many ways the most symbolic portion of the entire building complex. Everywhere, the surfaces of the school were of smooth stucco or glass, but in the workshop wing, the wall was entirely of glass, fully transparent (no visually disruptive opaque panels) and suspended away from the reinforced concrete floor slab [19.18]. It was intended as the model of what all architecture should become.

Although Behrens and Gropius had hoped to raise the factory to the level of architecture, the economy of a war-ravaged Germany redirected Behrens's dream. Forced by the Treaty of Versailles to pay enormous reparations to the victorious allies after World War I, Germany experienced disastrous inflation, with the result that in many buildings, the desired excellence of construction and durability of materials had to be sacrificed. Instead of Behrens's hope of raising the factory to the higher plane of Architecture, architecture was reduced to the perfunctory utility of a factory.

Ludwig Mies van der Rohe (1886–1969)

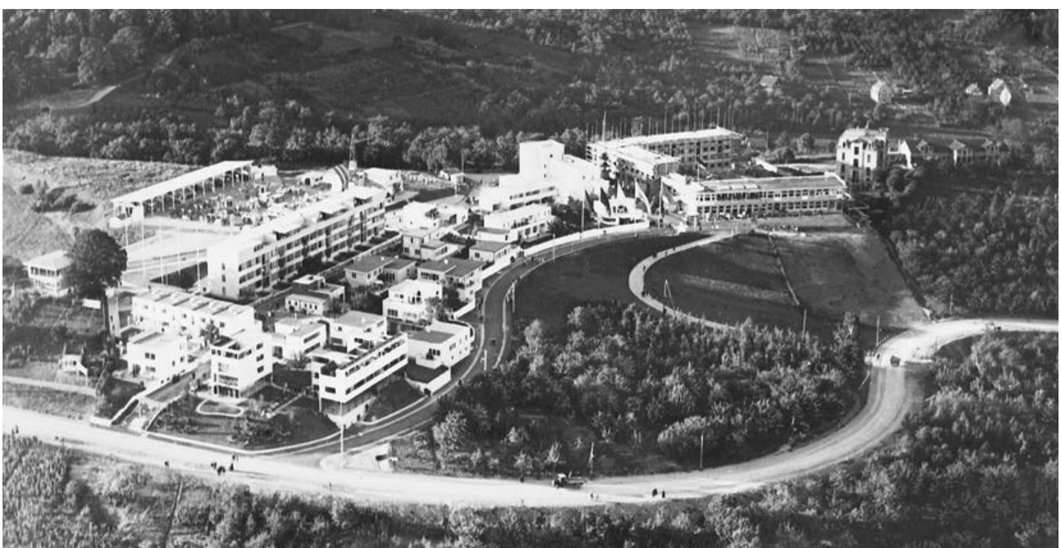
Gropius's two concerns—the development of an industrialized architecture, and social responsiveness to housing needs—were shared by his colleagues in Behrens's office, Ludwig Mies and Charles-Édouard Jeanneret. Mies (who later added his mother's surname, van der Rohe) chose to concentrate on the perfection of the industrial image in consummately crafted buildings, whereas Jeanneret (who soon adopted the professional pen name Le Corbusier) focused his concern on housing. Ludwig Mies van der Rohe was born in Aachen to a family of stonemasons, from whom he inherited a strong sense of craft in building construction.[20] In 1905, he moved to Berlin and entered the office of the designer Bruno Paul. Three years later, Mies moved to the office of Peter Behrens, where, after the departure of Walter Gropius, he became Behrens's chief assistant.

It was from Behrens that Mies absorbed the concept of the artist as the agent of the taste of the age, and of architecture as an expression of technical power. He also learned from Behrens a keen appreciation of detail and precision in both design and construction, for in 1907 Behrens began an intensive study of the work of Karl Friedrich Schinkel



19.17. Walter Gropius and Adolf Meyer, Bauhaus, Dessau, Germany, 1925–1926. Aerial view. The school of design organized by Gropius provided the model for the proposed new, efficient, and objective architecture. Photo: Vanni/Art Resource, NY.

19.18. Workshop wing, Bauhaus, Dessau. In the workshop wing, particularly, Gropius succeeded in suggesting a weightless, transparent architecture; the wall, entirely of glass, is hung away from the supporting structure. Photo: Courtesy, Museum of Modern Art, New York.



19.19. Ludwig Mies van der Rohe, Weissenhof Siedlung ("White Housing Estate"), Stuttgart, Germany, 1927. Planned by Mies and incorporating designs by sixteen major progressive European architects (including Gropius and Le Corbusier), this was to be a model workers' housing complex. Photo: Foto Marburg/Art Resource, NY.

in which he involved his whole office staff. During 1913–1914, Mies produced several austere, almost Neoclassical, Schinkelesque residences, but then his career, too, was interrupted by World War I.

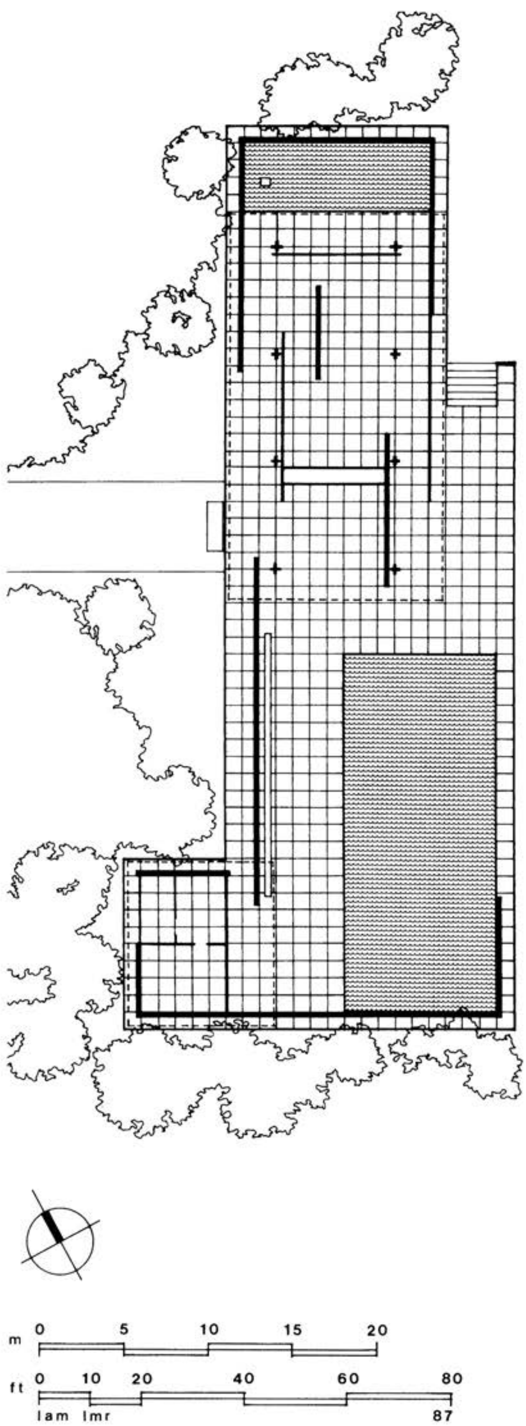
After the war, in 1919, Mies joined the Novembergruppe and, with three other young idealists, published a magazine entitled *G: Material zur Elementum Gestaltung* (*G: From Material to Form*), or simply *G,* devoted to promoting a new architecture. Mies's postwar designs were dramatically evocative, as evident in several projects he exhibited and published in 1919. Among them were two designs for soaring office skyscrapers, free-form in plan and completely sheathed in glass, one sharply angular and the other more rounded in form, and also a project for a horizontal, concrete office block.[21] In *G,* Mies published statements of his design principles, pithy epigrams such as "architecture is the will of the age conceived in spatial terms" and "create form out of the nature of the task with the means of our time."[22] Like Gropius, Mies saw a certain connection between architecture and industry: "I see in industrialization the central problem of building in our time. If we succeed in carrying out this industrialization, the social, economic, technical, and also artistic problems will be readily solved."[23]

Given the depressed condition of the German economy in the postwar Weimar republic, however, construction of Mies's idealized glass towers was not feasible. Nonetheless, Mies was able to build country houses for a few wealthy intellectuals who shared his views. He also rose to professional prominence organizing and directing the Werkbund housing exhibition at Stuttgart in 1927, the Weissenhof Siedlung ("White Housing Estate") [19.19]. Conceived as a demonstration of the best in housing design, the exhibition involved major avant-garde architects from across Europe, each designing a cluster of apartment units built on a hill outside Stuttgart and to be sold after the exhibition (the buildings still stand today).

As a result of this success, Mies was put in charge of the German exhibits at a small international trade fair held in Barcelona in the summer of 1929. Mies's particular responsibility was to design a pavilion for official ceremonies, and on this pavilion, Mies lavished his attention [19.20, 19.21, Plate 30]. At the same time, he was designing a residence for the Tugendhats at Brno, Czechoslovakia, 1928–1930.

The two buildings are much the same in their free organization of space. The principal difference is that while the German pavilion was completely open, since it was intended to be used only during the warm summer months of 1929, the Tugendhat House was to be built in a much cooler central European climate and, hence, was enclosed with large

19.20. Ludwig Mies van der Rohe, German Pavilion, Barcelona, Spain, 1929. This open-air pavilion was designed as an expression of the precision of German industry for an international exhibition held in Barcelona during the summer of 1929; demolished at the end of the year, it was reconstructed on the same spot in 1984–1986. Photo: Courtesy, Mies van der Rohe Archive, Museum of Modern Art, New York.



19.21. German Pavilion. Plan. Drawing: L. Maak and L. M. Roth.

sheets of glass. Both the main living level of the Tugendhat House and the single level of the German Pavilion consist essentially of a single space delineated into subsidiary spaces by isolated planes arranged in space. In both, the best materials were selected and hand-assembled with infinite care: red and green onyx, travertine, marble, macassar wood veneers, smoked glass, chrome-plated steel, and raw silk for the draperies in the Tugendhat House. The curious irony concerning the German Pavilion, designed as it was to demonstrate the ideals and achievement of German industry, was that it was painstakingly handmade. Indeed, all of Mies's later architecture—as industrialized as it appears, and despite how important mass production and prefabrication of parts were to its realization—required patient hand assembly to achieve its apparent automatic mechanical perfection. Mies achieved an elemental and essential simplicity, fusing Classical clarity with industrial production.[24]

Le Corbusier (1887–1966)

Le Corbusier (Charles-Édouard Jeanneret-Gris) was born in La Chaux-du-Fonds, Switzerland. He was initially trained in the local Arts and Crafts school to take up the family trade of watch engraver and enameller; his teacher was Charles L'Eplattenier, who inculcated in his pupil the social responsibility of the artist and the role of architecture as symbolic expression.[25] After 1908, Jeanneret moved to Paris, where he began working in the office of architect Auguste Perret, the early master of reinforced concrete, learning from Perret the enormous potential of this new material.

In 1910, Jeanneret began traveling, going to Berlin where for six months he worked in the office of Peter Behrens. Then he toured the Balkans, Turkey, and Greece, returning through Italy. A northern European with an alpine background, he was captivated by the sharpness of Classical forms seen in the crisp Mediterranean sunlight (unlike Mies, who always remained partial to the cloud-covered skies of his native Aachen); Jeanneret lingered for days on the Akropolis in Athens, sketching the Parthenon and other buildings. Enamored by the geometric precision of Classicism, he designed several houses on his return to La Chaux-du-Fonds with stylized Classical ornament and governed by Classical proportional systems. Despite the war, in 1917 Jeanneret settled permanently in Paris, painting, writing, and joining Amédée Ozenfant in promoting a new character in art and architecture. They published a journal, *L'Esprit nouveau* (New Spirit), in which Jeanneret expounded a theory of a new socially responsive architecture based on expressing structural necessity. For these articles, he adopted the pen name Le Corbusier, a loose derivative of the French for raven, *le corbeau,* which he used professionally for the rest of his life.

Out of these essays came Le Corbusier's manifesto, *Vers une architecture* (Paris, 1923), translated in English as *Towards a New Architecture* (London, 1927). Although he acknowledged that "architecture goes beyond utilitarian needs," Le Corbusier extolled the mechanical perfection of the modern airplane, steamship, and automobile as supreme expressions of the beauty of form determined by absolute response to modern function. In his book, he placed photographs of these modern machines side by side with views of the Parthenon, arguing that twentieth-century machines possessed the same elegance of form and function [19.22]. The problem, he wrote, was that the functional requirements of modern architecture had not yet been adequately formulated. Once that was done, as in the design of an automobile, the appropriate form would automatically and immediately spring forth. After all, he pointed out, "the house is a machine for living in." And lest his readers underestimate the urgency of completely reshaping modern architecture, Le Corbusier laid out this ultimatum: "It is a question of building which is at the root of social unrest today: architecture or revolution."

Meanwhile, Le Corbusier busied himself designing prototypes for the new architecture. In 1920–1922, he produced what he called the Citrohan House, a prototype concrete-frame single-family unit, with one upper-level bedroom on a balcony overlooking a two-story living room [19.23]. The name was a pun on Citroën, the popular French automobile, since Le Corbusier hoped that such houses, using standardized factory architecture components, would be as easy and cheap to build as low-priced automobiles and, similarly, available to everyone. Simultaneously, he drew up a scheme for a City for Three Million. At its center was to be an aerodrome set in the center of a cluster of regularly spaced office towers, with biplanes buzzing about the buildings [19.24]. Around this core ranged five-story apartment blocks set in large, grassy parks dotted with playing fields and athletic facilities. The entire city was crisscrossed by multilane automobile freeways. In his drawings, Le Corbusier provided a basic blueprint of the city of the mid-twentieth century, with high-rise towers flanking such a broad thoroughfare.

In the City for Three Million, Le Corbusier made a clear, functional distinction between the lofty high-rise towers, which were to house business and governmental offices, and the lower, linear buildings for housing. After World War II, when American planners began to turn to Le Corbusier's ideas as the basis for actual city planning, they misappropriated the high-rise tower for housing since it allowed greater population density per acre. An unfortunate example, one of many public housing developments built in the United States following this model, was the Pruitt-Igoe complex built by the city of Saint Louis, Missouri, in 1952–1955, after designs by architect Minoru Yamasaki (see p. 606).

Although Le Corbusier produced several city plans on paper in the 1920s, he built only a single group of fifty model housing units at Pessac, outside Bordeaux, in 1924–1926, and then two apartment buildings in the Weissenhof housing exhibition, Stuttgart, in 1927. What he actually built in the 1920s were expensive private suburban villas for members of the artistic avant-garde in Paris. These private commissions culminated in the Villa Savoye at Poissy, outside Paris, 1928–1931. The house is a square, lifted up on what Le Corbusier called *pilotis* (literally, "piles," or stilts) set in a broad field with a view of the Seine [19.25, 19.26]. An elaborate retreat, it incorporated all of the five points that Le Corbusier had stipulated in an article published in 1927.[26]

First, the building has no traditional supporting walls but instead has a spare, concrete structural frame, with slender *pilotis* that lift the building free of the earth. This eliminates problems of dampness in the house as well as providing usable space under the house. At the Villa Savoye, the turning radius of an automobile determined the curvature of the glass wall of the ground floor, for there, under the shelter provided by the raised living level, is a covered driveway, a three-car garage, plus a reception area, and other auxiliary spaces. Visitors may mount to the raised living level by means of a helical curved stair or by taking a long, sloping ramp that doubles back through the center of the house.

Second, by using a concrete frame, Le Corbusier could achieve a free plan, for no wall is structurally determined. On the third level of the Villa Savoye, for example, purely sculptural walls are curved to shape special spaces.

Third, by cantilevering the floors beyond the column supports, Le Corbusier produced a free facade. The facade wall was also freed of any supporting function and could be opened or closed as function and artistic decisions determined.

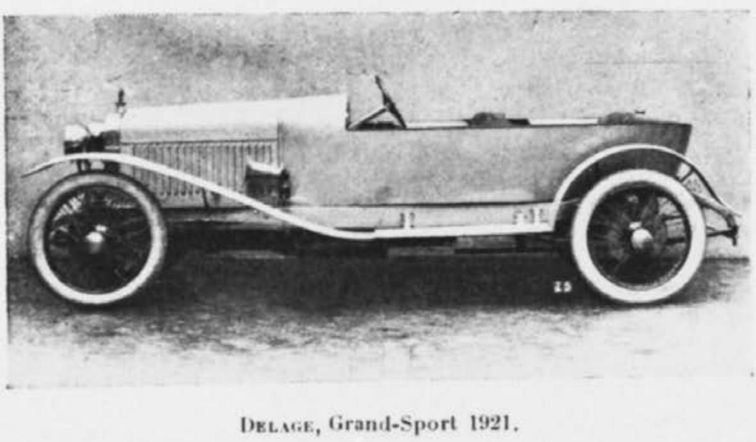
Fourth, the Villa Savoye had free fenestration, the horizontal ribbon window that Le Corbusier was convinced provided better illumination of the interior.

Cliché Albert Morancé. PARTHÉNON, de 447 à 434 av. J.-C.

faire mieux que l'adversaire *dans toutes les parties*, dans la ligne d'ensemble et dans tous les détails. C'est alors l'étude poussée des parties. Progrès.

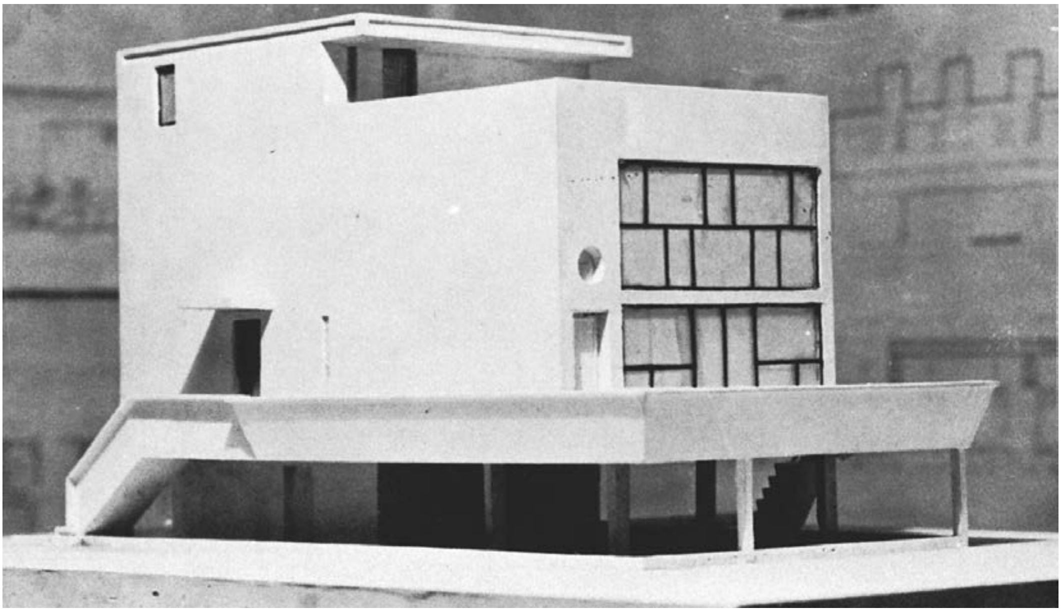
Le standart est une nécessité d'ordre apporté dans le travail humain.

Le standart s'établit sur des bases certaines, non pas arbi-



DELAGE, Grand-Sport 1921.

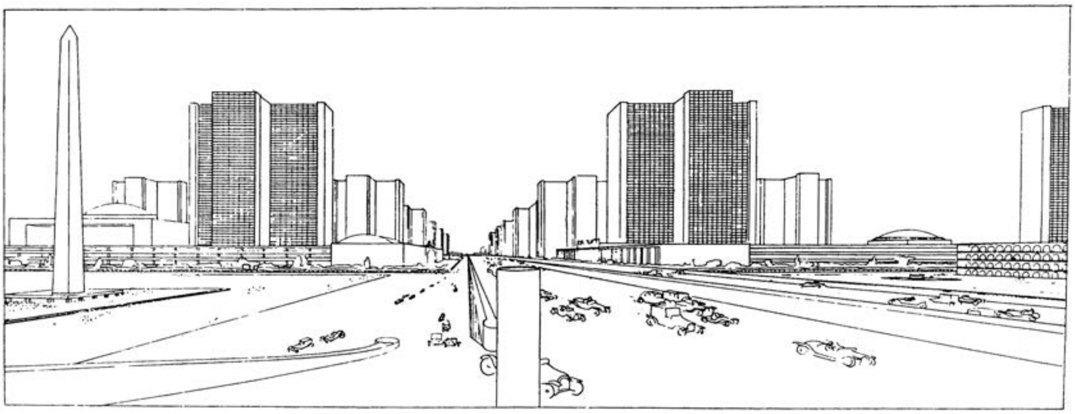
19.22. Le Corbusier, page 125 from Vers une architecture *(Paris, 1923; translated as* Towards a New Architecture, *London, 1927). Through such comparisons, Le Corbusier suggested that modern automobiles were like Greek temples, in their adaptation to function, economy of form, and precision of assembly; modern architecture, he argued, should aspire to the same qualities. From* Towards a New Architecture *(London, 1927).*



19.23. Le Corbusier, model of the Citrohan House, 1920–1922. This was Le Corbusier's proposal for mass-produced housing. The name was word-play on the Citroën automobile, since Le Corbusier wanted the same mass-production techniques to be used to lower the cost of housing. Photo: Rosenthal Collection, Department of Art History, Northwestern University.

Fifth, the villa was provided with a roof garden. The garden showed the influence of Le Corbusier's study of Mediterranean vernacular architecture, which uses the flat roof to reclaim additional living space.

In the Villa Savoye, the main living level is divided into the usual enclosed living, dining, kitchen, and bedroom spaces, but there is also a large, outdoor living space or terrace [19.27]. Some of the long, horizontal window strips are the glazed windows of the enclosed living quarters, while others are openings onto the outdoor living room, through which the spreading countryside is viewed as though it were a broad panorama painting. From the outdoor living room, the ramp rises through one more switchback to the upper roof garden.



19.24. Le Corbusier, drawing for the City for Three Million, project, 1922. Le Corbusier proposed that the city of the future consist of regularly spaced office towers and low-rise apartment blocks connected by multilane automobile expressways. From Le Corbusier, Oeuvre complète de 1910–29 *(Zurich, 1946).*

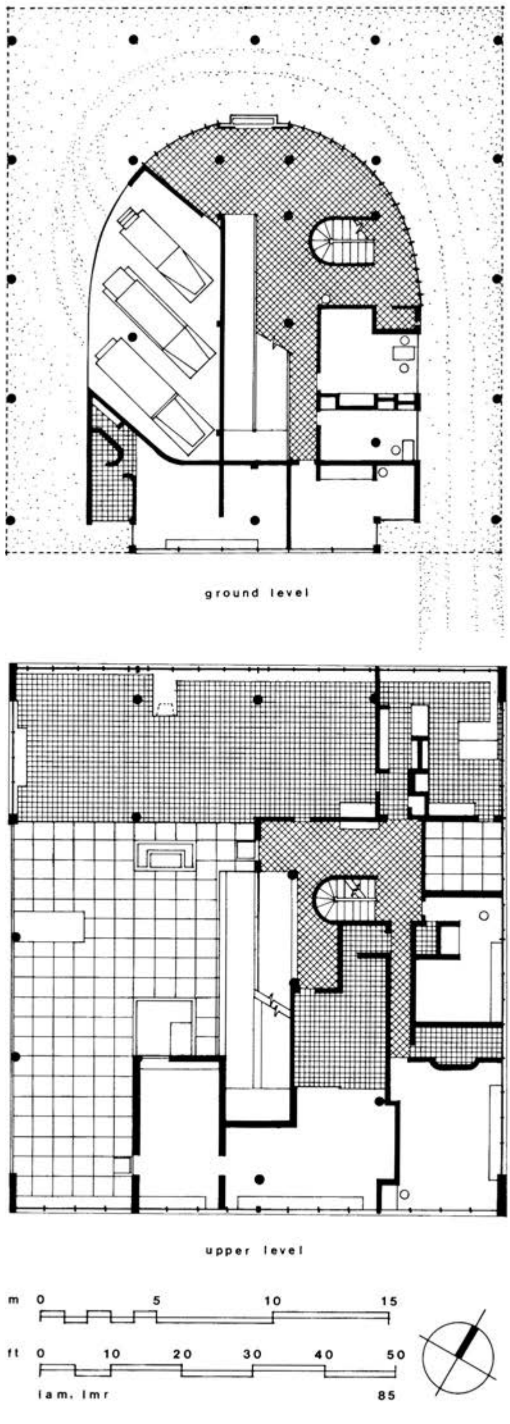
19.25. Le Corbusier, Villa Savoye, Poissy, near Paris, 1928–1931. View. In this house Le Corbusier perfected his vision of a dematerialized architecture, lifted free of the earth. It is also an architecture that reflects the impact of transportation by private automobile, for it sits atop a three-car garage. Photo: Ludwig Glaeser.

Le Corbusier continued to press for housing reform and, eventually, he had some success. In 1928, he persuaded officials of the Salvation Army in Paris to build a hostel for single men, the Cité de Réfuge. Built in 1929–1933, it was a long, glass-enclosed, austere slab block [6.10, p. 125]. Le Corbusier called it an *usine du bien,* a "factory of goodwill." Along the south wall, he experimented with a double glazing system as a way of generating heat in the winter and he called for a mechanical ventilation system to cool the building in the summer, since all the glass panes were to be fixed (this was one of the first hermetically sealed buildings). Unfortunately, the double glazing was omitted due to needed cost savings, as was the mechanical system, so the sealed building became a hothouse in the summer. After 1947, his cousin Pierre Jeanneret was called in to replace the windows with operable sashes set in a louvered concrete screen wall to keep sunlight off the glass.

Two years later, Le Corbusier made a similar mistake in not protecting the southern glass wall of the dormitory for Swiss students at the City University in Paris (the Pavilion Suisse), 1930–1932, but within a year, he hit upon a simple solution to the heat-gain problem. He began to use deep concrete wall-fins—vertical and horizontal louvers—to prevent sunlight from reaching glazed wall surfaces; he called these fins *brise soleils* ("sun breakers"). Even as late as 1965, however, Mies van der Rohe was still specifying all-glass buildings (with single panes) that mandated elaborate and expensive mechanical systems for cooling and heating these summer heat sponges and winter heat radiators (see Chapter 6). The driving cause of International Modernism in its early years had been social utilitarianism, the provision of the most supportive and healthful environment for the greatest number of people. Now it seemed that the new architecture, instead of being protective, was inflicting itself *on* its inhabitants. Something had gone amiss in the pure logic and social concern that had originally called modern architecture into being.

Modernism: Phase Two, 1945–1970

Civilian building in nearly every technically advanced country and their dependencies and colonies around the world ground to a halt in the years between 1939 and 1945 as the globe descended into a vicious series of interwoven conflicts that came to be called World War II, but which, it might be argued, was really a flaring up of unresolved issues left from the murderous first war of 1914 to 1918. Enormous numbers of exquisite buildings, the cultural legacy of the Middle Ages through the nineteenth century, were damaged if not totally destroyed. Particularly efficient in obliterating whole cities and their inhabitants was the atomic bomb used by the United States to force Japan to "endure the unendurable," as the emperor said on the radio to his people when he announced Japan's surrender. Sadly and ironically, some of the most intriguing



19.26. Villa Savoye. Plans of the ground floor and main living level. The curve of the glass wall around the entry vestibule in the lower level was determined by the turning radius of automobiles. Above the living level was a roof garden. Drawing: L. Maak and L. M. Roth.

and, given their purpose, disturbingly beautiful structures to come out of the war were the sharply geometric and massive concrete artillery emplacements designed by German architects and engineers for the "Atlantic Wall" defenses. In the United States, which was spared the blanket bombardment that was inflicted on European and Asian cities, the factory system that was built up to make automobiles (but was quickly converted to produce aircraft, jeeps, trucks, and tanks) remained and, after the war, began producing the flood of consumer goods that fueled the American recovery. The United States emerged ascendant and its architects established an international standard (at least in the business world). It was ironic that the reductive Modernism born in Germany in the 1920s was brought to the United States and from there was spread around the globe.

Modernism Exported Globally, 1937–1970

In 1937, Mies van der Rohe left Germany, where he had been prevented from working for several years by the National Socialists. He accepted the position of head of the Architecture Department at the Illinois Institute of Technology, Chicago, and began a career of international reach. Virtually all of the buildings Mies van der Rohe designed after coming to the United States were prototypes for universal buildings, a few models adaptable to a wide range of uses. In essence, his buildings from this point onward were either tall vertical shafts of stacked floor levels or single-level horizontal boxes, most often containing a single universal space. This prototypical approach was first clearly demonstrated in his Lake Shore Drive Apartments, Chicago, 1948–1951.

At last, with the industrial production capacity of the United States available to him, Mies was able to realize the dream of the glass tower conceived in his northern cloud-covered homeland. The site available for building was a trapezoid looking eastward to Lake Shore Drive and Lake Michigan. Mies might have devised a molded building, presenting the largest possible number of windows to the lake, the preferred view, but instead of creating one single, extremely tall shaft, he created two identical towers, each with the Classically proportioned bay structure of three by five. By turning one tower perpendicular to the other, he arrived at an L-shaped arrangement that would fit in the trapezoid [19.28, 19.29]. The twin apartment blocks were reduced to their simplest terms, functionally and structurally, with a small glass-enclosed lobby at the ground floor, freestanding structural columns

19.27. Villa Savoye. View of the outdoor living room, showing the ramp to the upper roof garden. Photo: © Jeff Goldberg/Esto.

(actually steel-sheathed, concrete-enclosed structural steel columns), and a flat top. The major structural bays, three on the short side and five on the long side, were then subdivided by prefabricated aluminum window mullions whose alternation of widths sets up a counter rhythm to the regular, larger rhythm of the structure (see the discussion in Chapter 4). All the facades of the two towers were made identical; there is no recognition that some face the lake while others have the hottest orientation to the south and west, where their glass-walled apartments become hothouses in summer afternoons.

Not only could such buildings be turned to any orientation (as they are in this demonstration), but they could also house a wide variety of functions, such as luxury apartments, speculative rental offices, and corporate headquarters (as this building type was used in the next several years). These glass towers, together with others being designed at the same time, first for Portland, Oregon, by Pietro Belluschi and then for New York City by Skidmore, Owings & Merrill, provided the prototype for the glass towers that soon became the mark of modernization and urban renewal in cities across the United States and then around the world.

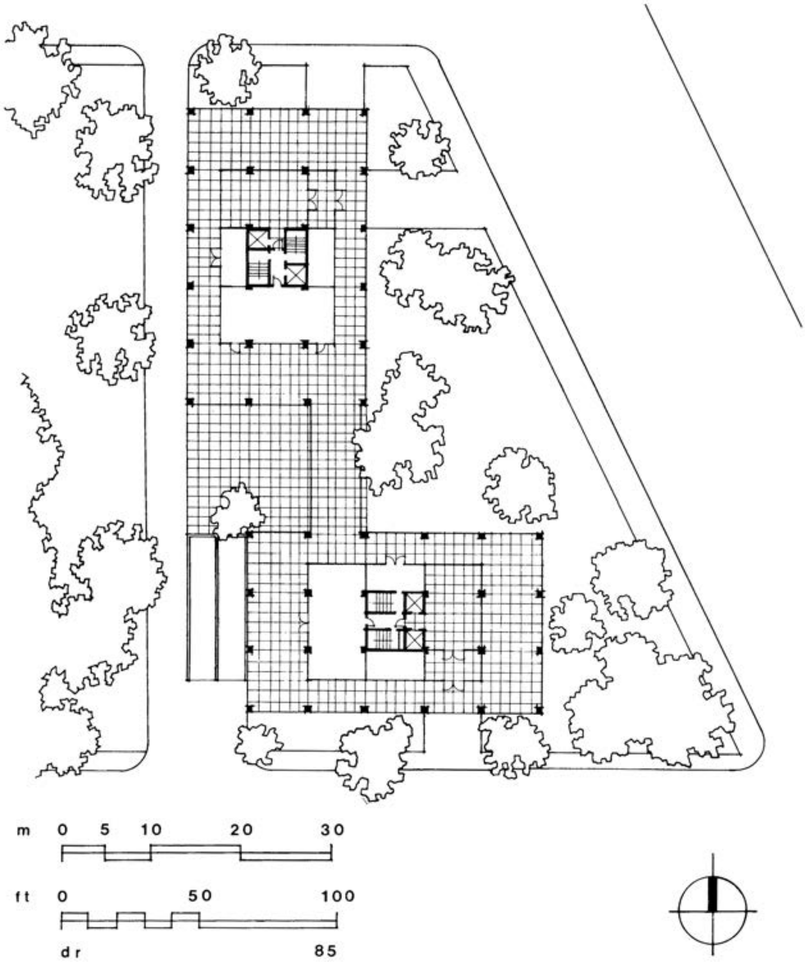
Mies himself demonstrated the purest essence of this reductivist Modernism in his corporate office tower for the Seagram Corporation on Park Avenue in New York, 1954–1958 [6.13, 6.14, p. 127]. In this design, the glass curtain-wall window was hung in front of the structural columns, hiding them completely except where they protrude and stand clear at the base. As this was a corporate headquarters, no expense was spared, so not only was the glass tinted a warm brown but the panels enclosing the structural columns and the mullions holding the glass were of bronze, also of natural brown patina.[27] Mies had done just what Gropius said was necessary—discovering and perfecting a type that could be used to the widest degree—and by the time of his death in 1969, Mies could see adaptations of his glass box tower type, both good and bad, around the globe.

Modernism: Form Follows Function—or the Other Way Around?

The pioneers of modern architecture in the 1920s and 1930s tried to create a wholly new idiom generated solely by functional use and structural systems. Their ascetic architecture was intended to make no statement other than to reveal itself. Modernism was not exactly *l'architecture parlent*—it was not "speaking architecture." Or at least, if the architecture did speak, it was only expressing current building technology and structural science. And yet in making an architecture of nonstatement, these theorists were, in fact, making a statement. Modernist architects had caught themselves up in an endless means-and-end cycle. Unwilling to acknowledge that architecture was something in and of itself, they insisted it was only a means to an end: utility. And as the philosopher Hannah Arendt warned, "utility established as meaning generates meaninglessness."

Some of the originators of Modernism—most notably, Le Corbusier and Alvar Aalto in Finland—had begun to move in decidedly different directions as early as the late 1930s. Le Corbusier's interest in intuited sculptural form and deliberate roughness or crudeness in construction, introduced in such work as his dining room projection in the Swiss Pavilion, is just one example. Following World War II, many of these architects shaped entirely new definitions of Modernism. For many architects, an interest in building form for its own sake began to inform their work, and these Modernists began to take particular care with the artistic statement their work would make. The call for this new interest in form was made by a young Polish American architect, Matthew Nowicki, in a series of essays published in 1949–1951. In a 1949 article entitled "Composition in Modern Architecture," not only did he use the

19.28. Ludwig Mies van der Rohe, Lake Shore Drive Apartments, Chicago, Illinois, 1948–1951. In the United States following World War II, Mies had access to the kind of industrial production that enabled him, at last, to realize his long-standing dream of a glass tower. This view, made shortly after completion, shows the impact the buildings made in their original setting (see also 6.16). Photo: © Wayne Andrews/Esto. All rights reserved.



19.29. Lake Shore Drive Apartments. Plan at ground level, showing the open, glass-enclosed lobby areas. Drawing: David Rabbitt.

terms *style* and *composition* (terms that had become anathema in canonical Modernism), but he also called for architectural design that would "provide human comfort in the *visual* and *psychological* as well as in the strictly physical sense of the word."[28] Two years later, he declared what conventional Modernism considered heresy: "In the overwhelming majority of modern design, form follows *form* and not *function*."[29]

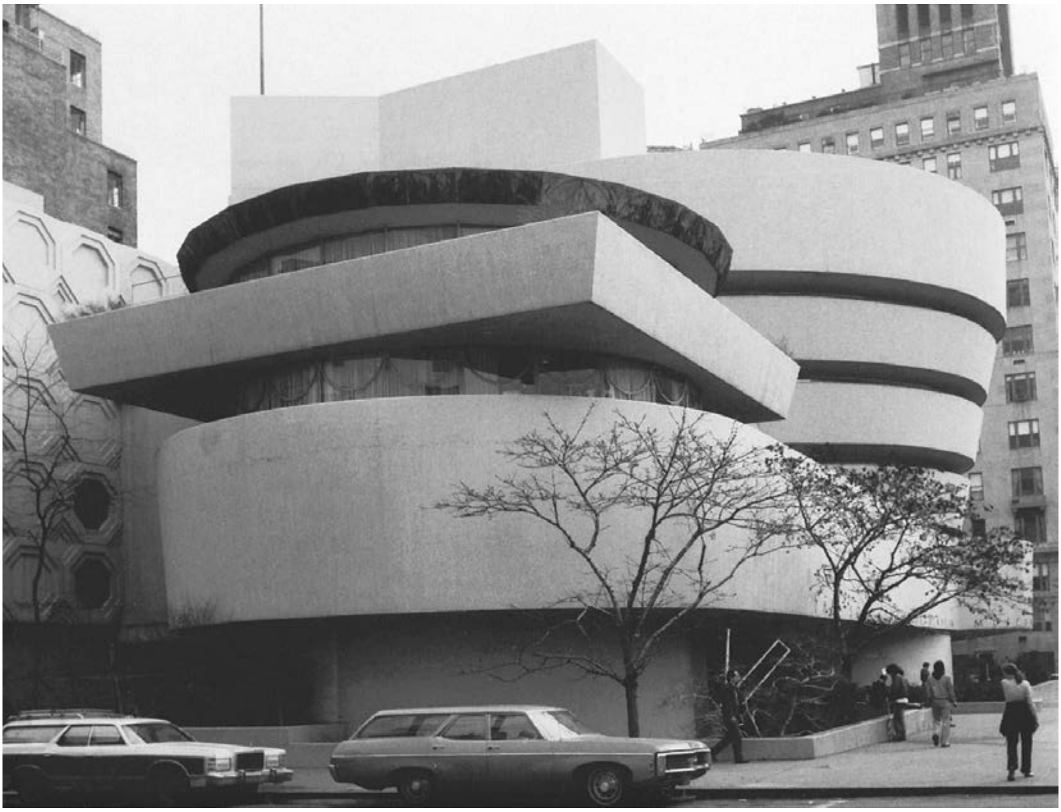
A parallel stirring was occurring in Europe. Faced with the daunting challenge of rebuilding so much that had been destroyed there in the war, architects were urged by the preeminent apologist of Modernism, critic Sigfried Giedion, in a lecture before the Royal Institute of British Architects in 1946, to infuse their new architecture with greater meaning and symbolism, to create a new monumentality. In the United States, a similar argument was advanced by architectural critic Lewis Mumford. In his 1949 essay "Monumentality, Symbolism, and Style," he argued that it was not enough for a contemporary building simply "to be something and do something; it must also say something. What is this, however, but a return to 'commodity, firmness, and delight,' with the emphasis, once more, on delight?"[30]

Among the postwar architects interested in architectural form for its own sake was Frank Lloyd Wright, but he had never rejected the powerful, evocative, sculptural power of architecture in the first place. Since the 1920s, Wright had been fascinated with the spiral helix as a means of both wrapping and defining space and also as a means of vertical movement, using it in a number of unbuilt designs. In 1943, Wright was approached by Solomon R. Guggenheim to design a museum to house Guggenheim's unparalleled collection of modern art, and in this request, Wright saw his opportunity to build a helical ramp building. By 1945, Wright had worked out the basis of a solution, but another eleven years passed as the details were designed and as New York building officials were persuaded that the design was safe to build; construction took place in 1956–1959. What Wright proposed was a gigantic helical ramp in reinforced concrete. The ramp would expand outward as it rose, enclosing a vast space to be covered by a glass skylight; the building would be a modern-day Pantheon whose space was contained not by static masses but by the sweep of a dynamic curve [19.30, 19.31, 19.32, 19.33].[31] Perhaps not since Schinkel built the unique Altes Museum had a museum building itself been as important a statement as the art it contained. Indeed, to some observers, the Guggenheim Museum promised to overpower the paintings. Certainly, Wright was declaring in this, the last building he supervised personally, that the form of a building could be as important as, perhaps even more important than, simple utilitarian accommodation of function.

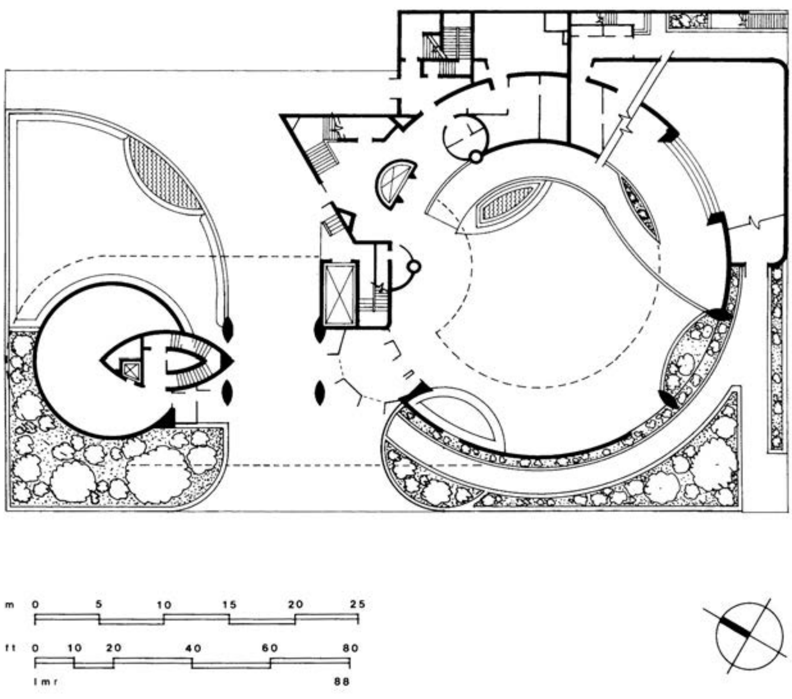
In contrast to Mies, who devised identical glass-sheathed towers for the Lake Shore Drive Apartments, Finnish architect Alvar Aalto (1898–1976) produced a far different solution for a comparable design situation. Baker House, a dormitory for the Massachusetts Institute of Technology (MIT) built in 1946–1948, is also essentially residential in function [19.34]. But the building is far from a prototypical solution that could be dropped down anywhere. During World War II, Aalto had taught at MIT and consequently had gotten to know well the physical environment of the university and its placement on the banks of the Charles River, overlooking Boston. When he was asked to design the dormitory, Aalto was given a site on the drive along the Charles River between two existing buildings. He resolved to orient the rooms toward the river, so that residents could see the city and watch the activity in the water. To fit the required number of student rooms into the available space, he bent the form of the building, which resulted in the visually commanding S, or rounded W, curve. Along the back side of the building, away from the river, are lounge rooms, lavatories, baths, and the stairs. The skin of the building is of brick enclosing a reinforced concrete frame—rough, misshapen clinker brick, irregular in color, in contrast to the mathematically uniform brick that Mies was using at the very same time for his buildings on the Illinois Institute of Technology campus [4.21, p. 82]. The south wall of Baker House, facing the river, is punctured by moderate-size individual windows at each room, so that by the simple selection of this traditional material, Aalto provided himself with easy solutions to potential scale, thermal, and textural problems. Mies's Lake Shore Drive Apartments can be anywhere; Aalto's Baker House can be only here, looking out across the Charles River.

From the moment Aalto embraced Modernism in the 1920s, his rendering of it was always strongly tempered by a warmth and humanism not easily found in the work of his contemporaries such as Gropius or Mies van der Rohe. In 1940, Aalto criticized the *existenz minimum* austerity of the work of his Modernist colleagues, contrasting conventional Modernist "architecture whose main concern is the formalistic style a building shall wear" with "architecture that we know as functionalist." Accommodating utilitarian function, he realized, was a deceptively easy and empty achievement, for "since architecture covers the entire field of human life, *real* functional architecture must be functional mainly from the human point of view." Despite the rigorously pure analysis of the empiricists of the 1920s, or of neo-functionalists later in the century, Aalto insisted that architecture can never be a precise science; architecture is not merely the process of defining mechanical function and supporting this function in the most economical structural skeleton. Architecture is, Aalto asserted, "still the same great synthetic process of combining thousands of definite human functions, and remains architecture. Its purpose is still to bring the material world into harmony with human life."[32]

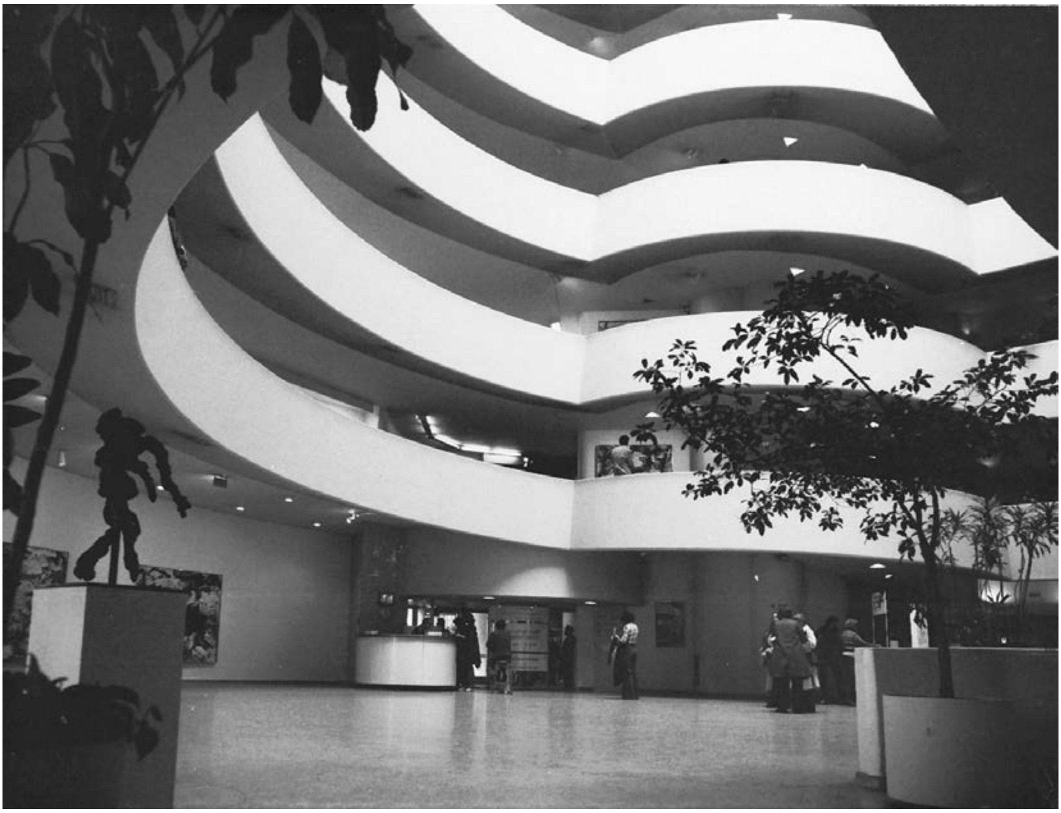
This humanist design approach especially shapes one of Aalto's last works: the library for the Mount Angel Benedictine Abbey, St. Benedict, near Mt. Angel, Oregon, 1967–1970 [19.35, 19.36, 19.37, 19.38]. Specifically sought out by the abbey librarian because of his previous library designs in Finland, Aalto responded to a dramatic building site, keeping the building low on the uphill side facing the campus quadrangle, but dropping the building down several levels on the downhill side. The interior is filled with a soft light reflected from the skylight and strategically placed task lights, while the Aalto-designed furniture throughout is of natural maple with black leather upholstery, on gray carpeting. The color was to be provided by the book covers arrayed on shelves. Everywhere, the spaces and finishes seem perfectly attuned to the activities planned to occur there; the door handles, for example, are aligned to the angle of the outstretched hand. When it was completed, *New York Times* architectural critic Ada Louise Huxtable found it to be "a small and perfect work" that was "elegant, humane, and full of sophisticated skills."[33]



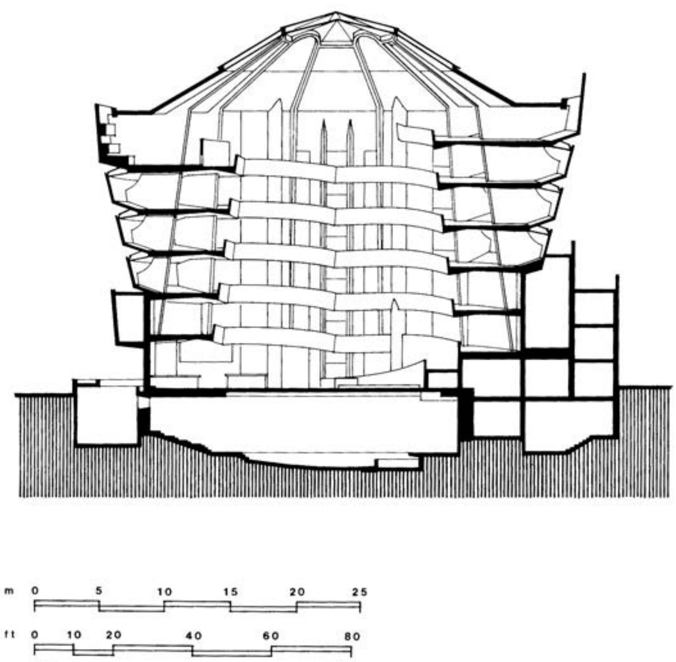
19.30. Frank Lloyd Wright, Solomon R. Guggenheim Museum, New York, NY, 1943–1959. Wright's museum, one of his last works, makes few concessions to its setting, but instead grew out of Wright's concept of a long, curved processional path, a spiraling helix. Photo: L. M. Roth.



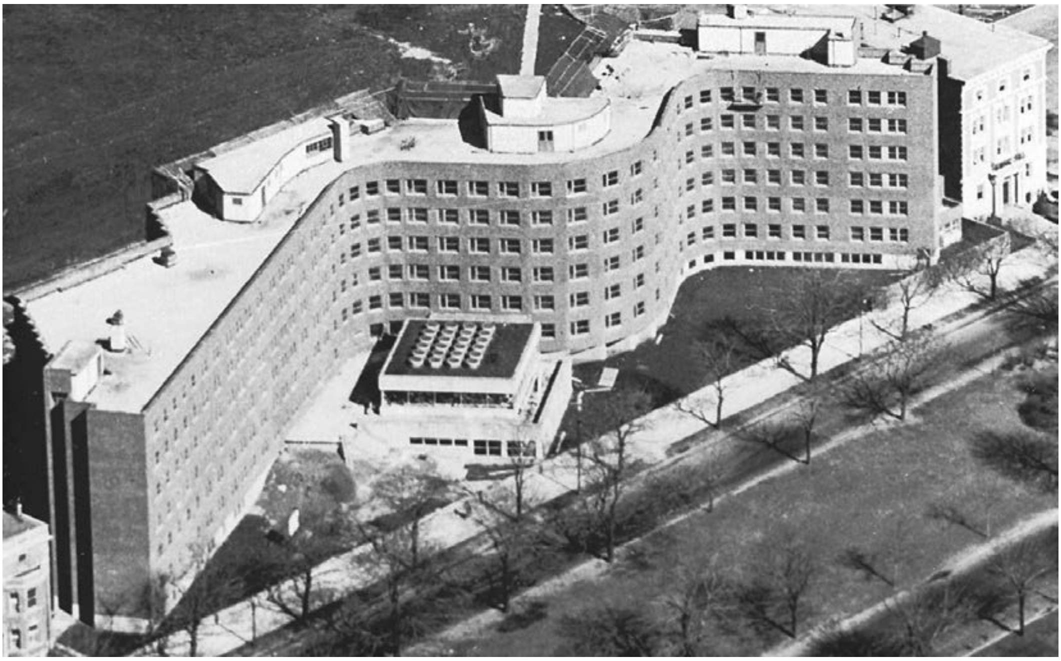
19.31. Guggenheim Museum. Plan. The plan is based on circular modules. Drawing: L. M. Roth, after Wright.



19.32. Guggenheim Museum. Interior. Photo: L. M. Roth.

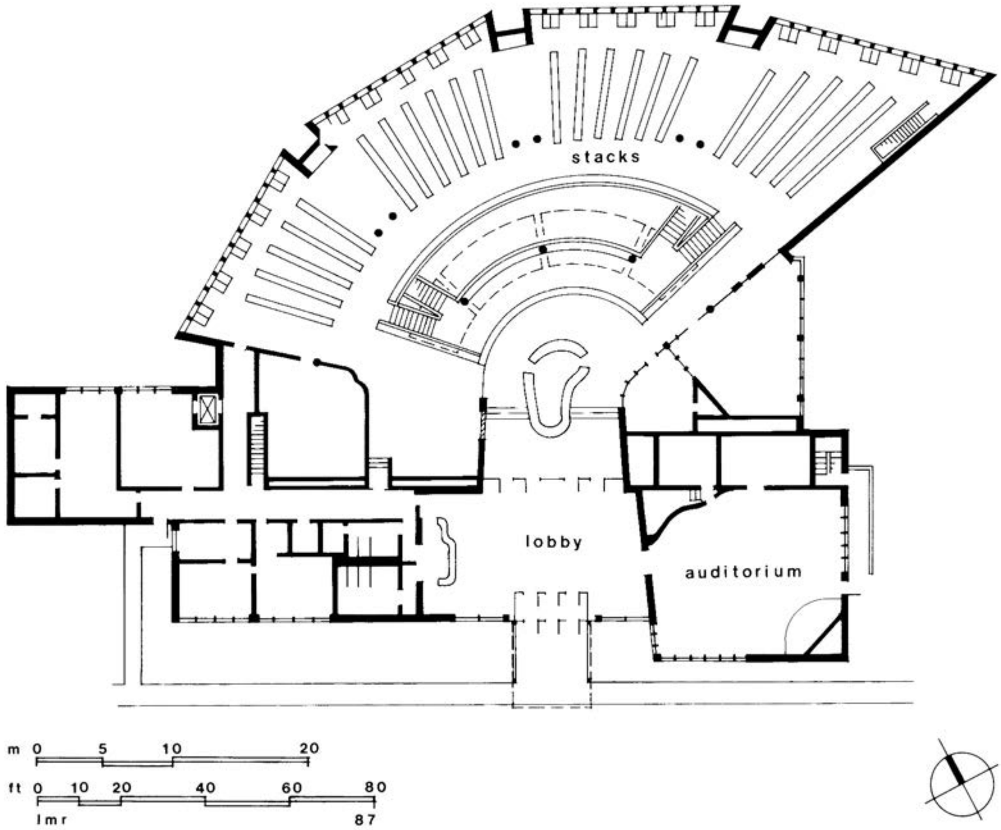


19.33. Guggenheim Museum. The section view shows how the spiral ramp swells outward as it rises. Drawing: L. M. Roth, after Wright.



19.34. Alvar Aalto, Baker House, Massachusetts Institute of Technology, Cambridge, Massachusetts, 1946–1948. Aerial view. Aalto bent his dormitory building to fit into the available space; in doing so, he provided oblique views across the Charles River and created a powerfully evocative form. Photo: Rosenthal Collection, Department of Art History, Northwestern University.

19.35. Alvar Aalto, Mount Angel Abbey Library, Mount Angel, Oregon, 1967–1971. Aalto's work repeatedly demonstrates that responding to function and human psychology can produce architecture of both noble purpose and stimulating form. Photo: L. M. Roth.



19.36. Mount Angel Abbey Library. Plan. The plan of the library combines closely arranged rectilinear offices with broadly fanned book stacks. Drawing: L. M. Roth.

19.37. Mount Angel Abbey Library. Section. By dropping the floors down the side of the hill, Aalto kept the main-entry story low and simple in deference to adjoining campus buildings. Drawing: L. M. Roth.

19.38. Mount Angel Abbey Library. Interior of the book-stack and reading area. Photo: L. M. Roth.

Two Solutions for Collegiate Chapels

It was becoming increasing clear that there was no one solution for any given building type, despite the Modernists' advocacy of types. Two examples of differing responses to the same problem are found in the chapels built at two engineering schools almost simultaneously—one for MIT and the other for the Illinois Institute of Technology (IIT). At IIT, the chapel and all the other institute buildings were designed by Mies van der Rohe from 1938 through 1969. The chapel, built in 1949–1952, is a steel-framed, cubical block with infill walls of uniform, buff, glazed brick [19.39]. At one end is a glass wall accommodating the entrance. The interior is decidedly unmystical, evenly illuminated by diffused light bounced off the glazed brick walls. As originally conceived, there would have been only a panel at the end behind the altar and no raised dais. It would have been the perfect all-purpose space, immediately adaptable for a handball court or a physics lab. (As built, it did have enclosed spaces behind the altar for office and sacristy as well as a dais denoting a chancel area. It was, in fact, converted to a storage facility in 1996.)

The contrast between this and the chapel built at MIT by Eero Saarinen in 1953–1955 is revealing [19.40, 19.41]. Saarinen was an architect who spared no effort searching for the unique form for each of his commissions. At MIT, he was given the dual task of designing a large auditorium for general university functions and an adjacent small chapel suitable for quiet meditation. Both structures had forms generated by circular or spherical forms, the auditorium a triangular segment that is one-eighth of a sphere, and the chapel a brick cylinder. The chapel was built of the rough, irregular brick similar to what Aalto had used in Baker House, but its outer cylindrical wall was supported by arches resting on stone blocks in a surrounding pool of water at the base. The principal source of light is through a single oculus in the roof, whose beam of light is caught, so to speak, on the twinkling metal blades of a sculpture by Harry Bertoia. There is no sculpted

19.39. Mies van der Rohe, Chapel, Illinois Institute of Technology, Chicago, Illinois, 1949–1952. Although a chapel, it has none of the conventional clues as to its function. Photo: Hedrich-Blessing, Chicago. Photo by Hedrich Blessing. Chicago History Museum, negative HB-15691-D.

19.40. Eero Saarinen, Chapel, Massachusetts Institute of Technology, Cambridge, Massachusetts, 1953–1955. Saarinen's chapel uses a simple cylinder form, unique to this campus, though built of the red brick typical of the Boston and Cambridge area. Photo: Ezra Stoller © Esto. All rights reserved.

figure of heavenly rapture, à la Bernini, yet the effect achieved by the focused light is much the same as in Bernini's Cornaro chapel.

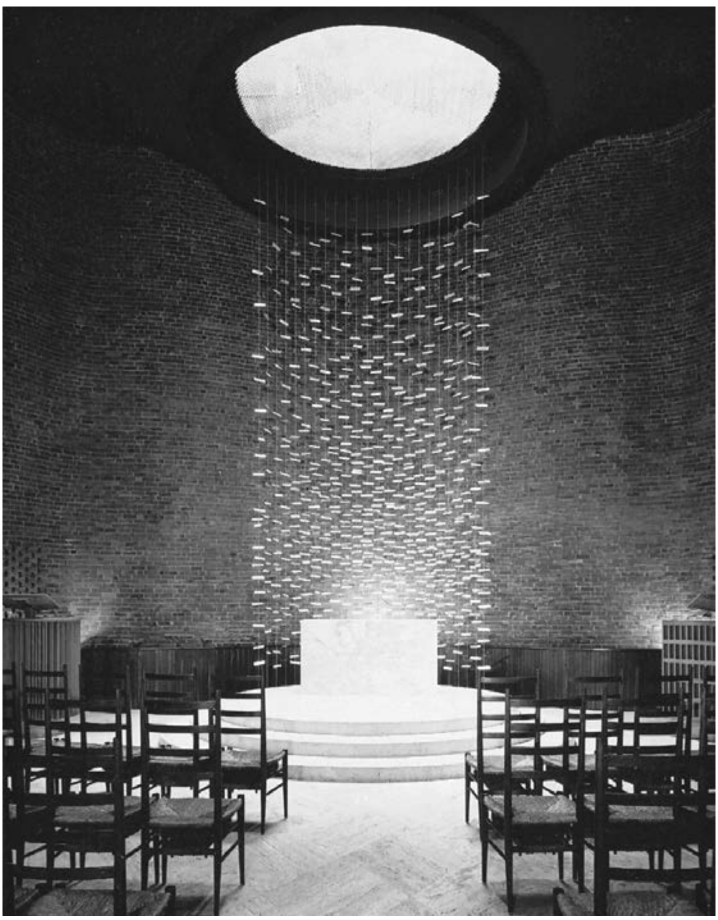
Le Corbusier's Later Work

In the 1930s Mies van der Rohe continued to push refinement in building form while Le Corbusier radically reconceptualized his architecture. The most dramatic evidence of this shift appeared in the buildings he designed immediately after World War II. These changes involved the molding of space, but more importantly, they revolved around a change in materials, away from the smooth stucco and the seamless surfaces of the 1920s to rough materials and deliberately crude workmanship, giving the surfaces of Le Corbusier's postwar buildings a rich, rough texture. The concrete he had used previously in thin structural frames hidden from view behind smoothed stucco was now revealed on the surface in bold masses and imprinted with patterns left by the carefully constructed rough-sawn lumber used for formwork. A good example is the Unité d'Habitation in Marseilles, 1946–1952, described in Chapter 4 [4.15]. The Unité, although taller, deliberately rougher in execution, and composed of apartments with an L-shaped cross section, in many ways nonetheless continued the themes begun in the apartment blocks that Le Corbusier had been designing since the 1920s. In particular, the building block is lifted aloft on massive concrete piers (recovering the ground plane for use), and the building has a huge, flat roof turned into a children's play yard (recapturing the top of the building for use).

The most vivid break with his past, and one for which most observers were unprepared, was Le Corbusier's chapel at Ronchamp, France, built just after the war. Notre-Dame-du-Haut at Ronchamp had been a site of pilgrimage since the twelfth century. There, on a hill at the base of the Vosges Mountains, a few miles from Belfort and the Swiss border, a statue of the Virgin Mary had long been the object of special veneration. Ronchamp had never become a major commercial pilgrimage city and hence had retained a particularly rural character, but it was nonetheless a strategic passage. A succession of chapels housing the statue had been built, destroyed, and rebuilt over the centuries. The nineteenth-century neo-Gothic chapel had been completely destroyed during World War II. In 1950, at the strong recommendation of several leaders of a reform movement in the French Catholic Church, Le Corbusier was selected to rebuild the chapel; he was given a completely free hand. Le Corbusier spent several days on the site in the ruins of the old chapel, sketching the profile of the surrounding forested hills. He absorbed the setting, and gradually, the new chapel formed itself in his mind, creating what he would call "a visual echo of the landscape."[34]

Although the plan of Notre-Dame-du-Haut at Ronchamp was based on a mathematically proportioned Modulor grid incised in the concrete floor, the chapel seemed completely at odds with the rational precision of Le Corbusier's prewar work (see Chapter 4). The thick outer walls curve in, and the heavy roof settles and sinks in the middle. When seen from outside, the curves seem to open out toward the landscape, but when experienced from within, they give a sense of compression and containment [19.42, 19.43, 19.44, 19.45]. To the east, the concave indentation of the wall and the overhanging curve of the roof frame an outdoor chancel that faces a hillside sanctuary where large crowds can gather for worship at special times of pilgrimage. The brilliant whiteness of the rough stucco exterior is in the sharpest contrast to the dark interior, which is lit only by small apertures in the south wall filled with colored glass, and by the reflected light scooped up in the towers and splashed down on the altars below (the manipulation of light at Ronchamp is discussed in Chapter 4).

To critics and historians of the rationalist camp, such as Nikolaus Pevsner and James Stirling, this apparent about-face by Le Corbusier was greatly puzzling.[35] Yet the free-form walls were not so different from the poetic shapes of the roof terrace of the Villa Savoye. What Le Corbusier intended to create here was a sculptural response to the site, an expression of what Stanislaus von Moos has called the "atavistic mysticism of nature."[36] It was a sacred building in a way far more profound than representing a particular religious institution or dogma; it

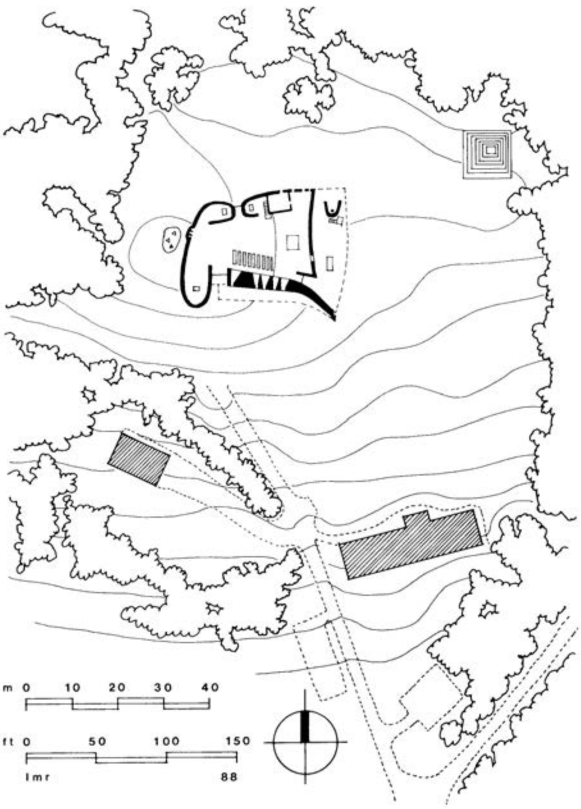


19.41. MIT Chapel, Massachusetts Institute of Technology. Interior. The main source of light is a circular oculus at the top. Photo: Ezra Stoller

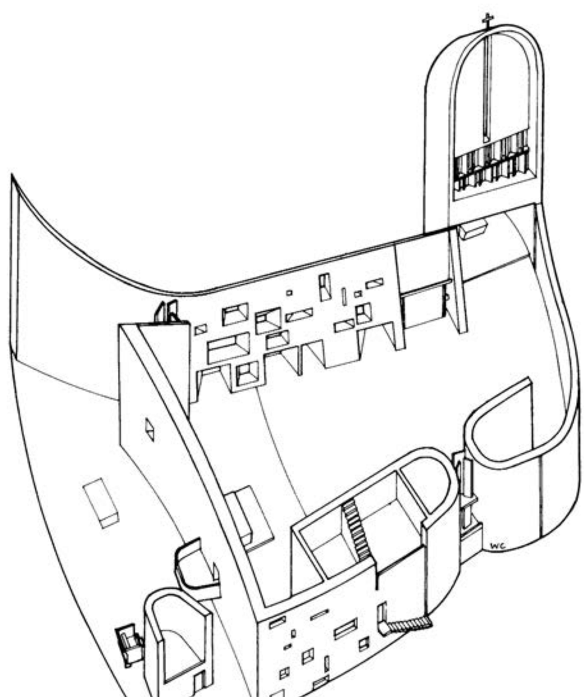
19.42. Le Corbusier, Notre-Dame-du-Haut, Ronchamp, France, 1950–1955. View from the southeast. The church seems like a huge piece of sculpture, molded according to some intuited vision of the architect. Photo: Ezra Stoller © Esto. All rights reserved.

spoke instead of the mystical connection of humankind and the cosmos. When the building was finished in 1955, Le Corbusier said to the Archbishop of Besançon at the dedication ceremonies: "When I built this chapel, I wanted to create a place of silence, of prayer, of peace and inner joy. The feeling of the sacred inspired our efforts."[37] To some, it was surprising that a person who was not a practicing Catholic could design what they saw as the most religious building of its time (the 1950s and '60s). Le Corbusier confounded sectarian orthodoxy. For him, Ronchamp was a symbol of the sacral element of life and not of a specific creed, for, as he said to the archbishop, "Some things are sacred and others are not, regardless of whether or not they are religious."

If Le Corbusier's early buildings of the 1920s had suggested the utilitarian efficiency of ocean liners in their abstract economy of form, the swelling roof of Ronchamp suggested many things—a nun's cowl, a monk's hood, a ship's prow, praying hands. Le Corbusier himself said his inspiration was a clam shell he had picked up on the beaches of Long Island in 1946.[38] That Ronchamp represented something larger than itself was compounded by the way the building was not what it seemed. In places, the walls were of concrete, elsewhere they were rubble stone, but all were covered with a uniform, rough stucco so as to suggest a single material. Moreover, once inside and with eyes adjusted to the cave-like light, the visitor can see that what seems from the outside to be a massive, heavy roof is actually light and is raised aloft by slender columns, hovering 10 inches (25 cm) above the thick walls [19.45]. Clearly, the structure is a hidden, delicate frame and not the massive-looking walls. And the south wall, pierced by the tiny windows on the outside, is actually hollow but made deliberately thick and opened in broad embouchures inside so that the tiny, colored windows can be seen from around the sanctuary. Le Corbusier was putting into concrete and stucco what Matthew Nowicki was then saying



19.43. Notre-Dame-du-Haut. General plan. The church is carefully positioned on the hill to take advantage of the views and to define individual spaces to the east, west, north, and south. Drawing: W. Chin and L. M. Roth.



19.44. Notre-Dame-du-Haut. Axonometric view. Despite the appearance of an intuited arrangement, the plan is actually determined by a modular system like that used in Le Corbusier's Unité d'Habitation in Marseilles. Drawing: W. Chin.

19.45. Notre-Dame-du-Haut. Interior. The roof, apparently massive when viewed from the exterior, appears much different when viewed from the interior, for it hovers above the walls, carried by widely spaced, slender piers. Photo: G. E. Kidder Smith, New York.

in print—that the primary function of a building is to mold space, to create form.

Saarinen: Two Airport Terminals

As the chapel at Ronchamp demonstrated, the International Style ban on symbolic expression was being swept away, while a new generation of Expressionists blossomed. Among the most inquisitive in his search for communicative, evocative form was the American architect Eero Saarinen (1910–1961). When presented with the commission to design the "flagship" terminal building for Trans World Airlines at Kennedy (then Idlewild) Airport in New York in 1956–1962, Saarinen decided to make a building that would suggest the miracle of flight [19.46]. He and his assistants, working with large-scale design models, shaped a pair of gigantic shells cantilevered out from central "feet," and before the glass was installed to enclose the volume below the shells, the cantilevered shells had very much the profile of a gull's outstretched wings [19.47]. At roughly the same time, in designing another airport terminal outside Washington, DC, the Saarinen team created an altogether different but equally dramatic solution (see the discussion of tensile structures in Chapter 3).

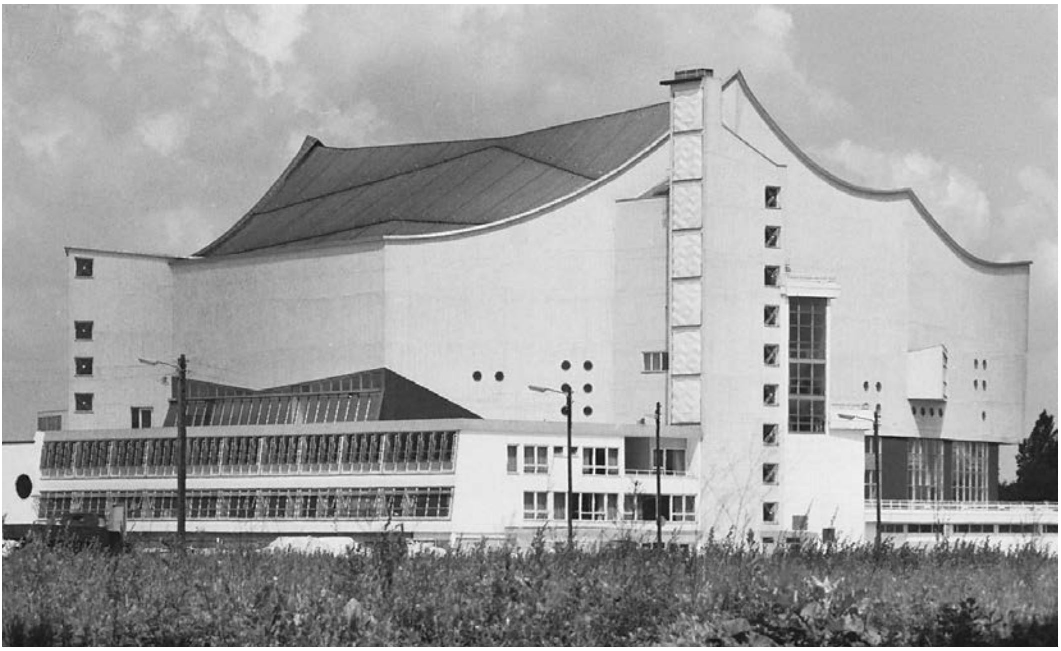
Hans Scharoun: The Philharmonie, Berlin

One of the most striking of these formally evocative and yet entirely functional buildings is the Philharmonie in Berlin, 1957–1965, by Hans Scharoun (1893–1972). The symphony hall is one of the last works of this Expressionist designer from the older generation [19.48, 19.49, 19.50, 19.51]. In this instance, however, the building form is shaped by the music, with the audience surrounding the musicians and seated on elevated sections lifted over lobbies on the ground floor below. The many angled surfaces and the convex curves of the ceiling (mirrored by the angles and curves of the exterior) disperse the sound well. Scharoun made clear his objectives:

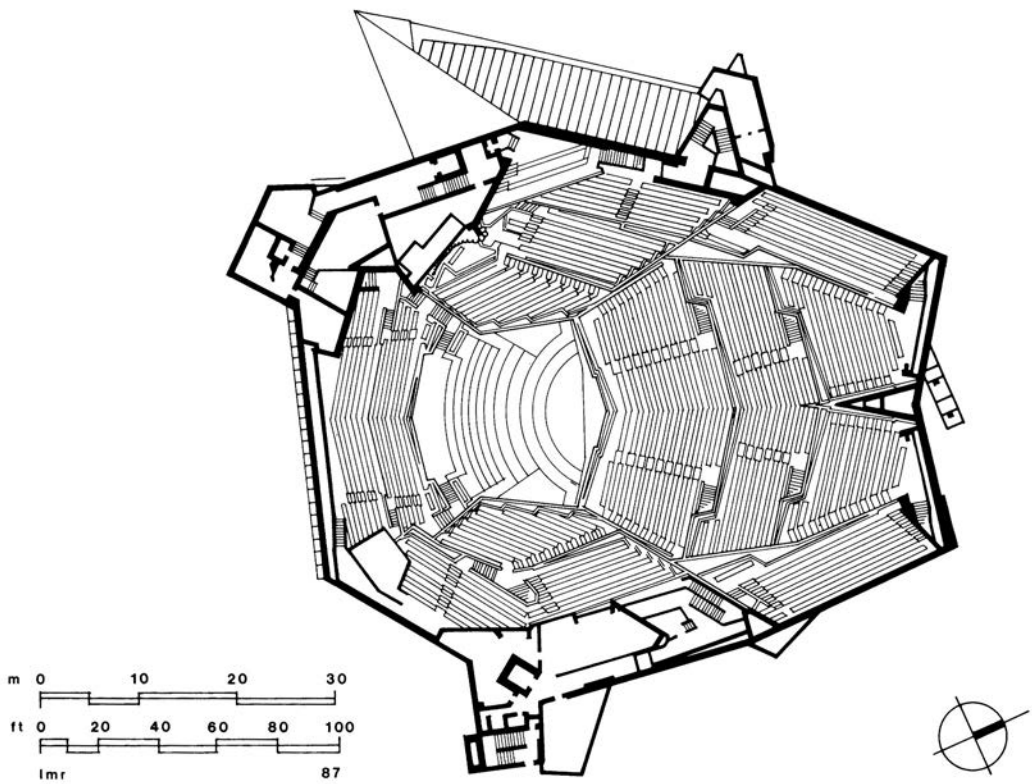
> Music as the focal point. This was the keynote from the very beginning. . . . The orchestra and

19.46. Eero Saarinen, Trans World Airlines Terminal, John F. Kennedy Airport, New York, NY, 1956–1962. With its soaring cantilevered concrete wings, Saarinen endeavored to shape in the TWA Terminal a symbolic representation of flight. Photo: L. M. Roth.

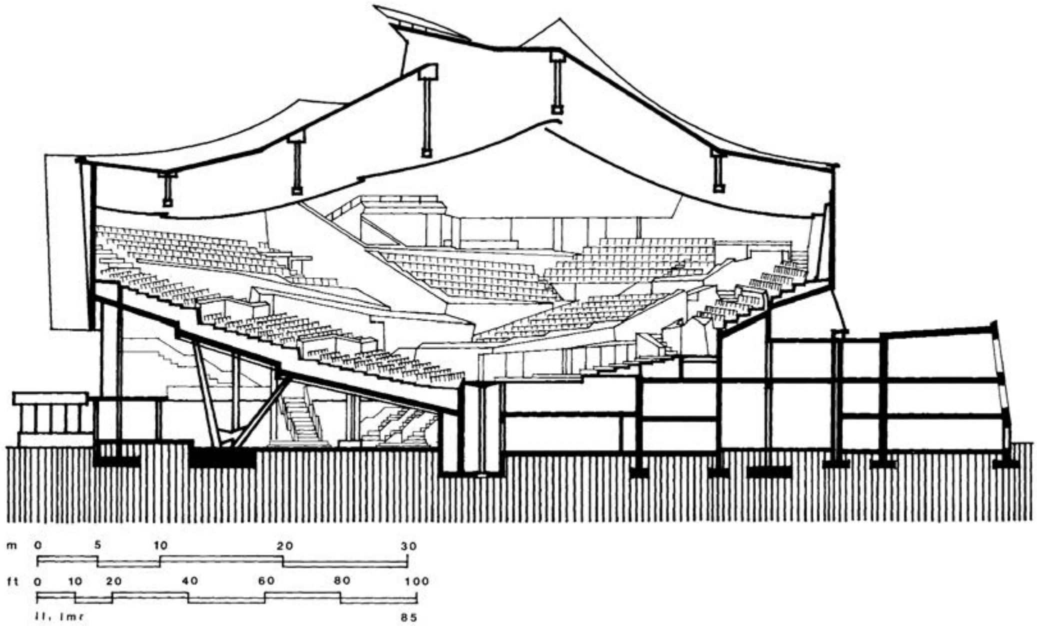
19.47. Trans World Airlines Terminal, John F. Kennedy Airport. This night view, taken from the parking area, shows well the enormous reach of the 80-foot cantilevered roof shells. Photo: Ezra Stoller © Esto. All rights reserved.



19.48. Hans Scharoun, Berlin Philharmonie, Berlin, Germany, 1957–1965. Exterior. The unusual plan and profile of this building were shaped by the desire to put music at the center of the audience. Photo: German Information Center, New York.



19.49. Berlin Philharmonie. Plan. Drawing: L. M. Roth.



19.50. *Berlin Philharmonie. Section. The exterior is determined in all its parts by internal functional requirements. Drawing: L. M. Roth.*

19.51. *Berlin Philharmonie. Interior. Scharoun wrote: "Music as the focal point, this was the keynote from the very beginning." Photo: German Information Center, New York.*

conductor stand spatially and optically in the very middle of things; and if not in the mathematical center, then certainly they are completely enveloped by the audience. Here you will find no segregation of "producers" and "consumers," but rather a community of listeners grouped around an orchestra in the most natural of seating arrangements. . . . Man, music, and space—here they meet on a new relational basis.[39]

Jørn Utzon: The Sydney Opera

The danger inherent in such monumental symbolism was that a captivating image could come to dominate the building, just as, at the other extreme in International Modernism, structural systems or reputed function had become dominant. This point was reached in the striking 1957 design of the Sydney Opera House. The unusual structure was built in 1965–1973 at the end of Bennelong Point, jutting into the middle of the harbor of Sydney [19.52]. The design was based on the sketch submitted by the Danish architect Jørn Utzon (1918–2008) in a celebrated international competition in 1957, even though it was not at all clear how Utzon intended to build the nested shells. The image was simply too compelling not to build. The rising shells suggested sails in the harbor, and the undulating ceilings of the auditoria not only recalled the surrounding water but also suggested sound waves. How to build the shells, and how many of the details of the building were to be resolved, was far from clear. Utzon worked on the design through 1965, when he resigned.[40] The profile of the design was changed by the subsequent architects and engineers to make the shells pairs of triangles cut from the same sphere; the shells were then fabricated of wedge-shaped, precast concrete segments. The details of the structural design were worked out by the engineer Ove Arup, and changes were made in the interiors of the auditoria. Quickly surpassing the original cost estimate of $9 million, the final cost spiraled to $131 million and eventually reached $400 million. Finally, in 1973, the Sydney Opera House opened to acclaim, even though its two auditoria did not always work especially well and were small. Whatever purely musical and performance aspects Utzon's design might have fallen short of providing, without any doubt the Opera quickly became the preeminent worldwide symbol of the spirit of Sydney and Australia.

19.52. Jørn Utzon, Sydney Opera House, Sydney, Australia, 1957–1973. Despite stupendous cost overruns, the Sydney Opera House was carried to completion as a symbol of the cultural aspirations of Sydney and of Australia. Photo: © Jack Sullivan/Alamy.

Louis I. Kahn: Functional Monumentality

By 1960–1965, numerous architects, especially in the United States, were asking why architecture had to move to such Expressionist extremes. Was it not possible to create an architecture that accommodated function to an optimum degree and yet expressed character and function in clearly recognizable ways? One alternative approach was proposed by Louis I. Kahn (1902–1974) of Philadelphia. Trained in the École des Beaux-Arts tradition at the University of Pennsylvania in the 1920s, Kahn viewed the purpose of architecture as elevating human institutions and human activity to an almost metaphysical mystical plane.

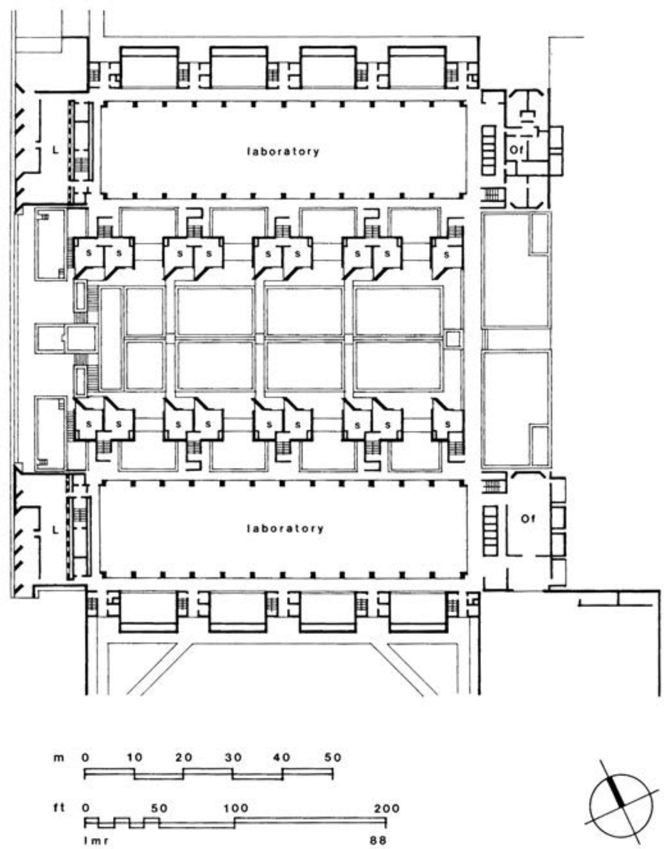
This viewpoint is well illustrated in his Jonas Salk Institute for Biological Studies (1959–1965) at La Jolla, California [19.53, 19.54, 19.55]. Kahn was fortunate in having as his client scientist Jonas Salk, who shared Kahn's conviction that the element of stately mystery was to be integral to the design of the laboratory. Kahn's original scheme for a complex of buildings on a cliff overlooking the Pacific Ocean called for three distinct groups around the edges of a ravine—a residential quarter, a research laboratory, and a community center—forming a balance of living, working, and communal activities. Of the three parts, only the laboratory was built. The laboratory is U-shaped, enclosing a court, with the open end of the U allowing an unobstructed view of the ocean and sky. The actual working labs are layered between open floors containing plumbing, wiring, and every conceivable utility. On the inner court sides of these laboratory blocks are the researchers' individual studies; the intimacy of the small, domestically scaled dens paneled in teak contrasts dramatically with the scientific objectivity of the laboratory spaces. The structural masses throughout are of reinforced concrete, carefully detailed to reveal the method of construction. There is imbued in the building the sense of a monastic community gathered together in a quest for truth, given a clarity of form that grows out of the work being performed. Kahn's Salk Institute is a monument to the celebration of human reason, but with the clear admonition, embodied in the studies clustered at the center, that part of scientific inquiry is contemplating the extended impact one is making on nature.

Brutalism: The Rough Edge of Modernism

In the hands of Gropius and most certainly Mies van der Rohe, there was an exertion to bring precision and perfection of connection to modern architecture. As noted, the gleaming chromium-steel-clad cruciform columns of Mies's German Pavilion were meticulously handcrafted despite their very mechanical appearance. Perhaps the apogee of this perfectionism was reached in the finishing of Mies's elegant weekend house for Dr. Edith Farnsworth. Not only were exquisite materials selected for the interior—travertine for the floor paving panels, natural primavera for some cabinetry, and shantung silk for the curtains—but the steel frame itself was meticulously finished as well. All welding marks at the connections of the columns and the edge beams were ground to achieve smooth fillet surfaces (with any gas bubble voids carefully filled and again ground down), then the finished frame was sandblasted to further smooth the surface, next a zinc coating was applied, and finally coats of white paint were carefully and repeatedly applied so that the final result appeared almost porcelain-like. As Mies's biographer, Franz Schulze, noted, although the most evident components of the house "were drawn from the inventory of modern technology, they were brought to completion by methods more suggestive of the crafts."[41]

While many architects at mid-century yearned for such perfectionism, others deliberately rejected this attempted cover-up of the messy realities of industrial production and the building process. Their reaction came to be called the New Brutalism by critic Reyner Banham and was discussed in a book of the same name that he published in 1966.[42] The catchphrase originated in Sweden, was quickly taken up in Britain, and was used even by some architects themselves to describe their work, particularly the team of Peter and Alison Smithson. The Smithsons' secondary school at Hunstanton, Norfolk, England, 1949–1954, with its frankly expressed welded-steel frame and brick and glass infill panels, was directly inspired by Mies van der Rohe's IIT buildings (which they then knew only through photographs). The Smithsons also were inspired by the emphatically rough surfaces carefully created by Le Corbusier in the concrete of his Unité d'Habitation apartment block in Marseilles and the monastery at La Tourette [4.15]. The Smithsons purposely left traces of the assembly, with deliberately crude weld joints, creating a texture of materials seemingly left "as found," as Banham put it, to convey "the rough grain of modern urban life in a new art," as William Curtis observed.[43] Pipes, electrical conduits, and other mechanical elements are frankly exposed, and this deliberate crudeness is celebrated in the arrangement of the bathroom pipes, which descend from sinks and drop their effluent into an open drain trough in the floor.

19.53. Louis I. Kahn, Jonas Salk Institute for Biological Studies, La Jolla, California, 1959–1965. View of study model, showing all three proposed portions of the complex—housing, laboratory, and community center; only the laboratory building was completed. Photo: Courtesy, L. I. Kahn.



19.54. Salk Institute. Plan. Although the drawing suggests that the laboratory spaces and the studies are on one level, the studies are actually one-half flight up. Drawing: L. M. Roth.

19.55. Salk Institute for Biological Studies. View of the interior court. The working areas are housed in large multifunctional spaces, whereas small, individual private studies are clustered in the central courtyard. Photo: L. M. Roth.

Shortly after the Smithsons began the Hunstanton School, Le Corbusier built the two Maisons Jaoul in 1952–1956 outside Paris, in Neuilly. The conjoined weekend villas had ordinary brick piers supporting shallow, segmental concrete vaults. The mortar bulged out from between the bricks, and the concrete bore the clear marks of rough board formwork. Everything was deliberately crude in construction. Quickly, British architects took to the use of similarly rough board formwork to leave impressions in their cast concrete, as did James Stirling and James Gowans in their apartment flats at Ham Common, London, 1958, with exposed concrete floor slabs and rough brickwork. Poured-in-place concrete, in particular, lent itself to this sort of coarse treatment. Many of the younger British architects, especially those working for public housing agencies such as the London County Council, treated building materials and construction methods similarly, as did other architects across Europe, in Italy, the Netherlands, Sweden, and Switzerland. In the United States, the work of Paul Rudolph in the 1960s fell into this classification, as in the married-student housing he designed for Yale University, New Haven, Connecticut, 1962. Even the early work of Louis I. Kahn manifested a certain roughness and "as found" quality in the materials used and the construction techniques, notable in the exposed-concrete space-frame floors and stair tower of his Yale University Art Gallery of 1953.

The subtitle of Banham's book posed the question "Ethic or Aesthetic?" and certainly in Kahn's case it was ethic, for he desired always to frankly and openly indicate the process of construction: "let me tell you how I was made" was what he hoped his buildings would communicate to the user. But in Rudolph's case, particularly in his Art and Architecture Building for Yale University, 1964, the jagged edges of the bush-hammered concrete ridges resulted from an aesthetic choice [4.22, p. 83]. What Brutalism clearly made evident, however, was that there was a latent dissatisfaction with conventional International or Canonical Modernism as taught and built by Gropius and Mies and their disciples, with its bland, smooth, industrially perfected surfaces and pure forms.

An Architecture of Perfect Function: Success or Failure?

International Modernism, labeled the International Style by Henry-Russell Hitchcock and Philip Johnson in 1932, had been viewed by its inventors and apologists as being technically and intellectually better than older forms of architecture, but it did not usher in a new millennium as its early proponents had anticipated.[44] By the 1960s, a growing discontent with what was viewed as the straitjacket of Modernism occasioned a frank admission, even by some who had once been champions of the cause, that modern architecture had come up short. A major reason was that it communicated so little at a symbolic level to ordinary users. The moment, some critics said, when the pure logical determinism of modern architecture died was 3:32 p.m., July 15, 1972, when the first dynamite charges were set off to level the Pruitt-Igoe housing complex in Saint Louis [19.56].[45] The housing complex had been thoroughly vandalized by its residents. Due to socially prejudiced judgments made by its designers, aspects of its layout facilitated the decline of the buildings into seedbeds for crime. Eventually, the impoverished residents it had been designed for flatly refused to live in it. What had been intended as a demonstration of the highest ideals of modern architecture serving enlightened social engineering had to be destroyed less than a quarter-century after its construction.[46]

Still, the pioneers of early modern architecture had realized significant successes. In pursuit of a modern style, Behrens, Gropius, Mies, and Le Corbusier had grappled with the industrial processes of making building components; they exploited industrial materials and forms evocative of the machine age. To an extent, they reestablished the connection between architecture and engineering and laid the basis for a rationalized architecture expansive enough in scale to meet the challenges of the twentieth century. They developed an architectural image of extended smooth planes and sharp cubic volumes, freed of the tyranny of formulaic bilateral symmetry, that unfortunate legacy of the École des Beaux-Arts. But to their discredit, they insisted on using the flat roof everywhere, even in climates where it could never be properly sealed against seepage from melting snow.

International Modernism failed in several significant ways, some of which did not become clearly apparent until a half-century had passed.[47] Despite the laudable social utopian goal, society was not to be transformed by buildings alone. And Modernism was founded in philosophical and ideological concepts that had little to do with architecture in itself. From capitalist industrial production it had adopted the notion that lean and maximum functional efficiency was *always* best. In a 1908 essay, Viennese architect Adolf Loos equated the luxurious extravagance of ornament with degenerate criminal behavior, and the brutal and total elimination of ornament became an article of faith of the new creed.[48] As centuries of weathering clearly demonstrated (had Modernist architects bothered to look around them), historical ornament provided very practical and visually satisfying ways of shedding water, accommodating expansion joints, or otherwise allowing for buildings to age gracefully. In less than two decades, in contrast, buildings like the Villa

19.56. Dynamiting the Pruitt-Igoe Housing Complex, Saint Louis, Missouri. At 3:32 p.m., July 15, 1972, the first charges of dynamite were detonated, demolishing what had once been considered a model public housing complex. All the vaunted high ideals of International Modern architecture seemed to come crashing down with it. Photo: St. Louis Post-Dispatch.

Savoye began to self-destruct, revealing that International Modernism is a very fragile architecture.

From Protestant evangelism came the notion of truth and honesty in architecture, so that all materials and methods of construction had to be expressed for exactly what they are; plumbing was to be proudly displayed and bare light bulbs could dangle in the center of cubical white rooms. From this root, too, came the evangelical zeal of spreading the word to the "unenlightened," so that International Modernism—and the Western cultural values that shaped it—were exported to all parts of the globe, irrespective of indigenous architectural cultures. Whether or not this exported architecture was appropriate to local climatic conditions or social institutions was never much considered. Gropius revealed his upper-middle-class European chauvinism when he wrote that "on the whole, the necessities of life are the same for the majority."[49] While this was perhaps true in the 1920s among the German workers Gropius intended to house, that philosophy was applied in such far-flung places as Pakistan, Yemen, Kenya, Iran, Indonesia, and Malaysia, where sealed, glass-sheathed skyscrapers rose in searing deserts and equatorial heat. Le Corbusier's once-proud boast of devising "one building, for all nations and climates" was actually attempted by the next generation of Modernists.[50] In fact, emerging Third World countries, often because of the aspirations of their Western-educated political leaders, were eager to see these towers built as evidence of their arrival in the international political arena.

The early Modernists also believed fervently in a kind of inverted Social Darwinism. They were convinced that if the physical architectural environment were improved, if the crowded slums and congested streets that were a legacy of past ages were swept away and replaced by sleek, glazed housing blocks in neat, rational rows, then crime and poverty would be lessened, even eradicated. Le Corbusier himself had asserted that, unless such "radiant cities" were built, the inevitable alternative was revolution.

For all its seductive simplicity and beauty, International Modernism was based on a number of fundamental fallacies. The most pervasive was that function in architecture was simple and therefore as easily analyzed as in a linear industrial manufacturing process. Ambiguity, surprise, and delight in architecture were disregarded as irrelevant, and circulation as a primary social function of architecture was also greatly undervalued and minimized.

The Modernist insistence on the causative relationship between function and beauty was shown to be fallacious, too, when, after the midcentury, eighteenth- and nineteenth-century buildings increasingly were converted to new uses, often accommodating their new uses better than the ones they had originally been designed for. As Stanley Abercrombie pointed out in *Architecture As Art,* function and beauty had very little absolute connection.[51]

Because of the unwavering faith in the possibilities of technology, Western architects in the late twentieth century, up to about the mid-1970s, stopped bothering to think about the interactive relationship of a building with its climatic or environmental setting. If a building was too hot or too cold, it was simply a matter of fortifying the cooling or heating equipment. If a new building material was required, the building-materials industry would eagerly supply the need. As good capitalists, however, these suppliers were more interested in the short-term expansion of their markets than in providing safe, stable, durable, and nontoxic materials. Whether a sealant, a plastic, or an adhesive would last even as long as the mortgage on the building was anyone's guess.[52]

International Modernism was based on an implicit faith in deified Cartesian reason, in the ability of the human mind to perceive, analyze, and solve any problem—a faith that was deeply shaken in the third quarter of the twentieth century. To paraphrase T. S. Eliot, things started falling apart. Where science had once been proclaimed the source of ultimate truth, it turned out also to be the source of the ultimate threat, for science had made easy the possibility of nuclear genocide. And even if global holocaust can be indefinitely held at bay, the ever-accumulating toxins resulting from nuclear power and industrial processing pose thorny problems. Hence, the poisonous by-products produced during the late twentieth century now pose a danger to life that will endure for an eon, extending into the future over a length of time equal to the ages elapsed since those first dwellings were built at Terra Amata.

In the end, ironically, the proponents of Canonical Modernism who had passionately searched for crystalline architectural purity in the service of social improvement, who had hoped to create an architecture beyond style and time, became the arrogant purveyors of what they were convinced were timeless, revealed, fundamental, universal architectural truths. Despite their lofty ideological ambitions, however, what they created was simply another historic style.

20.28. Norman Foster, Hong Kong Shanghai Bank, Hong Kong, 1979–1985. In such megastructures the expressive force of engineering reaches its height. Photo: Ian Lambot/arcaid.co.uk.

The Expansion of Modernism

From the Twentieth Century into the Twenty-First

. . . architecture is not a science. It is still the same great synthetic process of combining thousands of definite human functions, and remains architecture. Its purpose is still to bring the material world into harmony with human life. To make architecture more human means better architecture, and it means a functionalism much larger than the merely technical one. This goal can be accomplished only by architectural methods—by the creation and combination of different technical things in such a way that they will provide for the human being the most harmonious life.

—Alvar Aalto, "The Humanizing of Architecture," 1940

I believe that today there is a need for images, for emotion in architecture; a need for architecture to speak once again to people, to become "presence" once again, to become material, to reacquire a meaning that can sometimes be erotic; a need to reestablish a partnership with people, after decades in which architecture was so antiseptic, distant, after the International Style ruined all possibility of communication.

—Mario Botta, interview with Stuart Wrede, in Mario Botta*, 1986*

International Modernism or Canonical Modernism, as defined by Henry-Russell Hitchcock and Philip Johnson in 1932 in their momentous exhibition at the Museum of Modern Art, New York, was an architecture of normative standards, of sharp-edged industrial forms built of steel, concrete, and glass, an architecture that rejected the use of axially directed space in favor of random movement. By the late 1930s this aesthetic was being championed by architectural journals and by many architects who were convinced that this architecture was the most appropriate for the twentieth century (though there were some who pursued a more personal design path). Aside from a few isolated examples, such as the Philadelphia Savings Fund Society Building in Philadelphia, this sort of modernism was not widely embraced in the United States before 1940. Then, during World War II, civilian building essentially ceased in Europe and the United States between 1939 and 1945. After peace was achieved, and the European émigrés such as Gropius and Mies van der Rohe among many others were established in the United States, industrially driven modernism was embraced by corporate capitalism in this country and, with the emergence of the United States as a dominant economic and political power after the war, was exported around the globe.

The earnest social utopianism of earlier European Modernism of the 1920s and '30s, of early Gropius and Mies van der Rohe, was replaced after 1945 by a featureless standardized commercial aesthetic, exemplified by sleek, machine-like buildings, stripped of traditional ornament. This corporate modernism appeared in office and apartment towers, in suburban office parks, schools, and shopping centers. As the production of building assemblies also became standardized, modernism became increasingly cost-effective and was enthusiastically supported by the financial and corporate worlds. As Diane Ghirardo observed, it was not difficult to endlessly copy steel frames and glass curtain walls[1] [20.1]. Nonetheless, some postwar architects—Eero Saarinen, Jørn Utzon, Le Corbusier, and others—shaped their Modernism as a means of highly personal self-expression; and other individuals and groups, such as Buckminster Fuller, Superstudio in Italy, the Archigram Group in England, and the Metabolists in Japan, created what Ghirardo has described as "hyper-celebrations of the supposedly liberating possibilities of endless technological development" that "swept away any tedious connection with reality."[2]

20.1. Sixth Avenue at 50th Street, New York, NY. The hard sterility of the mid-twentieth century is evident here, with repeated glass-sheathed boxes reflecting each other, seemingly unendingly. Photo: Ezra Stoller © Esto. All rights reserved.

Modernism literally began to show cracks by the 1970s and even to fail in spectacular and horrific ways. One highly visible example, as already noted, was the self-destructing windows of the incomplete John Hancock Tower in the mid-1970s. Another was the failure of Modernist planning principles in the service of urban renewal of the 1950s that produced the social collapse of the Pruitt-Igoe housing complex in Saint Louis, precipitating its dramatic demolition in July 1972. Far more serious, however, was the structural failure of elevated walkways in the Hyatt Regency Hotel, Kansas City, Missouri, built in 1978–1980. The collapse, which occurred just about a year after the building was completed, was due both to the minimalist structural detailing so as to be virtually invisible and also to the construction methods of suspending the aerial atrium walkways. This disaster, the single worst American building failure arising solely from architectural design and the engineering of the construction process, was the direct result of the Modernist impulse to appear to defy gravity.[3]

Well before these building failures, however, during the mid-1960s there appeared several books challenging the increasingly empty character of Modernism and the misguided aims of Modernist urban planning and urban renewal. First appeared Jane Jacob's *The Death and Life of Great American* Cities (1961), which attacked the Modernist notions of rebuilding blighted urban areas and replacing living neighborhoods with sterile high-rise towers. Hassan Fathy's *Gourna: A Tale of Two Villages* (1969) exposed the unsuitability of Western Modernism in solving housing issues in developing countries such as Egypt. Also highly critical was Aldo Rossi's *The Architecture of the City* (1966). Perhaps the smallest book had the greatest impact in redirecting the course of modern design. This was the "gentle manifesto," Robert Venturi's slender volume entitled *Complexity and Contradiction in Architecture* (1966), which addressed the lack of communicated meaning in Modernist architecture. This small but richly illustrated book was the result of decades of reflection on what Venturi (born 1925) had studied during two years at the American Academy in Rome. He came to see that buildings from the past (and there was no shortage of examples in Rome)—both famous monumental architecture as well as ordinary vernacular buildings—were admired and cared for in proportion to their degree of complexity and layered meanings. Such buildings were double coded, he suggested, with multiple and sometimes contradictory intentions. What architects had to rediscover, he argued, was how to create a modern architecture that drew from the structure and materials modernists had developed in the early part of the twentieth century, while also incorporating ornament and visual references to the past and to local tradition. Architects had to avoid "either-or" formulaic design solutions in favor of "both-and" solutions in search of "the difficult whole," as he put it. What Venturi proposed in this new design approach to counter the blandness of Modernism was Postmodernism, as it was labeled by subsequent theoretical writers though Venturi did not use the term himself.[4]

Postmodernism Emerges

Coming out of his teaching at the University of Pennsylvania from 1954 to 1965, Venturi's "counterrevolutionary" principles were manifested in several of his early buildings, which attracted a great deal of critical attention. His initial experiment in this new mix of new and old was a house for his mother, in the inner suburbs of Philadelphia, but his first public demonstration of this philosophy was provided in an apartment house for elderly Quakers, Guild House, Philadelphia, 1960–1965 [20.2, 20.3]. The plan was complex, contained in a block that stepped back from the entrance at the sidewalk; the individual apartments, therefore, had irregular floor plans similar to those in apartment blocks of the 1920s. The red brick exterior was based on the surrounding ordinary brick industrial buildings of this dense urban setting. Yet Venturi also suggested the organization of a Classical building in the white tile base and the band of white glazed brick that sets off an attic story. The broad segmental window of the upper lounge recalled Classical pediments, and there was even ornament provided in the gold-plated television antenna at the very center; it was, in fact, a symbolic antenna, since in those pre-cable television days the real working antenna was at the back of the building. Venturi found a way to combine abstract references

20.2. Venturi and Rauch with Cope and Lippincott, Vanna Venturi house, Chestnut Hill, Philadelphia, Pennsylvania, 1959–1964. In the early 1960s, when the minimalism of International Modernism was still dominant, Venturi composed a modest house for his mother that incorporated in abstracted form a classical pediment, articulated by decorative moldings. Photo: Courtesy of Venturi, Scott Brown, and Associates.

20.3. Venturi and Rauch with Cope and Lippincott, Guild House, Philadelphia, 1960–1965. Venturi and his associates designed this apartment block to fit in with the surrounding industrial lofts and warehouses. Photo: Courtesy of Venturi, Scott Brown & Associates.

to traditional ornament and Classical form, and yet accommodate function in a building that endeavored to become integrated within its immediate environment. Venturi's Guild House suggested the possibilities of referring to the long-standing Classical traditions of Western architecture, particularly in older cities like Philadelphia.

Venturi, and the Postmodernists inspired by him, rejected aspects of Canonical Modernism while simultaneously making their buildings referential—addressing context and tradition, giving architecture a civic meaning beyond the esoteric formal concerns that appealed only to a handful of similarly inclined architects. In fact, Venturi's Postmodernism could be seen as a later variant of the Academic Eclecticism prevalent at the turn of the nineteenth century.

For some observers, the term *Postmodern* has been limited to meaning the over-scaled classical detailing and playful irony used by Venturi, Moore, Stern, and Graves in the 1960s and '70s. All of these architects moved on to other design approaches, and yet all of their work, as well as the many different reactions to modernism yet to be discussed, can be gathered under the overall umbrella of Postmodernism as a term referring not to a specific style of Ironic Classicalism but to the collected and continuing reaction worldwide to the reductivism of mid-twentieth-century Canonical Modernism.

Following Venturi's example, other architects pursued parallel paths, in a spreading movement that bifurcated repeatedly in the next several decades, producing many variants of Postmodernism, leading to a puzzling multiplicity of design alternatives. In the late 1980s, Robert A. M. Stern (born 1939) began examining these various modes of Postmodernism, suggesting the beginnings of a taxonomical tree of variants (at least those generally deriving from classicism) that helps to place these many diverse design approaches into an understandable pattern.[5] The categories devised by Stern included:

- Ironic Classicism (as illustrated by the work of the Americans Venturi and Charles Moore)
- Latent Classicism (Mario Botta in Switzerland, Kevin Roche in the United States)
- Fundamentalist Classicism (Aldo Rossi in Italy, Rafael Moneo in Spain)
- Canonic Classicism, essentially the continuation of nineteenth-century Academic Classicism (Quinlin Terry in England, Christian Langlois in France)

- Modern Traditionalism (Stern himself, Michael Graves, Thomas Gordon Smith)

Other writers and critics, among them Charles Jencks, James Steele, and W.J.R. Curtis, have since offered their own interpretations and expanded on Stern's list of stylistic modes.[6]

Ironic Classicism

The term *Postmodernism* became nearly synonymous with the early work of Robert Venturi or Charles Moore in 1970s. This initial form of Postmodernism was based on interpreted "quotations" of classical ornamental details. Comparable to the eclectic architects starting in the mid-eighteenth century, so too these mid-twentieth-century architects wished their building to be conveyors of meaning. In the case of the Ironic Classicists, it was often a sarcastic or deliberately whimsical message. Robert Venturi was among the very first to use this approach, in the Guild House apartment building noted previously, and even earlier in the residence for his mother. The Vanna Venturi house, in Chestnut Hill, Philadelphia, Pennsylvania, 1959–1964, with its broken gable roof and suggested classical moldings recalled traditional gable house roof forms while at the same time alluding to the broken-scroll pediments so often used in eighteenth-century doorway surrounds in Philadelphia.

The first international public demonstration of Postmodernism was in the exhibition held in Venice in 1980, the prestigious Biennale. The theme chosen for that year was "The Presence of the Past," and within the large hall used for the exhibition, twenty invited architects contributed facades along the "Strada Nouvissima" exploring this theme. Among them were such American architects as Charles Moore, Robert Venturi, and Robert A. M. Stern; Spanish architect Ricardo Bofill; and Viennese architect Hans Hollein. It is striking how many designs were classically derived, ranging from the personally idiosyncratic to virtual Neoclassicism. Clearly, both European and American architects were ready to employ ornament once again, and several in a whimsical, creative way.

Along with Venturi and Stern, Charles Moore was another American architect who early explored Ironic Classicism, and nowhere more whimsically than in his controversial and intriguing design for the Piazza d'Italia in New Orleans, Louisiana, 1975–1980. This was commissioned specifically as a gathering place for New Orleans's small Sicilian community, especially on the feast day of Saint Joseph. The piazza, fitted in among existing buildings, is paved to show a map of the boot of Italy (with Sicily at the very center); the edge of the piazza rises in steps toward a Palladian door centered in a semicircular Corinthian colonnade [Plate 13]. Highly colored and ringed with neon tubing, the "Classical" capitals are impishly rendered in chrome steel; jets of water sprout from unexpected places, such as the abstracted leaves of the Corinthian capitals.

Whimsical allusion was also intrinsic to Hans Hollein's Austrian Travel Agency headquarters in Vienna, 1978–1979. Since this is a place where travelers come to dream of romantic escapes, the lobby is filled with allusions to faraway places—tropical palm columns with the metal fronds, a Moghul Indian pavilion, a fragment of a pyramid, a Classical column whose broken shaft is transformed into a gleaming chrome cylinder. Other fragments refer to automobiles, ships, and planes, all covered by a curved milk-glass vault recalling the similar glass-vaulted banking room of Otto Wagner's Postal Savings Bank, 1904–1906, which stands a few blocks away.

Such flights of fancy and tongue-in-cheek allusions work best in buildings of festive function. Much more difficult is ironic allusion in buildings of more serious public service. This dilemma was evident in the first major American Postmodern public building, Michael Graves's Portland Building for the City of Portland, Oregon, 1978–1982 [20.4]. Graves was responding to the adjoining subdued Neoclassical Portland City Hall, 1893, in his enormous abstracted column forms, swags, garlands, and three-story keystone. Yet for all the architect's written assertions and visual intimations that this was a return to the gracious public architecture of the turn of the century, the gesture rings hollow, for the ornament is painted plaster and not marble, the entrances are constricted and not inviting, and the interior public spaces are cramped and not generous. Countering Graves's claim that this building was unique to its site, the four facades are sufficiently alike that the building could be turned in any direction. Postmodernism is bold and, as here, often audacious, but the results are often mannered and more than a little grotesque. Caprice and wit are to be welcomed in architecture, but in much early Postmodernism the result all too often was a modern idiom that had been changed, put in new fancy dress, but not necessarily improved.

Once the most prominent American champion of Modernism, and the man largely responsible for Mies van der Rohe leaving Germany and settling in the United States, Philip Johnson (with John Burgee) moved decidedly into the camp of the

20.4. Michael Graves, Portland Building, Portland, Oregon, 1978–1982. In this office block, Graves tried to make a visual connection to the Renaissance-inspired turn-of-the-century City Hall next door (1895) and also to evoke turn-of-the-century twentieth-century public architecture. Photo: Dallas Swogger, Portland.

Ironic Classicists in the design of a major corporate office tower in New York. Johnson's granite-clad AT&T building, 1978–1983 [20.5], has a Classical loggia base and a so-called Chippendale top that make clear allusions to such New York skyscrapers of the 1920s as Warren & Wetmore's New York Central Building (Helmsley Building), 1929, just a few blocks to the south. Here it was the unequivocal instructions of the client that determined the essential character of the design. In 1975, in the first discussions with Johnson, John deButts, then CEO of AT&T, laid out several criteria for the proposed building: the budget was to be big, the building design had to be unique (immediately suggesting to Johnson a highly distinctive crown at the top), and stone was to be used as a sheathing material (a marked departure from the metal exterior of Mies's towers). In particular, deButts instructed Johnson, "we would like the building to say, loud and clear, 'We love New York.'"[7]

Johnson's over-scaled broken pediment crown for the AT&T Building is easily identifiable, and in the 1980s one had only to say to the ordinary New Yorker on the street, "Oh, you know, the building that looks like a piece of furniture," and that person would understand precisely which structure you were referring to. Johnson at least made corporate architecture fun to look at again, and the subject of common discourse—even if the final result, in the long term, seemed curiously hollow and devoid of deeper significance.

Populist Modernism

When it first appeared, many critics of Postmodernist architecture, particularly those with a limited sense of humor, accused designers of seeking to reach the lowest common denominator among the public. In fact this was exactly what some architects *did* seek to achieve in a special genre called by James Steele "Populist Modernism" or, alternatively, "Novelty Architecture" (not included in Stern's analysis since it does not draw from the classical tradition). In this approach, architectural images are used that are widely recognizable. A good example is found in the Team Disney Building (a corporate office headquarters building) in Burbank, California, by the office of Michael Graves, 1985–1991 [20.6]. Using what had now become his signature color palette—buff, cream, terra cotta red-brown, and turquoise—Michael Graves devised a broad four-story building capped by an expansive pediment (the rear wall glazed within the defining cornices). The pediment is visibly supported from below by six nineteen-foot caryatid figures, representing the principal dwarfs from Disney's animated film *Snow White,* while the seventh and smallest dwarf, Dopey, stands within the pediment and lifts the ridge of the pediment. Other similar buildings by Graves for the Disney organization include the paired tourist hotels—the Dolphin and the Swan—outside Walt Disney World Resort, Lake Buena Vista, Florida, each surmounted by enormous figures of their namesake. This was Graves at perhaps his most whimsical.

20.5. Philip Johnson, AT&T Building, New York, NY, 1978–1983. In this corporate headquarters building, Johnson used bold ornament and pattern, recalling similar New York skyscrapers of the 1920s. Photo: Richard Payne.

20.6. Michael Graves, Team Disney Corporate Headquarters, Burbank, California, 1986. Populist Postmodern architecture typically incorporates imagery immediately recognized by the mass public, such as the Seven Dwarfs in this Disney office building. Photo: © Jeff Goldberg/Esto. All rights reserved. Disney characters © Disney.

Other examples of so-called populism in the United States include the themed resorts built during the roaring 1990s in Las Vegas, Nevada, such as the New York–New York Hotel and Casino Resort complex by Gaskin and Bezanski with Yates and Silverman, 1994–1997. Its New York City skyline of bundled miniatures of the Empire State Building, Ellis Island, and the Statue of Liberty is well known. Another was the Luxor of 1992–1993 with its huge stark black glass pyramid, fronted by an enormous sphinx. This was followed by the Venetian Resort Hotel Casino, Las Vegas, 1996–1999, marked externally by a reduced replica of the sixteenth-century Campanile bell tower in Venice, Italy, together with canals through the grounds, and elaborate interiors suggesting those of the Palace of the Doges in Venice. This use of populist imagery, labeled the phenomenon of "theming" by critic Louise Huxtable, became widespread in the United States for high-profile restaurants and resorts. Even when the theme is not kitsch, it can become over-the-top parody of late or high-tech modernism. While theming has been less evident in Europe (the difficulties of the EuroDisney theme park outside Paris being an example, since authentic examples of the "themed" architecture rise all about them), it has been very popular in Japan, as illustrated by the enormous and brightly colored combination hotel, commercial and entertainment complex called Canal City Hakata in Fukuoka, 1996, by the Jon Jerde Partnership.

At a somewhat more serious level and for knowledgeable architecture students, Philip Johnson did something comparable, returning to an iconic building project for the architecture school at the University of Houston, Texas, named for Gerald D. Hines, one of Johnson's principal clients in Houston. Johnson based his design very closely on the idealist "House of Education" (Maison d'Éducation) published by Claude Nicolas Ledoux in 1804, an example of Ledoux's functionally expressive *l'architecture parlent* [20.7]. In adapting this model for an architectural school, Johnson was compounding the reference, creating what might be called *l'architecture parlent redux*.

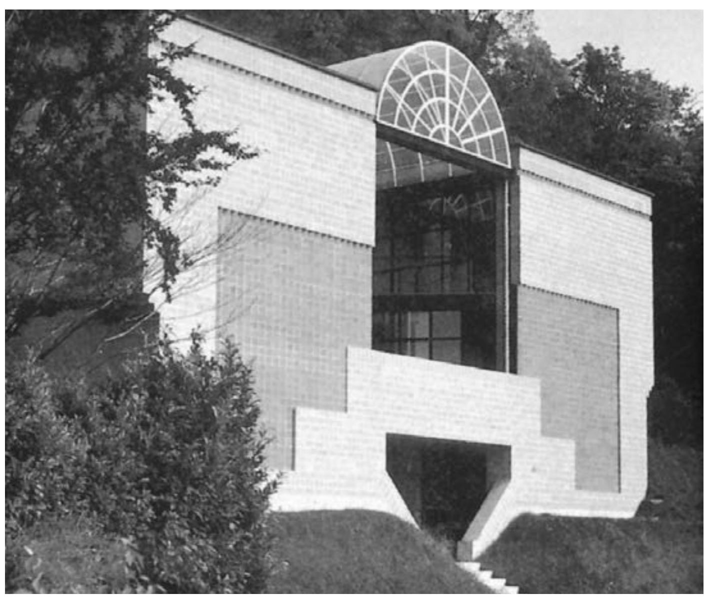
Latent Classicism

While some architects in the 1970s such as Stern and Moore clearly enjoyed the bemusement caused by the irony of some of their designs, other architects were carefully avoiding the mocking whimsy of Ironic Classicism, seeking instead a generic classical balance and order in their Postmodern work. Unlike the Ironic Classicists they were not especially interested in semiotics, in making the building a sign referring to something else. They were certainly not interested in whimsical humor, for as they were well aware nothing goes flatter faster than a joke; they were seeking a more timeless quality. Robert Stern described latent classicism as an attempt to marry the technologically driven aesthetic of Modernism with the composition principles of Classicism; it employs "a kind of erased Classical language, in which the traces, outlines, and impressions of the constructionally based forms remain, but the ornamental detail, whether in the decorative of an order or in idiosyncratic nuance, is eliminated."[8] Accordingly, architects belonging to this group typically opted for balanced symmetrical, often axial compositions.

Among the American architects who turned in this direction is Kevin Roche, as well illustrated in his General Foods Headquarters building, in suburban Rye, New York, 1977–1983 [20.8]. The materials and building methods clearly derive from Canonical Modernism, but the composition is axial, and the central pavilion hints at a dome. Another architect who merged clarity of form with a decidedly direct statement of building materials is the Swiss architect Mario Botta (born 1943). To these qualities Botta has added a primal imagery that makes his buildings look very old and yet new, as in a house in Viganello, Switzerland, 1981–1982 [20.9]. The precision of form and the careful handling of brick and concrete block clearly reveal Botta's debts to his two mentors, Le Corbusier and especially Louis I. Kahn (he worked briefly for both men). But Botta moved away from the nonreferential abstraction of their work, seeking forms that echo images dwelling deep in the human subconscious, endeavoring to make an "architecture to

20.7. Philip Johnson, University of Houston School of Architecture, Houston, Texas, 1982–1985. One wonders what message was meant for the students housed in a building that was essentially a realization of a project of Claude-Nicolas Ledoux of two centuries earlier. Photo: Richard Payne.

20.8. Kevin Roche, General Foods Headquarters, Rye, New York, 1977–1983. Latent Classicism incorporates a fundamental order, often based on bilateral symmetry, but couched in a language of modern building technology. Photo: Courtesy of Kevin Roche.



20.9. Mario Botta, house, Viganello, Switzerland, 1981–1982. Botta's early buildings, emphasizing dramatic geometric order, were created with the simplest of building materials and construction techniques. Photo: Alo Zanetta.

speak once again to people."[9] This impulse to carefully reveal the building process and the component materials is found in his later work as well—for example, his Evry Cathedral, Evry, France, 1995, with its precision brick work—and in his Museum of Modern Art for San Francisco, California, 1994. Later work along the same lines includes his Petra Winery, Suvereto, Tuscany, Italy, 1999–2003, with its pure cylinder cut by symmetrical narrow window bands, and his Leeum-Samsung Museum of Art in Seoul, South Korea, 1995–2004, with its crisply modeled banded brick.

Fundamental or Essentialist Classicism

Other architects moved toward even more abstracted form, "seeking to reduce buildings to the purest geometrical constructs, in an effort to achieve 'natural' essential truths," as described by Stern.[10] These architects were in search of a reduced Classicism that was timeless. Comparatively few American architects turned in this direction, although the early work of architects Andrés Duany and Elizabeth Plater-Zyberk—such as their Galen Medical Building in Boca Raton, Florida, 1981–1983—can be placed in this category. This husband and wife partnership would later become far better known, however, for their planning activities.

Perhaps the archetypal representative of this design approach is the Italian architect Aldo Rossi, seen in his early work such as the Cemetery for Modena, Italy, 1971–1976, as much as in his later building such as the austere Hotel Il Palazzo, in Fukuoka, Japan, 1989 [20.10]. What Stern identified as Fundamental or Essentialist Classicism is nearly the same as what James Steele calls "Minimalism." Some of the architects Steele places in this category are Tadao Ando of Japan, as represented in his Koshino house, Tokyo, Japan, 1981, or the

20.10. Aldo Rossi, Hotel Il Palazzo, Fukuoka, Japan, 1989. Rossi's Il Pallazo Hotel, part of the upscale redevelopment of the city of Fukuoka, makes generalized stylistic references to elemental classical forms. Photo: Uchida Design and Nacasa & Partners.

20.11. Herzog & de Meuron, Goetz Art Gallery, Munich, Germany, 1989–1992. The austere and pristine glass box of the Goetz Art Gallery is an excellent example of the minimalist architecture of the 1990s. Photo: Margherita Spiluttini, Schonlaterngasse 8, A–1010 Vienna, Austria.

Buddhist temple addition called the Water Temple, on Awaji Island, Hyogo Prefecture, Japan, 1990, in both of which pure circular or cylindrical forms figure importantly. This minimalism is simply and directly communicated in the small Goetz Art Gallery in Munich, Germany, the work of the Swiss architects Jacques Herzog and Pierre de Meuron, built in 1989–1992. Set in a flat lawn framed by trees, this gallery for a private art collector has been described as "a cool platonic box" forming "a perfectly neutral container, against which the art can be appreciated."[11] Viewed from the exterior, a middle opaque band floats above an etched-glass-enclosed ground floor, echoed by a similar etched-glass clerestory band at the top [20.11].

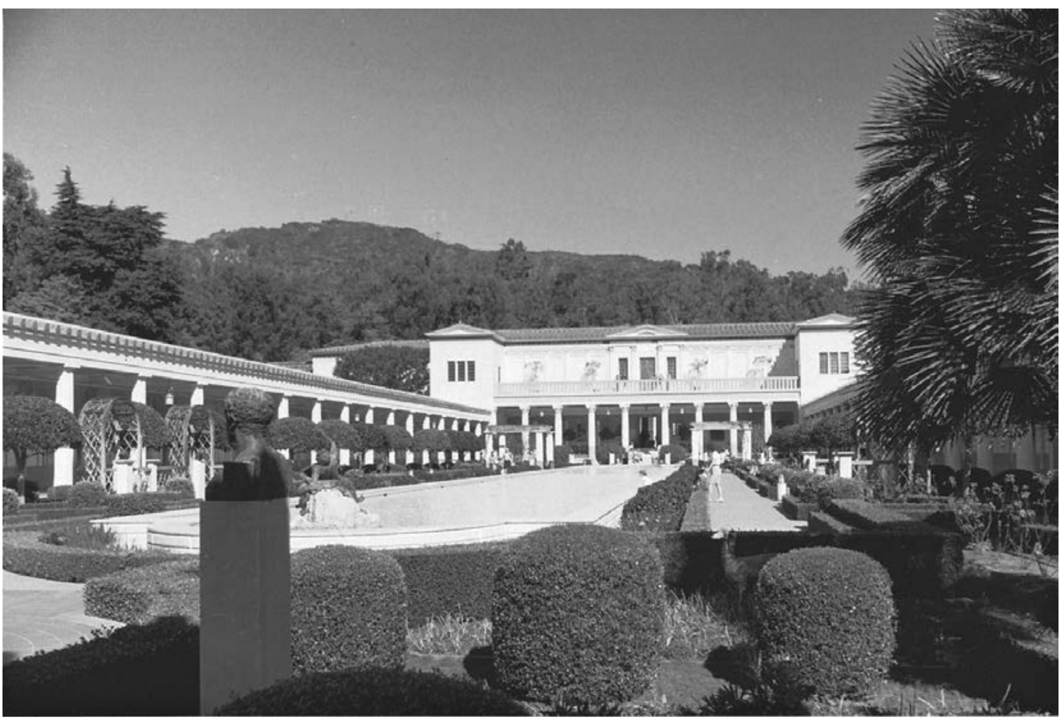
Canonic Classicism

If the Fundamentalists/Minimalists rejected modernism by moving toward pure abstract geometric form, the Canonical Classicists moved precisely in the opposite direction, insisting that eighteenth-century Neoclassicism is the true and proper language of Western modern architecture, and they strived to stay close to the established standards, or canon, of forms and details, while introducing only minimal modern modifications. Where the Fundamentalists/Minimalists see truth emerging from their return to elemental form, the Canonic Classicists see immutable truth embodied in age-old humanist architectural forms and ideals. In the view of Greek-born and London-based architect and theorist Demetri Porphyrios, "classicism is not a style; it transcends the vicissitudes of time and fashion as an enduring set of principles and in those things we call classical we recognize a kind of timeless present that is contemporaneous and at ease with every historical period." He goes on to say that the "classical order makes us see the immutable laws of nature by means of tectonic fiction."[12] Porphyrios made these theories tangible in his buildings for the new town extension of Pitiousa on the island of Spetses, Greece, 1993–1996, designed in a generalized Mediterranean vernacular.

One particularly early expression of this Neoclassical revivalism was the first Getty Museum (now called the Getty Villa) built in the hills of Malibu, California, a literal re-creation of the Roman Villa dei Papiri, outside Pompeii, destroyed by Mount Vesuvius. The replica was built in 1970–1975, designed by architects Robert Langdon and Ernest C. Wilson of Los Angeles, with archaeological advice by Dr. Norman Neuerberg[13] [20.12]. Shortly afterward, when the much larger Getty Center complex was designed by Richard Meier for Brentwood, Los Angeles, a far different architectural language was used.

Among the many architects who have championed Canonic Classicism, Allan Greenberg in the United States and Quinlan Terry in Great Britain can be singled out; both have returned to the classicism of the eighteenth century for wholly new work, even when not necessarily indicated by immediate context. Terry, in fact, published in 1981 a well-argued defense of his use of eighteenth-century classicism in an essay, "Seven Misunderstandings About Classical Architecture."[14] Greenberg was charged with providing ten appropriate meeting and reception rooms for the US State Department in the Executive Office Building, Washington, DC, built in 1984. He accomplished this using a meticulously crafted Composite Corinthian order taken directly from the portico of the Pantheon in Rome. Comparable to the mastery achieved by classicist architects trained a century earlier at the École des Beaux-Arts, Greenberg was able to subtly modify the order, substituting for the rosette customarily resting between the capital volutes an adaptation of the heraldic seal of the United States [20.13]. In a new building housing two newspaper operations in Athens, Georgia, Greenberg turned to strict Grecian classicism, providing the main public entry through a massive hexastyle pedimented portico. In an interior lobby his Greek details are precise, accurate to the point of being brilliantly painted as Greek temples originally were [Plate 31].

Quinlan Terry, in adding the Maitland Robinson Library to Downing College, Cambridge University, Cambridge, England, in 1992, chose to closely associate his new building to the strict Greek Revival classicism of its original buildings by William Wilkins, 1804–1821 [20.14]. Terry used an exacting Greek Doric order, employing a strict



20.12. Langdon and Wilson, with Dr. Norman Neuerberg, J. Paul Getty Museum, Malibu, California, 1970–1975. To house the Getty Museum (and according to Getty's personal direction), the architects meticulously re-created a Roman villa that had been buried outside Pompeii in AD 79. Photo: L. M. Roth.

20.13. Allan Greenberg, Diplomatic Reception Rooms, US Department of State, Washington, DC, 1984. Inspired by specific Classical models, Greenberg slightly modified the Corinthian order, strictly within the guidelines of the Classical canon, introducing an American bald eagle in place of the upper rosette of the capital. Photo: Courtesy of Allan Greenberg.

canonical correctness not seen for nearly a century and a half. Moreover, in the metope panels he incorporated relief sculpture reflecting the contents of the library, including one sculpted panel showing a radio telescope. For a redevelopment of a stretch along the Thames outside London, to house a mix of offices, shops, and restaurants—the Richmond Riverside Development, 1985–1987—Terry assembled a series of period London facades, ranging from the Georgian to the Regency periods (1700–1810), artfully varied and balanced, but behind them the rooms are rather plain late-twentieth-century examples of commercial Modernism.

To those not sharing views like Porphyrios's, such canonical and exacting revivalism seems hollow and out of its time, and accordingly such critics see not authenticity but vacuity. As William Curtis notes, Terry, who had been pursuing a modest if dull classical practice, suddenly found himself pushed to the forefront of a neo-conservative movement "which imagined that 'taste' and 'traditional values' might somehow restore national glory."[15] At its emptiest, such recollections from the past result in the kind of architecture critiqued in 1985 by Charles Newman:

> What we invariably end up with is a gesture of historical pathos without content; the restoration of historical images with no coordinates . . . testimony not to a new eclecticism but merely to the artist's erudition. What we have recently—in painting, music, and architecture, no less than in literature, in opposition to an uncritical rejection of the past . . . —is an uncritical reception, an all-embracing nostalgia, in which *all* historical styles are dredged up simultaneously, history as gesture to a "pastness" which disguises the real pain of history and the struggle

> for knowledge. The ideology of making it new becomes the ideology of making it (sort of) old. As Modernism has become the respectable culture, "tradition" becomes the Avant-garde.[16]

Yet there are many others who see the return to Renaissance classicism not as false posturing but as a return to reason, clarity, a fundamental truth. This view is particularly common among those today who react against Modernist Catholic churches they describe as "Ugly As Sin," as discussed in a book of the same title.[17] In many cases, as the twenty-first century opens, parishioners who believe that their churches were stripped of their nineteenth-century or early-twentieth-century historic detail in favor of then-fashionable "googie" modernist renovations during the 1960s and '70s are turning now to architects such as Duncan G. Stroik to replace the altars, baptismal fonts, even entire interiors so eviscerated a half-century ago. Even entirely new churches are being designed in this manner, in what is viewed by some as the proper spirit of a church as a sacred place, crafted to be appropriate to their particular setting. A good example is Stroik's chapel for Saint Thomas Aquinas, Santa Paula, California, 2003–2009, a reflection of the coastal California mission churches established by Fray Junípero Serra, with churches built by Father Fermín Francisco de Lasuén in the eighteenth century [Plate 32].

Creative Postmodern Traditionalism

As Postmodernism continued to develop in the 1980s and '90s, and as the early clever self-consciousness of Ironic Classicism faded from view, many of the early protagonists such as Robert Venturi and Robert A. M. Stern moved toward a

20.14. Quinlan Terry, Maitland Robinson Library, Downing College, Cambridge University, Cambridge, England, 1992. The Robinson Library incorporates the massive ancient Greek Doric order, a response to the Neoclassicism of the original Downing College buildings by William Wilkins. Photo: © Dennis Gilbert/View Pictures.

20.15. Venturi, Scott Brown & Associates, Sainsbury Wing, National Gallery of Art, London, England, 1985–1991. While clearly drawing inspiration from the Classicism of the adjacent original mid-nineteenth-century gallery, the Venturi and Scott Brown addition at the same time uses the Corinthian order in playfully inventive ways. Photo: Courtesy of Venturi, Scott Brown, & Associates.

Postmodern classicism that was less self-referential and whimsical, and endeavored to consider more the essential character of the context in which they were building. Here again Stern framed a useful definition, writing that "Modern Traditionalism" (as he labeled it) "attempts a synthesis, trying to reach a level of architectural discourse in which the representation is not necessarily ironic, types and ordering systems do not preclude the picturesque, and styles are seen as evolving dialects within a common language." In seeking such a synthesis and advocating a stylistically eclectic approach, Stern admits, this broadly creative Postmodern Traditionalism, exposes itself to

> charges of cultural, technological, and aesthetic opportunism, of "bourgeois" surrender to the tastes and production methods of consumer capitalism. Yet, for me at least [Stern continues], Modern Traditionalism offers the most optimistic and accommodating of all the points of view [among the five variants of Postmodern classicism he describes] and best renders architecture capable of achieving in our time the integrative role it enjoyed in its most illustrious periods.

Most important, for Stern, this Creative Postmodern Traditionalism results in an architecture that once again "is conceived of as a collective public entity, built up over time, continuing a dialogue with the past in the present."[18]

Contextual and site response was the key to the Sainsbury Wing that Robert Venturi and his associates added to the National Gallery, London, 1985–1991 [20.15]. Venturi took his cues from Wilkins's adjoining National Gallery, 1832–1837, holding to the same cornice line, using the same Corinthian plaster order, but manipulating the positions of the pilasters in a freer, more sculptural way. Particularly important, Venturi did not try to upstage Wilkins's National Gallery. Another splendid example, small, convincing, but short-lived, were the Observatory Hill Dining Hall additions at the University of Virginia, Charlottesville, Virginia, by Robert Stern in 1982–1984 [20.16]. The existing dining hall, built just ten years earlier, was already too small and Stern was engaged to attach additional dining pavilions on both the north and south sides of the existing facility. Stern retained the red brick and, on the south side where the ground fell away, used the substantial white classical Tuscan Doric orders favored by Jefferson in his nearby buildings. Stern kept the scale of the dining hall additions low, creating a building friendly toward and worthy of Jefferson's original campus, yet clearly not a replica of anything Jefferson had designed.[19] By 2000, however, further growth of the student body required nearly doubling the space of the dining hall, and, with no space available (allegedly), the proposed solution was to build a wholly new facility adjacent to the existing facility and then demolish and re-landscape the grounds where Stern's pavilions had been built just a decade earlier. Curiously, despite the care with which Stern had made his additions, no particular recognition of them was made by the university. In the official environmental impact report prepared for the university, the assessment was that "this project will not impact local historic resources. Observatory Hill Dining Hall in and of itself is not a significant historic structure nor are any of the surrounding structures, all of which are less than 50 years old."[20] Despite this snub, Stern continues to design using a contextual response, as seen in a building for a different university with its own venerable classical tradition: for the Mason School of Business at the College of William & Mary, Stern's office designed a Georgian-inspired building, hip-roofed and surmounted by a tall narrow cupola (recalling the original structure of 1695 that housed the college), 2010–2012.

In another building type that he made particularly his own—the shingled summer seaside house—Stern studied carefully the early houses of late-nineteenth-century American architects such as McKim, Mead & White, Peabody & Stearns, and John Calvin Stevens. It should be noted, moreover,

20.16. Robert A. M. Stern, Observatory Hill Dining Hall, University of Virginia, Charlottesville, Virginia, 1982–1984, demolished c. 2005. Elevating the dining rooms because of the sloping site, Stern uses brick arches and white Roman Tuscan Doric columns in an innovative way sympathetic to Jefferson's original campus buildings. Photo: Whitney Cox.

that Stern was an architecture student at Yale in the 1960s when Vincent Scully was there, defining the American Shingle Style, the building tradition to which Stern has returned again and again as a fountainhead of inspiration. This can be seen clearly in Stern's shingled house at Chilmark, Martha's Vineyard, Massachusetts, 1979–1983, inspired by the Low house by McKim, Mead & White, 1885–1886.

While Stern's classicism at the University of Virginia had been inventive, if somewhat literal, other architects have devised more abstract ways of responding to site and context. One good illustration is Rafael Moneo's National Museum of Roman Art in Mérida, Spain, 1980–1986 [Plate 33]. Moneo's work illustrates well the explosion of creative energy in Spanish architecture that erupted following the end of Fascist repression with the death of Generalissimo Franco in 1975. It is surely significant that many of the Spanish architects leading this reinvigorated late-twentieth- and twenty-first-century resurgence came out of the Escola Tècnica Superior d'Arquitectura of Barcelona, one of whom was Moneo. Educated in Madrid and Barcelona, Moneo (born 1937) pursued further study in Rome and this strongly affected his work, particularly his sense of the permanence and materiality of ancient Roman architecture. This interest in making connections to the past found its strongest expression in what is arguably Moneo's masterpiece, the Roman Museum at Mérida, 1980–1986. Mérida—originally the Roman military colony of Augusta Emerita, founded in 25 BC—had lost or covered up much of its ancient history. Moneo's museum was to be built over an excavation, with tall, spacious galleries for displaying Roman antiquities and revealing the bases of the exposed Roman walls. Essentially, the museum consists of a series of parallel concrete diaphragm walls, opened up by aligned arched openings. The structural concrete walls are covered with thin Roman brick of a warm sienna color, with three concentric rows of voussoir brick in each arc. At certain times of the day, shafts of light fall across the brick walls, accentuating the displayed objects. The criticism that the brick obscures the true structure of concrete fails to take into account that the Romans themselves covered their concrete building masses with colorful stone veneers, or even lined their formwork with brick that then became integrated into the final wall. Moneo's brick work reflects the city's Roman history and, at the same time, echoes the tall brick arches in Josep Fronserè's Reservoir Building in Barcelona, 1874–1880, thus linking the distant Roman past with a more recent Spanish past (although at some distance to the east). In the lower levels of the Mérida museum there is the sense of a vast hall of repeated arches that summons visions of the hypnotic arches repeated row after row in the Islamic Mosque of Córdoba. Such a response to a broad cultural context marks Moneo's work, not simply by alluding in obvious ways to adjoining buildings but also by making a multilayered connection to a more encompassing history. In the Roman Museum, Moneo navigated the difficult path between dry classical revivalism and the empty theatrics of Postmodern imagery, creating a strong but varied formal tectonic order that achieves timelessness.

Equally creative, but in a different direction, was one of the last buildings completed by James Stirling (1924–1992): the Neue Staatsgalerie in Stuttgart, Germany, 1977–1983. Having begun his career doing work described by Reyner Banham as "Brutalist," with its celebration of rough building materials in deliberately crude construction, Stirling quickly established his leading position in British architecture with the bold design of the Leicester University Engineering Building, 1959–1963, with its metal, glass, and brick construction honoring the dynamic building forms of the Russian Constructivists in the 1920s. Stirling's career flagged somewhat in the later 1960s and early 1970s but then was significantly boosted with the commission for the Neue Staatsgalerie. To be built next to the existing and exceptionally bland nineteenth-century Neoclassical city art gallery, Stirling's addition became the principal focus [Plate 34]. Employing honey-colored sandstone and travertine in banded masonry walls, Stirling made reference to the adjoining older building, but in a more informal, terraced composition descending the sloped site. References to the neighboring Neoclassicism are made through stout abstracted Doric columns, while the central circular rotunda court, open to the sky in the middle of the plan, presents the negative image of Karl Friedrich Schinkel's plan for the Altes Museum in Berlin. Against these references to the previous century, Stirling balanced the use of Le Corbusier–like ramps that create a path through the building mass with contrasting aspects of high-tech twentieth-century industrial Modernism. He incorporated an undulating glass wall with green glazing bars, bright pink and blue metal railings, and brilliantly red steel supports for the external glass canopies. In time, vines will drape over the stone walls, and this, together with randomly placed, seemingly dislodged stones, will suggest a discovered ruin and bring together the many elements of Stirling's sweeping historical yet modern collage.

Another historical mixture is the Harold Washington Library Center in Chicago, Illinois, 1987–1991, by Hammond, Beeby, and Babka [20.17]. This facility, the centerpiece of the Chicago public

20.17. Hammond, Beeby, and Babka, Harold Washington Library Center, Chicago, Illinois, 1987–1991. Responding to the downtown Chicago location, the architects incorporated many generic references to numerous surrounding historic early skyscrapers. Photo: Courtesy of Hamman, Beeby and Babka.

library system, was positioned in the southern end of Chicago's downtown "Loop" business district. Surrounded by the towers that had established the city's reputation as the birthplace of the modern office skyscraper a century earlier, the building makes many allusions to this rich history, from the brick masonry enclosure, especially in the sloped battered base and the tall wall arcades that refer not only to the enduring legacy of Richardson and Sullivan but also to the restrained classicism of the neighboring Second Leiter Building by Jenney directly across State Street to the east. There is additional reference to the city's rich classical heritage following the Columbian Exposition, suggested in the rising pediment that corresponds to the glass-roofed winter garden at the top of the building. Incorporating the latest in electronic library equipment, the building by itself is a summary history of commercial architecture in Chicago.

There is nothing, however, in Creative Postmodern Traditionalism that restricts its references to classicism alone. One good illustration of a counterpart is the New Longwall Quadrangle addition to Magdalen College, Oxford University, Oxford, England, 1991. Designed by Demetri Porphyrios, it is of solid coursed ashlar masonry, with restrained late-medieval details such as hood moldings over the windows, in reference to the adjoining fifteenth-century Perpendicular Gothic college buildings.

Late Modernism or Neo-Modernism

Another response to mid-century Canonical Modernism was what could be called Late Modernism or neo-Modernism. In this variant, proponents looked to the early work of Le Corbusier as their point of departure.[21] Perhaps the best example of a Late Modernist is Richard Meier (born 1934), who has continually stressed purity of form and sleekness of surface while increasingly exploiting the expressive power of the irregular form introduced into an otherwise insistent structural grid. One house that brought Meier early recognition unmistakably drew its inspiration from the mature Modernism of Le Corbusier, as evident in the pure white geometric forms and pipe railings of the Douglas House, Harbor Springs, Michigan, 1971–1973 [20.18]. As his recognition grew, Meier received larger public commissions, notably his High Museum of Art, Atlanta, 1980–1983. The building has five cubic masses arranged in an L that forms the sides of an atrium that sweeps around in a quarter-circle. This glass-enclosed atrium, with its constricted ramp providing vertical circulation, came from Wright's Guggenheim but without Wright's amplitude of space. The sleek white wall surfaces of porcelain-enameled square panels, attached to an underlying steel frame, was quickly established as Meier's trademark, and the pipe railings recall Le Corbusier. Yet in its formal and constructive purity, this building typified one of the problems of reductivist Late Modernism; it turned its back on the adjoining museum, built in the 1960s. There was no apparent link between the two.

By the time Meier was given the choice commission in 1984 for the expansive Getty Center complex, high atop the hills overlooking Brentwood (Los Angeles), California, his version of Late Modernism had matured. In response to the often brilliant light of Southern California (as well as nearby residents' concerns), he refrained from using white glazed metal panels in favor of honey-hued Italian travertine stone and matching buff-colored enameled panels. Because of the differing complexities of the divisions and operations of the Center, Meier devised not a single all-encompassing form but a village of five separate agencies that spread across the hilltop [20.19, 20.20]. Finished and opened to the public in 1998, it was the single most expensive building project to be undertaken up to that time: nearly 1 million square feet of space costing roughly $1,000 per square foot, for a total budget of approximately $1 billion—one of the first of a number of turn-of-this-century examples in which a new museum became the cynosure of public and cultural attention.[22]

Meier has remained consistent throughout the arc of his career, only slightly modifying his version of Late Modernism, as seen in such buildings by him as the Museum of Contemporary Art, Barcelona, Spain, 1986–1995; the US Courthouse and Federal Building, Islip, New York, 1993–2000; and the Burda Collection Museum, Baden-Baden, Germany, 2002–2004. In the early years of the twenty-first century, however, Meier expanded his design approach, as seen in the three curved rising walls in his Jubilee Church (La Chiesa del Dio Padre Misericordioso), Rome, Italy, 1996–2003 [Plate 35]. Yet other Meier projects retain the cubical purism of his early years, as in the stone and glass Ara Pacis Museum, Rome, 2006.

Meier's early contemporary, Peter Eisenman (born 1932), produced some of the most stringently neo-Modern designs in the 1970s. Later, however, he would shift radically to a quite different theoretical base, but in his first independent buildings (mostly residences, such as Falk house, Hardwick Vermont, 1969–1970, called House II), he developed a purely formal rectilinear architecture, totally devoid, he insisted, of any connection to outside sys-

20.18. Richard Meier, Douglas House, Harbor Springs, Michigan, 1971–1973. With its crisp geometries, dramatic whiteness, and such signature details as metal pipe railings, Meier's work in the early 1970s was clearly an homage to Le Corbusier. Photo: Ezra Stoller © Esto. All rights reserved.

tems of references. Eisenman's was a completely self-referential abstract architecture (even if coincidentally it did sometimes look like early Le Corbusier). He even used abstract aerial axonometric projection drawings when publishing his designs, a drawing type preferred by the De Stijl designers such as Theo van Doesburg and by architects such as Le Corbusier. To emphasize this nonreferential quality, Eisenman identified the houses he designed at this time by Roman numerals rather than by clients' names. House X (or House 10) was presented in such an axonometric view [20.21]. In fact, so nonreferential were these early designs as shown in his preferred axonometric presentations that the drawings have been repeatedly inverted when published, even in layouts created by visually trained professional

20.19. Richard Meier, Getty Center II, Los Angeles, California, 1984–1998. Aerial view of the Getty Center campus. In a cluster of five component buildings, this entry to the museum portion shows the incorporation of warm, golden-colored travertine panels in a light, slightly buff color scheme. Photo: © Scott Frances/Esto. All rights reserved. © The J. Paul Getty Trust.

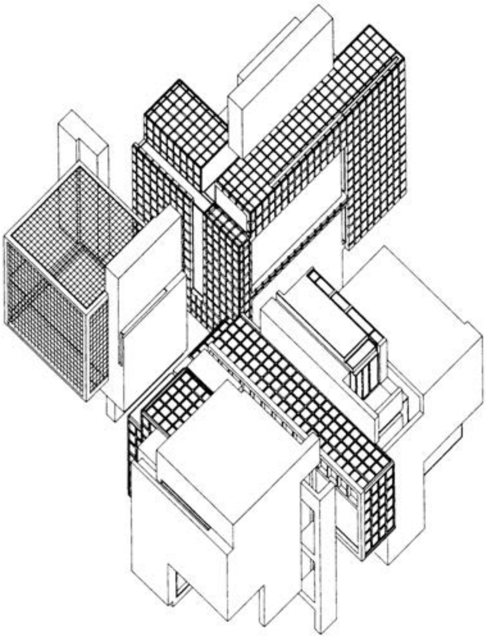
graphic designers. Later work by Eisenman demonstrated remarkable flexibility in design; examples include the deliberate historic references combined with an extremely abstracted grid in the Wexner Center for The Ohio State University, Columbus, 1989; the curved forms and brightly colored facade segments of his Columbus, Ohio, Convention Center, 1989–1993; and the smoothly molded metallic wall plates and retractable roof of the 78,000-seat University of Phoenix Stadium, Glendale, Arizona, 2002–2006. Interesting because they show another design paradigm shift are the rough stone blocks and sweeping curved roof of the Galicia Cultural Center at Santiago de Compostela, Spain, 1999–2012 [Plate 36]. The Late Modernism with which Eisenman started seems to have been left far behind.

Sculpted (Shaped) Modernism

A special variant of this Late Modernism appeared early in the development of modeled or Shaped Modernism, in which the rigid rectilinear geometries of mid-twentieth-century steel-framed, glass-sheathed office boxes became sculpted into singular and unique forms. Shaping an architecture that communicates with the user became the goal of a few former ardent Modernists, most notably Philip Johnson (1906–2005). Once the closest disciple of Mies—he quipped about being called "Mies van der Johnson"—Johnson had been Mies's associate architect in the design of the Seagram Building in New York City. Johnson first began his shift to sculpted masses in the curved shingled roof of his "Roofless Church," for the Blaffer Trust at New Harmony, Indiana, in 1960, making this one of the first reactions to the Canonical Modernism he had been so instrumental in establishing as the corporate model in the mid-1950s[23] [20.22]. The undulating form of the molded roof was meant to recall the rose that had been the symbol of the utopian community founded in New Harmony by social reformer Robert Owen at the beginning of the nineteenth century. Johnson's use of Shaped Modernism was then further encouraged by a series of commissions for Texas developer Gerald Hines, beginning with the clustered rounded-off office towers called Post Oak Central, in Houston, Texas, 1970–1981. Hines informed Johnson that he specifically wanted buildings that stood out and had unique character. Subsequently, when client J. Hugh Liedtke hired Johnson and his partner John Burgee in 1972 to design Pennzoil Place, Houston, Liedtke instructed the architects that he did not want just "another upturned cigar box."[24] He wanted something distinctive to establish an identity for his company. Instead of one tall, flat-topped tower, Johnson and Burgee devised twin towers, clad in black glass, appearing in plan to have been sliced on the diagonal from one large rectangular form; the tops, too, were sliced off on the diagonal [20.23, 20.24].

Another architect whose work was marked by this growing desire for sculptural form was I. M. Pei. This shift in his work was dramatically announced by his East Wing addition to the National Gallery, Washington, DC, 1968–1978, and then achieved truly international recognition in the extensive renovation of the Louvre (1983–1989), commissioned as one of the Parisian *Grands Travaux* ("Great Works") by French president François Mitterand. Much of this design was contained within the vast renovated building, but new spaces were created underground in the court, marked by Pei's transparent glass pyramid, which provides a new public entrance. Its space frame truss supports a skin of glass, dark during day but glowing from within at night [20.25].

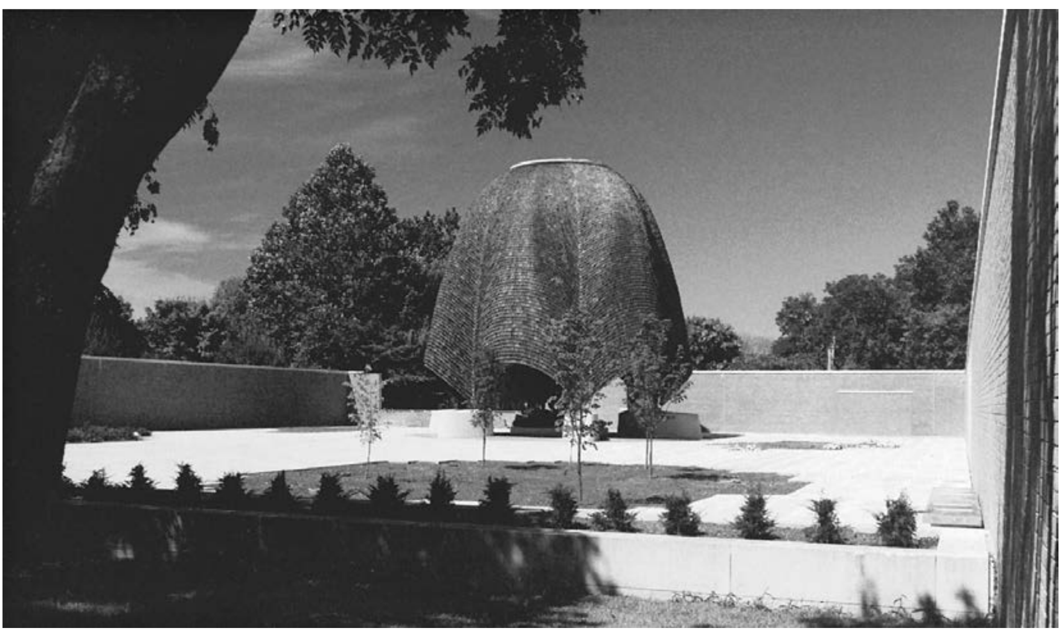
20.20. Richard Meier, Getty Center II. While crisp geometries continued to govern Meier's work in the 1990s, in the Getty Center buildings, muted color was introduced, as was tactile texture in the rough surfaces of the golden travertine panels. Photo: Scott Frances/Esto © The J. Paul Getty Trust.



20.21. Peter Eisenman, House X, 1976–1978. Eisenman's abstract, nonreferential aesthetic is clearly evident in the axonometric drawings used to present his early work. From P. Eisenman, House X *(New York, 1982).*

High Tech

Mid-century Canonical Modernism had drawn inspiration from the technology of structure, which led eventually to yet another reaction after about 1970, a sort of expressionism of exuberantly emphasized structural systems. This became known as High Tech architecture due to its extreme accentuation and exaggeration of structure and mechanical systems. One of the early manifestations of this approach was a new museum in Paris, the Centre Georges Pompidou, 1971–1977, designed by Renzo Piano and Richard Rogers [20.26]. This museum was one of the *Grands Travaux* initiated by President Georges Pompidou and continued by President Mitterand, and was aimed at greatly expanding art and cultural facilities in Paris. It is an immense rectangular box of glass, with all of its hardware pulled to the exterior so that the interior could be a series of huge Miesian universal spaces. The exterior, therefore, is a maze of color-coded air ducts, electrical conduits, and Plexiglas-enclosed escalators. This is an exo-skeletal building, with the supports made up of exposed steel members, most dramatically the large, almost biomorphic cast steel cantilevers, called *gerberettes,* that appear to clamp onto the exterior columns.[25] It is architecture-as-machine elevated to the most prestigious cultural level.



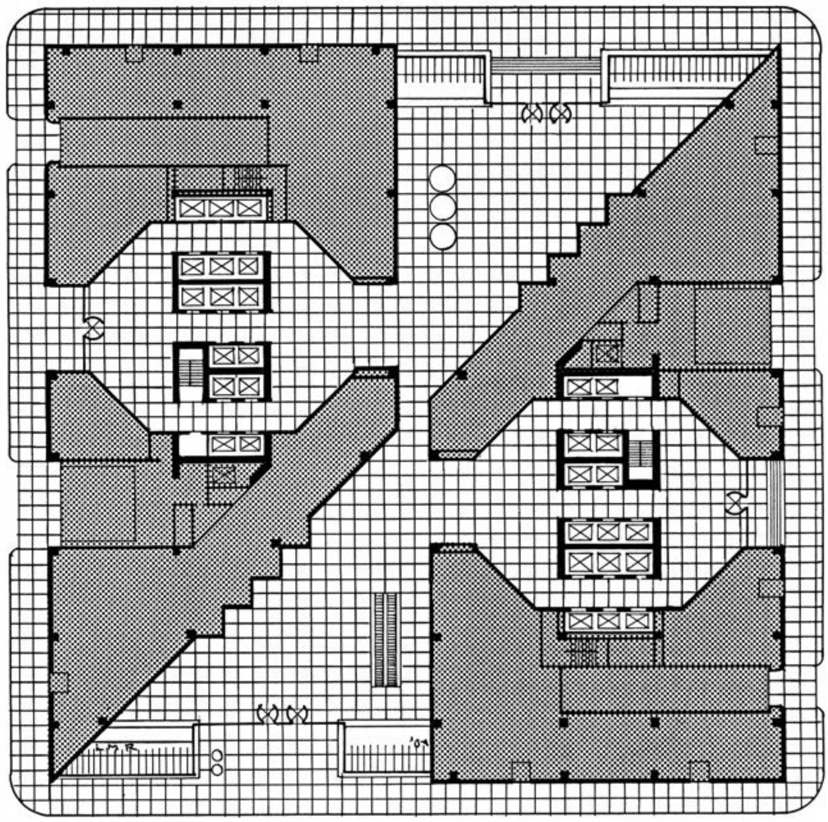
20.22. Philip Johnson, "Roofless Church," for the Blaffer Trust, New Harmony, Indiana, 1960. The molded form recalls the rose, an important symbol for this nineteenth-century utopian community, while the shingles refer to a traditional American material. This was one of the earliest designs by a former hard-line modernist to exploit sculptural form for its artistic and symbolic properties. Photo: L. M. Roth.

20.23. Philip Johnson, Pennzoil Place, Houston, Texas, 1972–1976. Johnson was among the first to move away from the boxy glass office tower and to invent unique forms as a way of creating identifiable office buildings. Photo: Courtesy, Philip Johnson.

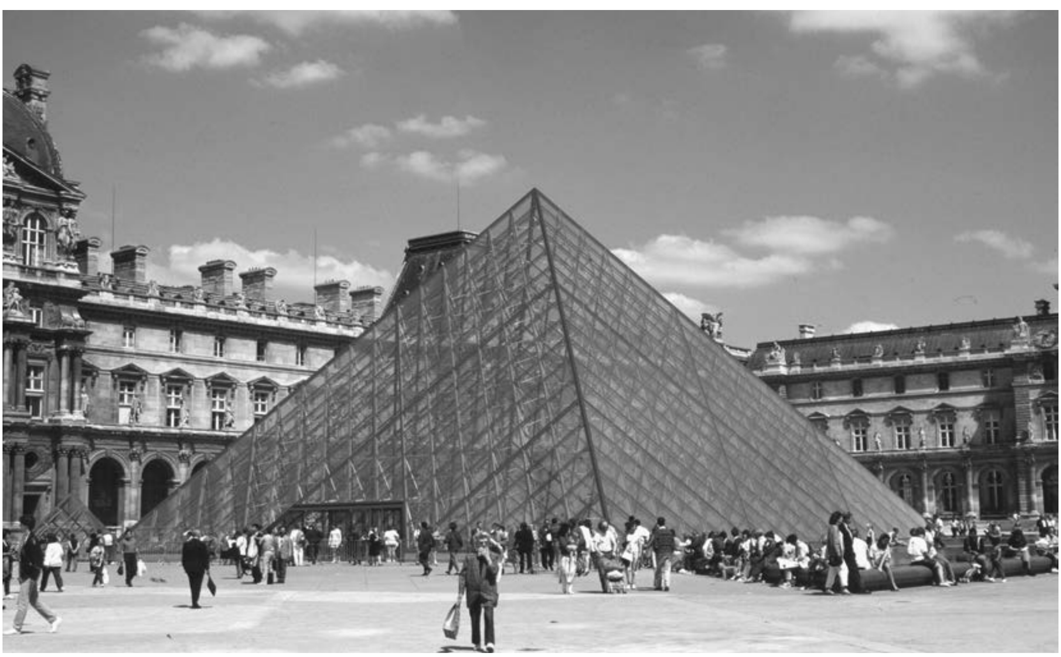
At times, and in the right hands, structural expression can transcend to poetic heights, becoming pure art. Few examples surpass the sheer elegance and emotive power of the work of the Spanish architect-engineer Santiago Calatrava (born 1951), based in Zurich, Switzerland. The evocative power of structure in his hands was made evident in his El Alamillo Bridge in Seville, Spain, 1992, with its single back-leaning counterweight mast and its dramatically diagonal cable stays. This bridge concept has been used several times by Calatrava with variations, as in his Samuel Beckett Bridge over the Liffy in Dublin, Ireland, 2006–2009. The base or "foot" of the concrete and steel shell for the terminal station he designed for the "Tres Grande Vitesse" rail line at Lyon-Satolas, France, 1988–1994, has a grace that is the outcome of structurally precise action married to an appropriate use of materials (concrete and steel), creating a biomorphic form suggestive of an alternative universe [20.27]. If Calatrava's buildings look like works of sculpture, it is because they are—but with a fusion of form perfected by engineering. This was confirmed by the title of an extensive exhibition of his work, "Santiago Calatrava: Artist, Architect, Engineer," presented at the Palazzo Strozzi in Florence, Italy, during 2000–2001. Calatrava's work aims at a sustainable correctness as well, as seen in the white "wing" parasol he designed for the expansion of the Milwaukee Art Museum, Milwaukee, Wisconsin, 1996–2001. Its curved ribs fan out or retract in response to changing light levels. Another form that has intrigued Calatrava is the twisted tower, as illustrated in the Turning Torso tower in Malmo, Sweden, 54 stories (623 ft, 190 m), 1999–2005, a motif that Calatrava enlarged in the 76-story (1,004 ft, 306 m) Infinity Tower, Dubai, United Arab Emirates, 2005–2013 [Plate 37].

Megastructures

Related to High Tech architecture, and inspired by the imaginative inventions of the British Archigramists and Japanese Metabolists in the early 1960s, were the megastructures of the second half of the twentieth century, huge buildings encompassing many connected functionally related activities, often made possible by the use of a repetitive



20.24. Pennzoil Place. Plan. The ground floor plan appears to have been generated by taking a long rectangle, sliced through the center on the diagonal, and the halves then slid past each other to fill a large square. Drawing: L. M. Roth.



20.25. I. M. Pei, The Grand Louvre, Paris, France, 1983–1989. In the Louvre court Pei used a markedly modern idiom to shape an ancient form, a pyramid of glass, referencing Napoleon's expedition to Egypt that opened ancient Egyptian history to France and the world at large. Photo: © Michael S. Yamashita/Corbis.

20.26. Renzo Piano and Richard Rogers, Centre Georges Pompidou, Paris, France, 1971–1977. This museum has been turned inside out, so to speak, with the structure and building utilities externalized so that the internal spaces can be opened up. Photo: Michel Proulx, Architectural Record.

20.27. Santiaga Calatrava, Lyon-Satolas TGV Terminal, Lyon, France, 1990–1994. Using the detailed analysis of structural action, Calatrava's team achieves forms suggesting organic forms in nature. Photo: © Patrick Durand/ Sygma/Corbis.

large-scale structural system. British architect Lord Norman Foster became particularly identified with this approach in several buildings of the 1980s, including the Lloyd's Building in London and his Hong Kong Shanghai Bank in Hong Kong, 1979–1985 [20.28, p. 608]. By convention we say such buildings are the work of a single person, but these megastructures quite obviously are the product of large firms, employing the services of scores of office designers, engineers, systems experts, drafts-people, and numerous other functionaries. In both of Foster's towers just mentioned, the service facilities were positioned around the exterior, opening up large internal spaces defined by boldly scaled structural systems whose individual bays embrace several floors or levels. Although Foster and his firm went on to design numerous notable buildings around the globe in the decade before and following the turn of the century—among them the restoration of the burned Reichstag, Berlin, with its dramatic glazed dome, 1999, and the diagonally framed "green" office building known as the Hearst Tower in New York City, 2002–2006, as well as the redesign and reconstruction of the Dresden railroad station with its glass barrel vaults, 2002–2006—it was scores of buildings in England that resulted in Foster being elevated to the peerage with the title Baron Foster of Thames Bank. Not since the Earl of Burlington in the eighteenth century has a peer of the realm had such an architectural influence. Foster's notable projects in Britain include the dramatically slanted bulbous glass tower for the Greater London Authority, 2000–2002, and the even more memorable high-rise tower called affectionately "The Gherkin" (officially known as 30 St. Mary Axe), 1996–2004, because of its elongated ellipsoidal shape sheathed in green glass set in a spiraling diagonal frame [Plate 38].

Offices Above the Clouds

Some writers assessing turn-of-this-century architecture include as megastructures the many giant office towers that went up around the globe in the 1980s and 1990s, including the Messeturm in Frankfurt, Germany, 1990–1991 (850 ft, 259 m), the Commerzbank also in Frankfurt, 1997 (850 ft, 259 m), both by Norman Foster, as well as the Tokyo City Hall towers, 1991 (797 ft, 243 m) by Kenzo Tange, and—most notably—the soaring twin Petronas Towers, 1992–1998, designed by the firm of American architect César Pelli [20.29]. In some cases, as in Europe, ground space is at a great premium, so the only practical way to build is straight up. But in other locations, depending on prevailing economic conditions, it usually makes no logical economic sense to erect office towers more than 80 stories tall. Such excessive heights result not so much from economic pressures as from a desire to make a dramatic signature statement about the power and resources of the patron, and about a nation's arrival among the big players on the world stage. For example, there was ample open ground around the site of the Petronas Towers when they were first conceived (although there has been substantial filling-in subsequently), but rather than accommodate the desired office space in a campus of lower buildings, the commissioning agency wanted to make the most dramatic political and economic statement possible. As the designs were being finished, it was also possible with slight changes to give the soaring towers the image of minarets, seen as particularly appropriate for this Muslim nation.

The beginning of the twenty-first century was marked by an upsurge in the impulse to build the world's tallest building. Particularly eager to announce its emergence as a major world economic power has been China, with Shanghai reestablishing itself as a principal place of interchange between East and West as it had been in the early twentieth century. In 1998 the 88-story Jin Mao Tower was completed in Shanghai from designs developed by Skidmore, Owings & Merrill (1,380 ft, 421 m). Another even taller tower was the Shanghai World Financial Center, from designs by Kohn Pedersen Fox, developed for Japanese entrepreneur Minoru Mori, begun in 1997 and finished in 2008 at 101 floors or 1,614 feet (492 m). Not to be outdone, mainland China's independently minded democratic satellite, Taiwan, set out to raise an even taller tower in Taipei. Designed by Taiwanese architect C. Y. Lee and called Taipei 101 (1997–2004), the tower rises 101 stories (1,670 ft, 509 m), including its spire [Plate 39]. Lee gave his enormous tower something of the form of a pagoda, with the upper floors in groups of eight—a most auspicious number in Chinese numerology. In Hong Kong, the International Finance Centre, also designed by the office of César Pelli, was simultaneously completed in 2003, rising 1,352 feet (412 m). But far taller still is the Burj Khalifa, a residential and mixed-use tower rising 2,717 ft (828 m) in Dubai, United Arab Emirates. Built in 2003–2010, it was designed as a series of rounded setbacks in a three-lobed plan by Skidmore, Owings & Merrill of Chicago, and built by a large South Korean contractor. For years, as the building was rising, the ultimate height was kept secret lest some other country, on hearing about the projected height, should set out to build something taller [20.30]. Here, too, such phenomenal height

20.29. César Pelli, Petronas Towers, Kuala Lumpur, Malaysia, 1992–1998. Rising like slender silver minarets, the twin Petronas Towers emphatically announced Malaysia's arrival on the stage of modern nations, as was intended. Photo: © Jose Fuste Raga/Corbis.

20.30. Skidmore, Owings & Merrill, Burj Khalifa, Dubai, United Arab Emirates, 2003–2010. For the moment the tallest building in the world, the tower has a series of setbacks at its base to provide a broader footprint. © Jose Fuste Raga/Corbis.

was needed simply to attract tourists, for the ruling Sheikh Mohammed bin Rashid Al Maktoum is quoted as saying that he "wanted to put Dubai on the map with something really sensational."[26]

The attacks on the World Trade Center Towers in 2001 and their resulting collapse occurred as a number of these gigantic towers were in the design stage or under construction. The New York towers' horrific collapse prompted intensive examination of the reasons for the structural failure, and why people in the upper stories of the World Trade Center were unable to evacuate the buildings before they collapsed. As noted earlier, the towers were strong enough for the 1960s, but only to the minimal extent required by law, strong enough to resist a Category 1 or 2 hurricane or perhaps the impact of an old Boeing 707 empty of fuel after a long flight and searching for one of New York's airports in fog. But there was insufficient structural redundancy in the towers, and the escape stairways were encased in a minimal breakaway drywall enclosure. Any sizeable explosion could have blown out the stairway walls as well as the blown-on fireproofing material, as happened. Hit by hijacked airliners full of fuel that were nearly twice the weight and size of the older 707s, the towers were mortally wounded and each fell within one to two hours of being hit. The towers in Shanghai, Hong Kong, and Taipei then being constructed were immediately and intensively evaluated and modified to ensure that they could not be brought down in the same way. Because of the ever-present threat of typhoons and earthquakes on the Pacific Rim, moreover, the towers going up there in the late 1990s had been designed to be far stronger, with inner concrete cores containing the elevators, stairs, and other critical services encased in walls two feet thick. In fact, as Taipei 101 was under construction, the city was subjected to an earthquake measuring 6.8 on the Richter scale. The building stood unharmed, although the temporary building cranes atop the unfinished building were shaken loose and plummeted to the streets below.

Building the world's tallest skyscraper is simply an invitation to be surpassed by the next patron, institution, or country seeking bragging rights (however briefly). And given the worldwide "Great Recession" of 2007–2009 with its lingering half-life, it was inevitable that the seemingly limitless hubris of clients and architects would intersect with the contemporaneous realities of financial funding. A case in point was the proposed Chicago Spire, designed in 2005 by Santiago Calatrava. It was to be another of his spiraling twisted towers, on Chicago's lakeshore, designed to rise 150 stories to 2,000 feet (610 m), intended to be (if only momentarily) the tallest skyscraper in the world. Construction began on the substantial foundations in 2007–2008, but by 2008, at the depths of the "Great Recession," only 350 of the 1,193 condominium apartments had been sold (at prices ranging from $750,000 to $40 million apiece); meanwhile, funding arrangements to pay for construction began to fall apart. By 2010, as the recession lingered, the financial situation had become so dire that the project was put in the hands of a receiver and the Chicago Spire project was pronounced dead, leaving only a hole in the ground where the foundations had been prepared [20.31].

Even as late as 2012, with the lingering effects of the recession, as many as two dozen proposed major projects—either for extremely tall towers or large building complexes, in design since the start of this century (and some with construction actually started)—had been suspended or cancelled outright.[27]

The International Architect

Except for Lee's Taipei 101 giant tower, nearly all the high-profile towers along the Pacific Rim and in the Islamic world, up to 2010, have been designed by European or American architects, and built by South Korean or other outside contractors. That American architects such as César Pelli, or Skidmore, Owings & Merrill, or Kohn Pedersen Fox were given these highly esteemed tower commissions indicates that many architects are now operating on an international scale, working on numerous buildings worldwide. European and Asian architects have been equally busy in the United States, as demonstrated by such work as Japanese-architect Arata Isozaki's Museum of Contemporary Art in Los Angeles, 1986; Swiss-architect Mario Botta's dynamically striped Museum of Modern Art, San Francisco, 1994; and the end-of-century renovation and enlargement of the Museum of Modern Art, New York, 1997–2004, by Japanese architect Yoshio Taniguchi. Other American architects have been engaged in Europe to design more horizontally orientated art museums, such as Richard Meier in Frankfurt and Barcelona, or Frank Gehry in Bilbao, Spain. At the turn of the twentieth century, art museums have become the highest-profile reputation-making building type.

Globetrotting by architects has continued into the twenty-first century, as illustrated by Gehry's commissions in Hong Kong; Barcelona, Spain; Sønderborg, Denmark; and elsewhere. Various high-rise tower commissions have also been given to Kohn Pedersen Fox in Tokyo, London, Hong Kong,

20.31. Santiago Calatrava, The Chicago Spire (proposed project), Chicago, Illinois, 2005–2010. Aiming to be the tallest building in the world (for however short a period of time), this projected building appears to be twice the height of the Sears Tower (left) and the Hancock Tower (right)—once the tallest buildings in the world. Photo: REUTERS/Handout.

and Seoul; Mario Botta's museum in Charlotte, North Carolina; Rafael Moneo's work in Los Angeles and Houston; César Pelli's commissions in Tulsa, Oklahoma, Barcelona, Spain, and Santiago, Chile; and Richard Rogers' work in Washington, DC, and Seville, Spain. Two more examples are Thom Mayne/Morphosis's Tour Phare in Paris and Dutch architect Rem Koolhaas's work ranging from Seattle to Dallas to Beijing. A word coined early in the twenty-first century to describe such internationally known architects with a high level of public recognition is "starchitects"—that is, designers selected for a project because simply the knowledge that they are to create a building automatically marks it as a building worth anticipating, a building into which a client or community will invest more than the usual funds, and one certain to attract substantial publicity once it opens. What certainly marks architects as having achieved this state of celebrity is their election to receive the annual Pritzker Architecture Prize, customarily described as the Nobel Prize for architects. Established by Jay A. and Cindy Pritzker and the Hyatt Foundation in 1979, it is awarded yearly to the architect, of whatever nationality or ideology, who is judged by a panel of five to nine "experts" in a range of disciplines to have achieved particular distinction in his or her built work. In the first several years it was awarded to long-admired older architects such as I. M. Pei or Gottfried Böhm because of their established record of excellence, but more recently it has been awarded to much younger architects, and in 2004 it was awarded for the first time to a woman, Zaha Hadid, born in 1950 in Iraq but now based in London. As of the early twenty-first century, the Pritzker Prize has also been awarded to architects largely unknown to the public such as Wang Shu of China, who was born in 1963 and became a Pritzker Laureate in 2012. The architect who was named the twelfth Pritzker Laureate in 1989, and who certainly has achieved this instant name recognition far beyond the esoteric realm of "high architecture," was Frank Gehry, now known principally for his work in Resurgent Expressionism.

Resurgent Expressionism

Diametrically opposed to both the formal correctness of the Late Modernists and the historical correctness of canonical revivalism was a renewed embrace in the late twentieth century of the visual and emotive power of pure architectural form, a return to Expressionism. There had been isolated instances of this impulse to shape expressive forms in preceding decades, as in the Berlin Philharmonie Concert Hall, Berlin, 1957–1965, by Hans Scharoun, arguably the last of the German Expressionists of the 1920s [19.48]. In the same group could be placed the nested shells of the Sydney Opera, 1957–1973, by Jørn Utzon, as well as the two airport terminals designed by Eero Saarinen begun in the late 1950s (see Chapter 19). After about 1980, however, a range of comparable Resurgent Expressionist designs began to appear around the globe.

One variant was structural expressionism, as illustrated in the industrial office building in Völkermarkt, Austria, 1995, by Günther Domenig. From a skeletal frame of concrete piers and beams extends a trussed steel and glass mass that curves as it reaches out, extending further in each story as it rises, with slender steel beams and diagonals further stretching out from the finished enclosure, as if construction has been interrupted [20.32]. While this seemingly "unfinished" structure was built in this way out of a conscious design decision to provoke comment, the similarly evocative structural expression of Santiago Calatrava results from pushing the engineering implications of structural systems to their artistic and poetic limits.

For many architects the driving concept of their design is achieving form that takes on the quality of being alive, what might even be described as an organic quality, a kind of biomorphic expressionism. The work of Hungarian architect Imre Makovecz could be placed in this category, as seen in his Roman Catholic Church at Paks, Hungary, 1987–1991. The origins of Makovecz's work lies perhaps in Transylvanian carpentry traditions and regional vernacular buildings.

But far better known, and bringing to its architect worldwide celebrity, is the Barcelona building for the Guggenheim Museum, Bilbao, Spain, by Frank Gehry in 1991–1997. Born Emphriam (Frank) Goldberg in Toronto, Canada, in 1929, Gehry has had a

20.32. Günther Domenig, industrial office building, Völkermarkt, Austria, 1995. The dramatic collisions and juxtapositions of the real and decorative structural members make a dramatic statement. Photo: Gisla Erlachet/arcaid.co.uk.

career that has metamorphosed several times, leading by stages to his signature curving, undulating creations.[28] Gehry earned an architecture degree from the University of Southern California in 1954 (while also studying sculpture) and then served in the US Army, where he learned how to make good use of ordinary building materials. After his army service, Gehry worked for a succession of architects specializing in minimal, flat-roof Modernist commercial structures, including Welton Becket, Pereira & Luckman Associates and finally the office of Victor Gruen. Meanwhile, Gehry was forming many friendships with artists in the Los Angeles area, and continuing his study of sculpture. In a combined studio and residence for Louis and Dorothy Danziger, 1964–1965, Gehry began to move away from the rather tepid Modernism ingrained in him by the firms he had worked for, employing a sculptural play of cubic forms. By 1972 he was using trapezoidal plan layouts, with angled roofs, incorporating ordinary materials such as corrugated sheet metal. The building that brought him national attention (not all of it positive at the time) was the renovation of his own ordinary Dutch Colonial gambrel-roofed house in Santa Monica, California, 1978, which was wrapped in new walls made of corrugated sheet metal and cyclone fencing. Increasingly thereafter his designs featured angled walls and angular roof planes. For the new campus for the Loyola Marymount University School of Law, however, he shifted momentarily to a kind of eclectic Postmodernism—not deliberately ironic—that was suggested by the faculty, who requested something that spoke of permanence and the traditions of the law. The final result incorporated highly abstracted colonnades and pediments but was built of ordinary materials.

In the later 1980s, Gehry and his design team began to employ curved forms, as in the twisted spiraling forms of the Vitra International Furniture Company's exhibition hall and gallery in Weil-am-Rhein, Germany, 1987–1989 [Plate 40]. The problem that Gehry and his team faced was how to translate the sculpted forms into inhabitable buildings; using models, they cut them into scores of sections and located the various wall, floor, and roof points to create the working drawings, all this work done by hand. As the buildings coming out of the Santa Monica office became more and more complex—for example, the American Center in Paris, 1988–1994 [20.33]; or the Center for the

20.33. Frank Gehry, American Center, Paris, France, 1988–1994. Moving away from the angular straight-line forms of his work in the previous decade, Gehry confronted the difficulty in hand-drawing construction drawings for free-form buildings, prompting his firm's interest in using the French aviation design software, CATIA. Photo: View Pictures Ltd/SuperStock.

Visual Arts, University of Toledo, Ohio, 1990–1992; or the Weisman Art and Teaching Museum, Minneapolis, Minnesota, 1990–1993—this process of creating the working drawings to direct construction was becoming increasingly burdensome. And the slightest change later would require that all the tedious work be laboriously redone.

While working on the American Center for Paris, Gehry and his design partner James Glymph were introduced to the French computer-aided design program CATIA originally developed by the Dassault aerospace company for aircraft design. Gehry and his team were already exploring non-Euclidean nonlinear design, but by adapting CATIA they could simultaneously explore design alternatives, calculate structural systems, and determine building costs on a day-to-day basis. CATIA allowed architects to make subtle changes in design, even returning to the very beginning of the conceptual design stage; all subsequent computer drawings would automatically reflect any changes as design refinement continued. This eliminated the costly manual reworking of the design development drawings. Even the subsequent working drawings for contractors and fabricators could be altered largely at will. The computer was gradually becoming a major tool—even a generator of form—in the design and construction process. Ironically, Gehry admitted early on that he personally did not like computers, but he and his design team eagerly embraced its capacity to make the realization of progressively more sculptural buildings feasible and more reasonable in cost.

In 1987, Gehry was approached by the Basque regional government and by Guggenheim Museum officials, in tandem, for the design of a new museum to be built in a former industrial district in Bilbao, Spain, in an urban renewal effort to bring tourists and cultural venues to the heart of the city. The result was the wondrously curved and shifting Bilbao museum, made possible by the recently adopted CATIA software. In portions of previous similarly curved buildings, Gehry's team had used lead-coated copper sheets as the outer covering, but these were now eliminated due to environmental concerns about lead's toxicity. At that historical moment there occurred the political collapse of the Soviet Union, and the new Russian government, desperate for cash influx, threw on the world market its considerable supply of the rare metal, titanium. Thus, titanium was selected for the new museum's skin, rolled in sheets so thin that when applied to the building they fluttered and shimmered in the wind, contributing a special luster to the museum [20.34, Plate 41].

When finished and opened in 1997 the Guggenheim Museum Bilbao was received with enormously positive critical and popular acclaim, so much so that Gehry almost immediately became a victim of his own success. The Bilbao museum became such a draw that it made the city a new tourist destination, creating what came to be called the "Bilbao effect." It certainly fulfilled the commercial hopes of the Basque government. Soon scores of other aspiring clients were contacting Gehry, requesting similar buildings of their own, buildings they described as having a "shwoosh." Very similar was the effect created by the Disney Concert Hall, in downtown Los Angeles, begun by Gehry's team in 1986–1987 and finished in 2003. In this building, too, after many delays caused by political complications and rapidly mounting cost estimates, the computer made the final result possible and buildable. Here, too, the final building opened to great critical acclaim; and most important, the concert hall's acoustics were praised by musicians. The Disney Concert hall became a major attractant, a cultural magnet for downtown Los Angeles—the "Bilbao effect" at work.

Without anticipating it, in the Bilbao museum and the Disney Concert Hall, Gehry created the prototype for younger generations of architects, providing a model that inspired subsequent museums, public buildings, and other civic structures, either swooping or sharply angular, many likewise clad in shining titanium. In 2010 a *Vanity Fair* writer surveyed more than fifty architects and critics, asking them to name what they considered the five most important buildings built after 1980.[29] The overwhelming selection among this group was Gehry's Bilbao museum. While both the Bilbao and Disney Concert Hall were intricate horizontal complexes, Gehry applied the same re-imagining of a typological form to the design of an urban apartment building, no longer simply a plain flat-surfaced box but essentially a thin soaring tower whose external glazed surfaces undulate as they rise. This is 8 Spruce Street, New York City, 2005–2011, rising 76 stories to 876 feet (267 m). While primarily intended for 898 very upscale apartments, the lower part of the tower houses a 5-story school and also space for the New York Downtown Hospital [20.35].

While the reshaping of the skyscraper archetype was oriented vertically—in this example, by having vertical wrinkles—another response was to reshape the edges of the horizontal floor slabs, the approach taken by architect Jeanne Gang of Studio Gang Architects in her condominium apartment in Chicago called simply Aqua, built 2007–2010 [Plate 42]. In this case, the glass walls are maintained as absolutely

20.34. Frank Gehry, Guggenheim Museum, Bilbao, Spain, 1987–1997. By exploiting the potential of computer-aided design technology to manage structural solutions and buildings costs, Gehry created a most dramatic building form that instantly put Bilbao, Spain, on tourist maps. Photo: © Jeff Goldberg/Esto. All rights reserved.

flat surfaces, but the projecting concrete floor slabs undulate horizontally in a pattern running vertically such that the building, especially when viewed from below, appears like rippling waves sliced through by the gleaming flat planes of glass. In addition, the projecting, curving balconies were designed (particularly on its southern face) to provide extensive shading of the glazed surfaces so as to reduce heat gain. At a height of 859 ft (262 m), when built, Aqua was the tallest skyscraper in the world to have a woman as lead architect at the time of its construction.

Deconstructivism

The most extreme reaction to the structural order and logic of Modernism has been Deconstruction, Deconstructivism, or Decon. The name *Deconstruction* originated as a reference to a contemporary movement in literary criticism, though its architectural inspiration comes in part from the earlier industrial designs of Russian Constructivism of the 1920s. In its literary origins, deconstruction referred to a deep analysis of a text, linked to related concepts of a later reader being unable to truly understand the times and conditions prevailing when an author wrote the text. Alois Müller described the essence of literary deconstruction as "a way of reading philosophical or literary texts in order to get to the bottom of them. . . . Deconstruction means burrowing deep, to find out what unconscious premises a text is based on and what the blind spot in the author's eye cannot see."[30] Architectural theorists, in adapting portions of these literary concepts, proposed a radical departure from previous thinking, suggesting that, fundamentally, a building exists as an isolated abstract phenomenon, and that the ultimate "function" of architecture is "disruption, dislocation, deflection, deviation, and disorientation."[31]

In the United States the arrival of Deconstructivism was marked by an exhibition mounted by the Museum of Modern Art in the summer of 1988, entitled "Deconstructivist Architecture." Featuring few actual buildings but many drawings (for works largely unbuildable at that point) by European and American architects, the exhibition was described this way by one reviewer: "They've tossed out every orderly precept of architecture since the Greeks and have prompted the most basic questions, starting with which end is up."[32] Mark Wigley, co-curator of the exhibition, said frankly that the buildings being displayed were "dangerously deranged."[33] Prior to the arrival of Deconstructivism, Robert Stern noted, architects operating in the public realm had considered their task the making of buildings to fulfill "grand public purposes," which had traditionally meant "providing an environment that is safe, secure, functional and orderly," providing some measure of comfort in an otherwise fractious world.[34] In the subsequent manifestoes and essays discussing Deconstructivism, a decidedly negative and violent vocabulary was adopted, laced with such verbs as *violate, tear, dislocate, infect, scar, reject, confuse,* and *destabilize*. Moreover, architects and theorists seemed unconcerned as to whether the general public—their potential clients—understood any of this, creating a special "argot of obfuscation." This mystification was evident in the reply by Peter Eisenman to a question concerning the role of the media in architectural discourse: "Architecture posits the question of aura in regard to both iconic and indexical signs. . . . I believe we are always going to have an auratic condition, meaning some kind of presence in architecture, because there is always some *being-in* as opposed to the condition of *being-as*. It is

20.35. Frank Gehry, 8 Spruce Street, New York, NY, 2005–2011. A multi-use building, at 878 feet in height this tower was reportedly the second-tallest residential building in the Western Hemisphere when built. Photo: © Ty Cole Ty Cole/ Arcaid/Corbis.

20.36. Coop Himmelb(l)au ("Blue Sky" Cooperative), rooftop remodeling (law office), Vienna, Austria, 1983–1988. In the starkest contrast to the staid classical building on which it sits, this rooftop office addition appears to be the twisted remains of a crashed biplane, exaggerating the contrast of balanced decorum in the nineteenth-century building below with discordant deconstruction above. Photo: Gerald Zugmann/Vienna.

the *being-in* of architecture that is questioned in the media today." In quoting this passage, historian Carter Wiseman observed that such impenetrable utterances can be understood only through access to the private and esoteric language of its participants. Theorists such as this, Wiseman said, have rediscovered the ancient mystique of appearing to be profound by using material with which their listeners or readers are unfamiliar, and which they are not likely to challenge while they willingly give the speaker or writer the status of guru.[35]

At the same moment this philosophy was introduced in print in the United States, a building addition was being completed in Vienna, Austria, that embodied perfectly the artistic sentiments characterizing Deconstructivism. Designed by the Viennese "Blue Sky" partnership called Coop Himmelb(l)au, comprising Wolf Prix, Helmut Swiczinsky, and Michael Holzer, this rooftop addition of a law office, 1983–1988, gave the appearance, especially from upper windows across the street, of a lightly metal-framed biplane that had crashed on the roof [20.36].[36] In Coop Himmelb(l)au's continuing work this sense of disorientation has continued at an ever-increasing scale, as in the firm's Akron, Ohio, Art Museum, 2003–2007, a commission it won in an international competition; the sharply angular building is marked by slanted glass walls and dramatically large cantilevered roofs. Even larger is the paired angular glass towers and adjoining lower auxiliary building complex for the European Central Bank in Frankfurt, Germany, with the tower rising 591 ft (180 m). Won by competition in 1999, the complex was begun in 2008; completion is expected in 2014.

The sense of destabilization is a recurrent theme, particularly evident in the sharply angled and folded glass envelope of the Seattle Central Library, by Rem Koolhaas (of the Office for Metropolitan Architecture, Rotterdam), with local architect Joshua Prince-Ramus of LMN [20.37]. Begun after passage of a bond measure in 1998 and opened in 2004 (with the additional gift of $20 million from Bill Gates), the new building was to replace the existing cramped building, since more than 60 percent of the library holdings were in storage due to lack of space; seismic issues also were a cause for concern in the existing 1960 building. Floating floor platforms inside the library are enclosed in a folded glass skin, with panes held in a diagonal lattice. Although the floor slab edges are kept away from the many angled glass envelope walls, the question remains as to how such an asymmetrical building will react to the vertical and lateral movements of an earthquake, which is a very real risk in Seattle.

Far larger and, from some perspectives, even more destabilized is the large CCTV building in Beijing, China, also by Rem Koolhaas and his office [Plate 43]. Built to house the China Central Television (CCTV) headquarters, the structure consists of a 44-story skyscraper shaped like a large squared upside-down U bent 90° in the middle. After winning this commission in an international competition in 2002, Koolhaas and his office associate Ole Scheeren worked with the engineering firm of Arup (London) to solve the complex engineering problems created by such a tall three-dimensional asymmetrical bent "arch" structure. Construction took place during 2004–2008. The structure can be described as the joining of two individual inverted L-shaped towers. The difficulty in dealing with locked-in structural differentials is illustrated in the final steps necessary in joining the two towers on May 30, 2007, which had to be done very early in the morning, when both sections were at the same temperature throughout. Internally there are closely spaced slender columns, though externally the skin of glass is crisscrossed with seemingly randomly positioned diagonal lines. In this seismic zone, too, the extreme asymmetry remains to be tested. Whatever happens when this building is put to the ultimate dynamic trial, it is nonetheless a most visually intriguing building. Together with the success of the Olympic Games held in Beijing in the same year as its completion, the CCTV tower certainly marks the arrival of China as a major international architectural force.

Critical Regionalism

For several centuries European nations carried to (one might say *imposed on*) their African and Asian colonies the architectural forms and types then in fashion at home, whether Classicism for governmental buildings or Gothic Revival for houses of worship. A generation after the breakup of these transglobal empires in the mid-twentieth century,

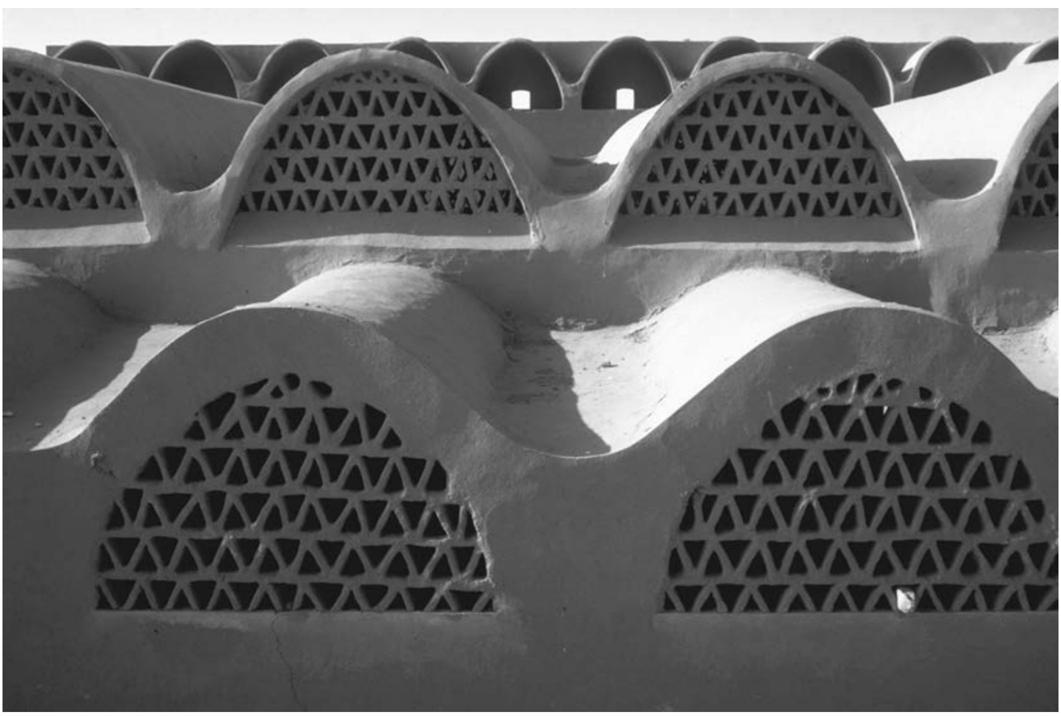
20.37. Rem Koolhaas and the Office for Metropolitan Architecture, Seattle Central Library, Seattle, Washington, 1998–2004. With projecting asymmetrical elements, this library suggests the dynamism of learning, while resembling a folded origami sculpture. Photo: © Russell Kord/Alamy.

architects in many regions began to create a new kind of Modernism using, where applicable, modern industrial materials and technologies, but stressing local traditional materials together with the combination of ancestral and traditional building forms with Western design concepts. Because this alternate style represents a deliberate and studied reexamination of local climate, structural, formal, and stylistic traditions, merging the "indigenous" with the "introduced," it has been called Critical Regionalism. It reinvigorated national vernacular building expressions and idioms (previously denigrated), in the process creating strong associative links to the heritages and histories of various regions of the developing Third World.

Hassan Fathy and Indigenous Egyptian Architecture

The model for this return to indigenous prototypes as inspiration for new architecture was provided by Hassan Fathy (1900–1989) at nearly the moment the British Empire began to be disassembled in the mid-1940s. Well aware of the cultural dependence that reliance on Western technologies and building materials made inevitable, Fathy rejected Western Modernism by returning to long-established Egyptian materials and building forms—sun-baked adobe brick in domed vaults. One of his earliest demonstrations was in the mosque for a new settlement, New Gourna, near Luxor, 1946–1953. Later projects, using a similar palette of materials and building methods, included another village complex at Anew Nariz, 1970; his own house at Sidi Krier, 1971; and the Khaleel-Al-Talhooly house at Ghur Memren, Jordan, 1988. One of the traditional design elements that Fathy re-embraced was the rooftop *malkaf,* "wind catch," an angled funnel used to direct prevailing cooling breezes into the building. He used ranks of these *malkaf* in the roofs of the market hall for a new agricultural settlement in New Baris, begun in 1967 about 37 miles (60 km) south of the Karga Oasis, Egypt. These *malkaf* effectively reduced the typical high summer temperature of 122° F to about 95° F (a drop from 50° C to 35° C) [20.38].

Equally important, however, were such activities as his establishment of the International Institute



20.38. Hassan Fathy, Market building for a new agricultural settlement, New Baris, in the Kharga Oasis, Egypt, 1967. Using traditional adobe (mud) brick, Fathy devised malkaf ("wind catcher") hoods that reduced the typical summer temperatures of 122° F by 95° (50° C down to 35° C). Photo: Courtesy of the Aga Khan Trust for Culture, William O'Reilly, Aga Khan Trust for Culture.

for Appropriate Technology in 1971 and his many published writings such as *Gourna: A Tale of Two Villages* (Cairo, Egypt, 1969), republished as *Architecture for the Poor: An Experiment in Rural Egypt* (Chicago and London, 1973), as well as *The Arab House in the Urban Setting: Past, Present and Future* (London, 1972) and *Natural Energy and Vernacular Architecture* (Chicago, 1986).

Greatly influenced by Fathy's principles, architect Abdel-Wahed El-Wakil (born 1943) continued this newly reaffirmed traditionalism, designing the Halawa house in Agany, Egypt, 1975, and going on to design several new mosques in Saudi Arabia, including the large Al-Miqat Mosque in Jeddah, 1991. Using a more abstracted architectural language, but one still rooted in types from the past, is the Jordanian architect Rasem Badran (born 1945), who completed the al Jame Mosque and Qasr al Hokm Justice Palace complex in Riyadh, Saudi Arabia, in 1992. Badran's work goes well beyond certain stylistic forms and details; placed in the heart of the old portion of the city, the mosque and court complex complement the traditional scale and character of the site. As Badran commented: "The solutions for any architectural problem are bound to a set of interconnected factors related to socio-cultural, environmental, morphological, and technical issues. As for my role as an architect in activating these factors, I see it as giving value to human needs through emphasizing the character of place, its architectural and morphological patterns and giving meaning to the built environment [in order] to truly relate it to its inhabitants."[37]

Balkrishna Doshi and Indian Architecture

In India the development of an indigenous architecture unfolded differently because of the enormous impact of Le Corbusier's design for Chandigarh, the new capitol of the Punjab, especially on young Indian-born architects such as Balkrishna Doshi and Charles Correa. Doshi (born 1927) studied in Poona and Bombay but then entered Le Corbusier's atelier in Paris, where he worked on some of the major buildings in Chandigarh and Ahmedabad, 1951–1957, subsequently working with Louis I. Kahn on the buildings of the Indian Institute of Management at Ahmedabad, in 1962. Doshi began his break with Western Modernism in his own studio called Sangath (meaning "moving together through participation"), on the outskirts of Ahmedabad, 1979–1981, with its various open barrel vaults and semi-subterranean placement, both strategies to mitigate heat.[38] The vaults, built up of wire mesh and concrete and clay strips (the concrete being applied by hand), are covered with a final outer coat of concrete plaster embedded with a mosaic of white glazed pottery fragments—a surface finish used on old Hindu shrines still found along the streets in Ahmedabad. This white mosaic finish has several advantages, allowing for smoothly rounding the intersecting curved surfaces but also providing extra insulation together with a high reflectivity to reduce heat gain. The architectural language that Doshi developed for Sangath progressed further, with a somewhat more formal character, for the Gandhi Labour Institute in Ahmedabad, 1980–1984, intended to continue the ideals of one of the greatest leaders in modern Indian history [20.39]. Doshi again exploited the repeated round barrel vaults covered with the white mosaic, but used contrasting walls of grey stone slabs. The many spaces, offices, and the director's residence are treated like building components in a small village.

Geoffrey Bawa and Sri Lankan Architecture

In Sri Lanka (Ceylon), the island southeast of India, another architect who successfully fused Modernism with traditional design concepts and building methods was Geoffrey Bawa (1919–2003). Bawa occupied the position of inspirational father figure for southeast Asian architects, much as Fathy did for architects in the middle Eastern Islamic world. Malaysian architect Ken Yeang honors Bawa, saying that "he is our first hero and guru."

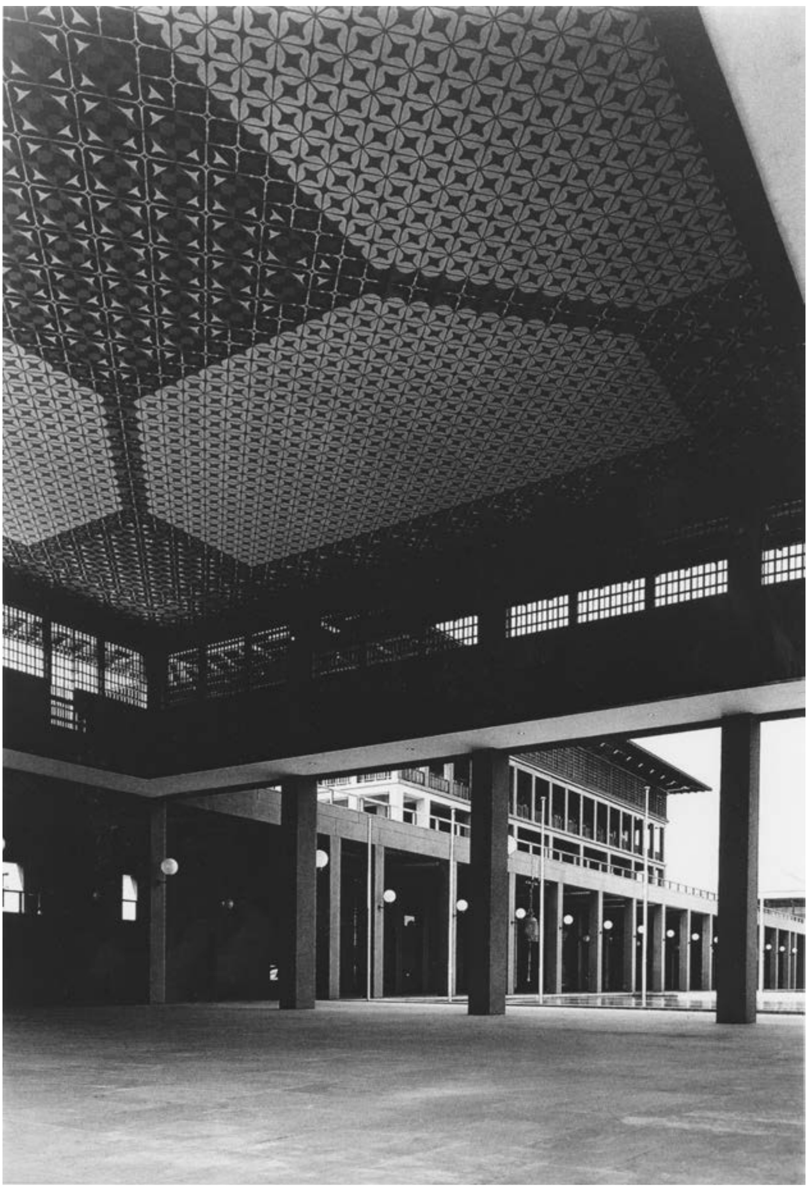
Bawa traced his lineage to both Dutch traders and indigenous Sinhalese. The implication of responding to and respecting indigenous building traditions became evident in the house that Bawa and his partners designed in 1961–1963 for Dr. Noel Bartholomeusz. A narrow building filling the middle of a long narrow lot in Colombo, the house project was dropped by the original client even before construction was completed, prompting Bawa and his partners to occupy it as their office and studio, which they did until 1997 when it was sold. Once Bawa had turned away from the modernism he had been exposed to in his training, he quickly concluded that the roof was the essential element in tropical architecture, and soon settled on a roof covering of half-round Portuguese clay tile laid on concrete sheeting that was watertight, durable, and provided good thermal insulation, even though the weight required a substantial timber structure of close-spaced rafters, purlins, and beams carried on polished coconut posts set on high stone bases. The broadly extended roofs, coupled with the many

20.39. Balkrishna Doshi, Gandhi Labour Institute, Ahmedabad, India, 1980–1984. Doshi has brought together influences from his teachers Le Corbusier and Kahn, in forms shaped by the ancient cultures of the subcontinent. Photo: From W.J.R. Curtis, Balkrishna Doshi: An Architecture for India *(New York 1988).*

courtyards, open loggias, and verandahs rendered mechanical air-conditioning unnecessary.[39]

Although Bawa built a number of elegant residences and hotels in Sri Lanka, arguably the pinnacle of his career was the new Sri Lanka Parliament, designed to fuse elements referring to the island's indigenous vernacular building traditions, while also incorporating references to the island's British colonial heritage [20.40]. Whereas the original Parliament building had been constructed under the British in a neo-Palladian Classical Ionic style in the old colonial port of Colombo, in 1978 the government decided on the construction of an entirely new capital complex. The site selected by the then-president was well outside Colombo, at Kotte, in the center of a new capital city. The new location was in fact strongly associated with the fifteenth-century kingdom, once centered at Kotte, that represented the last epoch of unified autonomous governance before the beginning of Western colonization, which lasted from the sixteenth century until the island regained its independence in 1948. Bawa was given the commission for the new parliamentary complex in 1979, but a particular problem Bawa faced was that there are two bitterly fractious ethnic groups in Sri Lanka—Tamil and Sinhalese, each with its own architectural traditions; he managed to meld the imagery, although clearly favoring the Sinhalese. After viewing the proposed building site from the air, Bawa suggested flooding a marshy area to create a lake and, with dredging, constructing an island in the center for the location of the new Parliament building.

The overall profile of the building complex, set on a low platform, featured broad extended copper-covered roofs on the main central building and its surrounding five pavilions, each roof covering encircling verandahs, thus recalling ancestral Sinhalese council buildings, while the plan had intimations of Moghul lake palaces as well as Sri Lankan Buddhist monasteries of the late-Anuradhapura period. In a series of interviews, Bawa commented on the Parliament design, saying it was "sort of a design continuum, reflecting the visual formalities of the old Sinhalese buildings, grand but not pompous," and giving the driving reason behind his design: "We have a marvelous tradition of building in this country that has got lost. It got lost because people followed outside influences over their own good instincts. . . . I just wanted to fit [the Parliament] into the site, so I opened it into blocks."[40] In the individual pavilions he employed extremely subtle saddle-back double-pitch hip roofs, a distant reminder of traditional "Kandyan" roofs; as Bawa wrote: "One unchanging element [in Sri Lankan architecture] is the roof—protective, emphatic and all-important—governing the aesthetic whatever the period, whatever the place. Often a building is only a roof, columns, and floors—the roof dominant, shielding, giving the contentment of shelter. Ubiquitous, pervasively present, the scale or pattern shaped by the building underneath. The roof, its shape, texture and proportion, is the strongest visual factor."[41] Begun in 1979, the Parliament complex was completed and opened in April 1982. In laying out the ceremonial approach to the Parliament complex, in drawing from ancient Buddhist temple plan arrangements, and in abstracting traditional Kandyan roof forms, Bawa created an architecture unique to its place and time; and in laying out his principle debating chamber like the House of Commons in London, Bawa acknowledged the debt of the modern democratic



20.40. Geoffrey Bawa, Parliament, near Colombo, Sri Lanka, 1978–1982. Interior view of one of the flanking pavilions. By emphasizing the roof, and using open latticework, Bawa suggested traditional building forms while also using shade and natural ventilation to good effect. Photo: From Steele, Architecture Today *(London, 1997).*

Sri Lankan form of government to former colonial power. Bawa and his partners (one a Jaffna Tamil and another a Buddhist Sinhalese) created what they hoped would be an inclusive expression of the aspirations of the whole nation.[42]

Renzo Piano: Recognizing New Caledonian Indigenous Traditions

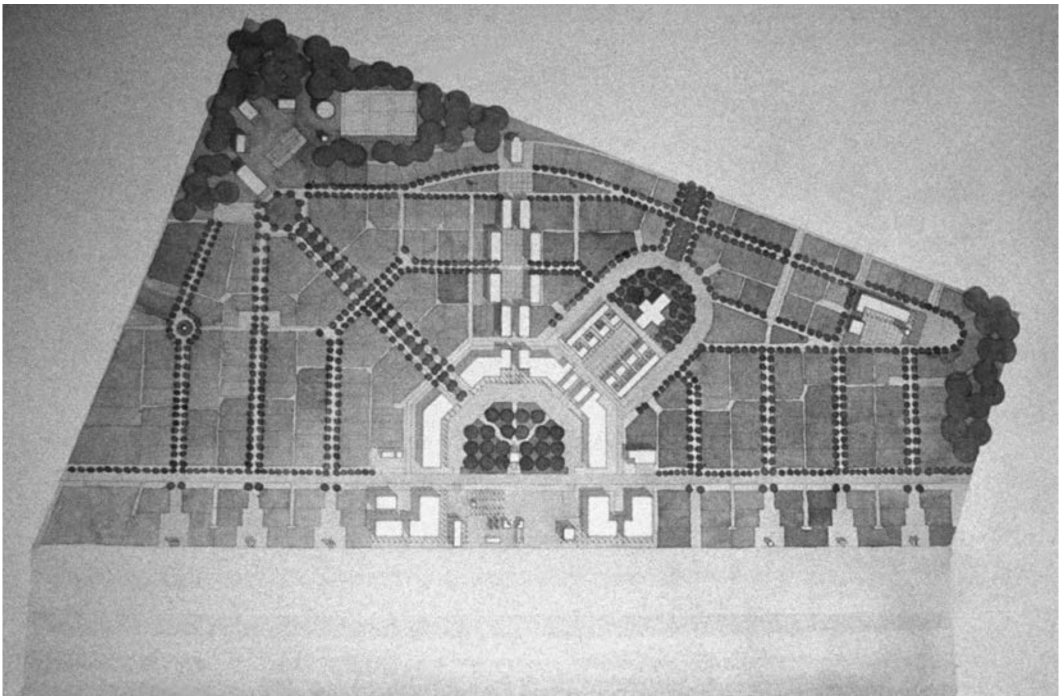
In the cases of Fathy and Bawa, we are dealing with architects from emerging nations, trained in the Western tradition but then reacting to those Western colonial traditions, endeavoring to create an indigenous expression using long-established materials or building forms that they know well from childhood. In the inverse of that approach, consider the work of Renzo Piano, formerly a champion of expressionistic high-tech building (as in his Pompidou Center, Paris), working on behalf of the people and government of New Caledonia, a group of tropical islands about 930 miles due east of Australia. The first European sighting of New Caledonia was made by Captain James Cook in 1774, and he named the land he saw using the ancient Roman name for Scotland, since he perceived a resemblance. Taken over by the French in 1853, the island group is today known as a "special collectivity of France," having two representatives in the French National Assembly.[43] In the late twentieth century, the island group pushed for greater political self-governance, encouraged by Jean-Marie Tjibaou, a Kanak indigenous to the islands who had long advocated for a special building complex honoring the local native language and culture. At the request of the New Caledonia government, France agreed to fund the construction of this cultural center named in honor of Tjibaou. As a result, the Tjibaou Cultural Center was built as the last and most far-flung of the *Grands Travaux* supported by French president François Mitterand in the 1990s. The design of the Tjibaou Center resulted from a competition held in 1991, won by the Renzo Piano Building Workshop of Geneva, Switzerland, begun in 1992 and completed in 1998.

Avoiding his earlier reliance on modern industrial expression, Piano redirected his practice toward climatic and environmental responsiveness in this tropical region. His Tjibaou Cultural Center, outside Nouméa, reflects and promotes the culture of the indigenous Kanak island people, avoiding counterfeit historicism while also reducing reliance on introduced outside technologies. Endeavoring to honor the traditions and history of the Kanak, their past, present, and future, Piano and his team decided against a literal replication of a Kanak village. On the long Tina peninsula, between the Bay of Magenta and a lagoon, along a gently curved walk, are spaced low rectilinear buildings and ten tall rounded diaphanous wooden shell pavilions, called "great houses" or "cases," whose steep profiles suggest the steeply conical traditional thatched houses of the Kanak. The buildings are clustered in three villages; presenting Kanak identity and culture and exhibiting contemporary Kanak art, they include a commemorative house for Jean-Marie Tjibaou together with administrative facilities. The "great houses" vary in height from 65 to 95 feet (20 to 28 m) and rise in staggered groups above the lush forest peninsula canopy [Plate 44]. The exhibits and demonstrations presented in the "great houses" interpret the traditional values of Kanak culture for an indigenous population undergoing extraordinary cultural change. The "great houses" themselves are constructed of tall curved laminated wood verticals, made of untreated but extremely durable iroko wood that is naturally resistant to termites, with galvanized steel tubes and rods used for the diagonal bracing. The pattern of louvers incorporated throughout the tall curved shells of the "villages" were carefully studied in wind tunnel tests to provide natural ventilation but also to allow typhoon-force winds to pass through. Although there was some controversy concerning its luxuriousness and monumental character, the siting of the Tjibaou Center with its emphasis on the landscape and its architectural response to tropical climatic conditions seems an appropriate solution for a European working on behalf of a recently tribal people.[44]

Building Communities

One of the pervasive components of the critical regionalist reactions to imported Euro-American Modernism was the reaffirmation of community, of creating environments for groups of people, living and working together. What makes housing complexes successful rests on two essential factors: a consistent design that results in a related family of forms and, even more important, an appropriateness of scale and an organization of spaces that arise from the ethos of those who will live there. Fathy's effort to relocate the residents of Gourna was only partially successful because of their resistance to moving; otherwise, his building designs fit well with local expectations and living patterns. Efforts to respond to the need for housing in the Postmodern period have yielded varied results.

In the United States, one planned town that attracted a great deal of attention was Seaside, Florida, a small enclave planned in 1978–1983 by the team of Andrés Duany and Elizabeth Plater-



20.41. Andrés Duany and Elizabeth Plater-Zyberk, Seaside, Florida, 1978–1983. Developer Robert Davis set out to have a beachfront community designed that emphasized foot traffic and closeness of municipal services instead of requiring everyone to use their automobiles. Courtesy of Duany and Plater-Zyberk.

Zyberk, with Leon Krier as consultant. What Robert Davis, owner of the land, desired was a community based on movement on foot, rather than by automobiles, so the distances between buildings are far less than commonly found in American suburbs [20.41]. The planners also drew up a building code that regulated building scale and architectural detail, to foster the ambience of a small southern town of the very early twentieth century. Although the greater density of buildings per acre would have encouraged a sense of greater community, homeowners opted to commute there on weekends from places like Atlanta. The town, with its buildings by many well-known architects, was lauded in the professional and popular press and became such a focus of attention that homeowners reportedly began renting their houses to visitors; eventually Seaside became a very upscale resort community. The town design seemed so perfect and yet unreal that it was selected as the outdoor set for filming *The Truman Show* (1998), a satirical drama about a baby raised to manhood in a commercial reality-television show set in a make-believe town. Some movie viewers were unaware that it was a real town in Florida, since its design and the close physical relationship of its buildings appeared too good to be true.

Particularly intriguing, because the final design results clearly seemed to belong in the category of Ironic Classicism, are the housing developments and new towns built around Paris in the 1970s and 1980s. The creation of Barcelona-based architect Ricardo Bofill (born 1939) and his atelier, the Taller de Arquitectura, these include the housing cluster called the Palace of Abraxas at Marne-la-Vallée, near Paris, 1978–1982 [21.42]. This and the other complexes are uniquely identifiable: vast and Baroque in scale, but Neoclassical in detail and broken down into varied component sections. Despite what appears to be handcrafted historicism, what made these housing complexes possible at a reasonable cost was prefabrication of massive precast concrete parts. Bofill, and Peter Hodgkinson, his principal designer, believed that previous modernist public housing lacked meaning, whereas they attempted an architecture in which daily life could be "exalted to become rich and meaningful."[45]

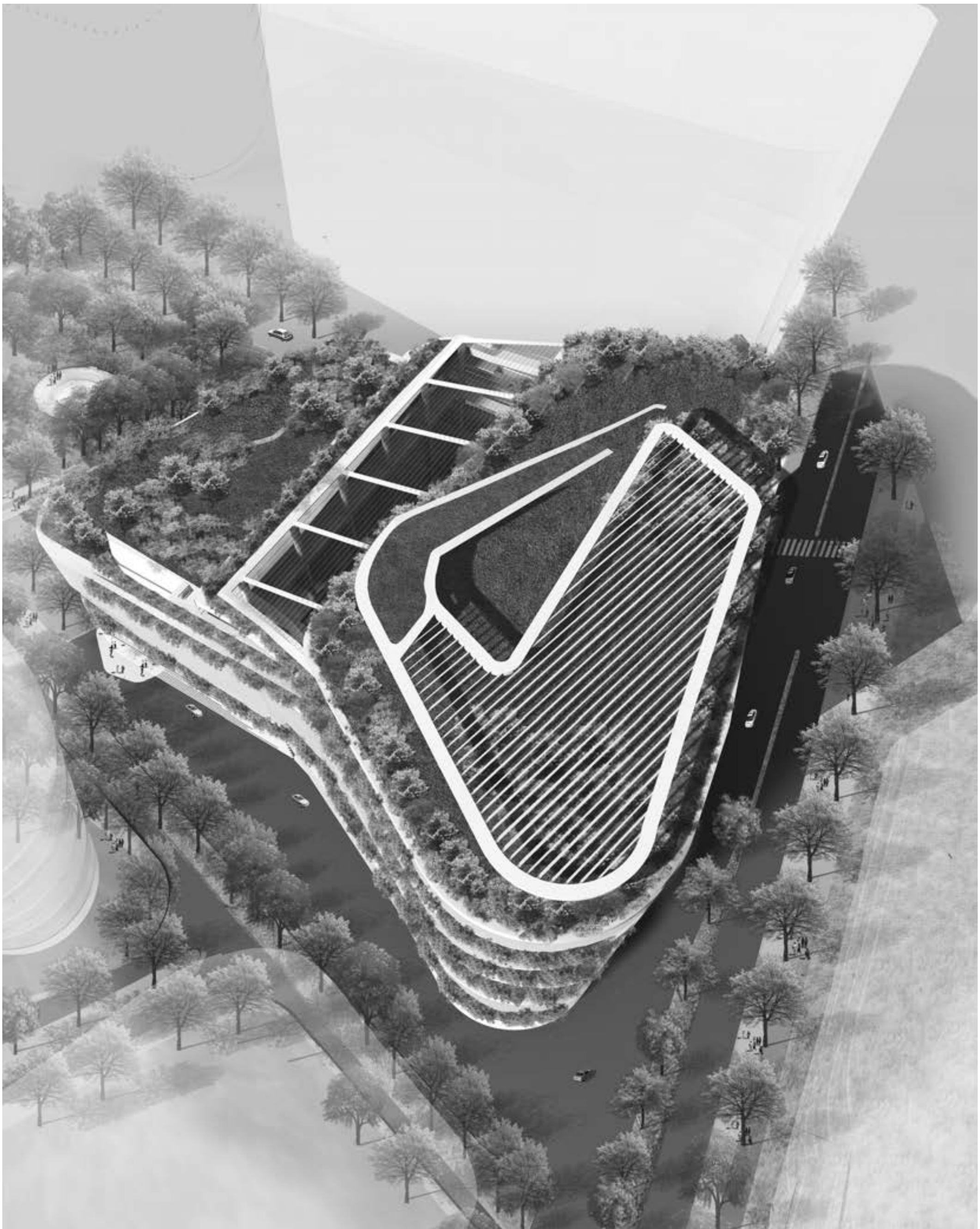
While prefabrication of large parts of Bofill's housing complexes in France brought the construction cost down, allowing rents to be within the reach of lower-income residents, a different approach was taken by architect Michael Pyatok in the United States. In the light of the Pruitt-Igoe housing debacle in Saint Louis of the mid-twentieth century, Pyatok realized that low-income residents resist being placed in apartments designed for them that look like barracks for the poor. As a solution to this problem, he and his partners designed compact housing clusters that could be squeezed into "left over" spaces, small in scale and designed in the same way as apartment complexes intended for prospective upper-middle-class occupants. The funding came from various civic agencies and charitable groups. The architects' experience indicated that the low-income residents mistreated the buildings that were so obviously "designed down" for them. Pyatok and his partners decided that their prospective residents deserved better, and subsequently the occupants developed a sense of personal ownership and treated their new homes with respect. As Pyatok posted on his website: "At the heart of Mike's work is the participatory design process he uses to deeply involve residents, community members, and stakeholders in the revitalization of low-income communities. Using hands-on modeling exercises, Mike helps communities identify their core needs and plan how to meet those needs through quality design."[46] The fact that these were subsidized housing units, available only to residents with greatly reduced incomes, was not allowed by the architects to diminish the excellence of their work or the quality of their design [20.43]. Pyatok and his partners were not building storage facilities for the poor but, rather, homes in which they could lift their damaged confidence in themselves and raise their standard of living. Pyatok recounts in public lectures that as his team was finishing up a complex of subsidized housing units next to an interstate, people began to arrive in their luxury vehicles, asking when these attractive new condos were to go on sale. They were astonished when they were informed that they could live there only if their income was somewhere below the federally established poverty level. Building livable com-

20.42. Ricardo Bofill, Palace of Abraxas Apartment Complex, Marne-la-Vallée, near Paris, 1978–1982. This and Bofill's other apartment complexes outside Paris establish clear and unique identities, avoiding the monotonous sterility of many twentieth-century housing developments. Photo: Ricardo Bofill, Paris/Deidi von Schawen.

20.43. Michael Pyatok, Tower Apartments, Rohnert Park, California, 1993. By arranging the low-rise apartments around interior courts, Pyatok and his associates created a strong sense of identity and community. Photo: Courtesy of Michael Pyatok.

munities applies to the well-off just as much as to those whose lives have been blunted through adversity and disadvantage, and architects need to address the spectrum of those needing places not just to live but to thrive.

The architecture extending past the twentieth century discussed in this section is still developing and progressing, so it is not appropriate to attempt a summation here. Nonetheless, a number of issues are influencing design as the twenty-first century moves into its next decade, and these are treated in the following concluding chapter.



21.7. Ken Yeang, Solaris Building, Singapore, 2009–2010. More than most other architects, Yeang designs buildings as total bio-climates. Here the wrap-around vertical garden offers more planted area than was possible on the site before the building was constructed. Photo: Courtesy of Ken Yeang.

Chapter 21

Into the Twenty-First Century

> When all the poems and music have become silent, the architecture will continue speaking.
>
> —*Chinese Proverb*

In a discussion of recent architecture, a point is reached where it is no longer possible to talk about what *has happened;* instead, we speak of what *is happening* and, further, what appears to be emerging as the issues of the architecture of tomorrow; hence, there is a shift from historical summary to critical comment. Compared to what it was a half-century ago, architecture now is clearly a global phenomenon, and, as was noted in the preceding chapter, well-known "starchitects" today routinely have commissions around the world. Architects in training, particularly from emerging nations, often seek their formal instruction in countries far from their place of birth. Their particular challenge when returning home is to find ways of bringing together learned modern methods and technologies with their ancestral social traditions, building typologies, and planning strategies. It is no longer possible to have a single universal modern architecture, the "one building for all people everywhere," as proposed by the European modernist advocates in the 1920s and attempted in the 1950s and '60s. Instead, there are now multiple regional inflected modernisms.

Without question, computer-aided design (CAD) continues to shape not only the design process but all phases of design development and the construction process. Since the beginning of the twenty-first century, CAD has given architects total control over building form, freeing them to use assertively dramatic irregular angles or amorphous rounded shapes, as seen in Daniel Libeskind's sharply crystalline-looking Denver Art Museum Hamilton Building addition (2002–2006) [Plate 45] or in Ai Weiwei and Herzog & de Meuron's Olympic arena in Beijing (2001–2008) [21.1]. With the development of ever-more sophisticated CAD programs for architectural and engineering design allowing for the simultaneous ability to track structural calculations, to explore building assembly methods, and to monitor material costs, it is now possible to design buildings of any imaginable shape. CAD also allows architects to freely alter complex forms even at an advanced stage in design development by going back to saved files or layers of design. Moreover, other specialists can use the design files to prepare three-dimensional images, both outside and inside a proposed building, showing the effects of building materials and colors, even creating moving images to allow clients or commissioning committees to explore the proposed building—all well before the first spade of earth is turned. Such digital imaging can be applied not only to work in progress but also to the virtual creation of buildings never actually built (such as the unrealized designs of Louis I. Kahn) or to the reconstruction of buildings and environments of antiquity that no longer survive (such as the Roman Forum of Trajan). It seems we have already arrived at the point where it is possible to identify the difference between buildings designed before the 1990s—before computers—and those that came afterward, just as it is common to speak of the evident change that occurred in nineteenth-century architecture due to the enormous increase in the production of iron, steel, and glass.

This "liberation" from the physical constraints of form and structure has led to what some critics have labeled "blobitecture," in which the buildings appear to shape-shift; others favor adjectives such as *curvy, fluid,* or *protoplasmic.*[1] Yet another descriptor is "biomorphic architecture," with a building form seeming to originate as an unknown life-form. Some recent examples would include project designs by

21.1. Herzog & de Meuron with artist/designer Ai Weiwei, Olympic National Stadium, Beijing, China, 2001–2008. Affectionately dubbed "The Bird's Nest" because of its interwoven strands, this and other dramatic buildings were commissioned to make a dramatic public announcement of China's arrival as a major player on the world's architectural stage, signified also by China's serving as host of the 2008 Olympic games. Photo: REUTERS/Alvin Chan.

Zaha Hadid for the Dubai Financial Market (2007), her Dubai Performing Arts Center (2006), or her Heydar Aliyev Cultural Center, Baku, Azerbaijan (2007–2012) [Plate 46]. Other examples might include the Sage Gateshead center for music performance by Norman Foster (opened 2004); or the Allianz Arena, Munich, Germany (2001–2005) by Herzog & de Meuron; or the Beijing National Center for the Performing Arts (2000–2007), a titanium-covered ellipsoidal dome by French architect Paul Andreu [Plate 47]. Arguably, also in this category of "blobitecture" could be Herzog & de Meuron's National Arena in Beijing, the stadium that became so familiar during the 2008 Olympic games as "The Bird's Nest."

The use of computers in designing complex building forms, however, has so far had minimal impact on the selection of building materials or the use of energy. Whether a building swoops or juts out with sharp points is of no consequence when architecture is examined for its continuing impact on the planet. Considering how many millennia humans have been building, it is only since about 1970 that any fleeting thought has been given to the after-effects caused in obtaining and processing all the materials from which buildings are now made. The impact on the planet includes the cutting of trees; the extraction of ores from the earth and the resulting environmental degradation; the energy consumed in smelting, pouring, rolling, and transporting the finished parts to the building site; the clearing of the building site prior to construction; the carting away of the debris of a demolished previous structure and its deposit in a landfill; the energy involved in raising a building (significant in the lifting of materials to great heights); the energy continuously expended in operating a building whether for ten years or a hundred; and the further consumption in all these categories when the whole process is repeated in the future for the seemingly inevitable "replacement" building. In recent years, all these costs have begun to be critically examined through what is called Life-Cycle Assessment or Life-Cycle Cost Analysis—an expanding activity and one that will be very much a part of building in the future.

Given these interwoven concerns, architects need to become more serious about sustainability and "green architecture," which involves such measures as reducing and recycling the water used in a building; diverting runoff from roofs, terraces, and parking lots into "rain gardens" for irrigation; using reflectors to redirect and use sunlight inside a structure; and using voids in a building's shape as a way of moving air to carry away unwanted heat, among many other considerations. To encourage architects to improve energy and material conservation, the LEED program was instituted in 1998 (the acronym stands for "Leadership in Energy and Environmental Design"). Developed by the US Green Building Council, the

LEED program, in its third iteration in 2009, provides guidelines with accreditation for designing professionals as well as certification of completed buildings in four classifications arising from the number of points awarded out of a maximum of 100. The categories range from "Certified" (40–49 points), "Silver" (50–59 points), "Gold" (60–79 points), and "Platinum (80 points and above).[2] Perhaps there is no more fitting example of a recent building given LEED Platinum status than the Aldo Leopold Legacy Center (2006–2007), designed by a team led by The Kubala Washatko Architects (TKWA) and built in Baraboo, Wisconsin, where Aldo Leopold lived and died [Plate 48]. As a challenge to other architects, the Center's zero net energy building is carbon-neutral in operation and produces more than 110 percent of its annual energy needs.

If the conservation movement has a patron saint, it would be Leopold, author of *A Sand County Almanac* (1949). Though his name may not be prominent today in the minds of ordinary building users, Leopold's influence in the ecological conservation movement has been profound. Well before the middle of the twentieth century, Leopold began to examine the rhythms of the natural world. A champion of conservation growing out of a land ethic, he wrote toward the end of this seminal book that "conservation is a state of harmony between men and land." Stating this objective is deceptively easy.

> This sounds simple: do we not already sing our love for and obligation to the land of the free and the home of the brave? Yes, but just what and whom do we love? Certainly not the soil, which we are sending helter-skelter down river. Certainly not the waters, which we assume have no function except to turn turbines, float barges, and carry off sewage. Certainly not the plants, of which we exterminate whole communities without batting an eye. Certainly not the animals, of which we have already extirpated many of the largest and most beautiful species. A land ethic of course cannot prevent the alteration, management, and use of these "resources," but it does affirm their right to continued existence, and, at least in spots, their continued existence in a natural state. In short, a land ethic changes the role of Homo sapiens from conqueror of the land-community to plain member and citizen of it. It implies respect for his fellow-members, and also respect for the community as such.[3]

In addition to buildings under design prior to construction, existing and recently completed buildings can be analyzed for their respective LEED achievement as well.[4] C. Y. Lee's Taipei 101 super skyscraper (1999–2004) was awarded Platinum status (the tallest building as of 2013 to receive this designation). Even existing buildings can be renovated and retrofitted to achieve LEED certification, as demonstrated by the renovated Empire State Building, New York, which in 2011 earned Gold status for this famous skyscraper originally built in 1929–1931, long before energy consumption was considered. LEED certification is based on site sustainability, consumption and recycling of energy, production cost of building materials, indoor environmental quality, and resource depletion and water intake, with additional special points for innovation in design and regional considerations. While perhaps not ideal, the ranking system is continually being refined and does offer an objective and empirical way of comparing individual buildings.

Some "starchitects" have achieved high professional status for their design gymnastics, pushing the limits of the weightlessness of their hovering cantilevers and creating splendid sculptures sheathed in the exotic gleam of rare metals, as exemplified by the Denver Art Museum by Daniel Libeskind, 2000–2006 [Plate 45]. Other architects, however, have made it a point of honor at the turn of this century to elevate the use of ordinary materials in their building efforts. But such a design decision to be unobtrusive and to deliberately simplify does not necessarily mean being relegated to professional oblivion. One example is the Australian architect Glenn Murcutt. Born in London in 1936, Murcutt was raised in New Guinea where he learned to appreciate uncomplicated aboriginal buildings. Although his father had introduced him to the work of Mies van der Rohe, he also grew to admire the philosophy of Henry David Thoreau. Bringing these philosophies together in his designing, he demonstrates that less can "simply" be more. Trained at the University of New South Wales, he was influenced by several local designers to focus his work on relationships with nature and on sustainability well before "sustainability" became a buzzword. He developed a particular sensitivity to the unique landscape character of Australia. Adhering to a professional motto inspired by Australian aboriginal precepts to "touch the earth lightly," Murcutt customarily employs ordinary materials, such as the corrugated sheet metal often used in rough "outback" ranch buildings. And he gives careful consideration to building orientation, wind direction, water flow, prevailing temperature, and light [Plate 49]. Despite conducting a small one-person practice (when so many Priztker Laureates direct architectural corporations with hundreds of employees), as well as focusing on small-scale buildings including many residences, Murcutt was awarded the prestigious Pritzker Prize in 2002. The language of the award citation summarizes why he received such high recognition:

> Glenn Murcutt is a modernist, a naturalist, an environmentalist, a humanist, an economist and ecologist encompassing all of these distinguished qualities in his practice as a dedicated architect who works alone from concept to realization of his projects in his native Australia. Although his works have sometimes been described as a synthesis of Mies van der Rohe and the native Australian wool shed, his many satisfied clients and the scores more who are waiting in line for his services are endorsement enough that his houses are unique, satisfying solutions. His is an architecture of place, architecture that responds to the landscape and to the climate. . . .
>
> His houses are fine tuned to the land and the weather. He uses a variety of materials, from metal to wood to glass, stone, brick and concrete—always selected with a consciousness of the amount of energy it took to produce the materials in the first place. . . . One of Murcutt's favorite quotations from Henry David Thoreau, who was also a favorite of his father, [reads:] "Since most of us spend our lives doing ordinary tasks, the most important thing is to carry them out extraordinarily well." With the awarding of the 2002 Pritzker Architecture Prize, the jury finds that Glenn Murcutt is more than living up to that adage.[5]

In an analogous approach, the inspirational American architect Samuel Mockbee (1944–2001) made it his mission to provide professional services to the architecturally disenfranchised, impoverished rural folk of west Alabama. A graduate of the architectural program at Auburn University in 1974, Mockbee moved his practice from affluent Jackson, Mississippi, to Hale County, Alabama, creating what he called the Rural Studio. He persuaded architectural students from Auburn to join him in designing and building needed community structures in an area plagued by grinding poverty since before the early twentieth century. He and his students listened closely to the potential building users, employed their ideas, used ordinary and "found" materials like rammed earth or hay bales for walls, and old license plates or discarded automobile windshields for roof coverings [21.2]. They have fashioned buildings improvised by Mockbee and his students with little concern for garnering celebrity for the "master architect." Using old tires knitted together with steel rods and overlaid with wire mesh and stucco, covered with a lightly framed salvaged wood roof over a floor of slate found nearby, Mockbee and the Rural Studio created the Yancey Chapel (1995) in Sawyerville, Hale County [Plate 50]. With its unusual walls, roof, and floor framing an open view through a woodland over a forest canopy and grassy valley beyond, the Yancey Chapel encapsulates the same quiet serenity in an undisturbed natural setting that characterized the chapels of Faye Jones, as in his tranquil Thorncrown Chapel (1980), Eureka Springs, Arkansas. Not all aspiring architects can create a grandchild of the Bilbao museum, all aglitter in its titanium skin and bringing acclaim to its designer; but all aspiring architects *can* seek daily to improve the lives of ordinary people, using the ordinary materials at hand, in inspiring and uplifting ways, as the Auburn students and their supervisors continue to do, after leukemia took Mockbee well before his work was done.

The aboriginal concept of touching the earth lightly also informs the rising practice of green architecture by architects around the globe as they aim to lessen the negative impact of human activity. One method is to introduce "green roofs," working together with "rain gardens." The objective of both is simple, though a green roof requires careful design of the underlying flat roof structure to carry the eventual weight and to ensure protection against water infiltrating the building below. A green roof is made up of planted beds that present a green surface to the sun. One politically visible installation is the green roof of the Chicago City Hall Building; though it cannot be seen from the streets below, it is clearly visible from the thirty-three office skyscrapers surrounding it [Plate 51]. This example, designed in 2001 by Conservation Design Forum, Inc., is also important because it was installed on a building already a century old, demonstrating that green roofs are not intrinsically restricted to placement only on proposed new buildings. The layer of earth provides effective insulation against both solar heat gain in the day and heat loss through radiation at night. The evaporation of water in the planted surfaces also achieves a measure of cooling on the building below, as well as cooling the air immediately above the garden. Measurements by the city taken in the decade following installation of the City Hall roof garden indicate that in the summer the roof is 30° cooler than surrounding traditional flat roofs.[6] The garden also protects the underlying roof membrane from deterioration due to incessant ultraviolet light as well as providing habitat for birds.

21.2. Samuel Mockbee and the Rural Studio, Mason's Bend Community Center, New Bern, Alabama, 2000. Using found materials (including dumped tires), Mockbee and his Rural Studio students built a small chapel in a wooded copse overlooking a valley. Photo: Timothy Hursley.

Roof gardens accessible only to maintenance personnel can be composed of low-lying plants like sedums and mosses in appropriate climates, since they can endure extended periods without watering—a consideration in situations where frequent maintenance or regular irrigation is not available. Or the planting beds can be deeper, supporting shrubbery and small trees, which, together with paved terraces, can create an aerial garden accessible to building occupants, as is the landscape atop the Chicago City Hall.

Another example is the green roof over the new building for the California Academy of Sciences (2005–2008), designed by Renzo Piano; from a

21.3. Renzo Piano, California Academy of Sciences, Golden Gate Park, San Francisco, California, 2005–2008. Covering the entire roof with gently undulating roof gardens, Piano and his associates created a landscape that mediates between the park and nearby hills. Photo: © Lee Foster/Alamy.

distance, it resembles gently rolling hills [21.3]. The green roof, which is not publically accessible, enables the Academy of Sciences building to achieve a 35 percent energy savings over what was required by the building code. Other significant green roofs built in the United States include those of the Ford Motor Company's River Rouge Plant, Dearborn, Michigan, which collectively has 450,000 square feet of roof surface covered by sedum plantings. Even larger, though arguably not a true roof garden since it includes large pedestrian paved areas, is Millennium Park in Chicago. This 25.5-acre area is a roof over the Millennium Park garage, built on what had been a huge, unsightly rail yard since the end of the nineteenth century. Now an enchanting adult playground in the city's front yard, Millennium Park illustrates dramatically how a dead space that was once a major urban heat generator and eyesore can be made into a place that brings people delight [Plate 52]. Other examples in the United States include the roof garden at Ballard branch of the Seattle Public Library; the roof garden at the Morgan Processing Center of the New York City Postal Service (which saves the Postal Service nearly $30,000 annually in reduced heating and cooling costs); and, most appropriately, the retrofitted green roof of the headquarters building of the American Society of Landscape Architects, in Washington, DC, designed by landscape architect Michael Van Valkenburgh.

The Chicago City Hall roof garden was inspired by similar installations in Germany, where research started in the 1980s and experimental roof gardens were created in cities like Stuttgart. In Germany, the impetus for roof gardens was to reduce stormwater runoff and requisite treatment. New building materials were developed specifically for such roof gardens, professional standards were formulated, and a professional rating organization, the FFL (an acronym for the German research organization for landscape architecture) was created. In 2008, the FBB (from the German words for "green roof association") was formed. Green roof building has become a major activity in Germany, with about 10 million square meters of green roofs constructed there every year in the first decade of the twenty-first century. Other countries have also begun installation of roof gardens, including Greece and the

United Kingdom. Switzerland, Sweden, and Iceland all had long-standing traditions of sod roofs, so the introduction of roof gardens on modern buildings was readily accepted. An example in Asia is the ACROS Fukuoka building in Fukuoka City, Japan, a concert hall and convention building having a stepped profile on its south face, but straight glass walls on the other three sides (screened with projecting sun shields). Designed by Emilio Ambasz and opened in 1995, the stepped-back south wall consists of tiers planted as dense gardens, so that it presents something of the appearance of a thickly planted terraced hill when viewed from the south [21.4].

Another advantage to green roofs is the reduction in rainwater runoff, though with heavy precipitation there may be some "filtered" overflow. To deal with this periodic discharge from low-rise buildings such as suburban office complexes and residences, the roof runoff can be used to irrigate a rain garden—a ground-level garden designed specifically to absorb excess rain, reducing or even eliminating storm water runoff that needs to be treated by municipalities. Many cities grant tax credits for buildings not placing a rain-load on municipal facilities, and some require large businesses to provide such rain gardens to treat runoff from their parking lots.

The architectural work done by Murcutt and Mockbee exemplifies sustainable or ecological design, another issue on which future building will increasingly depend. Briefly, sustainable architecture results in minimum negative impact on the environment—through the materials used and the energy consumed—as well as on the relationship of the building to the site. If done correctly, such architecture will not reduce the opportunities of future generations. This means conserving energy and the consumption of fossil fuels, both in the building process and through minimizing the need for future fuels to heat, cool, ventilate, and provide illumination throughout the building's lifetime by integrating into the design the use of solar, thermal, and wind technologies. In the construction process, it means investigating the use of both sustainable and recycled materials. Mockbee's and the Rural Studio's buildings illustrate how this can work. Though much on the Internet is regrettably evanescent, websites such as e-architect.co.uk can provide a

21.4. Emilio Ambasz, ACROS Fukuoka Building, Fukuoka City, Japan, 1995. Seeming to hint at the famous hanging gardens of ancient Babylon, Ambasz provides here a plant-covered man-made hill in the middle of a hard urban environment. Photo: © Andrea Balzano.

wealth of updated information on architects, buildings (including images), and building products and materials, as well as on political developments and other news affecting sustainable design.

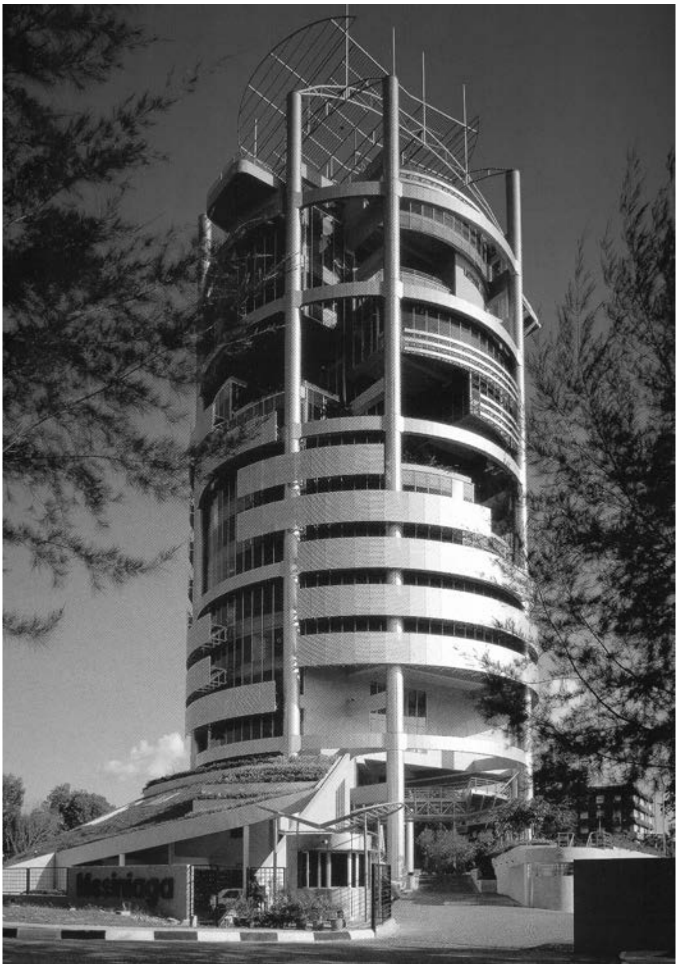
The small scale of such architectural designs will need to be implemented on a far grander scale, argues architect and planner Ken Yeang. Born in Penang, Malaysia, in 1948, Yeang studied at the Penang Free School and then at Cheltenham Boys College (a British "public school" in Gloucestershire, United Kingdom). His professional education was at the Architectural Association, London, where he came into contact with the fantastic futuristic urban schemes of the Archigram group. Yeang later earned a PhD from Cambridge University in the fields of ecological design and planning, his dissertation subsequently published as the book *Designing With Nature* (New York, 1995). In 1975, Yeang returned to Southeast Asia, where he worked in an architectural office in Kuala Lumpur and eventually entered into partnership with Tengku Robert Hamzah. By the early 1980s, Yeang had begun to define a new building type, the *tropical skyscraper,* exploiting strategies for reducing the need for energy consumption (especially for ventilation and cooling), for incorporating elevated masses of landscaping, and for creating "neighborhoods" or communities of people within the built high-rise. A prolific architect, writer, and speaker, Yeang makes an eloquent and powerful case for a broad ecological approach to total design, beginning at the scale of a building and extending out to the city and region. His expanding and successful practice is in both these areas; he also now has offices not only in Kuala Lumpur but also in London (as the firm of Llewelyn Davies Yeang) and in Beijing (as North Hamzah Yeang Architectural and Engineering Company). Yeang, who currently resides in London, is considered by many of his colleagues as a leader in green design.[7]

Yeang's reaction to Western-derived high-rise design—typical Western box-like buildings with closed flush wall surfaces of glass and metal panels—is illustrated in his study, *The Architecture of Malaysia* (1992). Such conventional glass-enclosed skyscrapers were originally conceived for latitudes ranging from 40° to 60° north (New York, Chicago, Berlin, Stockholm), often-cloudy regions with cold winters, whereas Yeang's designs are for sun-drenched, humid tropical latitudes ranging from 3° to 6° north. For such hot climates, one must think about buildings anew. In addition to carefully calculating initial materials and construction labor costs, he also suggests that the protracted cost of the building over time—material replacement and energy consumption—be factored into the total cost. Yeang describes the commercial-residential towers he designs as the equivalent of vertical "urban districts"; he observes that "the basis for the vertical theory of urban design is the recreation up in the sky, of ideal habitable urban conditions found at ground level."[8]

Yeang's Menara Mesiniaga Tower (*mesiniaga* means "business machine"), built to house the local IBM franchise in Selangor, Malaysia (1989–1992), represented an early realization of his principles [21.5]. The 15 stories have separations, and the service core is completely open, allowing air to flow through the building; windows facing east and west are shaded by external louvers. Here the "vertical landscaping" is not as pervasive as it would become in later designs, but the gaps in the floors, opening up as "skycourts," are evident. Not installed so far have been the solar electro-voltaic cells on the roof, but the louvered skeletal armature for them, looking like a crowning sculpture, provides shade for the rooftop swimming pool.

Also striking is Yeang's taller Malayan Borneo Finance (MBF) Tower in Penang, Malaysia (1990–1993), a 31-story mixed-use building with 68 apartments above ground-level offices and banking facilities. The columnar reinforced concrete frame provides for two parallel rows of stacked apartment units, with open skycourts between the units. Together with large voids in the main shaft, the two parallel rows of apartment clusters, and the open lobby floors at each level, this openness allows for easy air circulation through the entire structure. Additionally, the deep recesses of the individual apartment terraces shade the windows, preventing heat buildup inside. As his practice expanded, Yeang has enlarged on his early objectives. His firm won the competition in 1998 to design the Singapore National Library [21.6]. The 16-story exterior presents a series of projecting floor slabs as well as numerous recesses and skycourts, achieving a lively play of light and shadow while simultaneously preventing sunlight from heating the library or damaging the books. A broad range of sensing systems constantly adjusts cooling rates, depending on outside conditions and whether there are humans present in the building. In terms of how the building reacts to conditions and occupancy, it seems almost alive.

As Yeang's work expanded into city planning, he created a design approach that suggests that any building being constructed needs to be designed as an intimate part of its surrounding ecosystem; as Yeang remarks, architects should understand that making green architecture is more than simply having photovoltaic panels on the roof—it is the buildings themselves that are the ecosystems.



21.5. Ken Yeang, Menara Mesiniaga (IBM) Tower, Subang Jayan, near Kuala Lumpur, Malaysia, 1992. By introducing open levels between floors and separating the central spine from the surrounding offices, and by incorporating sun screens calculated in accordance with the building's orientation, Yeang and his associates facilitate natural ventilation while reducing the solar heat load. Photo: Courtesy of Ken Yeang.

Throughout the past, from the time that permanent buildings began to be built about five thousand years ago, the usual practice has been to make structures that were nonorganic—a practice that worked reasonably well so long as there were vast organic expanses of grasses or forests nearby to balance human construction. But today, especially with cities and populations rapidly expanding around the globe, that ancient building mentality can no longer continue. Yeang urges us to consider building with a more balanced approach—one that is founded on a better ratio between inorganic and organic elements within the buildings themselves. Moreover, we need to construct and operate our buildings more efficiently; as Yeang notes, 30 to 50 percent of a developed nation's energy expenditure is consumed by its buildings, and as much as 60 percent of the material going into landfills comes from waste from the building industry, whether from the manufacturing of building components or as the residue from the building process.[9] He insists that we need to do better.

Green and sustainable architecture and planning impose a number of responsibilities on clients and municipalities. One is that "green building" means thinking beyond the customary parameters, for, as Yeang asserts, the cost of a building is not just its one-time up-front expenditure but must also include the expenses involved in its continued operation and maintenance. LEED buildings are not only more expensive to construct, he notes, but come with associated long-term costs: he estimates that achieving Silver status entails 10 percent more cost over conventional design, Gold status costs an additional 15 percent, and Platinum status, the most prestigious, requires an additional 20 to 25

21.6. Ken Yeang, Singapore National Library, Singapore, 1998–2005. In a graceful form for this tropical high-rise, Yeang incorporates varied projecting floor ledges and fins, as well as open spaces, to reduce heat gain and allow wind to circulate through portions of the building. Photo: Courtesy of Ken Yeang.

percent more in initial cost. Aside from the bragging rights connected with being the owner of a LEED-designated building, financial payback is reached after ten to fifteen years, when the accumulated energy savings matches the initial extra cost (and this break point may occur sooner as energy costs rise). After that, the savings become a perpetual benefit, a silent gift to future owners and occupants.

As Yeang says, using current conventional economic calculations, there may never be any persuasive commercial justification for green building. Nevertheless, he insists, there is an ethical justification that architects must persuade clients to embrace. For Yeang, buildings and cities need to be designed as total living things, as integrated ecosystems, responding to four basic infrastructures that he identifies by symbolic colors: gray, blue, red, and green. The gray component includes the physical and structural elements, including "greentech" solutions, sustainable energy systems, and sewage and material recycling systems. The blue component encompasses water systems, including hydrological management, a "closed" water cycle, water conservation and management, gray-water reuse, rainwater harvesting, sustainable drainage, and other considerations. The red component, since red is the color of blood, encompasses the human dimension: "This human ecoinfrastructure consists of our human community. . . . This is the social and human dimension that is often missing in the work of many green designers. It is evident that our present profligate lifestyles, our economies and industries, our modes of transport, our diet and food production, etc., need to be changed to be sustainable."[10] The green component involves the full integration of living plant systems in the design, with features such as connected ecological corridors, zones, and networks that link existing and new open spaces, providing various habitats for fauna and flora, as well as natural resource management and integrated urban food production systems. This green living component, Yeang observes, is the one most frequently reduced or eliminated in conventional design, and yet it is precisely the component that must be most vigorously defended.

A good illustration of Yeang's all-embracing ecodesign is his firm's Solaris building, part of an even larger commercial and research district built in Singapore called Fusionopolis, whose master plan was devised by Zaha Hadid [21.7, p. 656; Plate 53]. Yeang's firm won the competition in March 2008 for the latest office building/research complex to be added to this district. Constructed in 2009–2010, the 15-story Solaris building (often identified by the single word "Solaris") continues the fluid curvilinear design concepts used by Hadid in planning the district, but with a particularly distinctive external feature: a 10-foot wide spiral balcony ramp around the building that extends for a continuous mile, densely planted with trees and shrubs from bottom to top. Project architect Mitch Gelber reports that the total area of green space on the encircling ramp (which also serves as a most effective sunscreen protection for the windows) amounts to 90,000 square feet, or about 20 percent *more* green space than was available on the original empty building site covering roughly 75,000 square feet. The plantings are varied according to the side of the building and depending on the variations in sunlight. Moreover, the enclosing vegetation is planned to be self-sustaining through the use of rainwater. Yeang envisions that "a green building should look like what the term indicates—'green.' It should look like a human-made ecosystem—a balance of organic and inorganic mass that works as a whole and is [connected] to the landscape at the ground. It should look, I believe, indeterminate, fuzzy or hairy."[11]

For hundreds of centuries, people and their succession of architects have built abundantly and often extravagantly. Stone, wood, sand for glass, deposits of rich iron ore were everywhere, ready for the taking. And since the time of the Industrial Revolution, with its rise of readily available energy, heavy machinery, and elaborate transportation systems, little attention has been paid to the true and long-term cost of how we build. Fuel, stone, old-growth wood, and the range of other building materials—even the easy availability of water—all are finite, though we have never been obliged to think much about it before the twenty-first century. For the past two hundred years, it is true, we have set aside some land as preserves and built landscaped parks, but the inclusion of a substantial living, organic component within our buildings never was seriously considered before now, except by a handful of architects. Moreover, we humans are increasing our numbers at a logarithmic rate: from 1 billion around the globe in 1800 to 7 billion sometime in 2013, and perhaps reaching over 10 billion by 2050, a tenfold increase in just two and a half centuries. Even now, a half-century after humans first saw the iconic photographs taken from the moon in the 1960s showing the tiny blue globe of the earth set in the black limitlessness of space, most of us continue to conduct our lives (though intellectually we may know better) as though our resources will always be without limit and that we can comfortably go on forever with things just as they are now. This cannot continue indefinitely. It is time for humankind to pause, to consider, to begin building—our architecture and our cities—as though our lives depend on it.

For in truth they do.

Suggested Readings

INTRODUCTION

Roger Caras, ed. *Animal Architecture.* Richmond, VA, 1971.

E. T. Cook and A. Wedderburn, eds. *The Works of John Ruskin.* London, 1903–1912.

Michael Henry Hansell. *Animal Architecture.* New York, 2005.

Ada Louise Huxtable. "Inventing American Reality." *New York Review of Books* 39 (December 3, 1992): 28.

Louis I. Kahn. "Remarks." *Perspecta* 9–10 (1965): 305.

Walter McQuade. "Where's the Architecture?" *Connoisseur* 215 (November 1985): 82.

Nikolaus Pevsner, *An Outline of European Architecture.* London, 1943.

Sir Herbert Read, *The Origins of Form in Art.* New York, 1965.

John Ruskin. *The Seven Lamps of Architecture.* London, 1849.

CHAPTER 1: ARCHITECTURE: THE ART OF SHAPING OF SPACE

Andrew Baum and Stuart Valins. *Architecture and Social Behavior: Psychological Studies of Social Density.* Hillsdale, NJ, 1977.

Amos Ih Tiao Chang. *The Tao of Architecture.* Princeton, 1956.

C. M. Deasy. *Design for Human Affairs.* New York, 1974.

Clovis Heimsath. *Behavioral Architecture: Toward an Accountable Design Process.* New York, 1977.

Bill Hillier and Julienne Hanson. *The Social Logic of Space.* Cambridge, England, 1984.

Glenn Robert Lym. *A Psychology of Building: How We Shape and Experience Our Structured Spaces.* Englewood Cliffs, NJ, 1980.

Christian Norberg-Schulz. *Existence, Space and Architecture.* New York, 1971.

Yi-Fu Tuan. *Space and Place: The Perspective of Experience.* Minneapolis, 1977.

Dom H. Van der Laan. *Architectonic Space.* Leiden and New York, 1983.

Bruno Zevi. *Architecture As Space.* New York, 1957.

CHAPTER 2: "COMMODITIE": BUILDING FUNCTIONS

Adolf Behne. *The Modern Functional Building*. Translated by Michael Robinson. Santa Monica, CA, 1996.

William W. Caudill, William M. Peña, and Paul Kennon. *Architecture and You: How to Experience and Enjoy Buildings.* New York, 1978.

Adrian Forty. *Words and Buildings: A Vocabulary of Modern Architecture.* New York, 2000. See the entry on "Function."

Karsten Harries. *The Ethical Function of Architecture.* Cambridge, MA, 1998.

Neil Leach, ed. *Rethinking Architecture: A Reader in Cultural Theory.* New York, 1997.

Jan Michl. "Form Follows *What*?: The Modernist Notion of Function as a *Carte Blanche.*" http://janmichl.com/eng.fff-hai.html.

Farshid Moussavi and Daniel Lopez. *The Function of Form.* Cambridge, MA, 2009.

James F. O'Gorman. *ABC of Architecture.* Philadelphia, 1998.

Niels Luning Prak. *The Language of Architecture: A Contribution to Architectural Theory.* The Hague, 1968.

Harold Small, ed., *Form and Function: Remarks on Art.* Berkeley, CA, 1947.

CHAPTER 3: "FIRMENESS": STRUCTURE, OR HOW DOES THE BUILDING STAND UP?

Carl W. Condit. *American Building: Materials and Techniques from the Beginning of the Colonial Settlements to the Present,* 2nd ed. Chicago and New York, 1982.

———. *American Building Art: The Nineteenth Century.* New York, 1960.
———. *American Building Art: The Twentieth Century.* New York, 1961.
Norman Davey. *A History of Building Materials.* New York, 1971.
James Edward Gordon. *Structures: Or Why Things Don't Fall Down.* New York, 1978.
Matthys Levy and Mario Salvadori. *Why Buildings Fall Down: How Structures Fail,* rev. ed. New York, 2002.
Rowland J. Mainstone. *Developments in Structural Form.* Cambridge, MA, 1975.
Steven Ross. *Construction Disasters: Design Failure, Causes, and Prevention.* New York, 1984. Includes discussion of the Hancock Tower fiasco, the failure of the Kemper area roof, and the Hyatt Regency skywalk collapse.
Mario Salvadori. *Why Buildings Stand Up: The Strength of Buildings,* rev. ed. New York, 1990.
Mario Salvadori and Robert Heller. *Structure in Architecture: The Building of Buildings,* 3rd ed. Englewood Cliffs, NJ, 1986.
Stephen Timoshenko, *History of the Strength of Materials.* New York, 1983.
Alexander J. Zannos. *Form and Structure in Architecture: The Role of Statical Function.* New York, 1986.

CHAPTER 4: "DELIGHT": SEEING ARCHITECTURE

Stanley Abercrombie. *Architecture As Art: An Aesthetic Analysis.* New York, 1984.
Rudolf Arnheim. *Art and Visual Perception.* Berkeley, CA, 1971.
———. *Principles of Visual Perception.* New York, 1976.
Faber Birren. *Color and Human Response.* New York, 1978.
Sinclair Gauldie. *Architecture.* Oxford Appreciation of the Arts Series. New York, 1969.
Heath Liklider. *Architectural Scale.* New York, 1965.
Frank H. Mahnke and Rudolf H. Mahnke. *Color and Light in Man-Made Environments.* New York, 1987.
Frank Orr. *Scale in Architecture.* New York, 1985.
Roy Osborne. *Lights and Pigment: Color and Principles for Artists.* New York, 1980.
Steen Eiler Rasmussen. *Experiencing Architecture,* 2nd ed. Cambridge, MA, 1962.

CHAPTER 5: ARCHITECTURE AND SOUND

Hope Bagenal and Alexander Wood. *Planning for Good Acoustics.* London, 1931.
Arthur Benade. *Fundamentals of Musical Acoustics.* New York, 1976.
Leo L. Beranek. *Acoustics.* New York, 1954.
———. *Music, Acoustics, and Architecture.* New York, 1979.
Leslie L. Doelle. *Environmental Acoustics.* New York, 1972.
M. David Egan. *Architectural Acoustics,* 2nd ed. New York, 1988.
Michael Forsyth. *Buildings for Music: The Architect, the Musician, and the Listener from the Seventeenth Century to the Present Day.* Cambridge, MA, 1985.
George C. Izenour. *Theater Design.* New York, 1977.
Peter Lord and Duncan Templeton. *The Architecture of Sound: Designing Places of Assembly.* London, 1986.
H. J. Purkis. *Building Physics: Acoustics.* Oxford, 1966.
Wallace C. Sabine. *Collected Papers on Acoustics.* Cambridge, MA, 1922; New York, 1964.

CHAPTER 6: ARCHITECTURE: PART OF THE NATURAL ENVIRONMENT

G. Z. Brown. *Sun, Wind, and Light: Architectural Design Strategies.* New York, 1985. A guidebook for those learning architectural design, this volume is filled with essential data and historical examples and concludes with a glossary of terms and an extensive bibliography.
Ken Butti and John Perlin. *A Golden Thread: 2500 Years of Solar Architecture and Technology.* New York, 1980.
Hassan Fathy. *Natural Energy and Vernacular Architecture.* Chicago, 1986. A study by one of the leading architects advocating a return to traditional construction methods.
James Marston Fitch. *American Building,* Vol. 2: *The Environmental Forces That Shape It,* 2nd ed. Boston, 1972.
James Marston Fitch and William Bobenhausen. *American Building: The Environmental Forces That Shape It.* New York, 1999. A thorough revision of Fitch's earlier groundbreaking book, first published in 1948.
Mohsen Mostafavi and David Leatherbarrow. *On Weathering: The Life of Buildings in Time.* Cambridge, MA, 1993.
Benjamin Stein, John S. Reynolds, and William J. McGuinness. *Mechanical and Electrical Equipment for Buildings,* 7th ed. New York, 1986.

CHAPTER 7: THE ARCHITECT: FROM HIGH PRIEST TO PROFESSION

Martin S. Briggs. *The Architect in History.* Oxford, 1927. Somewhat dated but still very useful.

Howard Davis. *The Culture of Building.* New York, 1999.

Edmund B. Feldman. *The Artist.* Englewood Cliffs, NJ, 1982. Surveys the parallel social history of the painter and the sculptor.

Alexander Garvin. *The American City: What Works, What Doesn't,* 2nd ed. New York, 2002. An analysis of planning that examines aesthetics, politics, finances, history, and culture.

Spiro Kostof, ed. *The Architect: Chapters in the History of the Profession.* New York, 1977. Consists of chapters written by experts in their respective fields.

Leland M. Roth. *America Builds: Source Documents in American Architecture and Planning.* New York, 1983.

———. *American Architecture: A History.* Boulder, 2001. A comprehensive survey.

Andrew Saint. *The Image of the Architect.* New Haven, CT, 1983. Examines the self-image of the architect in the nineteenth and twentieth centuries, including a discussion of the fictional architect Howard Roark in Ayn Rand's 1943 novel *The Fountainhead.*

CHAPTER 8: ARCHITECTURE, MEMORY, AND ECONOMICS

Hilary Ballon. *New York's Pennsylvania Stations.* New York, 2002.

John Burchard and Albert Bush-Brown. *The Architecture of America: A Social and Cultural History.* Boston, 1961.

John Kenneth Galbraith. *Economics, Peace, and Laughter.* Boston, 1971.

Paul Goldberger. *Why Architecture Matters.* New Haven, CT, 2009.

Ada Louise Huxtable. *Goodbye History, Hello Hamburger.* Washington, DC, 1986.

Lewis Mumford. *Architecture.* Chicago, 1926.

———. *The Highway and the City.* New York, 1963.

Leland M. Roth. *McKim, Mead & White, Architects.* New York, 1983.

John Ruskin. *The Seven Lamps of Architecture.* London, 1849.

CHAPTER 9: THE BEGINNINGS OF ARCHITECTURE: FROM CAVES TO CITIES

R.J.C. Atkinson. *Stonehenge.* Baltimore, 1960.

Michael Balter. "Çatalhöyük: How a Flamboyant Englishman Found the World's Largest Stone Age Village." *Archaeology Odyssey* 8 (May/June 2005): 16–25, 50–51. Balter is the archaeology writer for the journal *Science.*

———. *The Goddess and the Bull: Çatalhöyük—An Archaeological Journey to the Dawn of Civilization.* New York, 2005.

———. "The Seeds of Civilization." *Smithsonian* 36 (May 2005): 68–74.

George Bataille. *Lascaux.* Geneva, 1955.

Antonio Beltrán, ed. *The Cave of Altamira.* Barcelona and New York, 1998–1999.

Thomas G. Brophy. *The Origin Map: Discovery of a Prehistoric, Megalithic, Astrophysical Map and Sculpture of the Universe* (Bloomington, IN, 2002).

Dale Brown and Edmund White. *The First Men.* New York, 1973.

Göran Burenhult, ed. *People of the Past: The Epic Story of Human Origins and Development.* San Francisco, 2003. An extensive presentation of more recent thinking concerning the paleontology and archaeology of humankind and of Neolithic and Bronze Age settlement, with contributions by fifty scholars and scientists.

Jean-Marie Chauvet, Eliette Brunel Deschamps, and Christian Hillaire. *The Dawn of Art: The Chauvet Cave, the Oldest Known Paintings in the World.* New York, 1996.

V. Gordon Childe. *Man Makes Himself.* London, 1936. Rev. ed., New York, 1951.

———. *Skara Brae.* London, 1931.

Jean Clottes and Jean Courtin. *The Cave Beneath the Sea: Paleolithic Images at Cosquer.* Paris and New York, 1994–1996.

Desmond Collins. *The Human Revolution: From Ape to Artist.* Oxford, 1977.

George Constable. *The Neanderthals.* New York, 1973.

John Darnton. *Neanderthal.* New York, 1997.

Brian Fagan. *Ancient Lives: An Introduction to Archaeology and Prehistory,* 5th ed. Boston, 2012.

———. *Cro-Magnon: How the Ice Age Gave Birth to the First Modern Humans.* New York, 2010.

Brian Fagan, ed. *Avenues to Antiquity: Readings from Scientific American.* San Francisco, 1975. Contains articles by Henry de Lumley on Terra Amata as well as other essays on Ukrainian settlements.

Shahina Farid. "Çatalhöyük: Modern Excavations." *Archaeology Odyssey* 8 (May/June 2005): 26–32. Farid is the excavation site director for Çatalhöyük.

Clive Finlayson. *Neanderthals and Modern Humans: An Ecological and Evolutionary Perspective.* New York, 2004.

Sigfried Giedion. *The Eternal Present,* Vol. 1: *The Beginnings of Art.* New York, 1962.

———. *The Eternal Present,* Vol. 2: *The Beginnings of Architecture.* New York, 1964.

Gerald S. Hawkins. *Stonehenge Decoded.* Garden City, NY, 1965.

André Leroi-Gourhan. *Prehistoire de l'art occidentale,* 3rd ed. Paris, 1973.
———. *The Art of Prehistoric Man in Western Europe* (translation of *Prehistoire de l'art occidentale*). London, 1968.
David Lewis-Williams. *The Mind in the Cave: Consciousness and the Origins of Art.* London and New York, 2002.
Euan Mackie. *The Megalith Builders.* Oxford, 1977.
James Mellaart. *Çatal Hüyük: A Neolithic Town in Anatolia.* New York, 1977.
Paul Mellars. *The Neanderthal Legacy: An Archaeological Perspective of Western Europe.* Princeton, 1995.
Tom Prideaux. *Cro-Magnon Man.* New York, 1973.
Mario Ruspoli. *The Cave at Lascaux: The Final Photographs.* Paris and New York, 1986–1987.
N. K. Sandars. *Prehistoric Art in Europe,* 2nd ed. New Haven, CT, 1985.
Ann Sieveking. *The Cave Artists.* London, 1979.
Olga Soffer. *The Upper Paleolithic of the Central Russian Plain.* Orlando, 1985.
Robert S. Soleckei. *Shanidar: The First Flower People.* New York, 1971.
Michael Van Walleghen. *The Last Neanderthal.* Pittsburgh, 1999.
Fred Wendorf et al. *Holocene Settlement of the Egyptian Sahara.* New York, 2001.
Robert Wernick. *The Monument Builders.* New York, 1973.
Randall White. *Prehistoric Art: A Global Perspective.* New York, 2003.

CHAPTER 10: THE ARCHITECTURE OF MESOPOTAMIA AND ANCIENT EGYPT

Dieter Arnold. *Building in Egypt: Pharonic Stone Masonry.* New York, 1991.
———. *The Encyclopedia of Ancient Egyptian Architecture.* Cairo, 2003.
Alexander Badawy. *Architecture in Ancient Egypt and the Near East.* Cambridge, MA, 1966.
———. *A History of Egyptian Architecture,* 3 vols. Berkeley, 1954–1968.
M. L. Bierbrier. *The Tomb-Builders of the Pharaohs.* London, 1982.
Göran Burenhult. *Old World Civilizations: The Rise of Cities and States.* New York, 1994.
Lionel Carsen. *Ancient Egypt.* New York, 1965.
Rosalie David. *Handbook to Life in Ancient Egypt,* rev. ed. New York, 2003.
I.E.S. Edwards. *The Pyramids of Egypt,* rev. ed. Baltimore, 1961.
Ahmen Fakhry. *The Pyramids,* 2nd ed. Chicago, 1969.
James Fitchen. "Building Cheop's Pyramid," *Journal, Society of Architectural Historians* 37 (March 1978): 3–12.
Henri Frankfort. *The Art and Architecture of the Ancient Orient,* 5th ed. New Haven, CT, 1996.
Charles Gates. *Ancient Cities: The Archaeology of Urban Life in the Ancient Near East and Egypt, Greece and Rome.* London, 2003.
Sigfried Giedion. *The Eternal Present,* Vol. 1: *The Beginnings of Architecture.* New York, 1964.
Dora Jane Hamblin. *The First Cities.* New York, 1973.
Kevin Jackson and Jonathan Stamp. *Building the Great Pyramid.* Westport, CN, 2003.
T.G.H. James. *Introduction to Ancient Egypt.* New York, 1989.
Paul Jordan. *Egypt: The Black Land.* New York, 1976.
Paul Lampl. *Cities and Planning in the Ancient Near East.* New York, 1968.
Mark Lerner. *The Complete Pyramids.* London, 1997.
Seton Lloyd, Hans Wolfgang Müller, and Roland Martin. *Ancient Architecture: Mesopotamia, Egypt, Crete, Greece.* New York, 1973.
Kurt Mendelssohn. *The Riddle of the Pyramids.* New York, 1974.
John Romer. *Ancient Lives: Daily Life in Egypt of the Pharaohs.* New York, 1984.
Regine Schulz and Matthias Seidl, eds. *Egypt: The World of the Pharaohs.* English edition, Potsdam, 2010; German edition, Köln, 2004.
Earl Baldwin Smith. *Egyptian Architecture As Cultural Expression.* New York, 1938; reprint, Watkins Glen, NY, 1968.
W. Stevenson Smith. *The Art and Architecture of Ancient Egypt,* 3rd ed., revised. New Haven, CT, 1999.
Desmond Stewart. *The Pyramids and the Sphinx: Egypt Under the Pharaohs.* New York, 1977.
Jon Manchip White. *Everyday Life in Ancient Egypt.* New York, 1963.
Ruth Whitehouse. *The First Cities.* Oxford, 1977.
Richard H. Wilkinson. *The Complete Temples of Ancient Egypt.* New York, 2000.
John A. Wilson. *The Burden of Egypt: An Interpretation of Ancient Egyptian Culture.* Chicago, 1951.

CHAPTER 11: GREEK ARCHITECTURE

Mary Beard. *The Parthenon.* Cambridge, MA, 2010.
M. Bieber. *The History of the Greek and Roman Theater.* Princeton, 1961.
J. S. Boersma. *Athenian Building Policy from 561/0 to 405/4 B.C.* Groningen, The Netherlands, 1970.
H. Brevé, G. Gruben, and M. Hirmer. *Greek Temples, Theaters, and Shrines.* London, 1963.
V. J. Bruno, ed. *The Parthenon.* New York, 1974.

John M. Camp. *The Archaeology of Athens.* New Haven, CT, 2002.
———. *The Athenian Agora: Excavations in the Heart of Classical Athens.* London, 1986.
R. Carpenter. *The Architects of the Parthenon.* Baltimore, 1970.
F. Castagnoli. *Orthogonal Town Planning in Antiquity.* Cambridge, MA, 1971.
J. J. Coulton. *Ancient Greek Architects at Work.* Ithaca, NY, 1977.
———. *The Architectural Development of the Greek Stoa.* Oxford, 1976.
W. B. Dinsmoor. *The Architecture of Ancient Greece,* 3rd ed., rev. New York, 1975.
A. Evans. *The Palace of Minos.* New York, 1921. Now dated but a lively account by the archaeologist who excavated this site.
J. W. Graham. *The Palaces of Crete.* Princeton, 1962.
R. Higgins. *Minoan and Mycenaean Art.* New York, 1967.
Wolfram Hoepfner and Ernst-Ludwig Schwandner. *Haus und Stadt im klassichen Greichland.* Munich, 1994.
J. M. Hurwit. *The Acropolis in the Age of Pericles.* Cambridge, England, 2004.
———. *The Art and Culture of Early Greece, 1100–480 B.C.* Ithaca, NY, 1985.
———. *The Athenian Acropolis: History, Mythology, and Archaeology from the Neolithic Era to the Present.* New York, 1999.
H.D.F. Kitto. *The Greeks,* rev. ed. Baltimore, 1957.
Arnold W. Lawrence. *Greek Architecture,* 5th ed. New Haven, CT, 1987.
P. MacKendrick. *The Greek Stones Speak: The Story of Archaeology in Greek Lands.* New York, 1962.
Nanno Marinatos. *Minoan Religion: Ritual, Image, and Symbol.* Columbia, SC, 1993.
R. D. Martienssen. *The Idea of Space in Greek Architecture.* Johannesburg, 1956.
J. J. Pollitt. *Art and Experience in Classical Greece.* New York, 1972.
Donald Preziosi and Louise Hitchcock. *Aegean Art and Architecture.* New York and Oxford, 2000.
Robin F. Rhodes. *Architecture and Meaning on the Athenian Acropolis.* Cambridge, England, 1995.
Donald S. Robertson, *A Handbook of Greek and Roman Architecture,* 2nd ed., rev. Cambridge, England, 1954.
V. Scully. *The Earth, the Temple, and the Gods,* rev. ed. New Haven, CT, 1979.
J. Travlos. *Pictorial Dictionary of Ancient Athens.* London, 1971.
J. B. Ward-Perkins. *Cities of Ancient Greece and Italy: Planning in Classical Antiquity.* New York, 1974.
R. E. Wycherley. *How the Greeks Built Cities.* New York, 1962.
———. *The Stones of Athens.* Princeton, 1978.

CHAPTER 12: ROMAN ARCHITECTURE

R. H. Barrow. *The Romans.* Baltimore, 1949.
Axel Boëthius. *Etruscan and Early Roman Architecture,* 2nd ed., rev. New Haven, CT, 1987.
Frank E. Brown. *Roman Architecture.* New York, 1961.
Mark Wilson Jones. *Principles of Roman Architecture.* New Haven, CT, 2003.
Heinz Kähler. *The Art of Rome and Her Empire.* New York, 1963.
T. Kraus and L. von Matt. *Pompeii and Herculaneum.* Translated by E. Wolf. New York, 1973.
William L. MacDonald. *The Architecture of the Roman Empire,* Vol. 1: *An Introductory Story.* New Haven, CT, 1965.
———. *The Architecture of Rome,* Vol. 2: *An Urban Appraisal.* New Haven, CT, 1986.
———. *The Pantheon: Design, Meaning, and Progeny.* Cambridge, MA, 1976.
A. G. Mackay. *Houses, Villas, and Palaces in the Roman World.* London, 1975.
Paul MacKendrick. *The Mute Stones Speak: The Story of Archaeology in Italy.* New York, 1960.
L. S. Mazzolani. *The Idea of the City in Roman Thought.* Translated by S. O'Donnell. Bloomington, IN, 1970.
R. Meiggs. *Roman Ostia.* Oxford, 1973.
Morris Hicky Morgan, *The Ten Books of Architecture.* Cambridge, MA, 1914. A translation of Vitruvius's *On Architecture.*
E. Nash. *Pictorial Dictionary of Ancient Rome,* 2 vols. London, 1961–1962.
James E. Packer. *The Forum of Trajan in Rome: A Study of the Monuments.* Berkeley, 1997.
Lawrence Richardson. *Pompeii: An Architectural History.* Baltimore, 1988.
Donald S. Robertson. *A Handbook of Greek and Roman Architecture,* 2nd ed. Cambridge, England, 1954.
Frank Sear. *Roman Architecture.* London, 1982.
M. Vitruvius. *On Architecture,* 2 vols. Translated by F. Granger. Cambridge, MA, 1931.
John B. Ward-Perkins. *Cities of Ancient Greece and Italy: Planning in Classical Antiquity.* New York, 1974.
———. *Roman Imperial Architecture.* New York, 1981.
Mortimer Wheeler. *Roman Art and Architecture.* New York, 1964.

ESSAY 1: INDIAN ARCHITECTURE

Vidya Dehejia. *Indian Art.* London, 1997.

Satish Grover. *The Architecture of India: Buddhist and Hindu.* New Delhi, 1980.
Susan L. Huntington and John C. Huntington. *The Art of Ancient India: Buddhist, Hindu, Jain.* New York, 1985.
Thomas R. Metcalf. *An Imperial Vision: Indian Architecture and Britain's Raj.* Berkeley, 1989.
George Michell. *Hindu Art and Architecture.* London and New York, 2000.
———. *The Hindu Temple: An Introduction to Its Meaning and Forms,* 2nd ed. Chicago, 1988.
Jan Morris. *Stones of Empire: The Buildings of the Raj.* Oxford and New York, 1983.
R. Nath. *Islamic Architecture and Culture in India.* Delhi, 1982.
Benjamin Rowland. *The Art and Architecture of India,* 3rd ed. Baltimore, 1967.
Christopher Tagdell. *The History of Architecture in India: From the Dawn of Civilization to the End of the Raj.* London, 1994.

CHAPTER 13: EARLY CHRISTIAN AND BYZANTINE ARCHITECTURE

Roland H. Bainton. *Christendom: A Short History of Christianity,* 2 vols. New York, 1974.
J. Beckwith. *The Art of Constantinople.* New York, 1961.
William C. Brumfield. *Gold in Azure: One Thousand Years of Russian Architecture.* Boston, 1983.
J. Davies. *The Origin and Development of Early Christian Church Art.* London, 1952.
O. Demus. *The Church of San Marco in Venice.* Cambridge, MA, 1960.
George Heard Hamilton. *The Art and Architecture of Russia,* 3rd ed. New Haven, CT, 1992.
Heinz Kähler. *Hagia Sophia.* Translated by E. Childs. New York, 1967.
Spiro Kostof. *The Orthodox Baptistery of Ravenna.* New Haven, CT, 1965.
Richard Krautheimer. *Early Christian and Byzantine Architecture,* 4th ed. New York, 1986.
———. *Rome: Profile of a City, 312–1308.* Princeton, 1980.
John Lowden. *Early Christian and Byzantine Architecture.* London, 1997.
William L. MacDonald. *Early Christian and Byzantine Architecture.* New York, 1962.
Rowland J. Mainstone. *Hagia Sophia: Architecture, Structure, and Liturgy of Justinian's Great Church.* London, 1988.
Cyril Mango. *Byzantine Architecture.* New York, 1977.
T. F. Mathews, *Early Churches of Constantinople, Architecture and Liturgy.* University Park, PA, 1971.
David Talbot Rice. *Art of the Byzantine Era.* New York, 1963.
S. Runciman. *Byzantine Style and Civilization.* Harmondsworth, England, 1975.
E. B. Smith. *The Dome: A Study in the History of Ideas.* Princeton, 1950.
E. H. Swift. *Hagia Sophia.* New York, 1940.
Robert L. Van Nice. *Saint Sophia in Istanbul: An Architectural Survey.* Washington, DC, 1965.

ESSAY 2: ISLAMIC ARCHITECTURE

Bianca Maria Alfieri and F. Borromeo. *Islamic Architecture of the Indian Subcontinent.* London and New York, 2000.
Catherine B. Asher. *Architecture of Mughal India.* Cambridge, England, and New York, 1992.
Sheila Blair and Jonathan M. Bloom. *The Art and Architecture of Islam, 1250–1800.* New Haven, CT, 1996.
Issam El-Said. *Islamic Architecture: The System of Geometric Design.* Reading, England, 1993.
Richard Ettinghausen, Oleg Grabar, and Marilyn Jenkins-Madina. *Islamic Art and Architecture, 650–1250.* New Haven, CT, 2002.
M. Frishman and H.-U. Kahn. *The Mosque: History, Architectural Development, and Regional Diversity.* London, 1994.
Oleg Grabar. *The Formation of Islamic Art.* New Haven, CT, 1973.
Robert Hillenbrand. *Islamic Architecture: Form, Function, and Meaning.* New York, 2004.
John D. Hoag. *Islamic Architecture.* New York, 1987.
———. *Western Islamic Architecture.* New York, 1963.
J. Kehrman. *Earthly Paradise: Garden and Courtyard in Islam.* London, 1980.
E. Koch. *Mughal Architecture: An Outline of History and Development.* Munich, 1991.
George Michell, ed. *Architecture of the Islamic World: Its History and Social Meaning.* New York, 1978.
R. Nath. *Art & Architecture of the Taj Mahal.* Agra, India, 1996.
Jean-Louis Nou. *Taj Mahal.* New York, 1993.
Diana Preston. *A Teardrop on the Cheek of Time: The Story of the Taj Mahal.* London, 2008.
M. Sevcenko, ed. *Theories and Principles of Design in Architecture of Islamic Societies.* Cambridge, England, 1988.
Henri Stierlin. *Islamic Art and Architecture: From Isfahan to the Taj Mahal.* New York, 2002.

CHAPTER 14: MEDIEVAL ARCHITECTURE

William Anderson. *Castles of Europe from Charlemagne to the Renaissance.* London, 1970.

Günter Bandmann. *Early Medieval Architecture As Bearer of Meaning.* Translated by K. Wallis. New York, 1995.

John Beckwith. *Early Medieval Art.* Translated by M. M. Postan. New York, 1964.

Maurice Beresford and John Hurst. *Wharam Percy: Deserted Medieval Village.* New Haven, CT, 1991. A valuable treatment of nonmonumental medieval architecture.

Marc Bloch. *Feudal Society.* Chicago, 1968.

Jean Bony. *French Gothic Architecture of the Twelfth and Thirteenth Centuries.* Berkeley, 1983.

Robert Branner. *Chartres Cathedral.* New York, 1969.

———. *Gothic Architecture.* New York, 1961.

Wolfgang Braunfels. *Monasteries of Western Europe: The Architecture of the Orders.* Translated by A. Laing. Princeton, 1973.

R. Allen Brown. *The Architecture of Castles: A Visual Guide.* New York, 1984.

Donald A. Bullough. *The Age of Charlemagne.* New York and London, 1966.

Robert Calkins. *Medieval Architecture in Western Europe, AD 300–AD 1500.* New York, 1998.

Nicola Coldstream. *Medieval Architecture.* Oxford, 2002.

Kenneth J. Conant. *Carolingian and Romanesque Architecture, 800 to 1200,* 4th ed. New Haven, CT, 1992.

———. *Cluny: Les églises et la maison du chef d'ordre.* Macon, France, 1968.

George Gordon Coulton. *The Medieval Village, Manor, and Monastery.* New York, 1960.

Joan Evans. *Monastic Life at Cluny, 910–1157.* London, 1931.

Brian Fagan. *The Little Ice Age: How Climate Made History, 1300–1850.* New York, 2001.

John Fitchen. *The Construction of Gothic Cathedrals: A Study of Medieval Vault Erection.* New York, 1961.

Henri Focillon. *The Art of the West in the Middle Ages,* Vol. 1: *Romanesque Art.* London, 1963.

———. *The Art of the West in the Middle Ages,* Vol. 2: *Gothic Art.* New York, 1963.

Paul Frankl. *Gothic Architecture,* 2nd ed. New Haven, CT, 2001.

Joseph Gies and Frances Gies. *Life in a Medieval Village.* New York, 1990.

Jean Gimpel. *The Cathedral Builders.* Translated by Teresa Waugh. New York, 1983.

Louis Grodecki. *Gothic Architecture.* Translated by I. M. Paris. New York, 1977.

John Harvey. *The Gothic World, 1100–1600.* London, 1950.

———. *The Master Builders: Architecture in the Middle Ages.* London, 1971.

Denys Hay. *Europe in the Fourteenth and Fifteenth Centuries.* New York, 1966.

George Henderson. *Early Medieval.* Harmondsworth, England, 1972.

———. *Gothic.* Harmondsworth, England, 1967.

Walter Horn and Ernst Born. *The Plan of St. Gall,* 3 vols. Berkeley, 1979.

Johan Huizinga. *The Waning of the Middle Ages.* London, 1924; New York, 1954.

Hans Jantzen. *High Gothic: The Classic Cathedrals of Chartres, Reims, Amiens.* Translated by James Palmes. Princeton, 1983.

Peter Kidson. *The Medieval World.* New York, 1967.

Hans Erich Kubach. *Romanesque Architecture.* New York, 1972.

Walter Leedy. *Fan Vaulting: A Study of Form, Technology, and Meaning.* London, 1980.

Joseph Lynch. *The Medieval Church: A Brief History.* London and New York, 1992.

Emil Male. *Religious Art in France: The Twelfth Century.* Princeton, 1978.

Robert Mark. *Experiments in Gothic Structure.* Cambridge, MA, 1982. A highly interesting account of engineering analyses of selected Gothic churches.

Erwin Panofsky. *Abbot Suger on the Abbey Church of St.-Denis and Its Art Treasures,* 2nd ed. Princeton, 1979.

———. *Gothic Architecture and Scholasticism.* New York, 1957.

Henri Pirenne. *Medieval Cities: Their Origins and the Revival of Trade.* Translated by Frank D. Halsey. Princeton, 1952.

Talbot D. Rice, ed. *Dawn of European Civilization.* New York, 1965.

Fritz Rörig. *The Medieval Town.* Berkeley, 1971.

J. C. Russell. *Medieval Cities and Their Regions.* Bloomington, IN, 1972.

Howard Saalman. *Medieval Architecture.* New York, 1962.

———. *Medieval Cities.* New York, 1968.

Veronica Sekules. *Medieval Art.* Oxford, 2001.

Otto von Simson. *The Gothic Cathedral: Origins of Gothic Architecture and the Medieval Concept of Order,* 2nd ed. New York, 1962.

Earl Baldwin Smith. *The Architectural Symbolism of Imperial Rome and the Middle Ages.* Princeton, 1956.

Richard William Southern. *The Making of the Middle Ages.* New Haven, CT, 1953.

Roger Stalley. *Early Medieval Architecture.* New York, 2000.

Marilyn Stokstad. *Medieval Art,* 2nd ed. Boulder, CO, 2003.

Geoffrey F. Webb. *Architecture in Britain: The Middle Ages.* Harmondsworth, England, 1956.

John White. *Art and Architecture in Italy, 1250–1400,* 3rd ed. New Haven, CT, 1993.
Christopher Wilson. *The Gothic Cathedral. The Architecture of the Great Church, 1130–1530.* London, 1990.

CHAPTER 15: RENAISSANCE ARCHITECTURE

James Ackerman. *The Architecture of Michelangelo,* 2nd ed. London, 1986.
———. *Palladio.* Baltimore, 1966.
Leon Battista Alberti. *De re aedificatoria: On the Art of Building in Ten Books.* Translated by J. Rykwert, N. Leach, and R. Tavernor. Cambridge, MA, 1988.
Giulio C. Aragon. *The Renaissance City.* New York, 1969.
E. Battisti. *Filippo Brunelleschi.* New York, 1981.
Anthony Blunt. *Art and Architecture in France, 1500 to 1700,* 4th ed. New York, 1980.
———. *Artistic Theory in Italy, 1450–1600.* Oxford, 1940.
Bruce Cole. *Italian Art, 1250–1550: The Relation of Renaissance Art to Life and Society.* New York, 1987.
Giovanni Fanelli. *Brunelleschi.* Florence, 1980.
Joan Gadol. *Leon Battista Alberti: Universal Man of the Renaissance.* Chicago, 1969.
Richard Goldthwaite. *The Building of Renaissance Florence: An Economic and Social History.* Baltimore, 1980.
Ludwig H. Heydenreich. *Architecture in Italy, 1400–1500.* Revised by Paul Davies. New Haven, CT, 1996.
Ludwig H. Heydenreich and Wolfgang Lotz. *Architecture in Italy, 1400 to 1600.* Translated by Mary Hottinger. Baltimore, 1974.
Christopher Hibbert. *The Rise and Fall of the House of Medici.* London, 1974.
Norman Johnston. *Cities in the Round.* Seattle, 1983.
Ross King. *Brunelleschi's Dome: How a Renaissance Genius Reinvented Architecture.* London and New York, 2000.
Claudia Lazzaro. *The Italian Renaissance Garden: From the Conventions of Planting, Design, and Ornament to the Grand Gardens of Sixteenth-Century Central Italy.* New Haven, CT, 1990.
Wolfgang Lotz. *Architecture in Italy, 1500–1600.* Revised by Deborah Howard. New Haven, CT, 1995.
G. Masson. *Italian Villas and Palaces.* London, 1959.
Peter Murray. *The Architecture of the Italian Renaissance.* London, 1963.
———. *Renaissance Architecture.* New York, 1977.
Norman Newton. *Design on the Land: The Development of Landscape Architecture.* Cambridge, MA, 1971. Contains excellent discussions of Renaissance villas and gardens.
Paolo Portoghesi. *Rome of the Renaissance.* Translated by P. Sanders. London, 1972. Useful for its illustrations.
John Shearman. *Mannerism.* Harmondsworth, England, 1967.
J. C. Shepherd and G. A. Jellicoe. *Italian Gardens of the Renaissance.* London, 1925; new ed. Princeton, 1986. Dated, but useful for its illustrations.
Christine Smith. *Architecture in the Culture of Early Humanism: Ethics, Aesthetics, and Eloquence, 1400–1470.* New York, 1992.
John Summerson. *Architecture in Britain, 1530 to 1830,* 6th ed. New York, 1977.
M. Wackernagel. *The World of the Florentine Renaissance Artist.* Translated by A. Luchs. Princeton, 1981.
David Watkin. *A History of Western Architecture.* London and New York, 1986. Has good summaries of the spread of Renaissance architecture throughout Europe.
Dora Wiebenson, ed. *Architectural Theory and Practice from Alberti to Ledoux.* Chicago, 1982.
Rudolf Wittkower. *Architectural Principles in the Age of Humanism,* rev. ed. London, 1962.

ESSAY 3: ANCIENT ARCHITECTURE IN THE AMERICAS

Elizabeth P. Benson and Beatriz de la Fuente, eds. *Olmec Art of Mexico.* Washington, DC, 1996.
Kathleen Berrin and Esther Paztory. *Art from the City of the Gods.* London, 1993.
Elizabeth Hill Boone. *The Aztec World.* Montreal, 1994.
J. J. Brody. *The Anasazi: Ancient Indian People of the American Southwest.* New York, 1990.
Román Piña Chan. *The Olmec: Mother Culture of Mesoamerica.* New York, 1989.
Michael D. Coe. *Breaking the Maya Code,* 3rd ed. London and New York, 2012.
———. *The Maya,* 8th ed. London and New York, 2011.
———. *Mexico from the Olmecs to the Aztecs,* 7th ed. New York, 2013.
Michael D. Coe et al. *The Olmec World: Ritual and Rulership.* Princeton, 1996
T. Patrick Culbert. *Maya Civilization.* Montreal, 1993.
Richard A. Diehl. *The Olmecs: America's First Civlization.* London, 2004.
———. *Tula: The Toltec Capital of Mexico.* London and New York, 1983.

Brian M. Fagan. *Ancient North America,* 4th ed. New York, 2005.
———. *Chaco Canyon: Archaeologists Explore the Lives of an Ancient Society*. Oxford and New York, 2005.
Graziano Gasparini and Luise Margolies. *Inca Architecture.* London and Bloomington, IN, 1980.
John Hemming and Edward Ranney. *Monuments of the Incas,* rev. ed. London and New York, 2010.
John S. Henderson. *The World of the Ancient Maya,* 2nd ed. Ithaca, NY, 1997.
George Kubler. *The Art and Architecture of Ancient America: The Mexican, Maya and Andean Peoples,* 3rd ed. New Haven, CT, 1990. Considered a classic in the field.
Joyce Marcus and Kent V. Flannery. *Zapotec Civilization: How Urban Society Evolved in Mexico's Oaxaca Valley.* London and New York, 1996.
Rebecca Stone Miller. *Art of the Andes from Chavín to Inca.* London and New York, 1995.
Laura L. Minelli, ed. *The Inca World: The Development of Pre-Colombian Peru, A.D.: 1000–1534.* Norman, OK, 2000. Includes an essay on Incan architecture by Jean-Pierre Protzen.
Eduardo Matos Moctezuma. *Teotihuacán: City of the Gods.* New York, 1990.
Peter Nabokov and Robert Easton. *Native American Architecture*. New York, 1989.
John M. Pohl. *Exploring Mesoamerica*. Oxford, 1999.
Tatiana Proskouriakoff. *An Album of Maya Architecture*. Mineola, NY, 2003. A reprint of a classic of beautifully detailed drawings showing many restored Mayan buildings. A skilled artist working in the 1940s, Proskouriakoff was one of the first to recognize that Mayan glyphs were the writing of their history.
Jean-Pierre Protzen. *Inca Architecture and Construction at Ollantaytambo.* New York, 1993.
James B. Richardson III. *People of the Andes*. Montreal, 1994.
Jeremy A. Sabloff. *The New Archaeology and the Ancient Maya.* New York, 1990.
Linda Schele. *The Code of Kings: The Language of Seven Sacred Maya Temples and Tombs.* New York, 1999.
Gene S. Stuart. *The Mighty Aztecs*. Washington, DC, 1981.
George E. Stuart and Gene S. Stuart. *The Mysterious Maya.* Washington, DC, 1977.
Victor W. von Hagen. *F. Catherwood: Architect-Explorer of Two Worlds.* Barre, MT, 1968. A study of the English architect who explored Central American in the mid-nineteenth century, making exacting views of Mayan monuments and sculpture.
Ray A. Williamson. *Archaeoastronomy in the Americas*. College Park, MD, 1981.
———. *Living the Sky: The Cosmos of the American Indian*. Boston, 1984.
Ray A. Williamson, ed. *Earth & Sky: Visions of the Cosmos in Native American Folklore*. Albuquerque, 1992.

CHAPTER 16: BAROQUE AND ROCOCO ARCHITECTURE

William Howard Adams. *The French Garden.* New York, 1979.
Germain Bazin. *Baroque and Rococo*. New York, 1964. Now dated, but compact while broad in coverage, including eastern and northern Europe.
Robert W. Berger. *A Royal Passion: Louis XIV As Patron of Architecture*. Cambridge, England, 1994.
Anthony Blunt. *Art and Architecture in France, 1500–1700,* 5th ed., revised by Richard Beresford. New Haven, CT, 1999.
———. *Borromini*. Cambridge, MA, 1979.
———. *François Mansart and the Origins of French Classical Architecture*. London, 1941.
———. *Some Uses and Misuses of the Terms Baroque and Rococo as Applied to Architecture.* London, 1973.
Anthony Blunt, ed. *Baroque and Rococo: Architecture and Decoration.* New York, 1978. A detailed study covering much of Europe through the mid-eighteenth century.
Allan Braham. *François Mansart.* London, 1973.
Kerry Downes. *English Baroque Architecture.* London, 1966.
Sigfried Giedion. *Space, Time, and Architecture,* 5th ed. Cambridge, MA, 1967. Now dated, but contains a useful summary of the planning of Rome by Sixtus V.
Karsten Harries. *The Bavarian Rococo Church.* New Haven, CT, 1983.
Francis Haskell. *Patrons and Painters: A Study in the Relations Between Italian Art and Society in the Age of the Baroque.* London, 1963.
Julius S. Held and Donald Posner. *17th and 18th Century Art: Baroque Painting, Sculpture, Architecture.* New York, 1972.
Eberhard Hempel. *Baroque Art and Architecture in Central Europe*. Baltimore, 1965.
Howard Hibbard. *Bernini.* Baltimore, 1965.
Henry-Russell Hitchcock. *German Rococo: The Zimmermann Brothers.* London, 1968.
———. *Rococo Architecture in Southern Germany.* London, 1968.
Wend Graf Kalnein. *Architecture in France in the Eighteenth Century*. New Haven, CT, 1995.

Richard Krautheimer. *The Rome of Alexander VII, 1655–1667.* Princeton, 1985.
George Kubler and Martin Soria. *Art and Architecture in Spain and Portugal and Their American Dominions.* Baltimore, 1959.
Irving Lavin. *Bernini and the Unity of Visual Arts.* New York, 1980.
John Rupert Martin. *Baroque.* New York, 1977.
Harold Alan Meek. *Guarino Guarini and His Architecture*. New Haven, CT, 1988.
Henry A. Millon. *Baroque and Rococo Architecture.* New York, 1961.
———. *The Triumph of the Baroque: Architecture in Europe, 1600–1750.* New York, 1999.
Christian Norberg-Schulz. *Baroque Architecture.* New York, 1974.
———. *Late Baroque and Rococo Architecture.* New York, 1974.
Christian Otto. *Space into Light: The Churches of Balthasar Neumann.* New York, 1979.
Richard Pommer. *Eighteenth-Century Architecture in Piedmont.* New York, 1967.
Paolo Portoghesi. *Borromini.* London, 1968.
———. *Roma Barocca: The History of an Architectonic Culture.* Cambridge, MA, 1970.
———. *The Rome of Borromini: Architecture As Language.* New York, 1968.
Clare Robertson. *"Il Gran Cardinale": Alessandro Farnese, Patron of the Arts.* New Haven, CT, 1992.
John Summerson. *Architecture in Britain, 1530 to 1830,* 6th ed. New York, 1977.
Rolf Toman, ed. *Baroque: Architecture, Sculpture, Painting*. Cologne, 1998.
John Varriano. *Italian Baroque and Rococo Architecture.* New York, 1986.
Rudolf Wittkower. *Art and Architecture in Italy, 1600–1750,* 6th ed. Revised by Joseph Connors and Jennifer Montagu. New Haven, CT, 1999.
———. *Studies in the Italian Baroque.* London, 1975.

ESSAY 4: CHINESE ARCHITECTURE

Almut E. I. Bettels. *Traditional Architecture in China*. Wabern, Germany, 2002.
Andrew Boyd. *Chinese Architecture and Town Planning, 1500 B.C.–A.D. 1911*. Chicago, 1962.
Chinese Academy of Science. *Ancient Chinese Architecture*. Beijing and Hong Kong, 1982.
Fang Xiaofeng, *The Great Gardens of China: History, Concepts, Techniques*. New York, 2010.
Fu Xinian et al. *Chinese Architecture,* trans. Nancy S. Steinhardt. New Haven, CT, 2002. Contains a detailed treatment.
Dieter Hassenpflug. *The Urban Code of China.* Basel, 2010.
Toshir Inaji. *The Garden As Architecture: Form and Spirit in the Gardens of Japan, China, and Korea.* Tokyo and New York, 1998.
Liang Ssu-Ch'eng. *Chinese Architecture: A Pictorial History*. Mineola, NY, 2005.
Liu Dunzhen and Joseph C. Wang, *Chinese Classical Gardens of Suzhou*. New York, 1993.
Laurence G. Liu. *Chinese Architecture*. New York, 1989.
Tuo Liu. *Classical Gardens in China*. New York, 2012.
Yun Qiao, Yang Gusheng, Chen Xiaoli and Cheng Liyao. *Classical Chinese Gardens*. Hong Kong, 1982.
Lou Qingxi. *Chinese Gardens*. New York, 2011.
Yang Hongxun and Hui Min Wang, *The Classical Gardens of China: History and Design Techniques*. New York, 1982.
Maurizio Scarpari. *Splendours of Ancient China.* London, 2000.
Laurence Sickman and Alexander Soper. *The Art and Architecture of China,* 3rd ed. Baltimore, 1971.
Nancy Shatzman Steinhardt. *Chinese Traditional Architecture*. New York, 1984.
Frances Ya-sing Tsu. *Landscape Design in Chinese Gardens*. New York, 1988.
William Watson. *The Arts of China to A.D. 900*. New Haven, CT, 1995.
Nelson I. Wu. *Chinese and Indian Architecture*. New York, 1963.

CHAPTER 17: THE ORIGINS OF MODERNISM: ARCHITECTURE IN THE AGE OF ENLIGHTENMENT, 1720–1790

Carl Becker. *The Heavenly City of the Eighteenth Century Philosophers.* New Haven, CT, 1932. Controversial but informative.
Leonardo Benevolo. *History of Modern Architecture,* 2 vols. Translated by H. J. Landry. Cambridge, MA, 1971. In particular, see 1:3–37.
Barry Bergdoll. *European Architecture, 1750–1890.* New York, 2000. Although compact, the best survey of this period, with an excellent bibliographical essay.
Allan Branham. *The Architecture of the French Enlightenment.* Berkeley, 1980.
Peter Collins. *Changing Ideals in Modern Architecture,* 2nd ed. London, 1965.
Peter Gay. *Age of Enlightenment.* New York, 1966.
———. *The Enlightenment: An Interpretation,* 2 vols. London, 1966–1969.
N. Hampson. *The Enlightenment*. Harmondsworth, England, 1968.
Wolfgang Herrmann. *Laugier and Eighteenth-Century French Theory.* London, 1962.

Sigfried Giedion. *Space, Time, and Architecture,* 6th ed. Cambridge, MA, 1967.

Henry-Russell Hitchcock. *Architecture; Nineteenth and Twentieth Centuries,* 4th ed. Baltimore, 1977.

Hugh Honour. *Neo-classicism*. Baltimore, 1968.

Christopher Hussey. *The Picturesque*. London, 1927.

Edward Hyams. *The English Garden.* London, 1962.

Dawn Jacobson. *Chinoiserie*. London, 1993.

Wend Graf Kalnein. *Architecture in France in the Eighteenth Century*. New Haven, CT, 1995.

Emil Kaufmann. *Architecture in the Age of Reason*. Cambridge, MA, 1955, and New York, 1968. Now dated, but still a useful overview.

Marc-Antoine Laugier. *Essai sur l'architecture* (An Essay on Architecture). Translated by Wolfgang and Anni Herrmann. Los Angeles, 1977.

Dominique de Ménil. *Visionary Architects: Boullée, Ledoux, Lequeu.* Houston, 1968.

Robin Middleton and David Watkin. *Neo-Classical and 19th Century Architecture.* New York, 1977.

Norman T. Newton. *Design on the Land: The Development of Landscape Architecture.* Cambridge, MA, 1971.

Nikolaus Pevsner. *History of Building Types.* Princeton, 1976.

Robert Rosemblum. *Transformations in Late Eighteenth Century Art*. Princeton, 1969.

Joseph Rykwert. *The First Moderns: The Architects of the Eighteenth Century.* Cambridge, MA, 1980.

———. *On Adam's House in Paradise.* New York, 1972.

John Summerson. *The Architecture of the Eighteenth Century.* London, 1986.

Dora Wiebenson. *The Picturesque Garden in France.* Princeton, 1978.

———. *Sources of Greek Revival Architecture.* London, 1969.

Rudolf Wittkower. *Palladio and English Palladianism.* London, 1974.

ESSAY 5: JAPANESE ARCHITECTURE

William Alex. *Japanese Architecture*. New York, 1963.

Werner Blaser. *Japanese Temples and Tea-Houses*. New York, 1956.

Delmer M. Brown, ed. *The Cambridge History of Japan: Ancient Japan*. Cambridge, England, 1993.

Heinrich Engel. *The Japanese House: A Tradition for Contemporary Architecture*. Tokyo and Rutland, VT, 1964.

Jiro Harada. *The Lessen of Japanese Architecture,* rev. ed. London, 1954.

Toshiro Inaji. *The Garden As Architecture: Form and Spirit in the Gardens of Japan, China, and Korea*. Tokyo and New York, 1998.

Arata Isozaki. *Katsura Villa: Space and Form.* New York, 1987.

Teiji Itoh and Yukio Futagawa. *Traditional Japanese Houses.* New York, 1980.

Andrew Juniper. *Wabi Sabi: The Japanese Art of Impermanence*. North Clarendon, VT, 2003.

Okakura Kakuzo. *The Book of Tea*. London, 1906. Among other editions see *The Book of Tea*, New York, 1964, edited with an Introduction by Everett F. Bleiler.

Penelope Mason. *History of Japanese Art*. New York, 1993.

Geeta K. Mehta and Kimie Tada. *Japanese Gardens: Tranquility, Simplicity, Harmony*. Tokyo and Rutland, VT, 2008.

Edward S. Morse. *Japanese Homes and Their Surroundings.* Boston, 1886, and New York, 1961.

Kazuo Nishi, *What Is Japanese Architecture? A Survey of Traditional Japanese Architecture*. Translated by H. Mack Horton. Tokyo and New York, 1996.

Kiyoyuki Nishihara. *Japanese Houses: Patterns for Living.* Tokyo, 1967.

Günter Nitschke. *From Shinto to Ando: Studies in Architectural Anthropology in Japan*. London, 1993.

Robert Treat Paine and Alexander Soper, with D. B. Waterhouse and Bunji Kobayashi. *The Art and Architecture of Japan,* 3rd ed. New York, 1981.

Richard R. Powell. *Wabi Sabi Simple*. Cincinnati, 2004.

Joan Stanley-Baker. *Japanese Art*. London and New York, 2000.

Nancy S. Steinhardt, ed. *Chinese Architecture*. New Haven, CT, 2002.

Seno Tanaka. *The Tea Ceremony*. New York, 1977.

Kenzo Tange and Nooru Kawazoe. *Ise: Prototype of Japanese Architecture*. Cambridge, MA, 1965.

Atsushi Ueda. *The Inner Harmony of the Japanese House*. Tokyo and New York, 1990.

Langdon Warner. *The Enduring Art of Japan.* Cambridge, MA, 1952.

David Young and Michiko Kimura Young. *The Art of Japanese Architecture* (Tokyo and Rutland, VT, 2007.

CHAPTER 18: THE ROOTS OF MODERNISM: THE NINETEENTH CENTURY

Leonardo Benevolo. *History of Modern Architecture,* 2 vols. Translated by H. J. Landry. Cambridge, MA, 1971.

———. *The Origins of Modern Town Planning*. Translated by H. J. Landry. Cambridge, MA, 1967.

Richard G. Carrott. *The Egyptian Revival: Its Sources, Monuments, and Meaning, 1808–1858.* Berkeley, 1978.

François Choay. *The Modern City: Planning in the Nineteenth Century.* New York, 1969.
Kenneth Clark. *The Gothic Revival: An Essay in the History of Taste*. London, 1950.
Peter Collins. *Changing Ideals in Modern Architecture.* London, 1965.
Carl W. Condit. *American Building,* 2nd ed. Chicago, 1982.
———. *The Chicago School of Architecture.* Chicago, 1964.
Roger Dixon and Stefan Muthesius. *Victorian Architecture.* New York, 1978.
Arthur Drexler, ed. *The Architecture of the École des Beaux-Arts.* New York, 1977. Includes an essay on Labrouste's Bibliothèque Sainte-Geneviève by Neil Levine.
Georg Germann. *Gothic Revival in Europe and Britain*. Translated by G. Onn. London, 1972.
Sigfried Giedion. *Space, Time, and Architecture,* 5th ed. Cambridge, MA, 1967.
David Handlin. *American Architecture.* London, 1985.
George Hersey. *High Victorian Gothic.* Baltimore, 1972.
Henry-Russell Hitchcock. *Architecture: Nineteenth and Twentieth Centuries,* 4th ed. New York, 1977.
———. *Early Victorian Architecture in Britain,* 2 vols. New Haven, CT, 1954.
Ebenezer Howard. *Garden City of To-morrow* (Cambridge, MA, 1965). This is a reprint of the original book started as *To-morrow: A Peaceful Path to Real Reform* (1898) and rewritten and published in London under the title *Garden City of To-morrow* (1902). The 1965 edition cited here includes a Preface by F. J. Osborn as well as an introductory essay by Lewis Mumford, the principal proponent of Howard's ideals in the United States.
F. Loyer. *Architecture of the Industrial Age.* New York, 1983.
Dugald MacFadyen. *Sir Ebenezer Howard and the Town Planning Movement*. Cambridge, MA, 1970.
Carroll L. V. Meeks. *The Railroad Station.* New Haven, CT, 1955.
Robin Middleton and David Watkin. *Neoclassicism and 19th-Century Architecture.* New York, 1980.
Kermit C. Parsons and David Schuyler, eds. *From Garden City to Green City: The Legacy of Ebenezer Howard*. Baltimore, 2002.
Nikolaus Pevsner. *Some Architectural Writers of the Nineteenth Century.* Oxford, 1972.
David H. Pinkney. *Napoleon III and the Rebuilding of Paris.* Princeton, 1958.
M. H. Port, ed. *The Houses of Parliament.* New Haven, CT, 1976.
Hermann G. Pundt. *Schinkel's Berlin.* Cambridge, MA, 1972.
Leland M. Roth. *American Architecture: A History*. Boulder, CO, 2001.
———. *A Concise History of American Architecture.* New York, 1978.
———. *McKim, Mead & White, Architects.* New York, 1983.
Howard Saalman. *Haussmann: Paris Transformed.* New York, 1971.
R. Schmutzler. *Art Nouveau*. New York, 1962.
Vincent Scully. *American Architecture and Urbanism.* New York, 1969.
———. *Modern Architecture,* rev. ed. New York, 1974.
Phoebe Stanton. *The Gothic Revival and American Church Architecture.* Baltimore, 1968.
———. *Pugin*. New York, 1971.

ESSAY 6: AFRICAN ARCHITECTURE

David Adjaye. *Adjaye, Africa, Architecture.* London and New York, 2011.
———. *African Metropolitan Architecture.* New York, 2011.
Kaj Blegvad Andersen. *African Traditional Architecture: A Study of Housing and Settlement Patterns of Rural Kenya*. London and New York, 1977.
Suzanne Preston Blier. *The Anatomy of Architecture: Ontology and Metaphor in Batammaliba Architectural Expression*. Cambridge, England, and New York, 1987.
Suzanne Preston Blier and James Morris. *Butabu: Adobe Architecture of West Africa*. New York, 2003.
Jean-Paul Bourdier and Trinh T. Minh-ha. *Vernacular Architecture of West Africa: A World in Dwelling*. London, 2011.
Lucy Bullivant. *British Built: UK Architecture's Rising Generation.* New York, 2005. Contains an examination of the work of David Adjaye, among others.
Dora P. Crouch. *Traditions in Architecture: Africa, America, Asia, and Oceania*. New York, 2001.
Thorsten Deckler, Anne Graupner, and Henning Rasmuss. *Contemporary South African Architecture in a Landscape of Transition*. Cape Town, 2006.
Fassil Demissie. *Colonial Architecture and Urbanism in Africa: Intertwined and Contested Histories*. London, 2012.
Nnamdi Elleh. *Architecture and Power in Africa*. New York, 2002.
———. *African Architecture: Evolution and Transformation.* New York, 1997.
J. W. Fernandez. *Fang Architectonics*. Philadelphia, 1977.
Antoni Folkers. *Modern Architecture in Africa.* Amsterdam, 2010.

Rene Gardi and Sigrid MacRae, trans. *Indigenous African Architecture*. New York, 1973.
Peter S. Garlake. *Early Art and Architecture of Africa.* Oxford, 2002.
Janet Berry Hess. *Art and Architecture in Postcolonial Africa.* Jefferson, NC, 2006.
Udo Kultermann. *New Directions in African Architecture*. New York, 1969.
Sabine Marschall. *Opportunities for Relevance: Architecture in the New South Africa*. Praetoria, South Africa, 2000.
J. C. Moughtin. *Hausa Architecture*. London, 1985.
Steven Nelson. *From Cameroon to Paris: Mousgoum Architecture In and Out of Africa.* Chicago, 2007.
Jonathan Alfred Noble. *African Identity in Post-Apartheid Public Architecture*. Farnham, England, 2011.
Labelle Prussin. *African Nomadic Architecture: Space, Place, and Gender.* Washington, DC, 1995.
———. *Architecture in Northern Ghana; A Study of Forms and Functions.* Berkeley, 1969.
———. *Hatumere: Islamic design in West Africa.* Berkeley, 1986.
———. "An Introduction to Indigenous African Architecture." *Journal of the Society of Architectural Historians* 33, no. 3 (October 1974): 182–205. Contains a most useful concise survey of tribal building traditions.
Amos Rapoport. *House Form and Culture*. Englewood Cliffs, NJ, 1969.
Dennis Sharp, ed. *The Illustrated Encyclopedia of Architects and Architecture.* New York, 1991.
Gary Van Wyck. *African Painted Houses: Basotho Dwellings of Southern Africa*. New York, 1998.

CHAPTER 19: VERSIONS OF MODERN ARCHITECTURE, 1914–1970

Reyner Banham. *The Architecture of the Well-Tempered Environment,* 2nd ed. Chicago, 1984.
———. *Theory and Design in the First Machine Age,* 2nd ed. Cambridge, MA, 1980.
Tim Benton and Charlotte Benton, with Dennis Sharp. *Architecture and Design, 1890–1930: An International Anthology of Original Articles.* New York, 1975.
Peter Blake. *Form Follows Fiasco: Why Modern Architecture Hasn't Worked.* Boston, 1977.
———. *Frank Lloyd Wright: Architecture and Space.* Baltimore, 1964.
———. *Le Corbusier: Architecture and Form.* Baltimore, 1964.
———. *Mies van der Rohe: Architecture and Structure.* Baltimore, 1964.
Brent C. Brolin. *The Failure of Modern Architecture.* New York, 1976.
Joan Campbell. *The German Werkbund: The Politics of Reform in the Applied Arts.* Princeton, 1978.
Alan Colquhoun. *Modern Architecture*. Oxford and New York, 2002. A succinct and insightful summary of architecture from 1892 through 1960.
Ulrich Conrads. *Programs and Manifestoes on 20th-Century Architecture.* Translated by Michael Bullock. Cambridge, MA, 1970. An essential collection of the most important theoretical writings by early Modernists.
Le Corbusier. *Towards a New Architecture.* Translated by Frederick Etchells. London, 1927.
William J. R. Curtis. *Le Corbusier: Ideas and Forms.* New York, 1986.
———. *Modern Architecture Since 1900,* 3rd ed. Englewood Cliffs, NJ, 1996.
Norma Evenson. *Le Corbusier: The Machine and the Grand Design.* New York, 1969.
James Marston Fitch. *Walter Gropius.* New York, 1960.
Kenneth Frampton. *Modern Architecture: A Critical History,* 3rd ed. New York, 1992.
Marcel Franciscono. *Walter Gropius and the Creation of the Bauhaus in Weimar.* Urbana, IL, 1971.
Sigfried Giedion. *Space, Time, and Architecture,* 5th ed. Cambridge, MA, 1967.
Walter Gropius. *The New Architecture and the Bauhaus.* London, 1935.
———. *The Scope of Total Architecture.* New York, 1962.
Henry-Russell Hitchcock and Philip Johnson. *The International Style: Architecture Since 1922.* New York, 1932; reissued as *The International Style,* New York, 1966.
Charles Jencks. *Modern Movements in Architecture.* Garden City, NY, 1973.
William H. Jordy. *American Building and Their Architects,* Vol. 4: *The Impact of European Modernism in the Mid-Twentieth Century.* Garden City, NY, 1972.
Barbara Miller Lane. *Architecture and Politics in Germany, 1918–1945.* Cambridge, MA, 1968.
C. Lodder. *Russian Constructivism.* New Haven, CT, 1983.
Stanislaus von Moos. *Le Corbusier: Elements of a Synthesis.* Cambridge, MA, 1979.
Wolfgang Pehnt. *Expressionist Architecture*. Translated by J. A. Underwood and E. Kustner. New York, 1973.
Nikolaus Pevsner. *Pioneers of Modern Design: From William Morris to Walter Gropius.* Baltimore, 1974.
Leland M. Roth. *American Architecture: A History*. Boulder, CO, 2001.
Franz Schulze. *Mies van der Rohe: A Critical Biography.* Chicago, 1985.

Vincent Scully. *Louis I. Kahn.* New York, 1962.
Dennis Sharp. *Modern Architecture and Expressionism*. New York, 1966.
Nancy J. Troy. *The De Stijl Environment.* Cambridge, MA, 1983.
Frank Whitford. *Bauhaus.* London, 1984.
Arnold Whittick. *Erich Mendelsohn,* 2nd ed. London, 1956.
Alan Windsor. *Peter Behrens, Architect and Designer.* London, 1981.
H. Wingler. *The Bauhaus: Weimar, Dessau, Berlin, and Chicago.* Cambridge, MA, 1969.
Stuart Wrede. *Sketches: Alvar Aalto.* Cambridge, MA, 1978. Contains translations of Aalto's speeches and published articles.
Richard Saul Wurman, ed. *What Will Be Has Always Been: The Words of Louis I. Kahn.* New York, 1986.
Bruno Zevi. *Erich Mendelsohn.* London, 1985.

CHAPTER 20: THE EXPANSION OF MODERNISM: FROM THE TWENTIETH CENTURY INTO THE TWENTY-FIRST

Wolfgang Amsoneit and Philip Jodidio, eds. *Contemporary European Architects,* 6 vols. Cologne, 1991–1998. A continuing series of assessments of recent work.
Reyner Banham. *The New Brutalism: Ethic or Aesthetic.* London, 1966.
Brent Brolin. *Flight of Fancy: The Banishment and Return of Ornament.* New York, 1985.
William J. R. Curtis. *Modern Architecture Since 1900,* 3rd ed. Upper Saddle River, NJ, 1996.
Francesco Dal Co. *Frank Gehry: The Complete Works*. London and Boston, 2003.
———. *Modern Architecture: A Critical History,* 3rd ed. New York, 1980.
———. *Richard Meier*. New York, 1999.
Arthur Drexler. *Transformations in Modern Architecture.* New York, 1979.
Diane Ghirardo. *Architecture After Modernism.* London and New York, 1996.
Charles Jencks. *Architecture Today,* rev. ed. New York, 1982.
———. *The Language of Post-Modern Architecture,* 6th ed. New York, 1991. This book, first published in 1977 and many times revised and reissued, has significantly shaped the definition of Postmodernism.
———. *Modern Movements in Architecture,* rev. ed. New York, 1987.
———. *The New Paradigm in Architecture: The Language of Post-Modernism*. New Haven, CT, 2002.
———. *What Is Post-Modernism?* 4th ed. New York, 1996.
Charles Jencks and Karl Kropf, eds. *Theories and Manifestoes of Contemporary Architecture*. Hoboken, NJ, 1998.
Philip Johnson and Mark Wigley. *Deconstructivist Architecture.* New York, 1988.
Heinrich Klotz, ed. *Postmodern Visions: Drawings, Paintings, and Models by Contemporary Architects.* Munich, 1984, and New York, 1985.
Stanislaus von Moos, *Le Corbusier: Elements of a Synthesis*. Cambridge, MA, 1979.
Paolo Portoghesi. *After Modern Architecture*. New York, 1980.
Robert Powell. *Rethinking the Skyscraper: The Complete Architecture of Ken Yeang.* London and New York, 1999.
Ivor Richards. *T. R. Hamzah & Yeang: Ecology of the Sky*. Mulgrave, Victoria [Australia], 2001. A well-illustrated treatment of Yeang's theory and tropical skyscraper designs.
Leland M. Roth. *America Builds: Source Documents in American Architecture and Planning.* New York, 1983.
———. *American Architecture: A History.* Boulder, CO, 2001.
Roger Scruton. *The Aesthetics of Architecture.* Princeton, 1979.
Vincent Scully. *American Architecture and Urbanism,* 2nd ed. New York, 1988.
———. *The Shingle Style Today, or, The Historian's Revenge.* New York, 1972.
James Steele. *Architecture Today*. London, 1997.
Robert A. M. Stern. *Modern Classicism.* New York, 1988.
Alexander Tzonis. *Santiago Calatrava: Complete Works.* New York, 2004.
Robert Venturi. *Complexity and Contradiction in Architecture.* New York, 1966. The book that laid out the theory of Postmodernism and provided its intellectual base.
Stuart Wrede. *Mario Botta.* New York, 1986.
Ken Yeang. *Reinventing the Skyscraper: A Vertical Theory of Urban Design*. Chichester, England, 2001. See also his earlier volume, *The Green Skyscraper: The Basis for Designing Sustainable Intensive Buildings*. Munich, 2000.

CHAPTER 21: INTO THE TWENTY-FIRST CENTURY

Bryan Bell. *Good Deeds, Good Design: Community Service Through Architecture*. New York, 2004.
Blaine Brownell. *Material Strategies: Innovative Applications in Architecture.* New York, 2011.
David Gissen. *Big and Green: Toward Sustainable Architecture in the 21st Century.* New York, 2003.

Sara Hart. *EcoArchitecture: The Work of Ken Yeang.* Chichester, UK, 2011.

David Moos and Gail Andrews Trechsel. *Samuel Mockbee and the Rural Studio: Community Architecture.* Birmingham, AL, 2003.

Andrea Oppenheimer Dean. “Samuel Mockbee,” *Architectural Record* 192 (June 2004): 184–203.

Andrea Oppenheimer Dean and Timothy Hursley. *Rural Studio: Samuel Mockbee and an Architecture of Decency*. New York, 2002.

Phaidon Atlas of 21st Century World Architecture. New York, 2008.

Bernard Tschumi and Irene Cheng, eds. *The State of Architecture at the Beginning of the 21st Century.* New York, 2004.

Ken Yeang. *Green Design.* London, 2011.

———. *Reinventing the Skyscraper: A Vertical Theory of Urban Design*. Chichester, England, 2001. See also his earlier volume, *The Green Skyscraper: The Basis for Designing Sustainable Intensive Buildings*. Munich, 2000.

NOTES

INTRODUCTION

1. Ada Louise Huxtable, "Inventing American Reality," *New York Review of Books* 39 (December 3, 1992): 28.

2. Louis I. Kahn, "Remarks," *Perspecta* (Yale architectural journal) 9–10 (1965): 305.

3. Roger Caras, ed., *Animal Architecture* (Richmond, VA, 1971); see also Michael Henry Hansell, *Animal Architecture* (New York, 2005).

4. Nikolaus Pevsner, *An Outline of European Architecture* (London, 1943). This has remained a standard work and continues to be reprinted.

5. Walter McQuade tells a similar story in "Where's the Architecture?" *Connoisseur* 215 (November 1985): 82.

6. Ruskin's *The Seven Lamps of Architecture* is still in print. Because of the many editions of Ruskin's writings over the past century and a half, the best source is the multivolume standard edition: E. T. Cook and A. Wedderburn, eds., *The Works of John Ruskin* (London, 1903–1912); for *St. Mark's Rest,* see vol. 24.

7. Sir Herbert Read, *The Origins of Form in Art* (New York, 1965), 182.

CHAPTER ONE: ARCHITECTURE: THE ART OF SHAPING OF SPACE

1. This observation might be open to question with the development of computer-generated imagery—especially CGI for generating three-dimensional images of cities, spaces, buildings, and interiors in motion pictures. Indeed, the coming together of story line and such imagery, set within a theater or home setting where observers willingly suspend belief, can cause powerful psychological effects.

2. Nikolaus Pevsner, *An Outline of European Architecture,* 7th ed. (Baltimore, 1974), 15.

3. Frank Lloyd Wright, *The Natural House* (New York, 1954), 220; he refers to Okakura Kakuzo, *The Book of Tea* (New York, 1906), 24, who in turn paraphrases Laozi (Lao-Tse).

4. Winston Churchill, speech before House of Commons, October 28, 1943, in *Onwards to Victory: War Speeches by the Right Hon. Winston S. Churchill* (Boston, 1944), 317.

5. For an explanation of the distinction between "BCE" and "CE," see note 1 in Chapter 9.

6. This concept is discussed in Edward T. Hall, *The Hidden Dimension* (Garden City, NY, 1966), and Robert Sommer, *Personal Space* (Englewood Cliffs, NJ, 1969).

7. Territoriality was another important but ignored design issue in the creation of Pruitt-Igoe; see the analysis of Pruitt-Igoe in Oscar Newman, *Defensible Space* (New York, 1972).

CHAPTER 2: "COMMODITIE": BUILDING FUNCTIONS

1. Vitruvius's *De Architectura,* written on ten scrolls, provides us our only glimpse into the thinking of the architects of antiquity. Although Vitruvius wrote around 15 BCE, the oldest complete *copy* of the lost original manuscript dates from the eighth century CE and was copied out by the monks of the Saxon scriptorium in Northumbria, England. Sixteen other complete copies survive, but all derive from the Northumbria copy and date from the tenth through the fifteenth centuries. The most recent English translation is by Ingrid D. Rowland and Thomas Noble Howe, *Vitruvius: Ten Books on Architecture* (Cambridge, England, 1999). In addition to an extended introduction, it has numerous illustrations. Somewhat more graceful if less literal is the English translation in the Harvard Loeb series, Vitruvius, *On Architecture,* 2 vols., trans. Frank Granger (Cambridge, MA, 1931), which lists the surviving medieval Vitruvius manuscripts. Like other translations in the Loeb series, it presents the Latin original on the left page and the corresponding English on the facing page.

The earlier translation—Vitruvius, *The Ten Books on Architecture,* trans. Morris Hickey Morgan (Cambridge, MA, 1914)—is even more gracefully idiomatic. The major translations of Vitruvius into European languages are listed in Granger, xxxiii–xxxiv, including the paraphrase version by Sir Henry Wotten, *The Elements of Architecture* (London, 1624).

The variations in recent translations of the Vitruvian Latin into English reveal both the shifts in thinking over time and varying desires for poetic felicity. For example, in 1914, Morris Hickey Morgan phrased the passage *Haec autem ita fieri debent, ut habeatur ratio firmitatis, utilitatis, venustatis* in this way: "All these must be built with due reference to durability, convenience, and beauty." Most recent is the painstaking translation of Rowland and Howe (1999), who translate it: "All these works should be executed so that they exhibit the principles of soundness, utility, and attractiveness."

2. Vitruvius, *Ten Books,* trans. Morgan, 17.

3. William A. Starrett, *Skyscrapers and the Men Who Build Them* (New York, 1928), 63. The building process was so finely studied and coordinated that steel columns and beams for the Empire State Building were rolled to specification at steel plants in Pennsylvania, loaded in flat bed train cars, transported to New York City, and hoisted into place within eighty hours of their manufacture. One could make the case that films or movies as an art form similarly require the coordinated efforts of hundreds of skilled individuals—actors, writers, producers, directors, art designers, and so many more—but with the difference that buildings may well last longer.

4. For a discussion of utility and adaptation to use in antiquity, see Edward Robert De Zurko, *Origins of Functionalist Theory* (New York, 1957), 15–31.

5. Walter Gropius, "Where Artists and Technicians Meet," *Die Form,* new series, 1 (1925–1926): 117–120.

6. Le Corbusier, *Towards a New Architecture,* trans. Frederick Etchells (London, 1927), 10.

7. Bruno Taut, *Modern Architecture* (London, 1929), 9.

8. Stanley Abercrombie, *Architecture As Art: An Esthetic Analysis* (New York, 1984), 99.

9. Louis I. Kahn, interview in John W. Cook and Heinrich Klotz, *Conversations with Architects* (New York, 1973), 204.

10. "Mies van der Rohe's New Buildings," *Architectural Forum* 97 (November 1952): 94.

11. Le Corbusier, *Précisions sur un état présent de l'architecture et de l'urbanisme* (Paris, 1930), 64.

12. Louis H. Sullivan, "The Tall Building Artistically Considered," *Lippincott's Magazine* 57 (March 1896): 403–409, reprinted in Leland M. Roth, ed., *America Builds* (New York, 1983), 340–446.

13. Louis Kahn, quoted in Ann Mohlor, ed., "Louis I. Kahn: Talks with Students," *Architecture at Rice* 26 (1969): 12–13. See also Peter Papademetriou, ed., *Louis I. Kahn: Conversations with Students* (Houston, 1998).

CHAPTER 3: "FIRMENESS": STRUCTURE, OR HOW DOES THE BUILDING STAND UP?

1. Louis I. Kahn, from a lecture at the School of Architecture, Pratt Institute, New York, 1973, quoted in John Lobell, *Between Silence and Light* (Boulder, CO, 1979), 42. In contrast, the tradition in China is that the column came first to support the roof structure. Only after the columns and tie beams were in place was the roof built, followed by construction of the walls underneath.

2. Research by George Hersey suggests that the Greek orders were first developed in imitation of the trunks of trees in sacred groves and that the names of the many parts that make up the orders can be traced to the sacrificial offerings made to the gods. This is discussed further in Chapter 11.

There are many books detailing the proportions of the various classical orders, from the Renaissance onward. Particularly informative—because it includes the Greek orders and those from Roman antiquity as well as Renaissance, Baroque, and eighteenth-century variations—is Arthur Stratton, *The Orders of Architecture: Greek, Roman and Renaissance . .* (London, 1931). More recent and also most useful because of its breadth of coverage is Robert Chitham, *The Classical Orders of Architecture* (New York, 1985).

3. For a structural analysis of the Pantheon, see Robert Mark and Paul Hutchinson, "On the Structure of the Roman Pantheon," *Art Bulletin* 68 (March 1986): 124–134. See also the discussions of the structure of the Pantheon in Rowland J. Mainstone, *Developments in Structural Form* (Cambridge, MA, 1975), and in Mario Salvadori, *Why Buildings Stand Up: The Strength of Buildings,* rev. ed. (New York, 2002).

4. See the analysis of the failure of the Hyatt Regency skywalks in Steven S. Ross, *Construction Disasters: Design Failures, Causes, and Prevention* (New York, 1984), 388–406, and in Matthys Levy and Mario Salvadri, *Why Buildings Fall Down: How Structures Fail,* rev. ed. (New York, 2002), 221–230. In January 1986, the state of Missouri revoked the professional licenses of two structural engineers who had designed the skywalks, after they had been cited for gross professional negligence in November 1985.

5. See Levy and Salvadri, *Why Buildings Fall Down,* 257–268.

6. See the structural-failure analysis in ibid. Several even taller office towers were in the design phase

in the fall of 2001, when the World Trade Center Towers collapsed—among them Taipei 101. Immediately, their structural designs were scrutinized to determine their degree of risk. Since these towers were planned for the Pacific Rim of Asia, earthquake stresses had been anticipated, leading to the use of thick inner concrete cores. Even so, the walls of these concrete cores were further thickened to more than 2 feet (0.61 m) to protect emergency exit stairs and to prevent collapse.

7. A memorial to the thousands killed has been built within the square footprints of the destroyed towers and, as this book goes to print, a greatly strengthened replacement "Freedom Tower" adjacent to the memorial has been topped off with a spire to reach a symbolic height of 1,776 feet.

CHAPTER 4: "DELIGHT": SEEING ARCHITECTURE

1. Bruno Taut, *Modern Architecture* (London, 1929), 9.

2. The importance of the psychology of vision is stressed in Niels Luning Prak, *The Language of Architecture* (The Hague, 1968). See also K. Koffka, *Principles of Gestalt Psychology* (New York, 1935); the many books by Rudolph Arnheim, especially his *Art and Visual Perception* (Berkeley, 1971) and his *Visual Thinking* (Berkeley, 1969); Carolyn M. Bloomer, *Principles of Visual Perception* (New York, 1976), which has a good bibliography; and Gyorgy Kepes, *The Language of Vision* (Chicago, 1944).

3. The intriguing manifestations of the Golden Mean are well-explored and explained in Mario Livio, *The Golden Ratio: The Story of Phi, the World's Most Astonishing Number* (New York, 2002). As Livio explains, phi is the mathematical "cousin" of pi.

4. See Heath Licklider, *Architectural Scale* (New York, 1965), which includes a chapter devoted to proportional systems. See also Frank Orr, *Scale in Architecture* (New York, 1985).

5. This subtle contrast between elements that, at first glance, appear to be the same is a good example of what has come to be called Mannerism. See Chapter 15.

6. Regarding Katsura, see Walter Gropius and Kenzo Tange, *Katsura: Tradition and Creation in Japanese Architecture* (New Haven, CT, 1960), and Akira Naito, *Katsura: A Princely Retreat* (Tokyo, 1977).

7. It is of interest that some of these "theatrical" aspects preceded their use in actual theaters in Italy.

8. For a discussion of the effects of color, see the many studies by Faber Birren, especially *Color and Human Response* (New York, 1978); see also Roy Osborne, *Lights and Pigments: Color Principles for Artists* (New York, 1980).

9. This may perhaps be a learned cultural response. Published evidence so far has focused on experiments performed in the West. Individuals from non-meat-eating cultures may react differently.

10. Written in part by Theo van Doesburg, "De Stijl Manifesto V" is translated into English in Ulrich Conrads, ed., *Programs and Manifestoes on 20th-Century Architecture* (Cambridge, MA, 1970), 66.

11. See Peter Collins, *Changing Ideals in Modern Architecture* (London, 1965), 243–248.

12. International Modernists were inspired by the essay by Adolf Loos, "Ornament and Crime," first published in 1908 and then republished in a collection of Loos's early essays, *Ins Leere Gesprochen* (Paris, 1921), and reprinted in Conrads, *Programs and Manifestoes*.

13. John Ruskin, addenda to lectures 1 and 2, *Lectures on Architecture and Painting* (London, 1854).

14. Adolf Loos, "Ornament and Crime," 1908, in Conrads, *Programs and Manifestoes,* 20.

15. See Michael Forsyth, *Buildings for Music . . .* (Cambridge, MA, 1985), 284–289; Bruce Bliven, Jr., "Annals of Architecture: A Better Sound," *The New Yorker,* November 8, 1976, 51ff.; and Sharon Lee Ryder, "Music to My Ears," *Progressive Architecture* 58 (March 1977): 64–68.

16. Regarding Chartres, see Robert Branner, ed., *Chartres Cathedral* (New York, 1969), and Adolf Katzenellenbogen, *The Sculptural Programs of Chartres Cathedral* (Baltimore, 1959; New York, 1964).

17. Regarding Olympia, see J. J. Pollitt, *Art and Experience in Classical Greece* (New York, 1972); see also Jeffrey M. Hurwit, "Narrative Resonance in the East Pediment of the Temple of Zeus at Olympia," *Art Bulletin* 69 (March 1987): 6–15. Although the temple was toppled by earthquakes centuries ago, a great deal is known about its appearance from the descriptions of Pausanias, a second-century CE physician who devoted twenty years traveling through Greece, making detailed descriptions of everything he saw; see Pausanias, *Guide to Greece,* 2 vols., trans. Peter Levi (New York, 1972).

18. A similar sense of the honorable striving for excellence in human endeavor prompted the modern revival of the Olympic games in 1896; while that sense of honorable contest endures, the use of chemical enhancements or other fraudulent behavior violates the spirit of the games and must be deplored.

CHAPTER 5: ARCHITECTURE AND SOUND

1. In 1971, an acoustical renovation—by Ronald Ward and Partners, architects, and Kenneth Shearer, acoustical consultant—significantly improved the acoustical performance of Royal Albert Hall.

2. There is some difference of opinion regarding whether such complicated spaces with side aisles function as precisely as simple, closed pipes.

3. Another example in which the acoustical properties of architecture influence musical composition and performance practice has been documented in the case of the Basilica of San Petronio, Bologna; see Marc Vanscheeuwijck, *The Cappelle Musicale of San Petronio in Bologna Under Giovanni Paolo Colonna 1674–95* (Brussels, 2003), 64. A low, strong tone created in this church generates a sustained third major triad harmonic overtone. Hence, when a musical piece is performed in a minor key, the sustained final chord will include the minor triad (as written in the score), but the minor triad would conflict with the acoustically generated major triad, causing dissonance. This automatically generated major triad may be a universal phenomenon, accounting for the widespread practice of ending many pieces written in the minor key with a major harmony in the extended final chord, as J. S. Bach did so frequently. I must thank Katie Moss for drawing my attention to this phenomenon; see Katie Moss, "Architectural Influences on the Composition and Performance of Sacred Music in the French Gothic Period," senior thesis, University of Oregon, spring 2005.

4. Hope Bagenal has suggested that in Bach's time, the church of Saint Thomas was lined with wooden paneling, greatly reducing the church's reverberation time, so that Bach's early organ pieces worked equally well in this later environment. See Hope Bagenal, "Bach's Music and Church Acoustics," *Journal, Royal Institute of British Architects* 37, no. 5 (January 11, 1930): 154–163; see also Hope Bagenal, *Planning for Good Acoustics* (London, 1931).

5. See the discussion of Boston Symphony Hall in Leland M. Roth, *McKim, Mead & White, Architects* (New York, 1983), 223–227, and in Michael Forsyth, *Buildings for Music: The Architect, the Musician, and the Listener from the Seventeenth Century to the Present Day* (Cambridge, MA, 1985), 243–253.

6. Louis I. Kahn, "Remarks," *Perspecta* 9–10 (1965): 318.

7. Hans Scharoun, *Akademie der Kunst* (Berlin, 1967), 95.

CHAPTER 6: ARCHITECTURE: PART OF THE NATURAL ENVIRONMENT

1. The British thermal unit (Btu) is the amount of heat required to raise the temperature of 1 pound of water 1° F. The figure of 2,750 Btu per square foot on a clear day in June in Albuquerque is derived from G. Z. Brown, *Sun, Wind, and Light: Architectural Design Strategies* (New York, 1985), 21.

2. Figures cited in James Marston Fitch, *American Building,* Vol. 2: *The Environmental Forces That Shape It,* 2nd ed. (Boston, 1972), 266–267.

3. Figures cited in Brown, *Sun, Wind, and Light,* 38.

4. The environmental qualities of the Robie House are analyzed in Reyner Banham, *The Architecture of the Well-Tempered Environment,* 2nd ed. (Chicago, 1984), 115–121. This work should also be consulted regarding the development of air-conditioning by Wallis H. Carrier.

5. For a discussion of the functional parts of the Salvation Army Building in the Cité du Refuge, see Stanislas von Moos, *Le Corbusier: Elements of a Synthesis* (Cambridge, MA, 1979), 154–517; regarding the building's environmental shortcomings, see Reyner Banham, *The Architecture of the Well-Tempered Environment,* 155–158. See also Brian B. Taylor, *Le Corbusier: The City of Refuge, Paris, 1929–33* (Chicago, 1987).

6. Such lateral forces had been encountered before in Gothic cathedrals. The high roofs, lifted 120 to 140 feet (37 to 43 m) in the air, were subject to winds nearly three times higher in velocity than at ground level. The Gothic solution was trussing in the wooden roof and externalized diagonal braces, or flying buttresses. Robert Mark of Princeton University conducted a number of experiments on models of Gothic cathedrals to measure the effects of wind pressure; see Robert Mark, *Experiments in Gothic Structure* (Cambridge, MA, 1982).

7. Carl W. Condit, "The Wind Bracing of Buildings," *Scientific American* 230 (February 1974): 92–105.

8. For reviews of this celebrated failure, see Steven S. Ross, *Construction Disasters: Design Failures, Causes, and Prevention* (New York): 274–287, and Matthys Levy and Mario Salvadori, *Why Buildings Fall Down: How Structures Fail,* rev. ed. (New York, 2002), 197–205.

9. The date overlap is due to the fact that the masonry pedestal was started before the iron frame components were completed and the copper skin arrived from France. The Statue of Liberty was the gift of the nation of France to the United States, with the cost of the base and erection borne by the American people. Though a piece of sculpture, it is on the scale of—and uses many of the same structural solutions then being developed for—the newly emerging American office skyscrapers. Literature on the Statue of Liberty is plentiful; see in particular James B. Bell and Richard L. Abrams, *In Search of Liberty: The Story of the Statue of Liberty and Ellis Island* (Garden City, NY, 1984); Jonathan Harris, *A Statue for America: The First 100 Years of the Statue of Liberty* (New York, 1985); Richard Seth Hayden and Thierry W. Despont, *Restoring the Statue of Liberty* (New York, 1986); Yasmin Sabina Khan, *Enlightening the World: The Creation of the Statue of Liberty* (Ithaca, NY, 2010); Barry Moreno,

The Statue of Liberty Encyclopedia (New York, 2000); Pierre Provoyeur and June H. Hargrove, *Liberty: The French-American Statue in Art and History* (New York, 1986); Cara A. Sutherland, *The Statue of Liberty* (New York, 2003); and Marvin Trachtenberg, *The Statue of Liberty* (New York, 1976).

CHAPTER 7: THE ARCHITECT: FROM HIGH PRIEST TO PROFESSION

1. Alexander Badawy, "Imhotep," in *Macmillan Encyclopedia of Architects,* ed. Adolf K. Placzek (New York, 1982), 2:455–464; Nabil Swelim, "Imhotep," in *The [Grove] Dictionary of Art* (New York, 1996), or also The Oxford Art Online, which includes Grove. The basic printed survey histories of the architectural profession are Martin S. Briggs, *The Architect in History* (Oxford, 1927), and Spiro Kostof, ed., *The Architect: Chapters in the History of the Profession* (New York, 1977). Now the basic resource, the Kostof book consists of chapters written by experts in their respective fields.

2. Alexander Badawy, "Senmut," in *Macmillan Encyclopedia of Architects* 4:33–37.

3. For discussions of the lives of the workmen at Deir el-Medina, see T.G.H. James, *Pharaoh's People* (Chicago, 1984), and John Romer, *Ancient Lives: Daily Life in Egypt of the Pharaohs* (New York, 1984).

4. Daedalus's exploits are described by Apollodorus and Ovid; see the narrative account in Edith Hamilton, *Mythology* (Boston, 1940). In addition, see Sarah P. Morris, "Daidalos," in *The [Grove] Dictionary of Art* (New York, 1996), or also Oxford Art Online, which includes Grove; and Kenneth D. S. Lapatin, "Daedalus," in *The Oxford Companion to Western Art,* ed. Hugh Brigstocke (Oxford, 2001).

5. J. J. Coulton, *Ancient Greek Architects at Work: Problems of Structure and Design* (Ithaca, 1977).

6. Lothar Haselberger has suggested that lines engraved on the walls of the Temple of Apollo at Didyma are in fact drawings for proportioning the columns; see *Scientific American* 253 (December 1985): 126–132.

7. Vitruvius, *Ten Books on Architecture,* 1.1.2, trans. Morris Hicky Morgan (Cambridge, MA, 1914). For further discussion of Vitruvius, see Eugene Dwyer et al., "Vitruvius," in *The [Grove] Dictionary of Art* (New York, 1996), or also Oxford Art Online, which includes Grove.

8. William L. MacDonald, "Anthemios," in *Macmillan Encyclopedia of Architects,* 1:84–87; Thomas E. Russo, "Anthemios of Tralles," in *The [Grove] Dictionary of Art* (New York, 1996), or also Oxford Art Online, which includes Grove.

9. Walter Horn and Ernest Born, *The Plan of St. Gall,* 3 vols. (Berkeley, 1979); this exhaustive analysis of the plan is summarized in Lorna Price, *The Plan of St. Gall: In Brief* (Berkeley, 1982). More recent research has suggested that, contrary to what Horn and Born write, the plan was not prepared as an outgrowth of a council of abbots in 816–817, that it was not a copy of another drawing, nor was it meant as an exemplar of monasteries to be built throughout Charlemagne's empire. See Warren Sanderson, "The Plan of St. Gall Reconsidered," *Speculum* 60 (July 1985): 615–632.

10. François Bucher, "Villard de Honnecourt," in *Macmillan Encyclopedia of Architects* 4:322–324; Theodore Bowie, ed., *The Sketchbook of Villard de Honnecourt* (Bloomington, IN, 1959); Carl F. Barnes Jr., "Villard de Honnecourt," in *The [Grove] Dictionary of Art* (New York, 1996), or also Oxford Art Online, which includes Grove; Nicola Coldstream, "Villard de Honnecourt," in *The Oxford Companion to Western Art,* ed. Hugh Brigstocke (Oxford, 2001).

11. Stephen Murray, "Libergier, Hugues," in *The [Grove] Dictionary of Art* (New York, 1996), or also Oxford Art Online, which includes Grove.

12. Peter Murray, "Donato Bramante," in *Macmillan Encyclopedia of Architects* 1:269–282; Paul Davies and David Hemsoll, "Bramante, Donato," in The [Grove] Dictionary of Art (New York, 1996), or also Oxford Art Online, which includes Grove.

13. Eugene J. Johnson, "Leon Battista Alberti," in *Macmillan Encyclopedia of Architects* 1:48–58; Paul Davies and David Hemsoll, "Alberti, Leon Battista," in *The [Grove] Dictionary of Art* (New York, 1996), or also Oxford Art Online, which includes Grove.

14. For a discussion of architectural treatises, see Dora Wiebenson, *Architectural Theory and Practice from Alberti to Ledoux* (Chicago, 1982).

15. This novel is more commonly known in the English-speaking world as *The Hunchback of Notre Dame.*

16. See James Ackerman, *Palladio* (Baltimore, 1966), as well as Douglas Lewis, *The Drawings of Andrea Palladio* (Washington, DC, 1982), and Andreas Beyer, "Palladio, Andrea," in *The [Grove] Dictionary of Art* (New York, 1996), or also Oxford Art Online, which includes Grove.

17. Andrea Palladio, *I quattro libri dell' architettura* (The Four Books on Architecture), trans. Robert Tavernor and Richard Schofield (Cambridge, MA, 1997).

18. The word *amateur* is used here in its original sense (from Latin, *amator,* "lover"), meaning a person who pursues an activity as a pastime, for the sheer pleasure it provides, rather than for payment; gentlemen-amateur architects, in fact, would have been insulted had they been offered payment.

19. Dorothy Stroud, "John Soane," in *Macmillan Encyclopedia of Architects* 4:95–101; David Watkin, "Soane, John," in *The [Grove] Dictionary of Art* (New

York, 1996), or also Oxford Art Online, which includes Grove.

20. Samuel Wilson, Jr., "Benjamin H. Latrobe," in *Macmillan Encyclopedia of Architects* 2:611–117.

21. Talbot Hamlin, *Benjamin Henry Latrobe* (New York, 1955); Jeffrey A. Cohen, "Latrobe, Benjamin Henry," in *The [Grove] Dictionary of Art* (New York, 1996), or also Oxford Art Online, which includes Grove.

22. For the reasons Pruitt-Igoe failed, see Oscar Newman, *Defensible Space* (New York, 1972).

23. See the assessment in J. M. Richards, Ismail Serageldin, and Darl Rastorfer, *Hassan Fathy* (Singapore and London, 1985), and in Hasan-Uddin Khan et al., "Fathy, Hassan," in *The [Grove] Dictionary of Art* (New York, 1996), or also Oxford Art Online, which includes Grove. Regarding Geoffrey Bawa, see David Robson, *Geoffrey Bawa: The Complete Works* (London, 2002), and John Musgrove, "Bawa, Geoffrey," in *The [Grove] Dictionary of Art* (New York, 1996), or also Oxford Art Online, which includes Grove.

CHAPTER 8: ARCHITECTURE, MEMORY, AND ECONOMICS

1. Lewis Mumford, *Architecture* (Chicago, 1926), 25–26.

2. Vitruvius, *Ten Books on Architecture,* 1.2, 8–9. It is significant that the École des Beaux-Arts particularly stressed achieving the most appropriate *caractère* ("character") in a building's design.

3. Paul Goldberger, *Why Architecture Matters* (New Haven, CT, 2009), 196–197.

4. Goldberger quotes Summerson's lecture, "The Past in the Future," reprinted in Summerson's *Heavenly Mansions and Other Essays on Architecture* (London, 1949, and New York, 1963).

5. For further information on Pennsylvania Station, see Leland M. Roth, *McKim, Mead & White, Architects* (New York, 1983), and Hilary Ballon, *New York's Pennsylvania Stations* (New York, 2002). Ballon's book also provides a good analysis of the struggle to prevent demolition.

6. First published in Mumford's continuing column, "The Sky Line," in *The New Yorker,* 1958, and reprinted in the anthology, Lewis Mumford, *The Highway and the City* (New York, 1963), 143–151.

7. Vincent Scully, *American Architecture and Urbanism* (New York, 1969), 143. Scully's judgment was quoted by Ada Louise Huxtable in a *New York Times* editorial, "Beaux-Arts Buildings I Have Known," November 9, 1974, and was reprinted in her anthology, *Goodbye History, Hello Hamburger* (Washington, DC, 1986), 131–134.

8. Goldberger, *Why Architecture Matters,* 209. For information on the legal case, see Charles M. Haar and Jerold S. Kayden, *Landmark Justice: The Influence of William J. Brennan on America's Communities* (Washington, DC, 1989).

9. John Ruskin, "The Lamp of Memory," in *The Seven Lamps of Architecture* (London, 1849), ch. 6, section 20. The italicized emphasis is Ruskin's.

10. John Burchard and Albert Bush-Brown, *The Architecture of America: A Social and Cultural History* (Boston, 1961), 5. "The Nature of Architecture," the preface to the hardcover edition of the book, is a perceptive introduction to the study of architecture; regrettably, it was deleted from the subsequent abridged paperback edition.

11. John Kenneth Galbraith, *Economics, Peace, and Laughter* (Boston, 1971), 158.

CHAPTER 9: THE BEGINNINGS OF ARCHITECTURE: FROM CAVES TO CITIES

1. A word about dating conventions used here: In this chapter, because many of the dates are so distant, the measure is backward from present time, hence the phrase "years ago." Occasionally, this phrase is replaced in some publications by the abbreviation BP, meaning "before the present," which equates to "years ago." In this book, "years ago" is how those distant dates are indicated. In the next three chapters, which discuss Mesopotamia, Egypt, Greece, and Rome, the dates are given with reference to the common dating system generally used around the globe today—that is, the Christian calendar. So, dates are given in either BCE, "before the common era" (which equates to BC, "before Christ"), or, for later dates, in CE, "common era" (which equates to AD, or anno Domini, "year of our Lord"). Later in the book, when the discussion is exclusively about more recent time frames—that is, after the Christian calendar had become established in Europe—era designations are eliminated.

2. Sir Herbert Read, "The Disintegration of Form in Modern Art," in *The Origins of Form in Art* (New York, 1965), 182.

3. One recent summary of the reevaluation of hominid research is Göran Burenhult, ed., *People of the Past: The Epic Story of Human Origins and Development* (San Francisco, 2003), with contributions from scores of leading researchers in their respective fields. Because of the continuing exploration, the most current sources are to be found online.

4. There is a difference of opinion regarding species names for what some paleontologists label *Homo ergaster* and what some label *Homo erectus*. The former term is a twentieth-century designation, while the

more familiar designation *Homo erectus* was proposed in the nineteenth century. See the clear, concise discussion in Juan Luis Arsuaga, *The Neanderthals' Necklace: In Search of the First Thinkers* (New York, 2002).

5. Steven R. James, "Hominid Use of Fire in the Lower and Middle Pleistocene: A Review of the Evidence," *Current Anthropology* (February 1989).

6. Henry de Lumley, "A Paleolithic Camp at Nice," *Scientific American* 220 (May 1969): 42–50.

7. Robert S. Soleckei, *Shanidar: The First Flower People* (New York, 1971). The alleged Shanidar "flower children" burials are now debated; it is intriguing how archaeological findings are interpreted in light of the ethos of the period, the Shanidar findings having originally been published at the height of the hippie "Flower Power" movement in the early 1970s. A much more cynical generation now views such findings through a very different lens.

8. Lascaux became a victim of its own celebrity, for the moisture introduced in the expelled breath of hundreds of thousands of visitors caused organisms to grow on the paintings, threatening to destroy them. Today, the original cave is closed to ordinary visitors; tourists view a painstaking replica built nearby. See Mario Ruspoli, *The Cave at Lascaux: The Final Photographs* (New York and Paris, 1986–1987).

9. André Leroi-Gourhan, *Prehistoire de l'art occidentale,* 3rd ed. (Paris, 1973), attempted to organize the cave paintings as a system of symbols rather than as naturalistic images. The recent publications on the newly discovered Cosquer and Chauvet caves present current thinking about the meaning of these striking images. See also David Lewis-Williams, *The Mind in the Cave: Consciousness and the Origins of Art* (London and New York, 2002).

10. The principal investigator, Professor Tom Dillehay, has published several accounts of his find, the primary one being the official excavation report, *Monte Verde: A Late Pleistocene Settlement in Chile,* 2 vols. (Washington and London, 1997). Prior to this, Dillehay published a summary in A. L. Bryan, ed., *New Evidence for the Pleistocene Peopling of the Americas* (Orono, ME, 1986), 319–337, and subsequently he offered a good précis in his own *The Settlement of the Americas: A New Prehistory* (New York, 2000), 160–168. See also J. M. Adovasio and J. Page, *The First Americans: In Search of Archaeology's Greatest Mystery* (2002), 207–216; John Wilford, "Chilean Field Yields New Clues to Peopling of Americas," *New York Times,* August 25, 1998, C1; David J. Meltzer and Tom D. Dillehay, "The Search for the Earliest Americans," *Archaeology* 52 (January/February 1999); Kambiz Kamrani, "Earliest Known Archaeological Evidence of Americans Found in Monte Verde, Chile," www.Anthropology.net, posted May 8, 2008.

11. Since it is possible that these models were children's toys, they should not be interpreted literally.

12. Danuta Piotrowska, Biskupin, "1933–1996: Archaeology, Politics and Nationalism," *Archaeologia Polona* 35–36 (1997–1998): 255–285; Z. Rajewski, "Biskupin-osiedle obronne sprzed 2500 lat," Arkady, Warszawa 1970.

13. Lewis Mumford, *The City in History: Its Origins, Its Transformations, Its Prospects* (New York, 1961), 7.

14. Klaus Schmidt, "Zuerst kam der Tempel, dann die Stadt," Vorläufiger Bericht zu den Grabungen am Göbekli Tepe und am Gürcütepe 1995–1999, *Istanbuler Mitteilungen* 50 (2000): 5–41. Author translation.

15. Such astronomical alignments in the distant past are not visible to present-day observers because of the precession of the earth's axis or rotation. Over a cycle of 26,000 years the earth "wobbles" in rotation, the axis making a complete circle. Hence, alignments as far back as 9,000 years ago involved an earth whose axis was in a different position.

16. Ulrich Boser, "Solar Circle," *Archaeology* 59 (July/August 2006): 30–35; Madhusree Mukerjee, "Circles for Space: German 'Stonehenge' Marks Oldest Observatory," *Scientific American* 289 (December 2003): 32–34.

17. Kevin Greene, "V. Gordon Childe and the Vocabulary of Revolutionary Change," *Antiquity* 73 (1999): 97–109.

18. The original excavator, James Mellaart, published *Çatal Hüyük: A Neolithic Town in Anatolia* (New York, 1977). For an examination of more recent findings by current excavator Ian Hodder, see Michael Balter, *The Goddess and the Bull: Çatalhöyük—An Archaeological Journey to the Dawn of Civilization* (New York, 2005), and also a digest of this study by Balter, "The Seeds of Civilization," *Smithsonian* 36 (May 2005): 68–74.

19. Balter, "The Seeds of Civilization," 72.

CHAPTER 10: THE ARCHITECTURE OF MESOPOTAMIA AND ANCIENT EGYPT

1. In his book *Legacy: The Search for Ancient Cultures* (New York, 1994), Michael Wood notes that it is highly significant that the very earliest forms of writing in India (Sanskrit) and in China (oracle bones) were devised to record religious concepts and to serve divination purposes, respectively. In Mesopotamia, however, writing was developed to catalog possessions; only later did literary and religious writing develop. Recent discoveries in Egypt indicate that very much the same materialist intent drove the initial development of writing there as well.

2. See Gavin Young, "Water Dwellers in a Desert World," *National Geographic Magazine* 149 (April

1976): 502–522 (with many photographs of how such bundled-reed dwellings are made); and Wilfred Thesiger, "Marsh Dwellers of Southern Iraq," *National Geographic Magazine* 113 (February 1958): 204–239. See also Edward L. Ochsenschlager, *Iraq's Marsh Arabs in the Garden of Eden* (Philadelphia, 2004). With pressure to modernize and with efforts to drain the marshes, this ancient way of life and its architecture are under threat. The pressure on these marsh-dwelling Ma'Dan people has been exacerbated recently because they are Shiite Muslims under a government that (until 2003) was controlled by Sunni Muslims.

3. Strabo (c. 64 BCE to 24 CE) spent the last years of his life writing and rewriting his comprehensive seventeen-book historical geography of the ancient world. For his account of Mesopotamia, and Babylon particularly, see Horace L. Jones, trans., *The Geography of Strabo* (London, 1927), 7:199.

4. Ibid., 7:201.

5. Quoted from Stephen Mitchell, *Gilgamesh: A New English Version* (New York, 2004), 168. Not a literal translation, Mitchell's version endeavors to convey the rhythm of the original text. For a more literal translation, see N. K. Sanders, *The Epic of Gilgamesh* (London, 1972), 102. The story of Gilgamesh, written down in the first centuries of the second millennium CE, had been formed many centuries earlier. Fragments of the story were discovered in nineteenth-century excavations of many Mesopotamian cities. The most complete edition was uncovered in the vast seventh-century CE library of Assurbanipal, the last great king of Assyria. The tale is the story of a hero's journey, as Mitchell explains, but it is also a story about how a man becomes civilized and how he learns to rule himself and therefore his people and to act with temperance, wisdom, and piety (Mitchell, *Gilgamesh,* 7). See also Wood, *Legacy,* 32.

6. Wood, *Legacy,* 213. See also Stephanie Dalley, *Myths from Mesopotamia* (Oxford, England, 1989), and Thorkild Jacobsen, *The Harps That Once . . . : Sumerian Poetry in Translation* (New Haven, CT, 1987).

7. Herodotus, *The Histories,* ii. 5.

8. To be accurate, there were incursions into Egypt, but the first—by the so-called Hyksos, who assumed domination in about 1674 CE—occurred after two millennia of protected cultural development. In any event, Hyksos domination had essentially no effect on redirecting Egyptian cultural development. The remaining Hyksos were expelled after about a century. With the expansion of the Egyptian Empire into Palestine and Syria came warfare with adjoining powers, and increasingly afterward, there were attacks from the sea. The Assyrians invaded in 671 BCE but were driven back about seven years later. The expansion of the Persian Empire drew Egypt into the Persian sphere of influence, and then, in 332 CE, Egypt was taken over by Alexander the Great. Upon his sudden death, Egypt fell under the rule of one of his generals, Ptolemy; although he assumed the role of pharaoh, there remained a strong Hellenistic cultural influence. By 47 CE, with the arrival of Julius Caesar, Egypt had become a part of the growing Roman Empire, and an essential part after its annexation in 30 CE, because Egypt supplied large amounts of grain to feed the urbanized Romans.

9. Wood, *Legacy,* 137.

10. Due to confusing archaeological evidence, there is some thought that the pharaohs Menes and Narmer are the same person—and that this person founded the First Dynasty. See Stephan Seidlmayer, "The Rise of the State to the Second Dynasty," quoted in R. Schulz and M. Seidel, eds., *Egypt: The World of the Pharaohs* (Köln, 2004).

11. It may have been during this unsettled period that the Hebrews were in servitude in Egypt; another interpretation is that it was during the reign of Ramses II.

12. At Zoser's pyramid at Saqqara, the Serdab (from the Arabic word for cellar or cave) was a small *Ka* chamber at the foot of the step pyramid, just large enough to house a painted limestone statue of Zoser (now in the Egyptian Antiquities Museum in Cairo). This life-size statue was the vessel for the king's *Ka* spirit. Two small holes in the chamber wall, aligned with the eyes of the statue, provided for a view out to what is called the Serdab court, where various offerings were made and rituals performed.

13. Quoted in Lionel Casson, *Ancient Egypt* (New York, 1965), 134.

14. These passages are quoted in I.E.S. Edwards, *The Pyramids of Egypt,* rev. ed. (Baltimore, 1961), 288–291. See also the translations in J. H. Breasted, *The Development of Religion and Thought in Ancient Egypt* (New York, 1912).

15. Tutankhamen's tomb in fact was entered shortly after it was sealed, and objects in it were disturbed. But the robbers apparently were caught in the act, and the tomb was then again officially re-consecrated, closed, and resealed; the imprinted clay seals were still hanging, intact, from the door handles three millennia later, when they were uncovered by Howard Cater in 1922. We can only guess at what delightful anticipation he experienced when he saw these seals untouched for three thousand years (as well as the mounting expectation of everything to be found behind them).

16. The evidence for a small pyramid is scanty; some other structure may have stood at the center.

17. The pyramid of Khufu was surrounded by pits cut into the rock plateau for holding full-scale wooden boats in which he could travel with Ra; one of these

pits was uncovered and the boat recovered intact in 1954. Crafted of Lebanese cedar, the boat had been carefully disassembled into 651 parts, carefully laid in 13 layers in a specially cut stone chamber. So carefully sealed was the boat chamber that when it was reopened in 1954 it was said the scent of cedar still lingered in the air. In 1991, near the temple of Khentyamentiu outside Abydos, archaeologists uncovered fourteen wooden boats dating from around 2950–2775 BCE.

18. The stone blocks removed from Akhenaton's temples, with their carved and painted surfaces, were turned around and the blank backsides presented in the new construction. These image fragments have been studied and recorded, which has allowed the image pieces to be reassembled by computer analysis on paper, like a gigantic jigsaw puzzle, to give some idea of the form of the original temples.

19. E. B. Smith, *Egyptian Architecture As Cultural Expression* (New York and London, 1938), 246–248.

20. Ibid., 249.

CHAPTER 11: GREEK ARCHITECTURE

1. This description, by an unknown writer of the second century BCE, is quoted in J. G. Frazer, *Pausanias' Description of Greece* (London, 1897), xliii, n. 1; quoted in Vincent J. Bruno, *The Parthenon* (New York, 1974), 71.

2. Plato, *Epinomis,* 987d, trans. W.R.M. Lamb (London, 1927), 473.

3. Plato, *Critias,* section 111. Quoted in H.D.F. Kitto, *The Greeks,* rev. ed. (Baltimore, 1957), 34.

4. The Thera Foundation website provides detailed information; see therafoundation.org. The preciseness of the date has been determined by tree-ring studies as far away as Ireland and Sweden.

5. C. M. Bakewell, *Source Book in Ancient Philosophy* (New York, 1939), 8–9. See also H.D.F. Kitto, *The Greeks,* rev. ed. (Baltimore, 1957), and Edith Hamilton, *The Greek Way* (New York, 1942).

6. Sophokles, *Antigone,* trans. E. F. Watting (Baltimore, 1947), 135.

7. This elemental relationship was first perceived by Vincent Scully; see his *The Earth, the Temple, and the Gods* (New Haven, CT, 1962). The concept is still considered somewhat controversial by traditional Classical scholars trained to think only of buildings in isolation.

8. Although the Athenians had several names for Athena, they performed rituals for Athena Polias only in the older, northern temple (later replaced by the Erechtheion) on the Akropolis; the larger, southern temple, the Parthenon, seems to have been built to embody civic ideals. See C. J. Herington, *Athena Parthenos and Athena Polias: A Study in the Religion of Periclean Athens* (Manchester, England, 1955), and particularly Jeffery M. Hurwit, *The Athenian Acropolis: History, Mythology, and Archaeology from the Neolithic Era to the Present* (New York, 1999).

9. Kitto, *The Greeks,* 75.

10. In contrast to the far more inclusive attitudes of the twenty-first century, for ancient Greeks political life and activity were restricted to free male citizens. Accordingly, the male pronoun is used here in discussions involving Greek and Roman political life.

11. Delphi was a remote site sacred to ancient female earth deities, but with the arrival of the Dorians it became associated with the male deity Apollo. Around the Bronze Age, apparently, the site had been discovered to possess extraordinary attributes, for priests who descended into a small grotto became possessed of special abilities and experienced visions. In time, the women priests associated with the shrine on this site would descend into the grotto several days after the new moon and answer questions while in a trance. Plutarch later described the oracle and the priestesses who made their utterances there, and Strabo wrote of "the seat of the oracle [being in] a cave that is hollowed deep down in the earth, with a rather narrow mouth, from which rises breath [*pneuma,* "vapor, gas"] that inspires a divine frenzy" (*Geography,* 9.3.4–5; see Horace L. Jones, trans., *The Geography of Strabo* [London, 1927], 4:349). Although this story has long been discounted in modern times, recent scholars have theorized that several days after the new moon and its tides, there arose from the fissure described in the floor of the grotto ethylene fumes, brought to the surface because of geophysical tectonic forces pressing on hydrocarbon deposits deep below. Inhaling these fumes put the oracle priestess, called the Pythia, in an ecstatic trance, during which she would answer the questions put to her. A major earthquake in 373 BCE changed the tectonics sufficiently that the gases gradually ceased rising to the surface and the oracle gradually became less efficacious. Strabo, writing circa 2 CE to 23 CE, describes the temple and shrine structure then as "much neglected." Regarding the role of ethylene vapors, see Jelle Z. de Boer and John R. Hale, "The Oracle at Delphi" *Archaeology Odyssey* 5 (November–December 2002): 46–53, 58–59.

12. According to legend, after the defeat of the Persians at Marathon, and aware that the Persians were about to sail to attack unprotected Athens, a soldier named Phidippides, wearing full battle armor, ran the twenty-six miles from Marathon to Athens to declare the victory and to warn the Athenians to prepare for the Persian attack. This is the origin of the 26-mile 385-yard marathon race celebrated at the modern Olympic games. Having presented his news and proven

his *arete,* Phidippides is reported to have dropped dead of exhaustion.

13. Aristotle, *Politics,* ii. 8, trans. B. Jowett (Oxford, 1905), 76.

14. Scully, *The Earth, the Temple, and the Gods,* 206.

15. The meaning of the Classical orders, at least in Roman times, and of their numerous component parts, is treated in George Hersey, *The Lost Meaning of Classical Architecture: Speculations on Ornament from Vitruvius to Venturi* (Cambridge, MA, 1988). For a discussion of the Corinthian order in particular, see Joseph Rykwert, "The Corinthian Order," *Domus* 426 (May 1965), reprinted in *The Necessity of Artifice,* ed. Joseph Rykwert (New York, 1982), 33–43. For a modern interpretation of the proportions of the orders, Greek and Roman, see Robert Chitham, *The Classical Orders of Architecture* (New York, 1985).

16. The list of the Seven Wonders, compiled by several authors in antiquity, originally varied slightly in the monuments they selected. See Peter Clayton, *The Seven Wonders of the Ancient World* (London, 1988).

17. As mentioned earlier, after their defeat at Marathon, the Persians withdrew, marshaled their forces, and returned a decade later in force; they invaded Greece, attacked Athens, and sacked the Akropolis, burning the temples there. There is, of course, the great irony that, the domination the Persians failed to win by force, Athens easily achieved over the smaller Aegean poleis through the Delian League. Eventually, however, this "empire" proved Athens' undoing, causing the long and disastrous Peloponnesian War, 435–404 BCE.

18. Jeffery M. Hurwit, *The Acropolis in the Age of Pericles* (Cambridge, England, 2004).

19. The cattle taken up to the Akropolis altar for slaughter remind us that we are not as close to the Greeks as we sometimes like to imagine. David Watkin, *A History of Western Architecture* (London, 1986), 38, cautions us to remember "the stench, squalor, and noise of such an occasion as the flies settled on the blackening blood in the stifling heat."

20. Although much is now missing from the Akropolis, as at Olympia and all other Greek sites, we have a detailed record of what was there and at other sites, in the meticulous travel record kept by the Greek traveler Pausanias, who toured Greece in the second century CE; see the translation by Peter Levi, *Guide to Greece,* 2 vols. (Harmondsworth and New York, 1971). See also the description of the Panathenaic festival in S. Kostof, *A History of Architecture* (New York, 1985), 149–158.

21. Vitruvius, *On Architecture,* III.4.5 and III.3.11–13. Vitruvius lists a treatise by Iktinos and Karpion (misspelling for Kallikrates?), which he says he consulted.

22. Jerome Pollitt, *Art and Experience in Classical Greece* (London, 1972), 76.

23. Joseph Fontenrose, *Didyma: Apollo's Oracle, Cult, and Companions* (Berkeley, 1988). The unfinished temple is described by Strabo, *Geography,* xiv.1.5, and by Pausanius.

CHAPTER 12: ROMAN ARCHITECTURE

1. This may be the basis of the legend, transcribed by Virgil in the *Aeneid,* that Rome was founded by Aeneas, who was fleeing from the ruins of Troy after its capture by the Greeks.

2. Although there have been numerous modern scholarly studies of the rise and fall of Rome, the magisterial work of Edward Gibbon, *The Decline and Fall of the Roman Empire,* 6 vols. (London, 1776–1788) remains unsurpassed for its wealth of information and superb poetic command of the English language. It also remains a sheer pleasure to read.

3. Virgil, *Aeneid,* I. 278, trans. W. F. Jackson Knight (Harmondsworth, England, 1956), 36.

4. The proper design of the temple is described in Vitruvius, *On Architecture,* books III and IV; trans. M. H. Morgan (Cambridge, MA, 1914).

5. Ibid., V:i.

6. Vitruvius discusses the considerations in city planning in ibid., I.iv–vii.

7. William L. MacDonald notes that the Roman foot was somewhat shorter than the modern foot, about 11.625 inches (29.5 cm). Hence, 2,400 Roman feet was roughly equal to 2,325 modern feet (708.7 meters); see MacDonald, *The Pantheon: Design, Meaning, and Progeny* (Cambridge, MA, 1976), 62.

8. Rules for the design of basilicas are given in Vitruvius, *On Architecture,* V.i.iv–x.

9. See the detailed restoration drawings in James E. Packer, *The Forum of Trajan in Rome: A Study of the Monuments* (Berkeley, 1997).

10. On the pediment of this building, the second Pantheon on this site, Hadrian retained the inscription that had appeared on the original: *m. agrippa. l. f. cos. tertium. fecit* ("Marcus Agrippa the son of Lucius, three times Consul, built this"). This inscription has often caused confusion among those not familiar with the history of the building.

11. Aside from periodic repairs faithfully restoring original work, the only major change in the interior of the Pantheon was the unfortunate introduction of a colored stucco treatment of the attic band just below the curve of the coffering. A portion of this attic band has been restored to show the original design, as depicted in the interior view painted by Panini about 1750 just before this alteration was made [see 3.27].

12. David Watkin, *A History of Western Architecture,* 3rd ed. (London and New York, 2000), 77. Perception shifts over time, and the Pantheon and Roman architecture were not always held in high regard, as the following comment by Arthur Kingsley Porter, made about 1919, attests (he was, incidentally, an early historian of medieval architecture): "Future investigations may possibly show that Roman architecture was not as dull as it now appears. I fear, however, that this is unlikely" (quoted in William L. MacDonald, *The Pantheon: Design, Meaning, and Progeny* [Cambridge, MA, 1976], 133).

13. Cicero, *Ad Atticum,* XIV.9 (letter to Atticus, April 17, 44 BCE), trans. E. O. Winstedt (London, 1918), 231.

14. Vitruvius, *On Architecture,* II.i and VI.i–viii, discusses the proper design of houses. For a concise account of the destruction of Pompeii and its later rediscovery, see Robert Etienne, *Pompeii: The Day a City Died* (New York, 1992).

15. Today, with our knowledge of the catastrophic nature of many volcanic explosive eruptions (notably those of Krakatau off Java in 1883 and of Mount Saint Helens in 1980), we might well wonder why the Pompeians did not all flee immediately. What must be remembered is that Vesuvius had not erupted for perhaps a thousand years and no one expected it to. Pliny the Elder, admiral of the Roman navy and a keen observer of natural phenomena, in fact ordered his ship to sail *to* Pompeii so that he might observe the eruption more closely; he remained there a day or two but succumbed to the ash because of his asthma (his nephew Pliny the Younger recorded this story later) (see Etienne, *Pompeii*). Volcanic eruptions elsewhere were known to the Romans at this time through the frequent eruptions of Stromboli off the north coast of Sicily, and through the activity of Mount Etna on that island. Both these mountains erupt frequently but with limited effect and quickly settle down afterward. These familiar volcanoes gave no suggestion of the nearly incomprehensible blasts that can happen without much warning.

16. Vitruvius, *On Architecture,* V.iii–viii, discusses theater design.

17. Regarding the theater at Aspendus, see George C. Izenour, *Theater Design* (New York, 1977), 182–183, 263–264.

18. Axel Boëthius and John B. Ward-Perkins, *Etruscan and Roman Architecture* (Baltimore, 1970), 271. Vitruvius, *On Architecture,* V.x, discusses the design of baths.

19. In antiquity, the settlement was known as Heliopolis in Coelosyria.

ESSAY 1: INDIAN ARCHITECTURE

1. Other buildings in India designed by Le Corbusier include Plan for Chandigarh, 1951; High Court, Chandigarh, 1951–1959; Secretariat, Chandigarh, 1951–1958; Governor's Palace, Chandigarh, 1951–1953; Millowners' Association Building, Ahmedabad, 1954–1956; Museum, Ahmedabad, 1954–1957; Sarabhai residence, Ahmedabad, 1955–1956; Shodhan residence, Ahmedabad, 1956–1957; Legislative Assembly, Chandigarh, 1956–1964; Sector 17, Central Business Area, Chandigarh, 1958–1969; Boat Club, Lake Sukna, Chandigarh, 1963–1965; School of Art and Architecture, Chandigarh, 1964–1969; and Museum and Art Gallery, Chandigarh, 1964–1969.

2. The other building by Kahn in Bangladesh is the Indian Institute of Management, Ahmedabad, 1962–1974.

CHAPTER 13: EARLY CHRISTIAN AND BYZANTINE ARCHITECTURE

1. For further discussion of the rise and spread of Christianity, among many useful surveys, see Roland Bainton's excellent study, *Christendom: A Short History of Christianity and Its Impact on Western Civilization,* 2 vols., rev. ed. (New York, 1966); John McManners, ed., *The Oxford Illustrated History of Christianity* (New York, 1990); and Jaroslav Pelikon, *Jesus Through the Centuries: His Place in the History of Culture* (New Haven, CT, 1985).

2. *Matthew* 16:18.

3. *Acts of the Apostles* 19:9–10; upon Paul's visit to Ephesus, the Christian community rented the lecture room of Tyrannus. In *Acts* 2:46, Luke writes that the first Christians met to break bread together [celebrate the *Eucharist*] "in [their] private houses." From *The New English Bible: The New Testament,* 2nd ed. (New York, 1971), and *The New Jerusalem Bible* (New York, 1985), among recent scholarly translations.

4. Constantine to his bishops, quoted in R. H. Barrow, *The Romans* (Baltimore, 1949), 185–186.

5. *Revelation* 6:9.

6. The dimensions of old Saint Peter's Basilica are based on Turpin C. Bannister, "The Constantinian Basilica of St. Peter at Rome," *Journal of the Society of Architecture Historians* 27 (March 1968): 3–32; included in this issue also is Kenneth J. Conant, "The After-life of Vitruvius in the Middle Ages," 33–38, which discusses the use of geometric ratios in planning early churches.

7. The decree and an early description of the Church of the Holy Sepulcher in Jerusalem are given in Eusebius, *Life of Constantine,* III.26; for a discussion of this and the other Constantinian churches, see Richard Krautheimer, *Early Christian and Byzantine Architecture,* 3rd ed. (New York, 1979).

8. In a bitter historical irony, the hilltop Abbey of Monte Cassino and its unequaled library, which had

served as a beacon of reason and enlightenment through the Middle Ages, were taken over by the German army during World War II as the Allies began their move up the Italian peninsula in the spring of 1944. The monastery occupied a strategic, high position, enabling the entrenched German forces to block the march of the Allied armies to Rome. After agonizing deliberation, in which the consequences were carefully evaluated, the regrettable decision was made to shell and bomb the monastery, totally destroying it. It was later discovered that soldiers occupied only the hillside, not the interior of the monastery itself. The monastery has since been rebuilt, as it had been earlier at numerous other times after attacks and earthquakes. The archives, the library, and some paintings, however, were saved.

9. Procopius of Caesarea, *Buildings,* trans. H. B. Dewing and G. Downey (Cambridge, MA, 1940), I.i.45–47.

10. Ibid., I.i.29, 48–49.

11. This often-repeated phrase, suggesting Justinian's preening self-importance, seems to be legendary, and was not written down until the eleventh century; see John W. Baker, *Justinian and the Later Roman Empire* (Madison, WI, 1966), 183, n. 12.

ESSAY 2: ISLAMIC ARCHITECTURE

1. The religion of Muhammad is called Islam and its adherents are known as Muslims. Islam, which can be roughly translated as "submission to god," is based on five basic precepts: first, proclaiming the *shahada* or Muslim creed: "*There is no god but God (Allah), and Muhammad is the messenger* [or, "*his Prophet*"] *of God";* second, *salah,* or obligatory ritual worship including five formal prayers each day, offered prostrate while faced toward Mecca; third, *zagāt,* or charity and the giving of alms; fourth, *sawm,* fasting in the daylight hours during the holy month of *Ramadan;* and fifth, making a pilgrimage, the *hajj,* at least once in one's life, to the holy city of Mecca.

2. Central Muslim administration was conducted by the successive caliphates, established by successive ruling families. The centers of their activities shifted from place to place over the centuries: The Rashadid Caliphate based in Mecca (632–661); the Umayyad Caliphate based in Damascus, Syria (661–750); a separate Umayyad Caliphate in Spain (c. 750–eleventh century); the Abbasid Caliphate centered in Baghdad, Iraq (750–1519); the Fatamid Caliphate based in Cairo (909–1171); the Mamluk Sultanate based in Cairo (1250–1517); and the Ottoman Caliphate based in Istanbul, Turkey (1517–c. 1918), which ended when Turkey was secularized after World War I. The overlaps in dates for some caliphates were due to the rival divisions between the Shia and Sunni branches of Islam.

3. Had the Umayyad forces been successful, all of western Europe might have experienced an era of great advancement in learning, development of the sciences, and architectural refinement, all extensions of Islamic scholarship and the arts; instead, only the Iberian peninsula remained Muslim and the rest of Europe fell into the Dark Ages.

4. Islamic architecture began in the deserts of northern Arabia and expanded largely into arid regions between the 10th and 40th parallels.

5. Not only was the site already holy to the Jews because of the former presence of the temple there (and because of the traditional Jewish view that this was where Abraham prepared to sacrifice Isaac following God's order), but it was sacred also to Christians because of Christ's activities in the temple during his life, culminating in his dramatic expulsion of the money changers and their commercial enterprise from the temple.

6. Further influence of the local Constantinian models is seen in the dimensions of the dome of the Church of the Holy Sepulcher, which is 20.2 meters in diameter with a height of 20.48 m, while the Dome of the Rock is 20.9 m in diameter with a height of 21.5 meters.

7. This was the age of such polymaths as Ibn Sina (c. 980–1037, usually called Avicenna in the West), who wrote 450 or so treatises on medicine, mathematics, physics, and astronomy, among a host of other topics. Sadly, when the Mongols overran Baghdad in 1258, they killed enormous numbers of residents and burned the great library of Baghdad, destroying much of recorded Muslim intellectual and scientific knowledge.

8. In part, the motivation for creating a semi-independent state in Persia was the strong resistance against colonizing efforts at creating an Arab culture that was deeply resented by the Persians, who viewed themselves as an entirely different ethnic group and as the heirs of a far more ancient and advanced culture.

9. Timur, who was a devout Muslim, exercised adroit but ruthless military expansion; he hoped to reestablish the sprawling Mongol Empire and, in a few short years, extended the rule of his Timurid dynasty from the Black Sea midway through modern Pakistan, and from the southern edge of Kazakhstan through Afghanistan all the way to the Indian Ocean.

10. Though Mecca is actually southeast of Córdoba, in a departure from strict tradition the *mihrab* points south.

11. This court is named for the large circular alabaster basin in the center supported by twelve small stylized lions from whose mouths jets of water pour into an encircling channel below. From that circular chan-

nel, water flows into four narrower channels, following the crossed axis and extending outward to fountains in the center of each of the projecting pavilions on the four sides of the court. For further information, see Robert Irwin, *The Alhambra* (Cambridge, MA, 2011).

12. See the incorporation of similar *chattras* ornamental pavilions in Sir Edwin Lutyens Viceroy's House in New Delhi, discussed in Chapter 19.

13. This emperor, whose Persian-inspired name can be translated as "Ruler of Everywhere," seems to have wished that his new mosque could accommodate all his subjects, for it is described as being able to simultaneously accommodate about twenty-five thousand worshippers.

14. This would put the completion of the Taj Mahal just prior to the start of Louis XIV's Versailles or Wren's St. Paul's Cathedral, London.

CHAPTER 14: MEDIEVAL ARCHITECTURE

1. This idea is explored in Erwin Panofsky, *Renaissance and Renascences in Western Art,* 2nd ed. (New York, 1972).

2. The Crusades, in which European Christian forces repeatedly attempted to recapture control of the Holy Land from the forces of Islam, have had long-lived consequences. While they introduced Europe to delicacies and luxury goods imported from India, China, and the spice islands of the Far East (which would later fuel ocean voyages to the west, leading to the discovery of the Western Hemisphere), the Crusades also ingrained in Islamic territories a continuing distrust, if not hatred, of the West that has endured through the centuries.

3. This interpretation of the origin and purpose of the plan of Saint Gall is based on research by Warren Sanderson, Paul Mayvaert, Norbert Stachura, and others; see Warren Sanderson, "The Plan of St. Gall Reconsidered," *Speculum* 60 (July 1985): 615–632. In their major publication, *The Plan of St. Gall,* 3 vols. (Berkeley, 1979), Walter Horn and Ernest Born interpret the inscription on the plan to mean that Abbot Haito sent the plan to Abbot Gozbertus as a result of the synods held at Aachen in 816–817 to effect Benedictine reform. Horn and Born also assert that it was a duplication of some other plan prepared at the Aachen meetings, intended as a model for emulation throughout the Carolingian Empire. Recent study of the inscription and of the physical evidence provided by the original parchment has led to differing conclusions. I am indebted to my colleague Richard Sundt for pointing out this shift in interpretation to me.

4. The Christian reconquest of Islamic Spain was to have an enormous influence on the development of European culture, for in the great centers of Islamic learning in Spain were found vast libraries of Greek manuscripts, many of them works of theoretical science translated into Arabic and previously unknown in Europe; when these were translated back into Greek and Latin, some of the Arabic technical terms, such as *zero* and *azimuth,* had to be left in Romanized Arabic because no substitute could be found in European languages.

5. From the Gallican liturgy quoted in Gregory Dix, *The Shape of the Liturgy* (London, 1952), 581.

6. Geoffrey Chaucer, *The Canterbury Tales,* prologue, trans. J. U. Nicolson (New York, 1934). The martyr mentioned is Saint Thomas Becket, archbishop of Canterbury, killed in 1170 and canonized in 1172. Chaucer describes a pilgrimage that he joined in the spring of 1387; in the party were thirty people, including a knight, a miller, a monk, a nun, a clerk, a merchant, a physician, and a farmer—a cross section of medieval society. The tales he relates are based on those told by the travelers for their mutual amusement and edification while on the road. The twelfth-century "Pilgrim's Guide" is translated into English in Annie Shaver-Crandell and Paula Gerson, *The Pilgrim's Guide to Santiago de Compostela: A Gazetteer* (London, 1995).

7. For an interesting description of the conflicts within the medieval monastic community concerning the study of Classical literature, see the novel by Umberto Eco, *The Name of the Rose,* trans. William Weaver (New York, 1983).

8. Erwin Panofsky, ed. and trans., *Abbot Suger on the Abbey Church of St.-Denis and Its Art Treasures,* 2nd ed. (Princeton, 1979), 101.

9. Ibid., 19.

10. Ibid., 63–65.

11. Ibid., 51.

12. Ibid., 101.

13. The Renaissance commentators used the phrase *maniera tedesca* ("German manner") to suggest this barbaric character in contrast to the classical humanist architecture then being invented in places such as Florence and Rome. However, by the time Sir Christopher Wren wrote about "what we now vulgarly call Gothic" at the end of the seventeenth century, the term *Gothic,* in England at least, had become neutral in connotation. (Wren used *vulgar* to mean "in common speech.") Wren's comment appeared in his autobiographical *Parentalia* (London, 1750; reprinted Farnborough, 1965), 306. See Nicola Coldstream, *Medieval Architecture* (Oxford, 2002), 26.

14. Jean Gimpel, *The Cathedral Builders,* trans. Teresa Waugh (New York, 1983).

15. A technical explanation of the failure is given in Robert Mark, *Experiments in Gothic Structure* (Cambridge, MA, 1982), 58–77; see also Stephen Murray,

"The Choir of the Church of St. Pierre, Cathedral of Beauvais: A Study of Gothic Architectural Planning and Construction Chronology in Its Historical Contest," *Art Bulletin* 62 (December 1980): 533–562.

16. Today, numerous substantial diagonal struts are placed inside the incomplete cathedral at Beauvais to enable the church to remain standing.

17. Desjardin, quoted in Mario Salvadori, *Why Buildings Stand Up* (New York, 1980), 222–224.

18. Peter Kidson, Peter Murray, and Paul Thompson, *A History of English Architecture* (Harmondsworth, England, 1965), 135.

19. A. B. Kerr, *Jacques Coeur: Merchant Prince of the Middle Ages* (New York, 1927).

CHAPTER 15: RENAISSANCE ARCHITECTURE

1. Giorgio Vasari, a student of Michelangelo, wrote *Vite de' più eccellenti architetti, pittori e scultori italiani* during the period 1546–1550. See the edited version, Giorgio Vasari, *Lives of the Artists,* trans. George Bull (Baltimore, 1965). The concept of the Renaissance is discussed in Erwin Panofsky, *Renaissance and Renascences in Western Art* (Stockholm, 1960).

2. Giovanni Pico della Mirandola, "Oration on the Dignity of Man," trans. Elizabeth L. Forbes, in *The Renaissance Philosophy of Man,* ed. Ernst Cassirer et al. (Chicago, 1948), 224–225. The quotations in Pico's text reveal his knowledge of Greek and Latin sources. Also included in Cassier's anthology are selections by Francesco Petrarch (such as his account of the ascent of Mount Ventoux), Marsilio Ficino, and others.

3. Ibid., 225, 227.

4. Brunelleschi, who had been trained as a goldsmith and then studied sculpting, had achieved recognition in 1402 by winning second place in a competition for new bronze doors for the Florence baptistery in front of the cathedral, Santa Maria delle Fiore. Vasari, *Lives of the Artists,* I:139, reports Brunelleschi's loss of the contest. Brunelleschi then spent several years in Rome making detailed examinations and taking measurements of the Roman ruins.

5. Recounted in ibid., I:146–147.

6. The intriguing story of Brunelleschi's solution to the Florence dome dilemma is told in detail in E. Battisti, *Filippo Brunelleschi* (New York, 1981); F. D. Prager and G. Scaglia, *Brunelleschi: Studies of His Technology and Inventions* (Cambridge, MA, 1970); and Howard Saalman, *Filippo Brunelleschi: The Cupola of Santa Maria del Fiore,* vol. 20 of the Studies in Architecture series (London, 1980). A condensed explanation is given in Rowland J. Mainstone, "Brunelleschi's Dome," *Architectural Review* 162 (1977): 156–166. Particularly clear is the account given by Mario Salvadori in *Why Buildings Stand Up: The Strength of Architecture,* rev. ed. (New York, 1990), 233–242. A recent, very readable, detailed biographical account is presented in Ross King, *Brunelleschi's Dome: How a Renaissance Genius Reinvented Architecture* (London, 2000).

7. Quoted in Marvin Trachtenberg and Isabelle Hyman, *Architecture from Prehistory to Postmodernity,* 2nd ed. (New York, 2002), 279.

8. Plato, *Philebus,* trans. B. Jowett (Oxford, 1953), 610–611.

9. Vitruvius, *Ten Books on Architecture,* trans. Morris H. Morgan (Cambridge, MA, 1914), 73.

10. Galileo, quoted in E. A. Burtt, *The Metaphysical Foundations of Modern Physical Science* (Garden City, NY, 1954), 75. One of the early modern reassessments of the Renaissance interest in number and proportional systems, first published in 1949 and still an important study, is Rudolf Wittkower, *Architectural Principles in the Age of Humanism,* 4th ed. (New York, 1988). More recent studies investigating Renaissance number and proportional systems include Robin Evans, *The Projective Cast: Architecture and Its Three Geometries* (Cambridge, MA, 1995); Alberto Pérez-Gómez and Louise Pelletier, *Architectural Representation and the Perspective Hinge* (Cambridge, MA, 1997); and, particularly well illustrated and clear, Lionel March, *Architectonics of Humanism: Essays on Number in Architecture* (London, 1998). For the continuation of this design theory, see also George Hersey, *Architecture and Geometry in the Age of the Baroque* (Chicago, 2000).

11. Leon Battista Alberti, *De re aedificatoria (On the Art of Building in Ten Books),* trans. Joseph Rykwert et al. (Cambridge, MA, 1988), VI.ii.

12. Ibid., IX.v.

13. For the basics of Brunelleschi's life, see Giuliano Chelazzi, "Filippo Brunelleschi," in *International Dictionary of Architects and Architecture: Architects,* ed. Randall J. Van Vynckt (Detroit, 1993), 117–121; Howard Saalman, "Filippo Brunelleschi," *Macmillan Encyclopedia of Architects,* ed. Adolf K. Placzek (New York, 1982), 1:303–314; and Harold Meek, "Filippo Brunelleschi," in *The Grove Dictionary of Art,* ed. Jane Turner (New York, 1996), and online at www.oxfordartonline.com.

14. Vasari, *Lives of the Artists,* 139. Vasari drew much of his information from the contemporary biography of Brunelleschi by Antonio Manetti, written about 1448–1449, shortly after the architect's death. Manetti described Brunelleschi as the innovator of "true architecture." See the translation of Manetti in Elizabeth Gilmore Holt, *A Documentary History of Art* (Garden City, NY, 1957), 1:167–179.

15. This clarity of spatial proportions, fixed in a three-dimensional grid, was analogous to the grid of equal squares being proposed at the time by the Flo-

rentine mathematician Paolo dal Pozzo Toscanelli for locating land masses on maps.

16. Marvin Trachtenberg has proposed that the Pazzi Chapel was the design of Michelozzo, but this reattribution has received little support.

17. Regarding Giuliano da Sangallo, see Richard J. Tuttle, "Giuliano da Sangallo," in *Macmillan Encyclopedia of Architects,* 3:644–645.

18. Regarding Alberti's architecture, see Charles R. Mack, "Leon Battista Alberti," in *International Dictionary of Architects and Architecture: Architects,* 10–14; Eugene J. Johnson, "Leon Battista Alberti," in *Macmillan Encyclopedia of Architects*, 1:48–59; and Paul Davies and David Hemsoll, "Leon Battista Alberti," in *Grove Dictionary of Art,* and online.

19. Alberti to Matteo de' Pasti, quoted in Peter Murray, *The Architecture of the Italian Renaissance* (New York, 1963), 50.

20. For biographical information, see Eunice D. Howe, "Donato Bramante," in *International Dictionary of Architects and Architecture: Architects,* 102–106; Peter Murray, "Donato Bramante," in *Macmillan Encyclopedia of Architects,* 1:269–282; and Paul Davies and David Hemsoll, "Donato Bramante," in *Grove Dictionary of Art,* and online.

21. Since the drawing by Bramante (now at the Uffizi in Florence), so often used for the reconstruction of the entire plan, is only a fragment showing half the plan, there is a possibility that the original intent was for a Latin cross plan with a nave. Drawing A20 at the Uffizi, presumably made by followers of Bramante, shows the plan of the old Constantinian basilica combined with that of Bramanate's church overlaid on it; this shows the beginnings of a nave. A somewhat different scheme with a centralized plan but a projecting entry facade is shown in a cutaway perspective of the new St. Peter's, made by Baldassare Peruzzi; this drawing is also at the Uffizi, Florence.

22. The Italian Renaissance palazzo was much more than a single-family residence, for it housed not only the business of the builder but also accommodations for the extended family as well as servants. See F. W. Kent, "Palaces, Politics and Society in Fifteenth Century Florence," *I Tatti Studies* (1987): 41–64.

23. Vasari, *Lives of the Artists,* 164.

24. Regarding Michelozzo's architecture, see Giuliano Chelazzi, "Michelozzo di Bartolomeo," in *International Dictionary of Architects and Architecture: Architects,* 577–578; Harriet McNeal Caplow, "Michelozzo di Bartolomeo," in *Macmillan Encyclopedia of Architects,* 3:179–181; and Francesco Quinterio, "Michelozzo di Bartolomeo," in *Grove Dictionary of Art,* and online.

25. Regarding Andrea Palladio, see Elwin C. Robison, "Andrea Palladio," in *International Dictionary of Architects and Architecture: Architects,* 638–642; Douglas Lewis, "Andrea Palladio," in *Macmillan Encyclopedia of Architects,* 3:345–362; and Andreas Beyer, "Ándrea Palladio," in *Grove Dictionary of Art,* and online.

26. More precisely, Almerico sold his house in Vicenza and made the Villa Rotunda his residence. See Bruce Boucher, *Andrea Palladio: The Architect in His Time,* rev. ed. (New York, 1998). James Ackerman has written extensively on Palladio and his villas; see his *Palladio,* rev. ed. (London and New York, 1991); *Palladio's Villas* (Locust Valley, NY, 1967); and *The Villa: Form and Ideology on Country Houses* (Princeton, 1990).

27. Regarding Michelangelo's architecture, besides James S. Ackerman, *The Architecture of Michelangelo,* 2nd ed. (London, 1986), see Bernaerd Schultz, "Michelangelo," in *International Dictionary of Architects and Architecture: Architects,* 572–576; Howard Hibbard, "Michelangelo," in *Macmillan Encyclopedia of Architects,* 3:165–179; and Anthony Hughes, "Michelangelo (Buonarroti) [Michelangelo di Lodovico Buonarroti Simoni]," in *Grove Dictionary of Art,* and online.

28. Alberti, *De re aedificatoria,* I.xiii.

29. Vasari, *Lives of the Artists,* 366.

30. Regarding Giulio Romano, see Bette Talvacchia, "Giulio Romano," in *Grove Dictionary of Art,* and online.

31. It is no coincidence that Mannerist architecture was admired by the early Postmodernists in the mid-twentieth century. The slipping keystones in the Palazzo del Te court are "double coded"; that is, they are not only whimsical but can also be seen as a literal representation of the ruinous nature of much of the ancient architecture then visible in Rome. A drawing of the Basilica Aemilia by Giuliano da San Gallo looks like it could be a study for the Palazzo del Te court.

32. See Claudia Lazzaro, *The Italian Renaissance Garden* (New Haven, CT, 1990).

33. See the catalog of architectural books in Dora Wiebenson, ed., *Architectural Theory and Practice from Alberti to Ledoux* (Chicago, 1982). Another assessment of the impact of printing and the use of illustrations is Mario Carpo and Sarah Benson, *Architecture in the Age of Printing: Orality, Writing, Typography, and Printed Images in the History of Architectural Theory* (Cambridge, MA, 2001).

ESSAY 3: ANCIENT ARCHITECTURE IN THE AMERICAS

1. That the indigenous peoples already "owned" their lands was ignored by the invading Europeans. Yet there were perhaps 20 million native inhabitants whose ancestors had been living in the Americas for millennia. That none of the natives had a written

language recognizable or acceptable to the European intruders worked against them heavily.

2. It was not until the middle of the twentieth century that the Mayan code began to be deciphered and that the remaining writing (almost entirely sculpted glyphs) could be read. See Michael D. Coe, *Breaking the Maya Code,* 3rd ed. (London and New York, 2012).

3. The groups consisted of the following, shown with the period in which they flourished: the Olmec (1,500 to 300 BCE), the Teotihuacaños (100 BCE to c. 800 CE), the Maya (c. 1800 BCE to 900 CE), the Zapotec (600 BCE to 700 CE), the Toltec (800–1000 CE), the Mixtec (900 to 1400 CE), and, finally, the Aztec (1100 to 1521 CE).

4. The much later Aztecs, so influenced by the Teotihuacán culture, also worshiped the god Quetzalcoatl, who they believed had left this world and sailed east on a great raft, promising to return to reclaim his kingdom. This belief is thought, by some authorities, to have contributed significantly to the collapse of their empire upon the arrival of the ships of Cortés.

5. The lower portion, the *talud,* is a sloped riser base (the angle is variable); the second part, the *tablero,* is a vertical element, typically the location of sculptural embellishment. The relative proportions of the two components were endlessly variable, each equal in height, or one or the other larger.

6. Over the centuries, the Maya lived in scores of cities in the area now known as the Yucatan peninsula of Mexico, Belize, Guatemala, and western Honduras, on lands that ranged from flat in the north to ruggedly mountainous. Although the Maya city-states developed according to individual local schedules, the Maya as a broad group are said by anthropologists and archaeologists to have proceeded through five cultural stages: Preclassic (3000 up to 300 BCE), Late Preclassic (300 BCE to 300 CE), Classic (300 to 900 CE), Early Postclassic (900 to 1250), and Late Postclassic (extending from 1250 up to the arrival of the Spanish). The dispersed individual Maya city-states rose and fell in power as their leaders pursued constant civil fraternal warfare. Although they achieved great heights of architectural and artistic achievement, they lost their political power and cultural authority once the Spanish overran their lands. A good overview of this development is provided in John M. Pohl, *Exploring Mesoamerica* (Oxford, 1999).

7. Bernal Diaz Del Castillo, *The Discovery and Conquest of Mexico 1517–1521,* ed. Genaro Garcia (New York, 1956), 269. Originally published in Spanish as *Historia verdadera de la conquista de la Nueva España* (*The True History of the Conquest of New Spain*).

8. The Aztecs believed that the continuity of their lives and the continuance of their city-state was dependent on daily offerings of the most precious commodity—human blood. This was a principal reason for their continued warfare to conquer new regions. The need for sacrificial offerings and the onerous tributes demanded from these new conquests generated growing resentment from the conquered territories. After landing, Cortés was almost immediately made aware of this hatred toward the Aztecs in their outlying territories, and he was enormously successful in recruiting these subjected peoples as allies as he marched toward Tenochtitlan with an ever-growing army.

Even though Cortés's Spanish forces were small and native allies quickly disappeared, in the months following Moctezuma's capture and death another even more lethal force was unleashed: the Spanish carried with them the smallpox virus to which, over the centuries, they had developed some resistance. So rapid was the transmission of this disease from tribe to tribe that Native Americans from Alaska to Terra del Fuego, who had never been exposed to such a pathogen, died by the millions. Subsequent conquest of the Incas by the Spanish led by Pizzaro two decades later was greatly facilitated by the epidemic that preceded them.

9. Much has been uncovered in the Plaza Major and examined during the past century, so that a great deal is now known of the appearance of Moctezuma's Tenochtitlan. A good introduction to Tenochtitlan and the Aztecs in general is found in John M. D. Pohl, *Exploring Mesoamerica* (New York, 1999), pp. 211–222; see also the bibliographic references concerning Tenochtitlan.

10. For an introduction to archaeoastronomy (the study and analysis of celestial observation and spatial marking by the ancients), see the work of Ray A. Williamson, including *Archaeoastronomy in the Americas* (College Park, MD, 1981); *Living the Sky: The Cosmos of the American Indian* (Boston, 1984); and his anthology *Earth & Sky: Visions of the Cosmos in Native American Folklore* (Albuquerque, 1992).

CHAPTER 16: BAROQUE AND ROCOCO ARCHITECTURE

1. See John Shearman, *Mannerism* (Harmondsworth, England, 1967), 15–22.

2. Quoted from Carlo Dati in Francis Haskell, *Patrons and Painters: A Study in the Relations Between Italian Art and Society in the Age of the Baroque,* rev. ed. (New Haven, CT, 1980), 103–104.

3. Giovanni Pietro Bellori, "Idea," lecture given in 1664 and published in 1672; translated in Anthony Blunt, *Borromini* (Cambridge, MA, 1979), 212.

4. Charles Augustin d'Aviler, *Cours d'architecture qui comprend les Ordes Vignole, avec des commentairs, les figures & descriptions de ses plus beaux bâtiments, & de ceux de Michel-Ange . . .* (Paris, 1693–1696).

5. Germain Brice, *Description de la ville de Paris et de tout ce qu'elle contient de plus remarquable* (Paris, 1713). This quote was kindly pointed out to me by my colleague Andrew Morrogh, who provided the translation, and who drew my attention to the preceding critiques as well.

6. See Kerry Downes, "Baroque," in *The Grove Dictionary of Art,* ed. Jane Turner (London, 1996), and online at www.oxfordartonline.com.

7. It might be noted that the client was born Giulio Raimondo Mazzarino, 1602, in Pescina in the Kingdom of Naples, Italy. Because of his political adeptness in the papal diplomatic service, he came to the attention of Cardinal Richelieu and was reassigned to work in the French court. Eventually he rose to become the chief minister under the French king and is now best know by the Gallicized version of his name—Cardinal Jules Mazarin.

8. Regarding Bernini, see Tod Marder, *Bernini and the Art of Architecture* (New York, 1998), as well as the following entries: Edward J. Olszewski, "Giovanni Lorenzo Bernini," in *International Dictionary of Architects and Architecture: Architects,* ed. Randall J. Van Vynckt (Detroit, 1993), 1:76–80; Howard Hibbard, "Giovanni Lorenzo Bernini," in *Macmillan Encyclopedia of Architects,* ed. Adolf K. Placzek (New York, 1982), 1:190–201; and Rudolf Preimesberger and Michael P. Mezzatesta, "Gianlorenzo (Giovanni Lorenzo) Bernini," *Grove Dictionary of Art,* and online.

9. Bernini, quoted in Rudolf Wittkower, *Art and Architecture in Italy 1600–1750,* 6th rev. ed. (New Haven, CT, 1999), 2:35.

10. Regarding Borromini, see Blunt, *Borromini,* and the following entries: C. Murray Smart, Jr., "Francesco Borromini," in *International Dictionary of Architects and Architecture,* 1:96–99; Joseph Connors, "Francesco Borromini," in *Macmillan Encyclopedia of Architects*, 1:248–260; and Peter Stein, "Francesco Borromini," in *Grove Dictionary of Art,* and online. An interesting account of the rivalry between the cheerfully positive Bernini and the dour Borromini is found in the dual study by Jake Morrissey, *The Genius in the Design: Bernini, Borromini, and the Rivalry That Transformed Rome* (New York, 2005).

11. The three generating modules—equilateral triangles, circles, and ovals—are clearly shown in Borromini's own drawings, now at the Albertina in Vienna and well reproduced in Paolo Portoghesi, *The Rome of Borromini: Architecture As Language* (New York, 1968). While the equilateral triangle seems to have been paramount, particularly regarding the determination of heights, there were other modules used, as in the circles shown in George Hersey, *Architecture and Geometry in the Age of the Baroque* (Chicago, 2000), 137–142, 194–195.

12. Quoted in Wittkower, *Art and Architecture in Italy,* 2:43.

13. Quoted in Leo Steinberg, *Borromini's San Carlo alle Quattro Fontane* (New York and London, 1977), 338.

14. See note 11 above. For other interpretations regarding the plan development and symbolism of Sant' Ivo, see John Beldon Scott, "S. Ivo alla Sapienza and Borromini's Symbolic Language," *Journal, Society of Architectural Historians* 41 (December 1982): 294–317, and two articles by Joseph Connors: "S. Ivo alla Sapienza: The First Three Minutes," *Journal, Society of Architectural Historians* 55 (March 1996): 38–57, and "Borromini's S. Ivo alla Sapienza: The Spiral," *Burlington Magazine* 138 (October 1996): 668–682.

15. Regarding Guarini, see Harold Alan Meek, *Guarino Guarini and His Architecture* (New Haven, CT, 1988); and the following entries: Elwin C. Robison, "Guarino Guarini," in *International Dictionary of Architects and Architecture,* 1:343–346; Henry A. Millon, "Guarino Guarini," in *Macmillan Encyclopedia of Architects,* 2:265–279; and Peter Stein, "Guarino Guarini," in *Grove Dictionary of Art,* and online.

16. Regarding the designers of Versailles, the following works are helpful. Regarding Le Vau, see Robert W. Berger, "Louis Le Vau," in *MacMillan Encyclopedia of Architects,* 2:695–297; Ann Stewart Balakier, "Louis Le Vau," in *International Dictionary of Architects and Architecture: Architects,* 516–518; and Dietrich Feldman, "Louis Le Vau," in *Grove Dictionary of Art,* and online. Regarding Le Nôtre, see F. Hamilton Hazelhurst, "André Le Nostre (Le Nôtre)," in *MacMillan Encyclopedia of Architects,* 2:665–675; Joyce M. David, "André Le Nôtre," in *International Dictionary of Architects and Architecture: Architects,* 506–508; and F. Hamilton Hazelhurst, "André Le Nôtre" in *Grove Dictionary of Art,* and online. Regarding Le Brun, see Claire Constans, "Charles Le Brun" in *Grove Dictionary of Art,* and online.

17. Regarding Vanbrugh, see Kerry Downes, "John Vanbrugh," *MacMillan Encyclopedia of Architects,* 4:257–269; David Cast, "John Vanbrugh," *International Dictionary of Architects and Architecture: Architects,* 918–920; and Kerry Downes, "Sir John Vanbrugh," in *Grove Dictionary of Art,* and online.

18. Information concerning the London Fire is abundant, including the eyewitness accounts of John Evelyn and John Pepys. See such studies as Neil Hanso, *The Dreadful Judgment: The True Story of the Great Fire of London* (New York, 2001); James Leasor, *The Plague and the Fire* (1961, 2011); T. F. Reddaway, *The Rebuilding of London After the Great Fire* (London, 1940); and Adrian Tinniswood, *By Permission of Heaven: The Story of the Great Fire of London* (London, 2003).

19. Regarding Wren, see Kerry Downes, "Christopher Wren," *MacMillan Encyclopedia of Architects,*

4:419–433; Lydia M. Soo, "Christopher Wren," *International Dictionary of Architects and Architecture: Architects,* 991–997; and Kerry Downes, "Sir Christopher Wren," in *Grove Dictionary of Art,* and online.

20. There was a similar grand, imposing staircase at Versailles—the Ambassador's Stair—but it was later removed and filled in with additional living space.

21. Regarding Neumann, see Christian Otto, "Johann Balthasar Neumann," *MacMillan Encyclopedia of Architects,* 3:279–290; Petra Leser, "Johann Balthasar Neumann," *International Dictionary of Architects and Architecture: Architects,* 607–610; and Christian Otto, "Balthasar Neumann," in *Grove Dictionary of Art,* and online.

22. For a discussion of Rococo as a stylistic movement and related essays on its florescence in various countries, see Harold Osborne and Marc Jordan, "Rococo," in *Grove Dictionary of Art,* and online.

ESSAY 4: CHINESE ARCHITECTURE

1. Due to the sharply increasing desire for tea, Great Britain used opium produced in India to pay for tea exports being shipped home in the early nineteenth century. The Chinese imperial government forbade this importation of opium, recognizing its serious negative health and social implications. In response, the British sent gun ships to bombard Chinese port cities in two episodes termed the Opium War, 1839–1842 and 1856–1860. In the Treaty of Nanking (Nanjing), 1842, China was obliged to permit opium imports and, further, to grant Great Britain the port of Hong Kong as a British Territory "in perpetuity." The British relinquished all claims and returned Hong Kong to the People's Republic of China in 1997. This was just one example of the way in which European nations acquired "favorable" trade positions (for them) in China.

2. The basic concept of the asymmetrical S-curve line in garden design was introduced in England by Sir William Temple in an essay, "Upon the Gardens of Epicurus," in his anthology *Miscellanea* (1692). Having discussed the formal geometric French sort of garden design, Temple continued: "The *Chineses* [*sic*] scorn this way of [regular] planting. . . . And though we have hardly any Notion of this Sort of Beauty, yet they have a particular Word to express it; and, where they find it hit their Eye at first Sight, they say the *Sharawadgi* is fine or is admirable." In fact, Temple may very well have coined this word himself for there is no such word in Chinese; various scholars have proposed conjectural etymologies, including derivation from the Japanese words *sorowaji* or *shorowaji,* which may have been heard by Dutch traders, the only Europeans who were permitted a restricted import-export station on an island in the Nagasaki harbor.

3. The animal representations are discussed in Nelson I. Wu, *Chinese and Indian Architecture* (New York, 1963), 12. The author cites the example of a Han dynasty tile showing these heraldic animal images inside a square frame.

4. Though this practice may strike some Western observers as superstition, much wisdom is incorporated in *fengshui.* Derek Walters describes the hypothetical case of a proposed farmstead being best located on the slope of a hill, not at the top where water would not be present, nor at the bottom where defense would be difficult. In addition, it should face south to take advantage of the sun. See Derek Walters, "Dragon Lines in the Land: Feng Shui," in John Matthews, *The World Atlas of Divination* (Boston, 1992).

5. Originally located on Siwei Road in Taipei, this house was slated for demolition but several agencies arranged to dismantle and move it, and meticulously reconstructed and restored it (1978–2000).

6. About two decades before the Huang house was built in Huangcun, the first ship left Salem bound for Canton where it was loaded with a cargo of tea; thus began the active sea trade out of Salem and the town merchants' interest in China. The tea trade between China and Salem, Massachusetts continued for decades into the nineteenth century. The ancestor organization of today's Peabody Essex Institute was established by several of these sea captains in 1799 as the East India Marine Society. Somewhat by chance, an institute visitor to the Huang house in the 1990s expressed concern for the house on learning of its probable demolition, and was asked simply, "Would you like to buy it?" This set in motion the complex international arrangements to allow the house to be sold to an American institution and be dismantled and moved to Salem for meticulous reconstruction.

7. For an interactive interpretation of the Yin Yu Tang house, see the website maintained by the Peabody Essex Institute: www.pem.org/yinyutang/. See also the two publications documenting this house: *Yin Yu Tang: Preserving Chinese Vernacular Architecture* (Albany, NY, 2003), available from the Peabody Essex Institute, Salem, MA, and Nancy Berliner, *Yin Yu Tang: The Architecture and Daily Life of a Chinese House* (Boston and Rutland, VT, 2003). These present a detailed history of the Huang family, the history of the house, its dismantling, and its reconstruction at the Peabody Essex Museum, Salem, MA, 1996–2003.

8. Started as the garden of a Tang dynasty court scholar, the garden was acquired by a series of later court administrator scholars who expanded and enriched it. The name of the garden was inspired by a poem by Pan Yue, and it was the subject of an ink painting by Wen Zhenming in 1533.

9. Po Chü-I, "The Spring River," *More Translations from the Chinese by Arthur Waley* (New York, 1919), 39.

CHAPTER 17: THE ORIGINS OF MODERNISM: ARCHITECTURE IN THE AGE OF ENLIGHTENMENT, 1720–1790

1. Ansley J. Coale, "The History of the Human Population," *Scientific American* 231 (September 1974): 40–51. The entire issue is devoted to population studies.

2. In the early twentieth century, after the appearance of automobiles, such compacted gravel road surfaces were finished with a layer of bitumen, creating the "macadam" familiar today.

3. Denis Diderot, "Random Thoughts on Painting," in Lorenz Eitner, *Neoclassicism and Romanticism: 1750–1850* (Englewood Cliffs, NJ, 1970), 64–66.

4. The full title was *Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers*. The first volume appeared in 1751 and the seventeenth in 1780. It was richly illustrated with engravings showing contemporary achievements in the sciences, construction, and industry. As many as sixteen thousand copies were published, exerting a great influence on the dissemination of progressive ideas. Because of the overall theme rejecting received wisdom and questioning authority, the *Encyclopédie* was considered subversive and its publication banned, necessitating that it be printed at changing locations.

5. For all the care they took measuring the Parthenon, Stuart and Revett seem to have failed to notice the entasis of the columns and the curvature of the stereobate.

6. Laugier, quoted in W. G. Kalnein, *Architecture in France in the Eighteenth Century* (New Haven, CT, 1995): 170.

7. Poland was the focus of constant political intrigue and foreign intervention during the eighteenth century. Drawn into conflict through treaty alliances, Sweden invaded Poland in 1700, installing Stanisław Leszczyński as a puppet king, though he was elected to the throne in 1704. His daughter Marie (later queen consort of Louis XV) was born in 1703 in Breslau (Wrocław, Poland). When Swedish support evaporated in 1709, Stanisław Leszczyński was deposed and escaped from Poland. After 1716 Poland was in effect a protectorate of the Russian Tzar, up to 1795. Stanisław Leszczyński was made Duke of Lorraine in 1738 and proved a good administrator there, creating an Academy of Science. See Jacques Levron, *Stanisław Leszczyński, Roi de Pologne, Duc de Lorraine: Un Roi Philosophe au Siècle des Lumières* (Paris, 1984).

8. The letters of Pierre Charles L'Enfant to George Washington relating to the design of the capitol city of the United States are reprinted in Leland M. Roth, ed., *America Builds: Source Documents in American Architecture and Planning* (New York, 1983), 32–33. For the plan of Washington, DC, see John Reps, *Monumental Washington: The Planning and Development of the Capitol Center* (Princeton, 1967). For more about L'Enfant, see Scott W. Berg, *Grand Avenues: The Story of the French Visionary Who Designed Washington, D.C.* (New York, 2007); Kenneth R. Bowling, *Peter Charles L'Enfant: Vision, Honor, and Male Friendship in the Early American Republic* (Washington, DC, 2002); and Elizabeth Sarah Kite, *L'Enfant and Washington, 1791–1792* (Baltimore, 1929).

9. Quoted in John Dixon Hunt and Peter Willis, *The Genius of the Place: The English Landscape Garden, 1620–1820,* 2nd ed. (Cambridge, MA, 1988), 15, 212.

10. Quoted in a letter by Joseph Spence, a close associate of Pope, quoted in Hunt and Willis, *Genius of the Place,* 271. To create the illusion that these ideal landscapes extended forever, the practice was to plant the highest distant ridges with dense masses of tress—as Pope says, to "conceal the Bounds."

11. See Vanbrugh's letter in Geoffrey Webb, *The Works of Sir John Vanbrugh,* Vol. 4: *The Letters* (London, 1928), 28–30. This correspondence between Vanbrugh and Sarah Churchill also appears in Hunt and Willis, *Genius of the Place,* 119–121.

12. The entire range of Piranesi's creativity can now be seen in Luigi Ficacci, *Giovanni Battista Piranesi: The Complete Etchings* (Cologne and New York, 2000), a complete compendium of his entire productivity.

13. Thomas Jefferson to James Madison, September 20, 1785, reprinted in Leland M. Roth, ed., *America Builds: Source Documents in American Architecture and Planning* (New York, 1983), 28.

14. Although the Maison Carrée was built during the reign of Augustus Caesar, and is thus technically speaking a Roman imperial building, it does closely follow the type of the earlier republican temple as seen in several small examples that survive in Rome. Soon after designing the Virginia State Capitol, Jefferson traveled to Nîmes to see the Maison Carrée for himself, but he never personally viewed such similar examples as the Temple of Fortuna Virilis in the Forum in Rome.

15. The eighteenth-century spelling "Gothick" is used to distinguish this early free adaptation of this historical style as distinct from the far more archaeologically correct Gothic Revival or neo-Gothic that developed in the 1830s and '40s.

16. "Flower pot" arches, as indicated in the factory floor construction, referred to the use of comparatively strong yet very lightweight hollow structural units rather like fired-clay flower pots. The same technology was used by Sir John Soane in the vaulting of the

various chambers added to the Bank of England, London, between 1788 and 1833; see 7.15, p. 149.

ESSAY 5: JAPANESE ARCHITECTURE

1. When the buildings are dismantled as part of the re-creation, the old materials, which were sanctified in constructing the Ise Jing shrine, are reused to replace parts of the many other Shinto shrines in the Isa area. Precisely when the twenty-year rebuilding cycle was firmly established is not clear, but it has certainly been going on for more than a thousand years.

2. This granary construction is called *azekura.* Given the problems that high humidity can cause with items stored in closed facilities, this *azekura* technique was developed so that as humidity rises in the rainy warmer seasons, the logs swell, closing the gap between the acute angles of the logs, sealing off the interior; as humidity drops, the gaps open, allowing air to circulate inside.

3. Rural farmhouses (*minka*), as at Omigachi, were traditionally built with thickly thatched, steeply pitched roof frames of peeled log and bamboo timbers tightly bound with straw rope so the frame could shift and adjust itself under heavy snow loads or flex during earthquakes.

4. Because the ravages of time, decay, and politics have caused so much of China's oldest architecture to be lost, the oldest surviving Japanese buildings are typically said to be good representatives of Tang Chinese buildings. Fu Xinian, in a most authoritative recent study of Chinese architecture, comments on this, noting that the early Buddhist monasteries of Hokki-ji and Shitennō-ji preserve elements of pre–Tang Chinese buildings; he further notes that the imperial Heian capitol at Kyoto, begun in 794, is "perhaps the most perfect implementation of the ideal Chinese city plan ever built" (quoted in N. S. Steinhardt, ed., *Chinese Architecture* [New Haven, CT, 2002], 132).

5. Some early Japanese Buddhist temples do have red painted wood frames, as in the Hondō hall at Yakushiji, Nara. Another shift was away from the Chinese-style deep green shiny ceramic roof tiles in favor of wood shingles or copper.

6. In an effort to encourage maximum ventilation and airflow through the house, there is an open space called the *ramma* between the *kamoi* upper rail and the ceiling. This opening can be left unfilled or contain different patterns of lattice. These design features are discussed in a number of books on Japanese houses, but one shows all of the parts of the house particularly well. Moreover, this volume was perhaps the first study to analyze the traditional Japanese dwelling. Published in Boston in 1886, *Japanese Homes and Their Surroundings* was author Edward S. Morse's endeavor to record traditional Japanese houses before, he feared, they disappeared in a wave of modernization.

7. The traditional Japanese form of his name is Kakuzō Okakura (family name first). Because of his many books written in English and his later professional activities, Kakuzo's name is normally presented in Western style as Okakura Kakuzo (given name first), as it is presented in the many editions of his well-known *The Book of Tea.*

8. As noted by Neil Levine in *The Architecture of Frank Lloyd Wright* (Princeton, 1996), 189, 461 n. 81,Wright mentioned reading Kakuzo in his London Lectures (1939). Wright often referred to the Laozi (Lao-Tse) passage, as in his book *The Natural House* (New York, 1954).

CHAPTER 18: THE ROOTS OF MODERNISM: THE NINETEENTH CENTURY

1. Horatio Greenough's critique "American Architecture" first appeared in *The United States Magazine and Democratic Review* 13 (August, 1843): 206–210, and is reprinted in Leland M. Roth, ed., *America Builds* (New York, 1983), 77–84.

2. See the comment by Winston Churchill regarding the importance of rebuilding the damaged House of Commons with careful attention to retaining the old medieval seating arrangement, for, as he said, "We shape our buildings, and afterwards our buildings shape us"; noted in Chapter 5.

3. The full title of this massive publication is *Description de l'Égypte, ou, Recueil des observations et des recherches qui ont été faites en Égypte pendent l'expédition de l'armée française, publié par les orders de Sa Majesté l'empereur Napolean le Grand* (Paris, 1809–1828), in twenty-one volumes; for a discussion of the historical context, see Richard G. Carrott, *The Egyptian Revival: Its Sources, Monuments, and Meaning: 1808–1858* (Berkeley, 1978). The *Description de l'Égypte* has been reprinted in one miniature thick volume of 1,008 pages: Gilles Neret, ed., Chris Miller, trans. (New York: Taschen, 1995).

4. John Foulston, *The Public Buildings Erected in the West of England* (London, 1838), quoted in Carrott, *The Egyptian Revival,* 3. The effusive italics are Foulston's.

5. Exactly the opposite approach was taken by the composer Richard Wagner in 1870, when he began sketching plans for an opera house at Bayreuth, Germany. For him the absolute primary purpose was for the audience to hear the music-drama and see clearly the action on the stage. Accordingly, little space was given over to the circulation, with all seats placed on a single steeply pitched fan for maximum visibility. This contrast

in the interpretation of functional needs and resulting building design is discussed in a chapter devoted to the Paris Opéra and the Festival Hall in Bayreuth in Michael Forsyth, *Buildings for Music* (Cambridge, MA, 1985), 163–196. See Chapter 5 of the present volume.

6. The development and evolution of this new building type is treated in Carroll L. V. Meeks, *The Railroad Station* (New Haven, CT, 1955). Very much the same cycle of invention and perfection occurred a century later with the development of airline passenger terminals.

7. For a dated but still highly useful and informative account of the development of metal train sheds and international exhibition buildings, see Sigfried Giedion, *Space Time, and Architecture,* 5th ed. (Cambridge, MA, 1967), 165–290.

8. For statistics on urban growth in the nineteenth century, see Adna Ferrin Weber, *The Growth of Cities in the Nineteenth Century* (New York, 1899; reprinted in Ithaca, NY, 1963).

9. Frederick Law Olmsted, *Walks and Talks of an American Farmer in England* (New York, 1852).

10. Concerning Pullman, see the illustrated and annotated contemporary assessment by Richard T. Ely, "Pullman: A Social Study," *Harper's Magazine* 70 (February 1885): 452–466, reprinted in part in Leland M. Roth, ed., *America Builds* (New York, 1983), 202–216. Although architecturally elaborate, Pullman was not truly representative of planned industrial communities built in the United States; see Gwendolyn Wright, *Building the Dream: A Social History of Housing in America* (New York, 1981), 58–72, 177–192. Other studies on company towns and company-built housing are: John Garner, ed., *The Company Town: Architecture and Society in the Early Industrial Age* (New York, 1992), which examines company towns in Europe and the United States, and also Margaret Crawford, *Building the Workingman's Paradise: The Design of American Company Towns* (London and New York, 1995).

11. "The Art and Craft of the Machine" was a lecture that Wright delivered in several versions, starting in 1901; it is reprinted in part in Frederick Gutheim, ed., *Frank Lloyd Wright on Architecture: Selected Writings, 1894–1940* (New York, 1941), 23–24, and in its revised entirety in Wright's *Modern Architecture* (Princeton, 1930), 7–23, as well as in Leland M. Roth, ed., *America Builds* (New York, 1983), 364–376.

12. Although the second and smaller of the Wasmuth publications has been reprinted several times, with varying new titles, it seldom included the original Ashbee commentary. For the full Ashbee text, retro-translated from the published German into English, see Leland M. Roth, *America Builds,* 391–398.

13. The original interiors of the Robie house are shown in rare photographs in Donald Hoffman, *Frank Lloyd Wright's Robie House: The Illustrated Story of an Architectural Masterpiece* (New York, 1984).

14. Only in the late twentieth century was Henri Labrouste perceived as a typical product of the École; in his own time he was considered something of a radical. See Neil Levine, "The Romantic Idea of Architectural Legibility: Henri Labrouste and the Néo-Grec," in Arthur Drexler, ed., *The Architecture of the École des Beaux-Arts* (New York, 1977).

15. Julien Guadet, *Eléments et théories de l'architecture,* vol. 1, ch. 3, trans. Leland M. Roth and Jean-François Blassel (4 vols., Paris, 1901–1904); quoted in Leland M. Roth, *America Builds* (New York, 1983), 334.

16. For accuracy it should be noted that Jenney's metal frame was one step short of being a true skeletal frame. The horizontal beams and lintels in the external wall were not fastened to the vertical exterior iron columns but simply rested on brackets that were part of the columns. This technique may have been intended to allow for flexibility due to temperature changes. See Leland M. Roth, *American Architecture: A History,* 269–274.

17. Louis Sullivan, "The Tall Office Building Artistically Considered," originally published in *Lippincott's Magazine* 57 (March 1896): 403–409; reprinted in Leland M. Roth, ed., *America Builds: Source Documents of American Architecture and Planning* (New York, 1983), 340–346.

18. The published statements of the architects regarding their intent in the design of Pennsylvania Station are quoted in Leland M. Roth, *McKim, Mead & White, Architects* (New York, 1983).

ESSAY 6: AFRICAN ARCHITECTURE

1. The many varieties of dwellings are discussed and illustrated in Kaj Blegvad Andersen, *African Traditional Architecture: A Study of Housing and Settlement Patterns of Rural Kenya* (London and New York, 1977). See also the many publications of Labelle Prussin on traditional buildings in Africa.

2. Such easy European dismissal seemed blind to the fact that European houses throughout the Middle Ages in moderate climates were made of wood frames with walls filled in with woven saplings and then covered with plaster (wattle and daub), yet these were seldom denigrated as "mud huts."

3. *Zimbabwe* is a Shona term meaning "ruined settlement." There are numerous zimbabwe ruins found in locations throughout the country now called Zimbabwe. *Great Zimbabwe,* however, is used in reference to the largest such ruin, seemingly the cultural center at the time the complex was built between the eleventh and fourteenth centuries.

4. For a discussion of this first wave of native Modernism, see Udo Kultermann, *New Directions in African Architecture* (New York, 1969).

5. A useful well-illustrated survey is provided in *The Phaidon Atlas of 21st Century World Architecture* (New York, 2008), 578–611.

6. David Sokol, "David Adjaye Contains a Miniature City of Art, Learning, and Social Experiences Inside the Museum of Contemporary Art Denver's Enigmatic Walls," *Architectural Record* 196, no. 3 (August 2008): 126–131. The Hamilton wing of the Denver Art Museum was designed as a joint venture by Studio Daniel Libeskind and the Denver firm Davis Partnership Architects (the architect of record).

CHAPTER 19: VERSIONS OF MODERN ARCHITECTURE, 1914–1970

1. John Ruskin, Preface of *St. Mark's Rest* (London, 1877).

2. With the end of the Fascist regime in Spain following the death of Franco, an outpouring of creative spirit swept Spain, leading to the rise of many architects such as Rafael Moneo. This upwelling of creative energy also prompted the increase of donations for completing the church of the Sagrada Familia. Work toward completion continues to this day.

3. Penn Station also continues to function, perhaps less efficiently due to its reliance on stairs to change levels rather than the ramps used in Grand Central; Penn Station also suffers from being reduced to a basement under an office building and Madison Square Garden. See the discussion of the stewardship of Penn Station in Chapter 8.

4. Lutyen's reference to the Great Sanchi Stupa is all the more revealing when one considers that the stupa, abandoned since the thirteenth century, had fallen into ruin and became covered in brush. With British support, restoration began in 1880, with a new reinvigorated restoration campaign beginning in 1912 just when Lutyens started work on his Viceroy's House designs. See Vidya Dehejia, ed., *Unseen Presence: The Buddha and Sanchi* (Mumbai, India, 1996), and also Robert Grant Irving, *Indian Summer: Lutyens, Baker, and Imperial Delhi* (New Haven, CT, 1981), a detailed history of the political background, design and completion of the Viceroy's House and the new Imperial capitol of India.

5. As a result of the acclaim that his Tribune Tower competition entry attracted, Saarinen was invited to come to the United States where he was soon appointed head of the Cranbrook Academy of Art, which he made into a sort of American Bauhaus school. For further discussion of Eliel Saarinen, see A. Christ-Janer, *Eliel Saarinen* (Chicago, 1948, rev. London, 1979), and Pekka Korvenmaa, "Eliel Saarinen," in *The [Grove] Dictionary of Art* (New York, 1996), or also Oxford Art Online, which includes Grove.

6. Heinrich Wölfflin, *Renaissance and Baroque* (1888), trans. K. Simon (Ithaca, NY, 1966), 78.

7. See these essays on Erich Mendelsohn: Wolf von Eckardt, in *Macmillan Dictionary of Architects,* ed. Adolf K. Placzek (New York, 1982), 3:157–159; Gilbert Herbert, in *International Dictionary of Architects and Architecture: Architects,* ed. Randall J. Van Vynckt (Detroit, 1993), I:570–572; and Ita Heinze-Greenberg, in *The [Grove] Dictionary of Art* (New York, 1996), or also Oxford Art Online, which includes Grove.

8. For Taut's essay, "A Necessity," see Rosemary Haag Bletter, "Expressionist Architecture," in *German Expressionism: Documents from the End of the Wilhelmine Period to the Rise of National Socialism,* ed. Rose-Carol Washton Long (New York, 1993). Paul Scheerbart's essay, "Glass Architecture," 1914, is included in Ulrich Conrads, *Programs and Manifestoes on 20th-Century Architecture,* trans. Michael Bullock (Cambridge, MA, 1975), 32–33.

9. See these essays on Hans Scharoun: Susan Strauss, in *Macmillan Encyclopedia of Architects,* 4:674–676; Uwe Drost, in the *International Dictionary of Architects and Architecture: Architects,* I:789–791; and Peter Blundell Jones, in *The [Grove] Dictionary of Art* (New York, 1996), or also Oxford Art Online, which includes Grove.

10. See Stanford Anderson, "Peter Behrens," in *Macmillan Dictionary of Architects,* 1:165–169; Otakar Máèel, "Peter Behrens," in *International Dictionary of Architects and Architecture: Architects,* 1:65–68; and Iain Boyd White, "Peter Behrens," in *The [Grove] Dictionary of Art* (New York, 1996), or also Oxford Art Online, which includes Grove.

11. See Joan Campbell, *The German Werkbund: The Politics of Reform in the Applied Arts* (Princeton, 1978).

12. Alan Colquhoun, *Modern Architecture* (Oxford and New York, 2002), 66.

13. One contemporary assessment is given by Robert Breuer, "Peter Behrens," *Werkkunst* 3 (February 9, 1908): 145–149.

14. See these essays on Walter Gropius: Reginald R. Isaacs, in *Macmillan Dictionary of Architects,* 2:251–263; Leslie H. Cormier, in *International Dictionary of Architects and Architecture: Architects,* 1:337–341; and Gilbert Herbert, in *The [Grove] Dictionary of Art* (New York, 1996), or also Oxford Art Online, which includes Grove.

15. Walter Gropius, "Program of the Statliches Bauhaus in Weimar," 1919, in Conrads, *Programs and Manifestoes,* 49. In the years immediately after World War I, Gropius took a theoretical position close to that of the Expressionists; the manifesto in which this passage appears had on its cover a dramatic angular wood-block print by Lyonel Feininger, depicting the

crystal cathedral that this new design ideology would produce.

16. Walter Gropius, "Dessau Bauhaus: Principles of Bauhaus Production," March 1926, in Conrads, *Programs and Manifestoes,* 95–96. Another translation appears in Frank Whitford, *Bauhaus* (London, 1984), 205–206.

17. Bruno Taut, *Modern Architecture* (London, 1929), 9.

18. Walter Gropius, "Principles of Bauhaus Production," in Conrads, *Programs and Manifestoes,* 95–96.

19. Herbert Bayer, Ise Gropius, and Walter Gropius, *Bauhaus, 1919–1928* (New York, 1938), 24–30, 127.

20. See these essays on Ludwig Mies van der Rohe: Ludwig Glaeser, in *Macmillan Dictionary of Architects,* 3:183–195; Franz Schulze, in *International Dictionary of Architects and Architecture: Architects,* 1:578–582; and Peter Carter, in *The [Grove] Dictionary of Art* (New York, 1996), or also Oxford Art Online, which includes Grove.

21. The angular, glass-sheathed tower, in particular, shown in Mies's drawings with sharp-pointed upper corners, illustrates his momentary connection with Expressionist sympathies.

22. Ludwig Mies van der Rohe, "Working Theses," 1923, in Conrads, *Programs and Manifestoes,* 74.

23. Ludwig Mies van der Rohe, "Industrialized Building," 1924, in Conrads, *Programs and Manifestoes,* 81.

24. With the onset of the Great Depression after October 1929 and the contemporaneous economic problems besetting the Germans, there was no serious effort to retain the German Pavilion and it was dismantled early in 1930. The critical success of Mies van der Rohe's achievement in the German Pavilion, however, was quick to emerge and grew exponentially among proponents of Modernism, though by then the object of this admiration was gone. One might argue that the loss of this epochal building was felt so keenly that the pavilion was re-created—on the original site in Barcelona from Mies's own drawings in 1983–1987—by Spanish architects Cristian Cirici, Ignasi de Solà-Morales, and Fernando Ramos. See M. Carmen Grandas, *L'Exposició Internacional de Barcelona de 1929* (Barcelona, 1988).

25. See these essays on Le Corbusier: Mary P. M. Sekler and Eduard F. Sekler, in *Macmillan Dictionary of Architects,* 2:630–648; A. Peter Fawcett, in *International Dictionary of Architects and Architecture: Architects,* 1:494–500; and Tim Benton, in *The [Grove] Dictionary of Art* (New York, 1996), or also Oxford Art Online, which includes Grove.

26. Le Corbusier and Pierre Jeanneret, "Five Points Towards a New Architecture," originally published in Alfred Roth, *Zwei Wohnhiiuser von Le Corbusier und Pierre Jeanneret* (Stuttgart, 1927), and in Conrads, *Programs and Manifestoes,* 99–101.

27. The Seagram Building was to have been a far more prosaic design until Phyllis Bronfman Lambert persuaded her father, Samuel Bronfman, owner of the company, to hire a truly distinguished architect; she suggested Mies van der Rohe. Lambert told the author (Leland M. Roth) that when the building was sold in the 1990s there was a covenant in the sale documents that requires future owners to maintain the annual waxing and oiling of the bronze so that it forever retains its brown color rather than developing its natural green patina.

28. M. Nowicki, "Composition in Architecture," *Magazine of Art* 42 (March 1949): 108–111; reprinted in Leland M. Roth, *America Builds: Source Documents of American Architecture and Planning* (New York, 1983), 558–564. See also these essays on Matthew Nowicki: Lynda Greenberg, in *Macmillan Dictionary of Architects,* 3:308; J. A. Starczewski, in *International Dictionary of Architects and Architecture: Architects,* I:618; and J. A. Starczewski, in *The [Grove] Dictionary of Art* (New York, 1996), or also Oxford Art Online, which includes Grove.

29. M. Nowicki, "Origins and Trends in Modern Architecture," *Magazine of Art* 44 (November 1951): 273–279; reprinted in Roth, *America Builds,* 564.

30. Lewis Mumford, "Monumentality, Symbolism, and Style," *Architectural Review* 105 (April 1949): 173–180; reprinted in Roth, *America Builds,* 545–558.

31. An excellent analysis of the design and function of the Guggenheim Museum is provided in William Jordy, *American Buildings and Their Architects,* Vol. 4: *The Impact of European Modernism in the Mid-Twentieth Century* (Garden City, NY, 1972), 279–360.

32. Alvar Aalto, "The Humanizing of Architecture," from *Technology Review,* in *Sketches: Alvar Aalto,* trans. Stuart Wrede (Cambridge, MA, 1978), 76–77.

33. Ada Louise Huxtable, "Finnish Master Fashions Library for Abbey in Oregon," *New York Times,* May 30, 1970, 23; republished as "Alvar Aalto: Mt. Angel Library," in Ada Louise Huxtable's anthology *Kicked a Building Lately?* (New York, 1976), 92–95.

34. Le Corbusier, *The Chapel at Ronchamp* (London, 1960; translation of *Ronchamp* [Zurich, 1957]), 89.

35. See Nikolaus Pevsner, *An Outline of European Architecture,* 7th ed. (Baltimore, 1963), 429, and James Stirling, "Le Corbusier's Chapel and the Crisis of Rationalism," *Architectural Review* (March 1956): 155–161.

36. Stanislaus von Moos, *Le Corbusier: Elements of a Synthesis* (Cambridge, MA, 1979), 254.

37. Le Corbusier, *Ronchamp,* 7.

38. Le Corbusier, *Text et dessins pour Ronchamp* (Paris, 1965).

39. Hans Scharoun, quoted in Michael Forsyth, *Buildings for Music* (Cambridge, MA, 1985), 303.

40. See David Messent, *Opera House Act One* (Balgowlah, New South Wales, 1997), and similar studies.

41. Franz Schulze, *Mies van der Rohe: A Critical Biography* (Chicago and London, 1985), 256.

42. Reyner Banham, *The New Brutalism: Ethic or Aesthetic?* (New York, 1966).

43. Quoted in William J. R. Curtis, *Modern Architecture Since 1900,* 3rd ed. (Upper Saddle River, NJ, 1996), 530.

44. The name "International Style" was coined by architectural historian Henry-Russell Hitchcock and architect Philip Johnson for an exhibition entitled "The International Style: Architecture Since 1922," held at the new Museum of Modern Art, New York, in 1932. The exhibition's catalog, illustrated with 140 plans and photographs of the most recent work of European and American architects, defined the elements of the new architecture, with its clear emphases on space enclosed by thin planes, regularity as distinct from bilateral symmetry, and a dependence on material, technical precision, and proportions in replacing applied ornament. The epochal catalog is still in print: H.-R. Hitchcock and P. Johnson, *The International Style* (New York, 1966).

45. See Peter Blake, *Form Follows Fiasco: Why Modern Architecture Hasn't Worked* (Boston, 1977).

46. For an analysis of the design problems of the Pruitt-Igoe housing complex, see Oscar Newman, *Defensible Space: Crime Prevention Through Urban Design* (New York, 1972).

47. For criticisms of Modernism, see Brent C. Brolin, *The Failure of Modern Architecture* (New York, 1976), and Blake, *Form Follows Fiasco.*

48. Adolf Loos, *Ornament and Crime: Selected Essays* (Studies in Austrian Literature, Culture, and Thought. Translation Series), trans. Michael Mitchell (Riverside, CA, 1997).

49. Walter Gropius, "Principles of Bauhaus Production," in Conrads, *Programs and Manifestoes,* 96.

50. Le Corbusier, *Précisions sur un état present de l'architecture et de l'urbanisme* (Paris, 1930), 64.

51. Stanley Abercrombie, *Architecture As Art: An Esthetic Analysis* (New York, 1984), passim.

52. In clearing out back issues of professional journals in an architectural office in the summer of 1962, the author (Leland M. Roth) came across an example of a sample model building code in one magazine; it proposed that buildings should be designed so as to be able to survive only just long enough to pay off the building's financing.

CHAPTER 20: THE EXPANSION OF MODERNISM: FROM THE TWENTIETH CENTURY INTO THE TWENTY-FIRST

1. Diane Ghirardo, *Architecture After Modernism* (London and New York, 1996), 12.

2. Ghirardo, *Architecture After Modernism,* 12–13.

3. For a brief discussion of the Hyatt elevated walkway structural failure, see Chapter 3 of the present volume. For analyses of these structural and building materials failures, see Matthys Levy and Mario Salvatori, *Why Buildings Fall Down: How Structures Fail* (New York and London, 2002), 197–205, 220–230. See also in this expanded and updated edition the discussion of building failures resulting from terrorist attacks on the Murrah Federal Building in Oklahoma City, Oklahoma, 1995, and the World Trade Center Towers, New York, in 1993 and again in 2001.

4. *Postmodernism* as a term describing a reaction to *Modernism* was first used by Spanish writer Federico De Onis in 1934 and then picked up by Arnold Toynbee in his *A Study of History* written in 1938 but not published until 1947. With respect to architecture specifically, the term was first used by Joseph Hudnut in an article entitled "The Post-Modern House," *Architectural Record* 97 (May 1945): 70–75, and then included in Hudnut's collection of essays *Architecture and the Spirit of Man* (Cambridge, MA, 1949), 109–119. The term was dormant for nearly thirty years, until 1975, when, almost simultaneously, the word *postmodern* was taken up, capitalized, and hyphenated, and employed by Robert A. M. Stern and Peter Eisenman in New York and by Charles Jencks in London. Jencks discussed the rise of Ironic Postmodernism in two essays published in 1975 and then in the first edition of his book, *The Language of Post-Modern Architecture* (London, 1977), which was quickly reissued in a series of updated editions. For an analysis of Postmodernism and its meaning in late-twentieth-century architecture, see Charles Jencks, *The Language of Post-Modern Architecture,* 4th ed. (New York, 1988), and his more recent *The New Paradigm in Architecture: The Language of Post-Modernism,* 7th ed. (New Haven, CT, 2002); Charles Jencks, *What Is Post-Modernism?* 4th ed. (New York, 1990); and Robert A. M. Stern, "The Doubles of Post-Modernism," *Harvard Architecture Review* 1 (1980): 75–97, reprinted in Leland M. Roth, *America Builds* (New York, 1983).

5. Robert A. M. Stern, *Modern Classicism* (New York, 1988).

6. See Charles Jencks, *The New Paradigm in Architecture: The Language of Post-Modernism,* 7th ed. (New Haven, CT, 2002); James Steele, *Architecture Today,* 2nd ed. (New York, 2001); and William J. R. Curtis, *Modern Architecture Since 1900,* 3rd ed. (New York, 1996).

7. DeButts, quoted in Kenneth Frampton, "AT&T Headquarters, New York, John/Burgee Architects," *Catalogue 9,* Institute for Architecture and Urban Studies (September-October 1878): 61. In the later twentieth century, real estate and building names change with each decade or so; what had been intended to make a dramatic corporate statement about AT&T was sold to the Sony corporation in 2002.

8. See Stern, *Modern Classicism,* 62, 113–114.

9. "Interview with Mario Botta," in Stuart Wrede, *Mario Botta,* exhibition catalogue, Museum of Modern Art (New York, 1986), 68.

10. Stern, *Modern Classicism,* 62, 131.

11. Steele, *Architecture Today,* 137.

12. Demetri Porphyrios, *Classical Architecture* (London, 1991), as quoted in Steele, *Architecture Today,* 142, 157.

13. The original Getty Museum was expanded with new exhibition spaces and an outdoor hemicycle classical theater.

14. Quinlan Terry, "Seven Misunderstandings About Classical Architecture," in *Quinlan Terry* (London, 1981); reprinted in *Architects Anonymous* (London 1994).

15. William J. R. Curtis, *Modern Architecture Since 1900,* 3rd ed. (Upper Saddle River, NJ, 1996), 621.

16. Charles H. Newman, *The Post-Modern Aura: The Act of Fiction in an Age of Inflation* (Evanston, IL, 1985), quoted in Curtis, *Modern Architecture Since 1900,* 621.

17. Michael S. Rose, *Ugly As Sin: Why They Changed Our Churches from Sacred Places to Meeting Spaces—and How We Can Change Them Back Again* (Manchester, NH, 2009).

18. This quoted passage and the preceding ones in the paragraph are from Stern, *Modern Classicism,* 63.

19. The design may have been worthy of Jefferson, but it was not seen so by the Regents of the University of Virginia, who authorized its demolition around 2000 to make room for a larger replacement structure. Sadly, such decisions do not encourage architects hired because of their high professional profile to create their most sensitive and accomplished work.

20. Office of Environmental Health and Safety University of Virginia, Environmental Impact Review, Observatory Hill Dining Hall Replacement, Project Number 207–16094, August 8, 2002. Posted online at http://ehs.virginia.edu/ehs/ehs.eir/eir.documents/examples/EIR%20OHill%20Replacement.PDF.

21. James Steele uses the phrase *New Modernism* to mean the Late Modernism described here. See Steele, *Architecture Today.*

22. The trust created by J. Paul Getty annually generates around $150 million, which, by law, must be fully expended each year.

23. Calling this a roofless church may appear to contradict appearances. The body of this commemorative church is open to the sky, enclosed by a high surrounding wall; the molded form illustrated here is a cover over what would be considered the altar area.

24. Liedtke, quoted in Franz Schulz, *Philip Johnson: Life and Work* (New York, 1994), 326.

25. The term *gerberettes* was derived from the French engineer Heinrich Gerber, who devised these massive cantilevers.

26. Megan K. Stack, "In Dubai, the Sky's No Limit," *Los Angeles Times* (October 13, 2005), retrieved online September 23, 2012.

27. As of 2013, a number of super towers were under construction, with their completion dates expected during 2014–2016. Initially the highest of these was the projected but now cancelled Digital Media City Landmark Building (also known as Seoul Lite Tower), Seoul, South Korea, with 133 stories, rising to 1,772 feet (540 m) with a broadcast antenna to have reached 2,099 feet (640 m). Also in Korea is the Busan Lotte World Tower, Busan, with 107 stories rising to 1,673 feet (510 m). At least three super towers are proposed for China: the China 117 Tower (also known as Goldin Finance 117), Tianjin, with 117 stories rising to 1,959 feet (597 m); the Shanghai Tower, Shanghai, with 121 stories rising to 1,826 feet (556.7 m) with the spire tip at 2,073 feet (632 m); and the Ping An Finance Center, Shenzhen, with 115 stories rising to 1,821 feet (555 m) with a spire reaching 2,165 feet (660). The last of these is the tallest building under way in China as of mid-2013.

Meanwhile, topped off in August 2012 is the replacement for the destroyed World Trade Center Towers, now called One World Trade Center, designed by David Childs and Skidmore, Owings & Merrill; it has 104 stories and reaches 1,368 feet (417 m) to the top of its roof; its final crowning spire was lifted and installed in May 2013, extending at its tip to a symbolic 1,776 feet (541.3 m) in accordance with its popular name, the Freedom Tower. This new tower has been designed specifically to withstand future terrorist attacks, with an inner elevator and stair core enclosed in concrete walls several feet thick, as well as an armored base to withstand huge truck bombs.

28. Aside from the abundant literature on Gehry, see the capsule biographical-architectural sketch in Leland M. Roth, *American Architecture: A History* (Boulder, CO, 2001), 523–528.

29. Matt Tyrnauer, "Architecture in the Age of Gehry," *Vanity Fair* (August 2010).

30. Alois Martin Müller, "The Dialectic of Modernism," *Architecture in Transition: Between Deconstruction and New Modernism,* ed. Peter Noever (Munich, 1991), 10.

31. Philip Johnson and Mark Wigley, *Deconstructivist Architecture* (New York, 1988), 17.

32. Cathleen McGuigan, "From Bauhaus to Fun House," *Newsweek* (July 11, 1988), 64.

33. 1. Quoted in Miriam Horn, "A New Twist on Architecture," *U.S. News and World Report* 105 (July 18, 1988), 40–42.

34. Ibid., 41.

35. Carter Wiseman, *Shaping a Nation: Twentieth-Century American Architecture and Its Makers* (New York, 1998), 345–348.

36. The curious spelling of the firm's name, a cooperative, indicates a double meaning. Without the "l" it means "heaven building;" with the "l" it means "blue heaven." The firm's name itself suggests ambiguity and disorientation.

37. Badran, quoted in Steele, *Architecture Today,* 230.

38. For further information on Doshi, see Curtis, *Modern Architecture Since 1900,* passim, and also his *Balkrishna Doshi: An Architecture for India* (New York, 1988), as well as James Steele, *Rethinking Modernism for the Developing World: The Complete Architecture of Balkrishna Doshi* (New York 1998).

39. David Robson, *Geoffrey Bawa: The Complete Works* (London, 2002), 84.

40. Ibid., 146–148.

41. Ibid., 150.

42. Despite the architects' high-minded hopes, the building could not mitigate the bitter political divisions that have split Sri Lanka. The building was finished with minimalized interior finishes as a result of "fast-track" construction methods, the development of the proposed surrounding garden city capital never took place as a result of political changes, and the onset of a bitter civil war between ethnic and religious factions modified Bawa's building complex in its final form. Nonetheless, the Parliament complex, when seen across the lake, is a powerful national statement, even if its richness of symbolic meaning resonates largely only with the Sinhalese population. See the political analysis in chapter 7 ("Sri Lanka's Island Parliament") of Lawrence J. Vale's *Architecture, Power, and National Identity* (New Haven, CT, 1992), 190–208.

43. New Caledonia is technically designated as a French Overseas Territory.

44. See Eric Waddell, *Jean-Marie Tjibaou, Kanak Witness to the World: An Intellectual Biography* (Honolulu, 2009).

45. Ghirardo, *Architecture After Modernism,* 149.

46. See http://www.pyatok.com/pyatok.html.

CHAPTER 21: INTO THE TWENTY-FIRST CENTURY

1. "Blobitecture" was coined by William Safire in a December 2002 article in the *New York Times Magazine,* though it seems to have been current in architectural circles somewhat earlier. It was originally used as a term of derision but almost immediately lost that negative connotation.

2. The US Green Building Council maintains a list of LEED certified buildings online at http://www.usgbc.org/LEED/Project/CertifiedProjectList.aspx. Comparable, though set up on an international level, is the Energy Star ranking created in 1992 by the US Environmental Protection Agency and the US Department of Energy.

3. Aldo Leopold, *A Sand County Almanac, and Sketches Here and There* (New York, 1948), 204.

4. See https://new.usgbc.org/leed.

5. Quoted from the Pritzker website at http://www.pritzkerprize.com/2002/jury.

6. Regarding "green roofs," see the US Environmental Protection Agency website (http://www.epa.gov/hiri/mitigation/greenroofs.htm) as well as the website maintained by the International Green Roof Association (http://www.igra-world.com/).

7. Yeang has produced several books presenting his work and ecodesign philosophy (see the Suggested Readings), most recently, his *Green Design* published in 2011. Other authors also have written books and articles examining his architecture and planning.

8. Ken Yeang, *Reinventing the Skyscraper: A Vertical Theory of Urban Design* (Chichester, England, 2002).

9. Yeang commented on these calculations in two interviews conducted in 2008–2009, one with Ross von Berg for the Club of Pioneers and the other with Richard Steer on GTV. The interviews are available online at http://www.youtube.com/watch?v=tYONQW78qbE and http://www.gleeds.tv/index.cfm?video=413, respectively.

10. See Ken Yeang's "Essay," in Sara Hart, *EcoArchitecture: The Work of Ken Yeang,* ed. David Littlefield (Chichester, England 2011), 261.

11. Yeang, quoted in Alexsandr Bierig, "Ramping Up Green: Ken Yeang's Visions for Greening the Skyscraper Move Toward Realization in Singapore," *GreenSource: The Magazine of Sustainable Design* (May, 2009); also published online at http://greensource.construction.com/people/2009/05_Ramping-Up-Green.asp.

Glossary

For additional terms and definitions, please consult such compact dictionaries as John Fleming, Hugh Honour, and Nikolaus Pevsner, *The Penguin Dictionary of Architecture,* 4th ed. (London and New York, 1991), and Henry H. Saylor, *Dictionary of Architecture* (New York, 1952), as well as these somewhat larger dictionaries: James Stevens Curl, *A Dictionary of Architecture and Landscape Architecture,* 2nd ed. (New York, 2007), and John Fleming, Hugh Honour, and Nikolaus Pevsner, *The Penguin Dictionary of Architecture and Landscape Architecture,* 5th ed. (London and New York, 2000). Even more extensive definitions may be found in these large works by Cyril M. Harris: *American Architecture: An Illustrated Encyclopedia* (New York, 1998), *Dictionary of Architecture and Construction* (New York, 1975), and *Historic Architecture Sourcebook* (New York, 1977). For brief biographies of important architects, see such resources as J. M. Richards, ed., *Who's Who in Architecture, From 1400 to the Present* (London and New York, 1977); *Macmillan Encyclopedia of Architects,* 4 vols. (New York, 1982); and the online resource *Grove Art Online*.

abacus (from Greek *abax,* "counting board") The square slab that forms the topmost element of a Classical capital. (See also *order*.)

abbey (from Old French *abaie,* which comes from Latin, *abbas,* "abbot") A monastery or convent, a place of residence, work, worship, and study for monks or nuns.

acanthus (from Greek *akanthos,* thorn plant) A plant, native to the Mediterranean region, whose thick, serrated leaves provided the model for the leaf-like forms of the Corinthian capital. (See also *order*.)

acropolis (from Greek *akropolis,* from *akro,* "top," plus *polis,* "city") Generic sense: the elevated plateau or citadel containing the principal municipal and religious buildings of a city. Specific sense: the ancient citadel of Athens, the site of the Erechtheion, the Parthenon, and other temples.

adobe (from Spanish *adobar,* "to plaster," which comes from Arabic *al-tūb,* "the brick") A brick of sun-dried mud (using soil rich in clay and silt) mixed with grass or straw, and by extension, buildings made of such brick.

aedicule (from Latin *aedes,* "temple," and *aedicule,* "small temple") A framing motif, around a *blind* window or door, or around an actual opening, consisting of columns or *pilasters* supporting an *entablature* and *pediment*.

aggregate (from Latin *aggregare*, "to add together") The crushed stone, sand, and other solid material used to make *concrete.*

agora (Greek) An open area used as a marketplace; in Greek cities of the Hellenistic period often lined by *stoa* buildings.

aisle (from Old French and from Latin *ala*) A passage or open corridor running parallel to the principal space or *nave* of a church or *basilica* and separated from it by an *arcade.*

ambulatory (from Latin *ambulare*, "to walk") A curved or polygonal aisle forming a passageway around the *choir* or *chevet* of a church.

amphitheater (from Greek *amphi,* "around," plus *theatron,* "watching place") Originating in Roman architecture, a round or oval arena for sports events, surrounded by tiers of seats.

annular vault (from Latin *anulus,* "ring") A tunnel or barrel vault (see *vault*) that curves around in a closed ring.

anta (from Latin *antae,* "pilasters") The pier or *pilaster* formed by the projection of the side walls of a building, often found at the ends of the *naos* chamber of Greek temples.

apse (from Latin *apsis,* "arch" or "vault") A semicircular projection from an enclosed space, typically covered by a hemispherical vault, often found on the short side of a Roman *basilica* or at the end of an Early Christian church.

aqueduct (from Latin *aqua,* "water," plus *ductus,* past participle of "to lead") A channel used to carry water, often raised up on a long *arcade*.

arcade (from Italian *arcata,* from Latin *arcus,* "arch") A series of arches, often raised on piers or columns; a covered passage with such arches on one or both sides; a covered passage with such arches on each side opening into shops or offices (used figuratively even when no true arch forms are present).

arch (from Latin *arcus,* "arch") A structure, formed of wedge-shaped blocks laid to form a semicircle or a parabola or some other curve, that spans an opening. A *flat arch* is formed by a segment of a semicircle and can have very little curvature.

architecture parlent (French) Literally, "speaking architecture." First used in eighteenth-century France to describe an architecture that clearly expressed its functional purpose.

architrave (from Old French and Old Italian *arch* plus *trabs,* "chief beam") Specifically, the lowest element in the entablatures of the Ionic and Corinthian columnar orders (see *order*), with two or three stepped-back faces; by extension the frame around windows, doors, and arches in classical architecture.

arcuated A structural form composed of numerous arches, in contrast to *trabeated*.

arris (from Old French *areste,* "ridge") The edge formed when two surfaces meet at an angle, as in the *flutes* of a classical column.

ashlar A dressed or squared stone, and a masonry wall or structure built of such hewn stone. Ashlar masonry may be coursed (with continuous joints) or random (with discontinuous joints).

astylar (from Greek *a* plus *stylos,* "without column") Term used to denote a building that, although embodying classical features, has none of the traditional orders or pilasters. (See also *order* and *pilaster.*)

atelier (from Old French *astelier,* "carpenter shop," from Old French *astele,* "splinter," from Latin *astula,* "board") A studio or workshop, particularly an artist's or architect's studio in which younger students are trained.

atrium (from Latin *atrium*) In Roman houses, the central court, open to the sky, that provided access to the principal rooms; by extension, any central circulation space, whether open to the sky or covered by a skylight.

attic A story above the main cornice level in classical architecture.

axis An imaginary line about which parts of a building or individual buildings in a group are disposed, usually with careful attention to bilateral symmetry.

axonometric projection A method of mechanical drawing to represent a building in three dimensions in which vertical lines are drawn vertically and horizontal lines are drawn at unequal angles to the true horizontal, usually 30° and 60°.

bailey (Middle English from Old French, *baille*) The outer wall of a castle, and by extension the open court enclosed by this wall.

balloon frame (from *balloon,* since the frame was said to go up as fast as a rising balloon) A building frame, historically developed in the mid-United States about 1830, made of slender wooden members, or studs, spaced about 16 inches (.5 meters) apart. In a true balloon frame, the wooden studs rise through two floors. In a *platform frame,* the studs rise only one floor and support a platform that forms the base for the next floor.

baluster (from French and Italian derivatives of Greek *balaustion,* the flower of the pomegranate, because of the shape of the post) An upright vase-shaped post used to support a rail.

balustrade A series of balusters supporting a rail.

baptistery In Christian architecture, a chamber or often a separate building used for the sacramental ceremony of baptism.

barrel vault A masonry *vault* resting on two parallel walls and having the form of a half cylinder; sometimes called *tunnel vault;* also, by extension, a nonstructural wooden ceiling of the same form.

base (from Latin and Greek *basis*) The lowest element of a column, pier, or wall.

basilica (from Latin and Greek *basilike,* "royal portico") In Roman architecture, a large meeting hall, most often used to hold law courts. Adapted for Early Christian churches, often with the addition of aisles on the long sides and terminating in an *apse.*

batter The downward and outward slope of a masonry wall, generally resulting in diminishing thickness.

battlement (from Old French *battillement*) A parapet built atop a wall with openings (*crenels*) for defense.

bay In a building, a regular and repeated structural or spatial unit or module marked by repeated beams or ribs.

bearing wall A structurally active wall, such as made with brick or stone, that carries its own weight plus the floor and ceiling loads of adjoining areas down to the foundation. Also called a structural wall or a load-bearing wall. This contrasts to a non-bearing wall such as those attached like curtains to an interior metal skeleton. (See also *curtain wall.*)

belt course (or stringcourse) A projecting horizontal course of masonry in a wall, of the same or dissimilar material of the wall, used to throw rainwater off a wall; usually coincides with the level of an interior floor.

blind arch An arch within a wall framing a recessed flat panel rather than an opening; used to enliven an otherwise plain expanse of masonry or to decrease the dead weight of a wall.

boss (from Old French *boce*) In architecture, a round ornamented keystone at the intersection of *ribs* in a rib vault.

bouleuterion (from Greek *boule,* the council of ancient Athens) The council chamber of ancient Greek cities.

boulevard (from Old French *bolovart* and German *bollwerk*) A rampart converted to a promenade) A major thoroughfare in a town, usually laid out where old fortifications were removed, often lined with rows of trees.

bracket A projecting brace used under cornices, eaves, balconies, or windows to provide structural support or visual support.

buttress (from Middle English and Old French *bouteret,* from *bouter,* "to strike against") A pier built into or against a wall to help it resist lateral forces. (See also *flying buttress.*)

caisson foundation (from French *caisse,* "box") A technique for constructing deep foundations in loose or water-saturated soils, developed in the United States, 1865–1890. An open-bottom airtight chamber is lowered into the soil and the earth is excavated from beneath it by workmen called "sand hogs." As the chamber descends, the air pressure inside the chamber is increased to match the water pressure outside; meanwhile, the hole left above is lined or filled with stones or *concrete*. When dense soils or solid rock is reached, the chamber is filled with dressed stones or concrete.

cantilever (from Middle English and Norman French *cant,* "side," plus *levier*, "to raise") A beam or a part of a building supported by such beams that is supported at one end only, with the other end hovering in the air.

capital The topmost part of a column (see *order*), above the shaft, which carries the *entablature*.

cardo The principal north-south street in an ancient Roman town or military camp. (See also *decumanus.*)

cartouche (from French, from Italian *cartoccio,* "card") A decorative tablet or panel, with carved edges resembling curled paper.

caryatid (from Latin and Greek *Karuatides,* the maidens of Karui, a village in ancient Greece) A building column sculpted in the form of a female figure.

cast iron. (See *iron*.)

castellated Having battlements (parapet walls with notched openings) and turrets like those of a medieval castle.

castellation In an upper wall parapet, the inclusion of spaced openings or notches to protect defenders. Essentially the same as *crennelation*.

castrum (Latin) An ancient Roman military camp, with streets laid out in a rectilinear grid. (See also *cardo* and *decumanus.*)

catacomb (from late Latin *catacumbae*) An underground passage or chamber used as a cemetery.

cathedral (from Latin *cathedra,* "chair") A church that contains the bishop's throne, from which official pronouncements are made. Usually, but not always, the largest church in the diocese.

causeway (from Middle English *caucewei,* "raised road") A roadway on a raised embankment.

cella (Latin) The Latin term for the *naos,* the inner chamber of a classical temple.

cement (from Latin *caementa,* "broken stones") Term used to identify the bonding agent in concrete; nowadays made from pulverized baked limestone.

cenotaph (from Greek *kenos,* "empty," plus *taphos,* "tomb") An empty tomb built as a monument to a person buried elsewhere.

centering Term used to describe the temporary support used to carry a vault or an arch until the keystone is put in place.

central plan A building plan focused on a central point and usually laid out on two axes crossed at right angles; square and octagonal plans are examples.

centuriation The system of land division practiced in ancient Rome, with units large enough to contain one hundred traditional farms.

chamfer (from French *chanfrein,* "a bevel") To remove the edge or corner; also, the flat surface left after the corner is cut away.

chancel (from Old French) In a Latin cross-plan church, the eastern end, including the choir, side aisles, ambulatory, and chapels. (In France this is called the *chevet*.)

chapel (from medieval Latin *capella,* a diminutive of the Latin *cappa,* "cloak"; derived from the name of a small chamber at the church of Saint-Martin, Tours, France, which contained the cloak of Saint Martin) A small chamber containing an altar and used for private worship; a similar room within a larger church or religious building. A *Lady Chapel* is one dedicated to the Virgin Mary.

chevet The French term for the *chancel,* or east end of a church, including side aisles, choir, ambulatory, and chapels.

choir (from Middle English *quer* and Old French *cuer,* from Latin *chorus*) An organized group of singers, such as medieval monks; hence, that part of the church in which the monks gathered for services, usually the area between the crossing and the altar at the east end of the *chancel* or *chevet*.

church (from Middle English *chirche* and from Greek *kuriakos,* "of the lord") The principal building used for Christian public worship.

circus (Latin, "circle") In ancient Roman architecture, a long, open arena used for chariot races and other contests. In the eighteenth century, this term was used to describe curved ranges of connected town houses.

classic Of the highest order, or representing the best of its type; often capitalized, referring to the art of architecture of ancient Greece or Rome.

Classical Referring to the art or architecture of ancient Greece or Rome; uncapitalized when used in reference to the generic properties of balance, order, and proportional relationships as seen in ancient Greek and Roman architecture; capitalized when referring particularly to the forms and details of Greek and Roman architecture. Analogous spellings are used for generic versus specific uses of words such as *modern/Modern* and *neoclassical/Neoclassical* and other similar terms.

Classicism The principles of design and proportion, as well as the repertoire of forms and details, found in ancient Greek and Roman architecture, as well as later Renaissance and Baroque architecture. (See also *Neoclassicism*.)

clerestory (from Middle English *clere,* "lighted," plus "story") Originally the upper section of the nave of a Gothic cathedral, with its banks of large windows; hence, any elevated series of windows for light and ventilation.

cloister (from Latin *claustrum,* "enclosed place") In a medieval monastery, the courtyard and its surrounding covered walkways enclosed by the church, dormitory wing, refectory, and storage buildings.

cloister vault A form of *dome,* with curved surfaces that rise from a square or polygonal plan; the intersections of the curved surfaces form *groins* or have *ribs* (example: the dome of Santa Maria del Fiore, Florence, by Filippo Brunelleschi).

coffer (from Middle English *coffre,* "box," and Latin *cophinus,* "basket") A recessed box-like panel in a ceiling or vault; usually square (trapezoidal in shape inside a dome) but sometimes octagonal or lozenge-shaped.

colonnade (from Italian *colonnato,* from Latin *columna,* "column") A row of evenly spaced columns, usually carrying a continuous entablature.

colonnette (French, diminutive of *colonne,* "column") A small, slender, or greatly elongated column, more often used for visual effect than for structural support.

column (from Latin *columna,* "column") A narrow round support post, often having a *base* and a *capital*. (See also *order*.)

compression A force acting on a structure that tends to push, crush, or squeeze. Many materials, whether crystalline or fibrous, are strong in compression.

concrete (from Latin *concretus,* past participle of *concrescere,* "to grow together" or "to harden") An artificial stone made by mixing water, *aggregate* made of crushed stone and sand, and a cementing or bonding material. Like crystalline stone, concrete is relatively weak in *tension;* the addition of iron or steel bars to resist the tensile forces creates *reinforced concrete.*

console (from Latin *consolator,* "one who consoles") Figuratively, a support. (See also *bracket*.)

corbel (from Middle English *corp* and Latin *corvus,* "raven") A block of masonry projecting from the plane of the wall used to support an upper element such as a cornice, battlements, or an upper wall.

Corinthian. (See *order.*)

cornice (from Greek *koronos,* "curved," referring to the curved profile) Specifically, the uppermost and projecting section of the entablature; hence, generically, the uppermost projecting molding or combination of brackets and moldings used to crown a building or to define the meeting of wall and ceiling. (See *order*.)

corps de logis In French classical architecture, the dominant center motif or element, in contrast to the flanking wings.

crennelation (from Latin *crena,* "notch") A series of openings or large notches in an upper parapet wall to protect defenders. (See also *battlement* and *castellation*.)

crocket (from Old French *crochet,* "hook") In Gothic architecture, a carved, foliate, hook-like projection used along the edges of roofs, spires, towers, and other upper elements.

cromlech (from Welsh *crwm,* "arched," plus *llech,* "stone") A prehistoric structure consisting of *monoliths* encircling a mound; the term is sometimes used in place of *dolmen.*

crossing In a Latin cross-plan church, the area where the four sections (nave, transepts, and chancel) come together; the area where the two axes of nave-chancel and of the two transepts cross.

cross-in-square plan A Byzantine centralized church plan of nine bays in which the central bay and the middle bay on each side are domed. (See also *quincunx plan*.)

crypt (from Latin and Greek *kruptos,* "hidden") A chamber or story beneath the main floor of a church, often below ground, usually containing graves.

cupola (from late Latin *cupula,* diminutive form for "tub") A rounded tower-like device rising from the roof of a classical building (usually Renaissance or Baroque), typically terminating in a miniature dome.

curtain wall In ancient fortifications and medieval castles the part of an enclosing wall between two towers. In modern architecture since 1885, a non-load-bearing wall or non-structural skin attached to an internal structural skeleton; since 1920, this lightweight outer skin or curtain has often been composed of panels of glass, steel, aluminum, or composites.

cyclopean (from Greek *Cyclops,* the one-eyed giant in Homer's *Odyssey*) A type of dry masonry characterized by huge irregular stones laid in random patterns.

decamanus (Latin) The principal east-west street in an ancient Roman town or military camp. (See also *cardo.*)

dentil (from Latin *dens,* "tooth") A small rectangular block used in a series below the cornice in the Corinthian order; any such block used to form a molding below a cornice. (See also *order.*)

dependency An outbuilding or other subordinate structure that serves as an adjunct to a central, dominant building.

diaphragm arch An arch that spans a space crosswise to support a ceiling or other superstructure; often an arch that spans across the nave of a church (example: Saint-Philbert of Tournous).

dolmen (from Celtic and Breton *tol,* "table," plus *men,* "stone") A prehistoric European structure consisting of two or three upright stones carrying a stone slab as a roof.

dome A convex roof with a smooth curved surface rising either from a circular or a polygonal base (if the latter, then is more accurately a *cloister vault*). The simplest true dome is a *hemispherical* dome; an *onion* dome may have a shape that is somewhat more than a half-sphere and may be pointed at the top (example: the Taj Mahal); a *saucer* dome is a low dome that is less than a half-sphere; a *melon* or *umbrella* dome is divided into radiating sections or gores by ribs (example: Santa Maria delle Carceri, Prato).

donjon (variation of dungeon, from Middle English and from Latin *dominus*, "master") The fortified tower at the center of medieval castles, either square or round in plan; the dwelling of the lord.

Doric. (See *order*.)

dormer (from Old French *dormeor,* "bedroom window") A vertical window and its housing, which projects outward from a sloping roof.

drum (because it resembles the musical instrument) A circular or polygonal wall that carries a dome; also, one of the individual cylindrical blocks of stone used to build columns.

dry masonry Blocks of stone, either regular or irregular in shape, laid in a wall without *mortar*.

duomo The Italian term for a cathedral.

eave The lower edge, often overhanging, of a roof.

echinus (from Latin and Greek *ekhinos,* "sea urchin") In the capital of the Doric order, the circular flaring block that carries the abacus.

eclecticism (from Greek *ek,* "out," plus *legein,* "to choose," "to select") The combination of selected elements from different sources to form one whole; in architecture, the use of historic styles from previous time periods to make associational links between appearance and functional use.

egg and dart A form of molding, or decorative band, in Classical architecture made up of forms that resemble alternated eggs and darts.

elevation (from Latin *elevare,* "to raise up") A drawing of the walls of one side of a building (either interior or exterior) with all lines of true dimension and shown vertical and horizontal; also used in reference to the vertical plane of a building, as in "the west elevation."

engaged column A column that is attached to and appears to emerge from the wall; in plan it forms a half to three-quarters of a fully rounded column. It is usually purely decorative and may serve as a buttress-like thickening of the wall.

entablature (French, from Italian *intavolatura,* "to put on a table," "to support") The horizontal beam-like member supported by Classical columns (see also *order*). Although the details and proportions of the entablatures of the Doric, Ionic, and Corinthian orders vary, each has three component parts: the lower architrave, the middle frieze, and the crowning cornice.

entasis (Latin, from Greek *enteinein,* "to stretch or strain") The subtly curved rising diminution of the thickness of the Classical column. (See also *order.*)

epistyle (from Greek *epi,* "upon," plus stulos, "column") The Greek term for architrave. (See also *order.*)

esplanade (from Italian and Latin *explanare,* "to flatten out") A flat open space, often laid out as a walkway.

estipite Spanish term for a pilaster whose surface is covered by elaborate secondary decorations, sometimes to such an extent that the basic pilaster is difficult to see (example: Cartuja, Granada, Spain).

exedra (from Greek *ex,* "out," plus *hedra,* "seat") A seat with a high back, curved in a semicircle; also a semicircular roofed recess in a building with seats or a curved bench.

facade (from Italian and Latin *facies,* "face") The face of a building, especially the principal face or front.

fenestration (from Latin *fenestra,* "window") A general term used to denote the pattern or arrangement of windows.

fillet (from Middle English and Old French, diminutive of Latin *filum,* "thread") A narrow flat molding, usually between two larger elements, as between the indented flutes of a Classical column.

finial (Middle English, variant of Latin *finis,* "end") A decorative ornament that ends a gable, pinnacle, or spire, usually foliate in form.

fireproof construction A system of construction employing masonry bearing walls and arches. When iron and steel frames were introduced in the nineteenth century, the metal was protected from exposure to fire by tile cladding or concrete/plaster.

flute One of the several shallow vertical grooves cut into the shaft of Classical columns or pilasters. (See also *order.*)

flying buttress An inclined or ramped arch extending from the wall of a building to an outer, freestanding buttress pier, thus transmitting outward thrusts from the main building to externalized supports.

foliate (from Latin *foliatus,* "bearing leaves") Having a two-dimensional or carved three-dimensional pattern based on leaves or plants; often stylized.

folly In eighteenth-century English gardens and landscape design, a garden ornament building such as a tower or fake ruin constructed to highlight a view.

forum (Latin) An open space in a Roman town used as a marketplace and public gathering place; hence, a place for civic discussion.

foundation. (See *caisson foundation, raft foundation,* and *spread foundation.*)

frame A structural support system composed of separate linear members (columns and beams) joined together to form a cage, as contrasted to solid masonry construction. Traditionally, a wooden frame was composed of large hewn hardwood members, connected with complex interlocking joints (see *mortise and tenon*). Also called braced frame.

fresco (from Italian for "fresh") A form of wall painting in which pigments are mixed into the wet, fresh plaster immediately after it is applied to the wall.

frieze (from Old French *frise,* from Latin *Phrygia,* the name of an ancient country in Asia Minor) In Classical architecture, the flat horizontal panel in the entablature of the Ionic order, between the lower architrave and the crowning cornice, ornamented with low relief sculpture. Hence, by extension, the center panel or section of all entablatures, even of the much different Doric order, which has grooved stylized beam ends (triglyphs) with the spaces between filled with panels of low relief sculpture (metopes). By further extension, any projecting horizontal decorative band or panel. (See also *order.*)

gable (from Middle English, via Old French from Old Norse *gafl,* of Germanic origin; related to Dutch *gaffel* and German *Gabel,* "fork") The triangularly shaped area enclosed by the two sloped surfaces of a gable roof and the wall below; a generic term distinct from pediment, which refers to a portion of a Classical facade.

gable roof A simple roof composed of two angled flat surfaces meeting to form a straight ridge.

gallery (from Middle English *galerie,* from medieval Latin *galeria*) In medieval architecture, especially Gothic churches, a passage above the side aisle and below the clerestory window that provided access to the roof over the side aisles; in general, a long passage, often with windows on one side, sometimes used for the display of paintings.

gambrel roof (from Old North French *gamberel,* from late Latin *gamba,* "leg," referring to the bent or crooked stick used by butchers to suspend carcasses) A roof, similar to a gable roof, but with two slopes on each side, a steeper pitch in the lower, outer portion of the roof, and a lower pitch in the upper, center portion of the roof. In England this term is used to denote a mansard roof.

gargoyle (from Middle English *gargoyl* and Old French *gargoule*) A rain spout carved in the form of a fantastical creature or demon; any such projecting ornamental feature in the form of a grotesque.

glacis (from Old French *glacier,* "to slide") In medieval military architecture, a long, gentle, open slope outside a fortified wall.

golden section A proportional ratio devised by the ancient Greeks that expresses the ideal relationship of unequal parts. Capable of being demonstrated by Euclidian geometry, it can also be stated thus: a is to b as b is to $a + b$; or $a/b = b/(a + b)$. If this is rewritten as a quadratic equation and the value 1 is assigned to a, and then solved for b, the value of b is 1.618034. Hence, the ratio of the golden section is 1:1.618.

Greek cross A type of centralized plan with two axes at right angles and with identical elements on each of the axes around the central element (example: San Marco, Venice, Italy).

groin (from Middle English *grinde*) The junction of the intersection of two curved vaults.

groin vault A vault formed when two barrel vaults intersect at right angles; sometimes called a cross vault (example: Baths of Caracalla).

hall church A late Gothic type of church in which the side aisles are as high as, or nearly as high as, the central nave.

hammerbeam A short beam projecting from a wall, supported from below by a hammer brace and used in turn as the support for the collar brace in a hammerbeam truss.

henge A circle of upright stones or wooden posts.

heroum (plural: *heroa*) (Latin) In ancient Greek and Roman architecture, a building or sacred enclosure dedicated to a hero, usually over a grave; such buildings typically had central plans.

hexastyle (from Greek *hex,* "six," plus *stulos,* "column") Having six columns; used to describe Classical temples according to the number of columns across the short side.

hipped roof A roof of four sloped surfaces that meet in a point (with a square plan) or a sharp ridge line (rectangular plan).

historicism The reference to historic periods in the past; the use of architectural forms derived from the past. In contrast to eclecticism, which may result in the combination of elements of many historic periods in one building, historicism may be said to confine the references in a single building to a single time period.

hood molding A large projected molding over a window used to throw rainwater away from the window; sometimes supported by brackets.

hôtel (French) A French town house of the eighteenth century, usually of one or two floors, spread out horizontally in a large suburban estate. The main living level was at ground level (see the contrast with *piano nobile*), with large casement windows or French doors that provided easy access to the garden terraces.

hypocaust (from Latin *hypocaustrum,* from Greek *hupo,* "underneath," plus *kaiein,* "to burn") In Roman architecture, a type of hollow floor, honeycombed with passages, through which hot air and smoke from fires were channeled as a means of heating the interior; used extensively in Roman baths.

hypostyle (from Greek *hupo,* "underneath," plus *stulos,* "column") Used to describe a hall or chamber whose roof is supported by many columns.

impost (from Old French *imposte,* from medieval Latin *impostum,* past participle of *imponere,* "to place upon") The block or line upon which the foot of an arch rests.

in antis (from Latin and Greek, meaning "within the walls") Used to describe the placement of two or four columns in the porch of a Classical building between the projecting antae or spur walls of the *naos* behind the columns.

insula (Latin, "island") Latin term for an ancient Roman multilevel apartment building that filled an entire city block.

intercolumniation (from Latin *inter,* "between," plus *columna,* "column") Term used to describe the distance between columns in a colonnade; expressed in terms of fractions of the diameter of the individual columns.

Ionic. (See *order.*)

iron A basic chemical element, Fe (from Latin *ferrum*), normally found in the form of one of several oxides and that can be smelted to produce iron metal. Architecturally, iron is used in three essential forms: cast iron, wrought iron, and steel.

1. Cast iron: Traditionally in cast-iron production the molten liquid iron is poured into special molds, often formed with special casting sand around a wood original or master that is then removed before pouring. As the molten iron cools and solidifies, it forms crystals—small when the cooling is more rapid and larger when the cooling is slower. The crystalline structure makes cast iron extremely strong in compression (as for cast-iron columns) but relatively weak in tension (when being stretched) so that it is not especially good for beams whose lower edge is in tension. Though small portions of other elements may be present in cast iron such as silicon, the high content of carbon—which can be up to 5 percent (the residue from the charcoal or coal used for smelting)—makes the cast iron brittle. Though not combustible in itself, cast iron melts at just under 2,200° F (1,200° C) and hence easily softens and deforms in the heat of a fire so that, unprotected by some form of insulation, iron by itself is not fire-proof.
2. Wrought iron (puddled iron): "Wrought," from Middle English *wroght,* from Old English

geworht, past participle of *wyrcan,* "to work." Hence, wrought iron is iron that has been re-smelted, formed into bars, and then reheated to a red to white hot stage and worked by forging or hammering. With controlled reheating and also through working or forging, the carbon content of wrought iron can be reduced from 2 percent to as low as 0.25 percent; this refinement also removed other impurities such as silicon, phosphorus, or manganese. The hammering or forging process destroys any crystalline structure and produces a more fibrous quality. As a result, wrought iron is good in tension and was quickly used in the bottom chords of trusses and also for beams, both of which are in tension. Wrought iron has a melting point of from 2,700 to 2,900° F (1480 to 1,500° C). The Eiffel Tower, Paris, is made of wrought or puddled iron and not steel (the steel-making process not yet being economically practicable in France).

3. Steel: This ferrous metal is an alloy, combining iron with specific quantities of other metals added during smelting; making steel often starts by melting cast-iron ingots and recycled steel. Heating the molten mixture to a temperature as high as 2,800° F drives off the carbon, reducing carbon content from a range of 2.1 percent down to 0.002 percent; this process also removes phosphorus, silicon, aluminum, and other deleterious elements. For special types of steel, small amounts of other elements such as nickel, chromium, manganese, and molybdenum are added to the molten mass. Stainless steel, for example, may have from 4 to 10.5 percent chromium and nickel. Although steel had been made for centuries, the process was difficult and yielded very small quantities. In the 1850s large-scale commercial smelting processes were developed by Henry Bessemer in England and William Kelly in the United States, followed by the Siemens-Martin open-hearth process in the 1860s. By the 1890s, steel was the major ferrous metal being produced and true wrought iron essentially gradually ceased to be used for architectural structures. Usually malleable, steel possesses good tensile strength, especially when rolled into shaped forms (I beams, H columns, angles, etc.) for structural use. Depending on the alloy composition, the melting point of steel is 2,600 to 2,800° F (1,425 to 1,540° C).

isometric projection (from Greek *isometros,* "of equal measure") A method of mechanical drawing to represent a building in three dimensions in which vertical lines are drawn vertical and horizontal lines are drawn at equal angles to the true horizontal, usually 30° or 45°.

jamb (from Middle English *jambe,* from late Latin *gamba,* "hoof") The vertical posts forming the sides of a door or window.

keep Also called *donjon,* the central fortified tower inside medieval castles.

keystone The uppermost central voussoir of an arch that locks all the other wedge-shaped voussoirs together, often bearing carved embellishment.

Lady Chapel A type of chapel dedicated to the Virgin Mary. (See also *chapel.*)

lancet (Middle English *launcea,* from Latin *lancea,* a lance or spear) Used to describe tall, extremely narrow, spear-like windows, particularly in early English Gothic architecture.

lantern (from Middle English, from Old French *lanterne,* from Latin *lanterna,* from Greek *lampter,* from the verb "to shine") In architecture, a small glass-enclosed square or round structure built atop a larger structure to admit light.

Latin cross Term used to describe the plan type of many Western Medieval churches shaped like a cross, with a long nave, short north and south transepts, and short chancel or chevet.

leaded glass Small glass panes, most of them clear but often colored too, forming a geometric or foliate pattern, held in place by channels of lead soldered together.

lierne (French) A subordinate, often purely decorative, rib that connects a principal rib to a tierceron.

lintel (Middle English, from Old French and Latin *limes,* "boundary" or "threshold") A beam used to carry a load over an opening or to span between two columns.

loggia (Italian, from French *loge,* "small house," "hut") A covered but open gallery, often in the upper part of a building; also, a covered passageway, often with an open trellis roof, connecting two buildings.

lunette (from Old French and Latin *luna,* "moon") A semicircular or crescent-shaped area, often opened with a semicircular window.

machicolation (from Old French *macher,* "to crush," plus *col,* "neck") In medieval castles, a projecting gallery at the top of the castle wall, supported by corbeled arches, with openings in the floor through which stones or boiling oil could be dropped on attackers below.

mansard roof (from François Mansart, French Baroque architect, 1598–1666, who employed this roof form extensively) A roof with two slopes on each of its four sides, a very steep and nearly vertical slope on the outside and a gentle, nearly flat slope on the top; the steeper outer roof slope may be flat, convex, or concave in profile.

martyrium (from Latin and Greek *martus,* "witness") A site where events in the life of Christ or an apostle occurred, or where the relics of a Christian martyr were deposited; also often used to identify the building (usually centrally planned) constructed over such a spot.

mass In architecture, term used to describe the sense of bulk, density, and weight of architectural forms.

mastaba or *mastabah* (from Arabic *mastabah,* "bench") Term used to identify ancient Egyptian tombs with flat tops and battered sides, built over subterranean burial chambers.

megalith (from Greek *megas,* "big," plus *lithos,* "stone") A stone of great size, moved in prehistoric times by teams of builders. *Megalithic* is used to describe prehistoric structures.

megaron (from Greek *megas,* "great") The principal reception room of a Mycenaean residence or palace; rectangular in plan, with a central hearth, and entered through a porch with two columns in antis.

melon dome. (See *dome.*)

menhir (from Celtic and Breton *men,* "stone," plus *hir,* "long") A prehistoric monument, a megalith, consisting of a large single upright stone; sometimes set in long parallel rows.

metope (Greek *meta,* "between," plus *ope,* "opening") In the Classical Doric order, a square stone panel placed between the beam ends covered by triglyph panels; the metope panel was embellished with narrative figural sculpture.

moat (from Middle English and Old French *mote,* "mound") A wide, deep ditch, either dry or filled with water, used for defense purposes. (See also *motte.*)

modillion (from French and Italian *modiglione,* from Latin *mutulus,* from an Etruscan root meaning "to stand out") A small curved and ornamented bracket used to support the upper part of the cornice in the Corinthian order; any such small curved ornamented bracket used in series.

module (from Latin *modulus,* diminutive of *modus,* "measure") A unit of measurement governing the proportions of a building. In Classical architecture, the module was either the diameter or half the diameter of the column at the base of the shaft. In modern architecture, the module is any unit of measurement devised by the architect, usually to facilitate prefabrication.

molding Any carved or modeled band either integral to the fabric of a wall or applied to it. In British usage, *moulding.*

monitor A form of lantern atop a roof, used to admit light to the space below, but wider and usually square in plan.

monolithic (from Greek *monos,* "single," plus *lithos,* "stone") Made from a single stone.

mortar (from Middle English *morter,* from Latin *mortarium*) A mixture of lime with sand and water used as a bed for setting stones in masonry walls. In medieval buildings, the lime mortar required oxygen to set properly; modern mortar is made with Portland cement instead of lime and cures without the presence of external oxygen.

mortise and tenon One of the basic wood joining methods; one member is cut with a rectangular or square hole (mortise) to receive the other member, cut with a rectangular or square tongue (tenon).

mosaic (from Greek *mouseios,* "of the Muses") A wall or floor covering made of small cubes (tesserae) of colored stone or glass, often laid out to form a figural image.

motte (from Middle English and Old French *mote,* "mound") A steep mound of earth surrounded by a ditch and surmounted by a timber stockade.

mullion (from Middle English *moniel,* from Latin *medianus,* "median") Originally the large vertical stone divider in medieval windows; later the vertical supports in glazed windows; often now any support strip, vertical or horizontal, in a glazed window.

muntin (from French *montant,* derived from verb "to rise") In windows, the thin bar used to hold glass panes in place; in paneled doors, the vertical central member used to hold the panels in place.

naos (Greek) The enclosed inner chamber of an ancient Greek temple.

narthex (from Greek *narthex,* "box") A vestibule or entry lobby in an Early Christian church.

nave (from medieval Latin *navis,* "ship") In a Roman basilica, the taller central space lit by clerestory windows; in a Christian church, the taller space in the western arm, lit by clerestory windows.

Neoclassicism Beginning in the late eighteenth century, the intentional reproduction of Classical Greek or Roman buildings in their entirety or in selected details such as orders from specific ancient buildings.

niche (from Old French *nichier,* "to nest") A recess or hollow in a wall, often meant to contain a statue.

non-load-bearing wall A wall that carries no structural load from above, but is typically attached to some sort of internal structural frame. Also called a *curtain wall.*

nymphaeum (from Greek *numphe,* a female spirit of woodland and water) A Classical building or room, decorated with plants and fountains, often located in a garden and intended as a place for relaxation.

obelisk (from Old French *obelisque,* from Greek *obeliskos,* "spit or pointed pillar") A tall, narrow square shaft, tapering and ending in a pyramidal point.

octastyle (from Greek *okta,* "eight," plus *stulos,* "column") Having eight columns; used to describe Classical temples according to the number of columns across the short side.

oculus (Latin, "eye") A round window in a wall or at the apex of a dome.

ogee (alteration of Old French *augive*) A double or reverse S-shaped curve.

ogive (from Old French *augive*) A diagonal rib in a Gothic vault; a pointed arch.

opus incertum Roman concrete faced with irregularly shaped stones.

opus quadratum Roman masonry of squared stones.

opus reticulatum Roman concrete faced with small pyramidal stones with their points embedded in the wall and laid on the diagonal, forming a net-like pattern.

opus sectile In Roman architecture, a wall or floor covering of stone laid out in a geometric pattern.

order (from Old French *ordre,* from Latin *ordo,* "line" or "row," possibly from Greek *arariskein,* "to fit together") Any of the several types of Classical columns, including pedestal bases and entablatures. The Greeks developed three orders, the Doric, Ionic, and Corinthian, of which the Romans adopted the latter two and added Tuscan Doric and the Composite, merging the features of Ionic and Corinthian (see 3.13).

1. The Greek Doric (see 3.15), developed in the western Dorian region of Greece, is the heaviest and most massive of the orders. It rises from the *stylobate* platform without any base; it is from four to six times as tall as its diameter; it has twenty broad flutes; the capital consists simply of a banded necking swelling out into a smooth echinus, which carries a flat square abacus; the Doric entablature is also the heaviest, being about one-fourth the height column. The Greek Doric order was not used after c. 100 BCE until its "rediscovery" in the mid-eighteenth century.
2. The Ionic order (see 3.16) was developed along the west coast of what is now Turkey, once Ionian Greece. It is generally about nine times as high as its diameter; it has a base, twenty-four flutes, and a much more elaborate capital, consisting of a decorative band and a circular egg-and-dart molding on which rests the distinctive volute; the volute in turn supports a thin, flat abacus. The Ionic entablature is about one-fifth the height of the column.
3. The Corinthian order (see 3.17), the most attenuated and richly embellished, was the least used by the Greeks. It is about ten times as high as its diameter, rising from a base, with twenty-four flutes (but sometimes unfluted, as with the Corinthian columns of the Pantheon, Rome) and a tall capital consisting of a band from which spread upward three or four layers of curling acanthus leaves ending in tight volutes in the four corners and supporting a concave abacus. The Corinthian entablature is about one-fifth the height of the column.
4. The Roman Doric order is much slimmer than the Greek prototype, being nearly as slender as the Ionic order, and, like it, fluted; moreover, it has a short base. Derived from this is the thicker Roman Tuscan Doric order, which has a base and an unfluted shaft and is about seven times as high as its diameter; its capital is similar to that of the Greek original but more strongly articulated.
5. The Composite order was formed by the Romans by combining the Ionic and Corinthian orders, and placing volutes atop acanthus leaves; this is the most sculpturally elaborate of all the orders.

oriel (from Middle English and medieval Latin *oriolum,* "porch") A projecting bay window, supported from below by a corbel or bracket.

palace (from Old French *palais,* from Latin *palatium,* the Palatine Hill, the site of the residence of the Roman emperors) The official residence of a royal person or high dignitary; hence, any splendid or elaborate residence.

palazzo (Italian) An urban residence, often including family business quarters as well as facilities for the extended family and retainers.

palisade (French *palissade,* from Latin *palus,* "stake") A fence of stakes forming a defense barrier.

Palladian motif (from Andrea Palladio, 1508–1580, who employed this device frequently) A window or door with three openings, the center wider opening having a semicircular arch springing from the entablature of narrow flanking bays. Since it was illustrated in a treatise of 1537 by Sebastiano Serlio, this motif has also been called a Serliana.

parapet (from French, from Italian *parapetto, parare,* to shield) A low protective wall at the edge of a roof, balcony, or other elevated platform.

parti (from French, from *prendre parti,* "to make a decision") A basic compositional scheme for a building plan or group of buildings. Emphasis on a clear, rational parti was a cornerstone of the instruction of the Ecole des Beaux-Arts, Paris, during the nineteenth century.

pavilion (from Old English *pavilon,* from Latin *papilio,* "butterfly," perhaps because of the resemblance of ornamental tents to butterfly wings) Originally a tent, especially an elaborately ornamented shelter; later, any portion of a building projected forward and otherwise set apart, or even a separate structure. Much favored in French Renaissance and especially Baroque architecture, and later in Second Empire Baroque architecture, 1850–1890.

pediment (from a variation of obsolete English, *perement,* perhaps from *pyramid*) Originally the triangular gable above the entablature of Greek and Roman temples, enclosed by the horizontal cornice of the entablature and raking cornices following the edges of the roof; later, any such cornice-framed embellishment over a door or window, either triangular, segmental, broken, or consisting of curved broken cornices ending in volutes.

pendentive (from French *pendentif,* from Latin *pendens,* "hanging") A curved triangular element that effects the change from the circular base of a dome down to a square plan below; first employed extensively in Byzantine architecture (example: Hagia Sophia, Istanbul, Turkey).

peripteral (from Greek *peri,* "around," plus *pteron,* "wing") Used to designate temples with a single row of columns all around.

peristyle (from Greek *peri,* "around," plus *stulos,* "column") A colonnade surrounding a building, or a court completely enclosed by an encircling colonnade.

perpendicular Relating to Gothic architecture, a term used to identify the phase of Late Gothic architecture in England, c. 1330 to c. 1580, characterized by multiple and emphasized vertical elements.

piano nobile (from Italian, figuratively "the noble level") In a European building, the main living level with reception and state rooms, usually the first floor above ground level.

piazza (Italian) A public square in an Italian town. From Italian and from Latin *plata*, "street," derived from Greek *plateia* (*hodos*), "broad" (way), feminine form of *platus,* "broad." In Italy, a broad open urban space or square (and pronounced with a hard "tz"). In eighteenth-century England and in its colonies, the term acquired a specialized meaning (pronounced with a soft "sz"), referring to broad residential porches or verandahs.

picturesque (early-eighteenth-century term, from French *pittoresque,* from Italian *pittoresco,* from *pittore,* "painter," from Latin *pictor.* Essentially, "like a painting") A term defined in the eighteenth century to describe landscapes or other designs characterized by ruggedness, irregularity, asymmetry, and a variety of textures and forms.

pier (Middle English *per*, from Latin *pera*) A solid support, often rectangular or square in plan and thick relative to its height.

pilaster (Old French *pilastre,* from Latin *pila,* "pillar") In Classical architecture, a flat protrusion from a wall, with ornamental elements corresponding to one of the Classical orders and having the same proportions.

piles, piling (from Middle English and Latin *pilum,* "spear") Heavy wooden timbers or shafts of metal or concrete driven into the earth as a support for a foundation. Groups of piles may be driven in a close pattern to support either a spread or raft foundation.

pillar (from Middle English and Latin *pila,* "pillar") A freestanding support or column.

pilotis (French, "stilt") An extremely thin vertical support; used by Le Corbusier to lift his buildings free of the ground.

place (French) An open public space in a French town.

plaza (Spanish, from Latin *platea,* "broad street") A broad street or an open public space in a Spanish town.

plinth (from Greek *plinthos,* "tile") Specifically, in Classical architecture the square slab forming the bottom element of a column base; by extension, any platform-like base for a building.

polis (Greek) An ancient Greek city-state.

polychromy (from Greek *polus,* "many," plus *khroma,* "color") In architecture, the use of many building materials of contrasting colors.

porch (from Middle English *porche,* from Latin *porta,* "gate") A covered or roofed entrance to a building, often employing columns to support the roof. (See also *portico.*)

portal (from Latin *porta,* "gate") An entrance to a building or enclosure, particularly one that is imposing.

porte cochère (from French, "coach door") A covered area, attached to a house, providing shelter for those alighting from carriages.

portico (from Latin *porticus* and *porta,* "gate") A covered entrance, often using Classical columns to support a pediment or other roof.

Portland cement A binding cement made of burned pulverized selected limestone and clay, so called because the finished concrete closely resembled the high-quality limestone from Portland, England.

post and lintel Term used to describe a generic structural type in which upright columns support horizontal beams; the structure may be stone, wood, or iron and steel.

propylaia (from Greek *pro,* "before," plus *pule,* "gate") An entrance gateway; refers to entrance gateways to Greek temple enclosures.

propylon An entrance gateway, but especially the large freestanding monumental entrances to Egyptian temples. (See also *propylaia.*)

prostyle (from Greek *pro,* "in front," plus *stulos,* "column") Referring to a type of temple with a portico of columns running across the front (or the rear, as well) but not along the sides.

pylon (from Greek *pule,* "gate") The large, imposing entrance to an Egyptian temple.

quarry-faced ashlar masonry Masonry built of stone blocks whose outer faces are left rough and irregular, much as they come from the quarry.

quincunx plan (from Latin *quinque,* "five," plus *uncia,* "twelfth," or "five-twelfths") A Byzantine centralized church plan of nine bays in which the central bay and the corner bays are domed. (See also *cross-in-square plan.*)

quoin (from Old French *coing,* "wedge") Originally the structural use of large masonry blocks to reinforce the corner of a brick or other masonry wall; but often used as a decorative embellishment in non-load-bearing materials.

radiating chapel One of a group of chapels in a Gothic church arranged around the curved ambulatory of the chancel or chevet and seeming to radiate out from the choir.

raft foundation A foundation type developed in Chicago in the early 1880s in which beams of either wood or steel are laid crosswise over piles and encased in concrete to form a wide but shallow pad or platform for the base of a structural pier or column. (See also *spread foundation.*)

random ashlar masonry Masonry of cut and finished stones but in which there are no continuous horizontal joints; instead, the stones vary in size vertically.

refectory (from Latin *reficere,* "to refresh") In a monastery, a room where meals are served.

reinforced concrete (See *concrete.*)

relieving arch (also *discharging arch*) In a masonry, but particularly in a brick wall, an arch built into the wall over an opening such as a window or door to direct the weight of the wall above away from the opening; the tympanum area directly over the window may be filled with brick or other material to maintain the rectilinear form of the window. Brick relieving arches were used in Roman concrete work to focus structural forces onto piers, as can be seen on the outside of the Pantheon, Rome.

revetment (from Old French *revestir,* "to reclothe") A wall facing or veneer consisting of panels of stone, marble, metal, or other material.

rib A slender arch used in the construction of Gothic rib vaults. The principal ribs are the transverse ribs that run across the nave from pier to pier, the diagonal ribs that cross over the nave and intersect at the center boss, and the ridge ribs that extend lengthwise and crosswise from the boss along the length of the nave and from side wall to side wall. The secondary ribs and more decorative ribs, used in later English and German Gothic architecture, are tierceron ribs, which extend from the wall piers to the longitudinal ridge rib; and lierne ribs, which extend from the center boss to the side walls, or from diagonal ribs to other lierne ribs. See 3.30 (p. 52).

rib vault The medieval variation on the tunnel vault in which the vault surface was divided into membranes or webs separated by arch ribs. The ribs of a bay were built first, forming a skeleton, and the webs then filled in.

rinceau (from Middle French *rainsel*, "branch") Ornamental work, often low relief sculpture, consisting of curvilinear intertwining leaves and branches.

rosette Stylized circular floral ornament in the form of an open rose.

round-point (French for "round point") In French Baroque landscape design and town planning, a circular plaza on which streets converge.

rusticated, rustication (from Latin *rusticus,* "of the country, rude, coarse") Refers to the treatment of stone masonry with the joints between the blocks deeply cut back; the principal surfaces of the blocks may be smoothly dressed, textured, or extremely rough (quarry-faced).

sacristy A room in a church housing sacred vessels and vestments; also called vestry.

sanctuary (from Latin *sanctus,* "holy") A sacred place, such as a church, temple, or mosque, but especially the most holy part of that place; in a Christian church, the altar and the area immediately around the altar.

sash (from French *chassis,* "frame") The frame in which glass windowpanes are set.

scenae frons (from Latin and Greek *skene,* "scene," plus *frons,* "facade") In a Roman theater, the richly embellished wall rising behind the stage area.

section (from Latin *sectio*, "act of cutting") In architecture, a drawing showing a slice through a building, either lengthwise (longitudinal section) or crosswise (cross section), with all horizontal and vertical lines shown at their full length as in an elevation drawing. In detailed section drawings the interior is drawn in elevation.

serdab In ancient Egyptian architecture, a closed chamber meant to contain a statue.

Serliana. (See *Palladian motif.*)

segmental Referring to a segment of a circle, used to describe an arch that is not a full semicircle, and also to a pediment, which has a partial circular curved upper part instead of a triangular peak.

setback A recessed upper section of a building; used in New York and Chicago skyscrapers of the 1920s as a way of admitting more light and air to the streets below.

shaft (from Old English *scheaft*) The main part of a column, between the base and the capital; also the main part of a pier. (See also *order.*)

sill course A horizontal course of brick or stone in a masonry wall, usually placed at the window sill level, differentiated from the rest of the masonry, often projecting.

skeleton frame. (See *skyscraper construction.*)

skyscraper construction The method of construction developed in Chicago in which all building loads are transmitted to a ferrous metal skeleton, so that any external masonry is simply a protective cladding. (See also *curtain wall.*)

soffit (from French *soffite* or Italian *soffitto,* based on Latin *suffixus* "fastened below") The exposed flat under-surface of any overhead building component, whether of an arch, eave, cornice, balcony, beam, or lintel.

space frame A form of truss, made of relatively short wooden or metal pieces, that extends in three dimensions and can be supported at virtually any of the points where the members are joined.

spandrel (from Middle English *spaundrell,* from Latin *expandere,* "to spread out") In arcuated structures, the wall area between the adjacent arches and an imaginary line drawn across their tops; in curtain wall structures, the panel between structural columns.

spire (from Old English *spir*) In architecture, an elongated, tapering structure that comes to a point.

spread foundation For a column or pier load, a foundation built like a broad pyramid to spread the weight over a large area. In soft soils, a spread foundation may be built over a cluster of piles. Spread foundations can be extended in a line for wall loads. (See also *raft foundation.*)

spring line The imaginary line from which an arch springs or starts to curve.

spur wall A short wall extending out from a main wall.

square In architectural planning, an open public space in a town, usually surrounded by buildings.

steel. (See *iron.*)

steeple (from Middle English *stepel,* from Old English *stepel,* related to Old English *steap,* "high, steep") A tall, comparatively thin tower-like building form made up of stacked diminishing components, often culminating in a spire.

stele (Greek, "pillar") An upright stone slab, usually bearing an engraved inscription and figural relief carving, placed to mark a grave or as a votive offering.

stereobate (from Greek *sterebates,* "solid base") The total substructure or base of a classical building; in a columnar building, the top or upper-most level is called the *stylobate*. *Stereobate* and *plinth* are often considered roughly synonymous.

stoa (Greek, "porch") In Classical Greek architecture, a long roofed portico open along one long side, most often facing out onto the agora.

stringcourse. (See *belt course.*)

stucco (Italian) An exterior plaster finish similar to mortar and mixed of lime cement (now Portland cement) and sand.

stylobate (from Greek, *stylobates*, "column foundation or base") The upper layer of the stereobate upon which the columns rest. (See also *stereobate.*)

temenos (Greek) The sacred enclosure around a temple site.

temple front In Neoclassical architecture, a decorative facade treatment consisting of columns carrying a pediment and resembling a Classical temple.

tenon (late Middle English, from Old French *tenir,* from Latin *tenere,* "to hold") A tongue-like projection carved or cut at the end of a beam or post, meant to fit into a matching mortise recess in a girt, sill, or upper plate in a heavy timber frame.

tension (from Old French and Latin *tendere,* "to stretch") In architecture, a force that tends to stretch and pull apart.

terra cotta (Italian *terra,* "earth," plus *cotta,* "baked") A thick clay material, mixed with crushed baked clay, molded and fired; used as a floor, wall, and roof covering.

tetrastyle (from Greek *tetra,* "four," plus *stulos,* "column") A portico of four columns.

thrust (Middle English, from Old Norse *thrýsta,* perhaps related to Latin *trudere,* "to thrust") In architecture, an outward, oblique, or downward force generated by gravity, wind pressure, or both working together.

torsion (from Latin *torsus,* "twisted") A force that tends to twist; often a problem in large modern skyscrapers due to wind pressure.

trabeated (from Latin *trabs,* "beam") Used to describe a structure consisting of posts and beams, or having a frame, in contrast to *arcuated.*

tracery (from Old French *trait,* "strap") Ornamental design of interlaced lines or straps, particularly the thin stone interlaces of Gothic windows.

transept (from Latin *trans,* "through," plus *saeptum,* "partition") Either of the two lateral arms in a Latin cross-plan church.

triforium (origin unknown) In a Gothic church, a narrow arcaded passage between the arcade of the side aisles and the clerestory windows; corresponds to the shed roof over the side aisles.

triglyph (Greek *treis,* "three," plus *gluphe,* "carving") In the frieze area of the Classical Doric order, the stone panel cut with three grooves originally used to protect the open-grain end of wooden beams.

tripartite organization A method of organizing the large mass of tall skyscrapers, associated with McKim, Mead & White, Daniel Burnham, Holabird & Roche, and Louis Sullivan, with a distinct base section, a tall mid-section of repeated identical floors, and a distinct terminating top section.

truss (from Middle English *trusse,* from Old French *trousser,* "to secure tightly") In architecture, a rigid frame, constructed of timbers or metal pieces forming triangular units; this rigid structure cannot be deflected without deforming one of its component members.

turret, tourelle (from Old French *tourete,* diminutive for "tower") A small tower, sometimes corbeled out from the corner of a building.

tympanum (Latin, from Greek *tumpanon,* "drum") The triangular space enclosed between the entablature and the moldings of a Classical pediment; the panel enclosed between a lintel and an arch rising above it.

vault (Middle English *vaute,* from Latin *volvere,* "to roll") A curved or arched masonry (or concrete) roof such as a tunnel or barrel vault that has the shape of a half-cylinder; a groin vault formed by the intersection of two tunnel vaults at right angles; an annular vault that results when a tunnel vault is curved into a circle; or a rib vault.

veranda, verandah (from Hindi *varanda,* which is partly from Portuguese *varanda,* akin to Spanish *baranda,* "railing") An extensive open gallery or porch.

vermiculated, vermiculation (from Latin, *vermiculatus*, past participle of *vermiculari,* "to be full of worms") Referring to a decorative carved treatment of stone whose rough surface resembles wood tunneled through and eaten by worms (see 15.40).

vestibule (Latin *vestibulum*) A lobby or entrance hall.

viaduct (from Latin via, "road," plus *ductus,* past participle of verb "to lead") A raised series of arches carrying a roadway.

villa (Italian from Latin) A country house, with associated outbuildings. In Italy, a villa rustica was a working farm, whereas a villa urbana was primarily intended for recreational purposes.

volume (from Latin *volvere,* "to roll") In architecture, the amount of space contained within a three-dimensional enclosure.

volute (from Latin *voluta,* "that which is rolled") A spiral ornament or whorl, best represented in the Classical Ionic capital.

voussoir (from Old French *vossoir,* ultimately from Latin *volvere,* "to roll") Any of the wedge-shaped blocks that make up an arch or a vault.

wattle and daub (*wattle,* a woven lattice of wood sticks, plus *daub,* from Middle English and Old French *dauber*) A rough form of construction in which a woven basketwork of split wood or twigs is coated with mud or adobe plaster; typically employed to fill the spaces between framing members.

westwork The elaborated western end of Carolingian and German Romanesque churches, which consisted of western transept arms and towers, a low entrance hall, and an upper room open to the nave (example: Saint Michael's, Hildesheim, Germany).

wrought iron. (See *iron.*)

ziggurat (from Assyrian *ziggurratu,* "summit," "mountaintop") A temple-tower of multiple stepped-back stages built by the Babylonians and Assyrians.

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