
SINGAPORE'S DEFENCE INDUSTRIES



Bilveer Singh



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ABSTRACT

This study analyses the state of Singapore defence industry. It traces the origins and evolution of the industry, examines the various motivating factors and analyses the impact of the industry on the country and beyond. From the study, it is clear that Singapore has one of the most developed defence industries in Southeast Asia and this has been achieved within a relatively short span of time. The monograph analyses the factors for this achievement, examines the decision-making process as far as the defence industry is concerned and examines problems that have been faced and might be faced by the defence industry in Singapore. Finally, the future directions of the defence industry are analysed.

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PREFACE

In line with the general pattern of military behaviour in other Third World regions, Southeast Asian countries have been spending a large proportion of their budgets on defence. An important component of the defence outlay is the increasing emphasis paid to domestic arms production, especially in the ASEAN (Association of Southeast Asian Nations) countries consisting of Indonesia, Malaysia, Thailand, Philippines, Singapore and Brunei. Among the ASEAN countries, Singapore's experience is worth studying as it testifies how a competitive defence industrial complex can be developed in the Third World.

While Singapore was not the first in the region to invest in a domestic defence industry, its arms industry has grown rapidly over the last twenty-five years, making the Republic the leading and most advanced arms producer in the region. Developing sporadically at first, the defence industries have grown into a massive integrated complex, organised along four lines : ordnance, aerospace, marine and industrial. As in the other industrial sectors, the role of the political leadership in directing the development of the defence industries is an important one. While the sword-plowshares debate can be easily aroused, it is obvious in the Singapore case that the Singapore Defence Industries play an important political, military, economic and psychological role, and it is the combination of these contributions and incentives which have generated the continued growth of the defence industries in a highly organised, efficient, rational and profit-oriented direction. Increasingly, the defence industries have also become an integral element of the country's defence strategy, becoming a critical element of its deterrence strategy, showing clearly how the defence industries can be successfully linked to the country's defence strategy without the state suffering loss in having to shoulder and support a burdensome defence industrial infrastructure.

While the term Singapore Defence Industries is used generically in this book to refer to the whole group of companies organised under the Ministry of Defence to undertake activities which are directly and indirectly military-related, increasingly there has been a concerted effort to play down the military role of these industries and take the label 'military' away from them, focusing more on their 'non-offensive' industrial role. Hence, the new generic label Singapore

Technologies was officially inaugurated in April 1989. While this change in focus, with an industrial emphasis, is in part aimed at reflecting the new and long-term importance of the industrial sector of the industries, the fact that these industries are an integral part of the Ministry of Defence and form part of its infrastructure permits the generic term Singapore Defence Industries to be used legitimately to describe the group of industries so organised to undertake defence production in the country.

CHAPTER ONE

DEFENCE INDUSTRIALISATION IN THE THIRD WORLD

In addition to political stability, economic development and military strength, defence industrialization has become an integral part of any country's strategic and defence capability. It is no longer merely part of the strategic thinking of the advanced industrial world to link weapons production to the political, economic and military strength of a particular country. Increasingly, more and more states in the Third World have, for various reasons but primarily due to multi-faceted security considerations, undertaken defence industrialization to acquire sophisticated, advanced weapons and service technologies to meet their strategic and military needs and possibly to have positive spillover effects on the country's civilian economy.

In this regard, Singapore has not behaved any differently from many other Third World states as far as defence industrialization is concerned. Over the years a highly advanced and integrated defence industrial complex has emerged to make the Republic a leading arms producer in the Third World. This book details the major activities of the Singapore Defence Industries (SDI). It commences with a brief examination of the emergence of arms industries in the Third World, with a focus on their incentives for, and probable problems faced in, defence industrialization. This is followed by an examination of the structure, organisation and dimensions of the Singapore Defence Industries. The imperatives and incentives for the Singapore Defence Industries are analysed next; then the decision-making process in the Singapore Defence Industries; the respective impact and limits of the SDI and, finally, the prospects and possible future directions of the defence industries are postulated.

Proliferation of Defence Industries in the Third World

Even though gunpowder was invented in China, for a very long time arms production was a monopoly of the Great Powers, who were also the economically and technologically advanced and developed countries of the world. Since the Second World War,

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however, there has been a steady growth in the number of Third World states producing arms to meet domestic needs and to compete in the very lucrative international 'arms bazaar'.¹ Beginning with about four arms producers in the Third World in 1950, today there are more than forty states in the Third World which are involved in defence production, with thirty-six alone from the non-communist world involved in the production of one or more categories of conventional weapons.²

In most cases, arms production in the Third World began through collaboration with advanced countries, both from the Eastern and Western blocs. In the main, there are three types of defence production in the Third World: licensed, joint development and indigenously designed production.³ In licensed production, initially a Third World state acquires licenses to assemble the whole weapon system or its parts, usually with considerable material and technical assistance from the licensed supplier. As the country's defence industry matures and the Third World state is able to develop backup

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- 1 See Anthony Sampson, *The Arms Bazaar*, New Edition, (London: Coronet Books, 1988), especially Chapters 9, 10 and 11.
 - 2 Cited in Jacquelyn Porth, 'Soviet Union World Largest Arms Supplier in 1985 [sic]', *East Asia/Pacific Wireless File*, EP2140412, 12 April 1988, p.20. For more information on the defence industries in the Third World see Herbert Wulf, 'Arms Production in the Third World', *SIPRI Yearbook 1985*, (Stockholm: Stockholm International Peace Research Institute, 1985), pp.329-343; Herbert Wulf, 'Developing Countries', in Nicole Ball and Milton Leiteberg (eds), *The Structure of the Defense Industry. An International Survey*, (London: Croom Helm, 1983), pp.310-343; Andrew L. Ross, 'Dimensions of Militarization in the Third World', *Armed Forces and Society*, Vol.13, No.4, Summer 1987, pp.561-578; Stephanie G. Neumann, 'International Stratification and Third World Military Industries', *International Organization*, Vol.38, No.1, Winter 1984, pp.167-197; James Everett Katz (ed.), *The Implications of Third World Military Industrialization*, (Lexington: Lexington Books, 1986); and Michael Brzoska and Thomas Ohlson (eds), *Arms Production in the Third World*, (London: Taylor and Francis, 1986).
 - 3 See *SIPRI Yearbook 1973*, (Stockholm: Stockholm International Peace and Research Institute, 1973), pp.350-354.

plants, a reasonable infrastructure and skilled personnel, the indigenous content of the weapon system and services involved are increased, if possible, totally through local production. The weapon system is still, however, produced under license. Once the weapon's know-how has been mastered, a state is able to reverse engineer and produce an indigenously designed weapon system or engage in joint development with a reputable arms producer from the developed world.

The pattern of development of local defence industries is the same for most of the Third World states.⁴ It commences with all defence materials and know-how being imported from advanced countries. Then facilities and infrastructure for maintenance and overhaul of imported arms and other systems are established, usually with assistance from foreign arms producers. Licences are then negotiated for the domestic assembly of either the whole weapon system or its sub-system. A step following this would entail a mutual understanding between a Third World state and a partner from the developed world to manufacture simple components which are politically and strategically uncontroversial locally, while the sophisticated and sensitive elements continue to be imported. With experience, the percentage of the system that is produced locally is increased to a point where the Third World state might be producing the entire system under license. With growing research and development capability and breakthroughs, brought about mainly through the growth of local scientific-technical talent, locally designed systems are then initiated, at first often using imported components. Later the whole system may be locally manufactured.

Confirming the generally uniform step-by-step pattern of domestic production of arms in the Third World, whereby knowledge and experience gained over time serves as a basis for subsequent phases of growth, Herbert Wulf has identified five stages which most Third World states go through:

The first step is usually the import of equipment for repair, maintenance and overhaul of imported weapon systems. Foreign suppliers export technological skills by training personnel in the recipient countries.

⁴ See Herbert Wulf, 'Arms Production in the Third World', p.330.

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The next step often involves the assembly of imported arms. Components, subsystems and unassembled kits of particular weapon systems are purchased abroad and assembled domestically.

During the third phase, simple components are produced locally under licence, while sophisticated and more expensive parts continue to be delivered from abroad. Licence-produced and imported components are then assembled domestically...

In the fourth stage, a major portion of the weapon system is licence-produced. While the number of imported parts is reduced so that it can be said that the weapon is 'produced domestically', many sophisticated components still have to be imported.

The fifth and final stage is the indigenous design and production of weapon systems. This stage can only be initiated - at least for technologically advanced weapon systems - on the basis of many years of production experience and when very sophisticated and diversified R&D facilities are set up. Design and production often are still dependent on some know-how and technology input from producers in the industrialized countries.⁵

Third World's Incentives for Defence Industrialisation

The motivation for Third World states to invest in a defence industry are varied. Some have been forced to develop a defence industry because of the dynamics of regional politics or international embargoes placed on them,⁶ while others have taken a conscious decision not only to increase self-reliance by reducing dependence on foreign suppliers but also, if possible, to carve out a niche for themselves in the highly lucrative but competitive arms market.

⁵ *Ibid.*

⁶ See Kapil Kaul, 'Establishment and Growth of Israel's Defence Industries', *Strategic Analysis*, Vol.11, No.7, October 1987, p.837.

The economic incentives are especially important. One of the principal motivations, especially in the light of reduced availability of military assistance programmes and hence the need to pay for expensive arms purchases, is to reduce the defence expenditure outlay. Through domestic production there is the expectation of cheaper unit cost of weapons. There is also the saving on scarce foreign exchange. In the light of the big defence budgets of Third World states, it might even contribute to reducing balance of payment deficits. Additionally, the domestic defence industry might give an impetus to scientific research and technological progress in the country. There may be spin-off benefits to the civilian industry by improving manpower skills and labour productivity. It might also stimulate general industrial growth, especially by supporting local manufacturing industries which might be associated with the defence industry of the country. This might also provide valuable jobs, especially for the less skilled. A defence industry would also provide employment for the highly skilled and professional population of a Third World state, and would be a useful mechanism for retaining local skilled manpower. It could also help to keep a Third World state abreast in modern strategic technology, which in turn could have civilian spin-offs.

While the potential benefits for Third World states that 'go defence industries' are many, including employment creation, skill generation, demand stimulation and foreign exchange savings and earnings, it is not true that this is the case all the time. A more discriminate, case-by-case analysis is needed to verify what appear to be clear economic benefits for Third World defence industrialization. While countries such as Israel, Brazil and China appear to have reaped substantial economic and technological benefits through defence industrialization, for many other Third World states the benefits are not so easily recognizable. As Ron Matthews has argued:

For these other states, it can be argued that military-led industrialisation has contributed less to employment, due to its capital intensity, than many other industrial sectors; has encouraged the growth of research, design and development in a direction incompatible with the needs of society in the Third World; has drained the civil economy of skilled labour; and it has inflated the import-bill, at least in

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the short to medium term. Furthermore, in terms of export earnings potential, it is unclear how many 'Brazils' the international market for arms could support over the longer-term.⁷

Even though India has emerged as the largest manufacturer of arms in the Third World, accounting for thirty-one per cent of all armaments produced in the Third World, followed by Israel with twenty-three per cent,⁸ the economic rationale for establishing an arms industry (as a short cut to industrialisation and to stimulate the civilian industry) has not been realised. For instance, in the Indian case the aircraft producer, Hindustan Aeronautics Limited, had as one of its major goals a programme to produce as many components of the military aircraft as possible. By the early 1980s, however, the Indian Defence Ministry was raising questions about the whole rationale of the indigenisation programme. An Indian Government Report commented:

The items to be indigenised cover a wide variety of materials and components which have to go through very rigid specifications and high standards of quality. Most of these materials are not used in general engineering industry and are peculiar to the aircraft industry.⁹

Hence, while the economic rationale is an important one justifying the establishment of defence industries in the Third World, their actual economic contributions need to be analysed more deeply to identify their specific spin-offs for the country's economy.

Equally important, and at times decisive, are the political motivations. One important incentive is the need to achieve self-sufficiency in order to reduce dependence on foreign suppliers, especially those with whom conflicts had broken out in the past or to preempt potential conflicts. It can also be part of a country's strategy to seek political independence by avoiding political strings which may be attached to arms imports, especially from a Great Power. In short,

7 Ron Matthews, *Defence Production in India*, (New Delhi: ABC Publishing House, 1989), p.8.

8 Cited in *The Tribune* (Chandigarh), 29 May 1989.

9 Quoted in Ron Matthews, *Defence Production in India*, p.13.

it is an exercise in seeking complete independence; this is an important motivating factor for most Third World states, which may seek 'total political independence' through autonomy in military technology. Hence, following the successful Indian test-launch of its intermediate-range ballistic missile *Agni* in May 1989, Prime Minister Rajiv Gandhi argued that its aim was to enhance the country's freedom and independence: India lost its independence two centuries ago, according to Rajiv Gandhi, because

we were disunited on the home front and not vigilant on the external front. We must remember that technological backwardness also leads to subjugation. Never again will we allow our freedom to be so subjugated.¹⁰

For some states, defence industrialisation is forced upon them by international embargoes. The need to circumvent embargoes or potential embargoes is often a compelling motivation. It has also been noted that, for middle or regional Third World powers, a credible defence industry is, in addition to its prestige consideration, part of an exercise in seeking regional influence. States in the Third World which have a fairly comprehensive defence industry have found, just as have the advanced arms producers, that political leverage and influence can be gained through arms exports. Direct and indirect political influence can be exercised on client states to whom sophisticated weapons are sold. More influence can be wielded if technicians, engineers and advisers are also dispatched to maintain and operate the weapon systems. Finally, political leverage can be explicitly exercised when badly needed spares are sold at exorbitant prices or, even worse, withheld in time of need. The Indian experience in this regard is illuminating. India experienced a particular strategic vulnerability during the Sino-Indian border war in 1962. While the world's major arms producers in the West were willing to sell weapons to India before and after the war, during the critical period of the war they tried to use India's predicament to force her to change her foreign policy. According to Ron Matthews:

When fighting was taking place, the Western position was that arms would only be made available to India

¹⁰ Quoted in *The Straits Times*, (Singapore), 24 May 1989.

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on condition that it moved closer to Pakistan's policy stance over the Kashmir dispute, and that non-alignment was diluted in favour of Western foreign policy objectives. Local [meaning Indian] arms production was thus viewed as being an essential industrial goal, necessary to assuage future application of linkage by a major arms supplying nation.¹¹

The military factor is equally a critical motivating force. When the military is involved in government, there is a general tendency to develop local defence industries as part of the military-industrial complex. Countries which are engaged in military conflicts, or are under potential threats of aggression, also tend to invest in a local defence industry to meet the country's defence needs. A defence industry would not only ensure availability of necessary spares and supplies in time of crisis, but the defence industry would also ensure a high state of operational readiness for all levels of the industry, and hence readiness for the country's defence capability, at least from the weapons-logistics sector. Additionally, a local defence industry can meet the unique requirements of a Third World state, tailoring production to meet the local human and environmental needs. The fact that 'off-the-shelf' purchases of weapons from the Western or Eastern bloc countries are tailored for the European theatre and strategic needs means that very often they are unsuited for the jungle or desert terrain of the Third World - hence the need to develop locally oriented armaments.

Finally, while a Third World state may invest in a defence industry for economic, political or military reasons, many Third World states have been greatly encouraged to establish defence industries by the easy availability of weapons production technology.¹² This is because the developed countries are generally willing to assist the Third World states to establish home-grown defence industries. The developed countries' generosity arises from two main considerations: political and economic. The export of weapons technology is seen as a new device to maintain political influence as well as to expand markets. The rationale is that it is profitable to maintain links with a

¹¹ Ron Matthews, *Defence Production in India*, p.53.

¹² Herbert Wulf, 'Developing Countries', pp.311-312.

traditional customer rather than to lose it to a new rival. In the same way, it is better to co-produce with a Third World state and reap benefits rather than to lose it to a competitor. Furthermore, a developed state stands to gain economically because by producing weapons systems or their components in the Third World, due to the cheaper production cost, a weapon system or its component can be more economically re-exported to the developed country from whom the licence was originally awarded to the Third World state.

In the light of the above incentives and motivations, different countries in the Third World are at different levels of arms production. They can be ranked according to the comprehensiveness of their defence industries.¹³ India, Israel, Brazil, South Africa and South Korea are among the most advanced arms manufacturers in the Third World, producing aircraft, armoured vehicles, warships and missiles. Next in ranking would be countries such as Argentina, Taiwan, Philippines, Indonesia, North Korea and Singapore. These countries produce most of the weapons under licence and their production ranges from assembling imported components to full-scale production from locally produced raw materials. Many have even begun producing indigenously designed weapon systems.

Despite the horizontal (numerical increase of Third World arms producers) and vertical (increase in the quality of their produce) proliferation of defence industries in the Third World, few countries have attempted to acquire self-sufficiency in all aspects of defence production. This is due mainly to the multifaceted problems Third World countries face in arms production, the most acute problems being shortage of financial resources, lack or limited supply of specific raw materials, the limited nature of defence-related industries and the severe shortage of highly skilled manpower. The generally weak across-the-board industrial base also imposes a severe technological handicap if production is to proceed beyond a certain point. In this regard, Third World arms producers are in a perpetual dilemma, in the sense that there is little demand for what they can most efficiently produce but they cannot produce high-technology based weapons which are in constant demand locally.

¹³ *Ibid.*; Stephanie G. Neumann, 'International Stratification...', p.167.

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In the light of this dilemma of whether to produce or purchase, the basic goal of achieving self-sufficiency in all areas of arms production in the Third World is largely illusory. At the same time, achieving total independence in arms production from the advanced countries is also almost impossible to achieve. Only the technically advanced countries can be self-sufficient, and without exception these are all in the developed world. Furthermore, the vital components and technologies are still monopolised by a few developed countries. At the same time, total independence in arms production might not really be welcomed if it proves to be economically exorbitant. In the main, however, the achievement of self-sufficiency will be problematic because the Third World states are generally still dependent on foreign suppliers for sophisticated weapons, are still dependent on imported components and even on foreign scientists and engineers. In fact, even when a Third World state is successful in 'taking off' in arms production, total independence is not achieved; rather, there is just another form of dependence, on a licence, vital component, technology or technical aid.

CHAPTER TWO

STRUCTURE, ORGANISATION AND DIMENSIONS OF THE SINGAPORE DEFENCE INDUSTRIES

In more than twenty-two years, the Singapore Defence Industries have grown from a single small plant established at the Chartered Industries of Singapore in 1967 into a highly integrated, high-technology, diversified industrial complex with a global outlook (see Table 1).¹ This growth has indeed been phenomenal by most Third World standards, prompting the journal *Defence Attache* in 1983 to describe Singapore as 'a defence producer of more than regional significance'² and the magazine *Defence Minister and Chief of Staff* to acknowledge in January 1986 that, as far as the defence industry was concerned, Singapore was 'on the international map as an innovator'.³ It has grown to such an extent that it is able to satisfy most of the

1 See Sir Laurence Hartnett, 'Operation Doberman: The Singapore Armaments Story', *Pacific Defence Reporter*, April 1982, pp.10-12; Gregory Copley, 'The Lion City-State Begins to Roar', *Defense and Foreign Affairs*, January-February 1983, pp.21-25; Michael Richardson, 'Singapore's Defence Industry', *Pacific Defence Reporter*, May 1983, pp.69-75; H.M.F. Howarth, 'Singapore Armed Forces and Defence Industry', *International Defence Review*, No.11, 1983, pp.1570-1572; Jacquelyn S. Porth, 'Singapore: A Little Dragon in Arms Production', in James Everett Katz (ed.), *The Implications of Third World Military Industrialization*, pp.225-240; Bilveer Singh and Kwa Chong Guan, 'The Singapore Defence Industries: Motivations, Organization and Impact', paper read at a conference on Research Project on Defence and Development in Southeast Asia: Arms Procurement Policies and Their Implications, 29 September-1 October 1988, Marina Mandarin, Singapore; and S. Bilveer, 'Defence Production in Singapore: Focus on the Ordnance Industries', *Asian Defence Journal*, No.1, January 1989.

2 Cited in Michael Richardson, 'Singapore's Defence Industry', p.69.

3 'Paced Development Holds the Key', *Defence Minister and Chief of Staff* (Singapore), No.1, 1986, p.11.

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TABLE 1
ARMS PRODUCTION IN THE THIRD WORLD
1982-1987

Country	Ground Forces Equipment				Aircraft and Tactical Missiles			Naval Equipment	
	Small Arms ¹	Artillery ²	Light Armour	Heavy Armour	Light Aircraft ³	Jet Fighters	Tactical Missiles	Small Warships	Large ⁴ Warships
Brazil	IM	IM	I	I	I	P	L	I	I ⁵
Israel	IM	IM	I	IM	I	P	I	I	
India	LM	IM	L	L	L	L	L	I	I ⁵
Argentina	IM	CM	P	P	I	-	C	L	L ⁵
South Korea	LM	CM	L	P	L	L	-	I	L
Taiwan	CM	IM	C	-	I	L	L	C	C
South Africa	IM	IM	I	-	C	-	C	L	
Egypt	CM	CM	I	-	L	-	C	C	
Chile	CM	M	I	P	P	-	-	-	
Indonesia	IM	M	-	-	L	-	-	L	
Mexico	IM	-	C	-	-	-	-	L	
Peru	M	M	-	-	-	-	-	L	L
Philippines	IM	-	-	-	L	-	-	L	
Singapore	IM	M	-	-	-	-	-	I	
Thailand	LM	-	-	-	L	-	-	I	
Pakistan	LM	M	-	M	L	-	-	-	
Turkey	LM	M	-	-	-	-	-	L	L ⁵
Venezuela	M	-	-	-	-	-	-	I	
Nigeria	LM	-	L	-	-	-	-	-	
Malaysia	M	-	-	-	-	-	-	L	
Sri Lanka	-	-	-	-	-	-	-	I	
Hong Kong	-	-	-	-	-	-	-	I	
Iran	LM								
Algeria	-	-	-	-	-	-	-	L	
Burma	CM	-	-	-	-	-	-	L	
Libya	L								
Saudi Arabia	LM								
Burkina Faso	M								
Cameroon	M								
Colombia	M								
Dominican Republic	M								
Iraq	M								
Morocco	M								
Paraguay	M								
Sudan	M								
Syria	M								

Key:

I = Independent design/production

M = Munitions for system

L = Licensed production

C = Copy or modification

P = Co-production/co-development

- = Not applicable

1 Includes mortars and anti-tank guns

2 Includes multiple rocket launchers

3 Includes trainers and helicopters

4 With displacement of more than 500 tons.

5 Also produces submarines under license

Source: US Arms Control and Disarmament Agency, *World Military Expenditures and Arms Transfers, 1987*.

highly sophisticated basic combat and services needs of the Republic's army, airforce and navy. In listing the 27 Third World's arms producers in 1973, the Stockholm International Peace and Research Institute (SIPRI) did not even mention Singapore's growing defence production capabilities.⁴ Yet in its 1986 publication, *Arms Production in the Third World*, Michael Brzoska and Thomas Ohlson argued that Singapore's 'arms industry is the most diversified and capable in ASEAN'.⁵ At present Singapore, despite its small size and various limitations (such as limited manpower resources, lack of raw materials and limited experience in arms production), is respectfully and competitively viewed as a leading Third World arms producer. This is best evidenced by the range of defence and non-defence related equipment and services that is produced and offered by the SDI for the domestic and international markets.

The defence industries in Singapore are largely government-owned through a holding company, Sheng-Li Holding ('Sheng-Li' means 'victory' in Chinese). While the Ministry of Finance is the legal owner of the SDI and oversees its finances, Sheng-Li's operations are largely supervised by the Ministry of Defence (MINDEF) and the latter does, to a very large degree, set the main policy guidelines for the operations of the different defence companies. At the same time, the companies do have a great leeway in their day-to-day operations. The main reason for MINDEF's overseeing role over the defence industries is to ensure that the defence companies are tailored to meet its military and strategic requirements as well as to ensure that they do not undertake activities which could embarrass or compromise the Singapore government in any way.

Sheng-Li was incorporated in 1974 to coordinate the mushrooming subsidiaries of the defence industry. Until April 1989, it had six subsidiaries and 43 indirect subsidiaries and associated companies which were organised under four main groups: Ordnance, Aerospace, Naval and General Services. Presently, it employs more than 11,000 workers. As the defence industries developed and expanded, restructuring of the industry became necessary in order to rationalise the organisation, especially in the areas of Ordnance,

⁴ *SIPRI Yearbook 1973*, p.348. See Table 10.1.

⁵ See Michael Brzoska and Thomas Ohlson, (eds), *Arms Production in the Third World*, p.67.

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Aerospace and Technologies. In 1982, two new divisions were introduced; namely, the Singapore Technology Corporation (STC), which grouped together the ordnance companies, and the Singapore Aircraft Industries (SAI), which rationalised all the aerospace-related companies.

A closer look at the different defence industries indicates that their growth and origins have been largely prompted by particular, immediate needs. In short, they emerged in response to certain developments and requirements. Like little branches growing from different directions, they have developed into a big oak tree called the SDI. While the particular needs of the 1960s and 1970s compelled the growth of individual companies, by the late 1970s the existence of more than sixteen defence companies forced the government to undertake a review of the industry. Partly in response to this, a rationalization programme was launched in 1982 with the aim of allowing for synergies; namely, for the industry to mature and grow by the optimal use of people, resources, capabilities and money. It was also to encourage the export of defence products. The success of the rationalization programme and the need to project a new image of the defence industries led to another massive reorganization of the industry in April 1989.

In the main, the SDI evolved through four phases. From 1967 to 1974, defence companies grew up sporadically and often opportunistically either to meet specific defence needs of the burgeoning military units or when the withdrawal of the British forces compelled the Singapore government to take over the operations of existing defence companies, such as was the case with the Singapore Shipbuilding and Engineering Company and the Singapore Electronic and Engineering Company Limited. With the establishment of Sheng-Li in 1974, a semblance of coordination and a general sense of direction could be observed in the industry. The next phase, 1982 to mid-1989, saw a massive reorganisation of the defence industry, showing clearly that the defence companies in the Republic had reached an advanced stage. Following this, the defence industry went through another major reorganisation exercise in April 1989, which marked the next phase of development for the SDI. A more vivid picture of the defence industry and its role will be best obtained by examining in greater depth the third and fourth phase of the SDI's growth.

The SDI from 1982 to April 1989

Details of the industry in this phase can best be grasped by examining the main industries under the Sheng-Li group, namely, the STC, SAI and the Singapore Shipbuilding and Engineering Company (SSE) (see Figure 1).

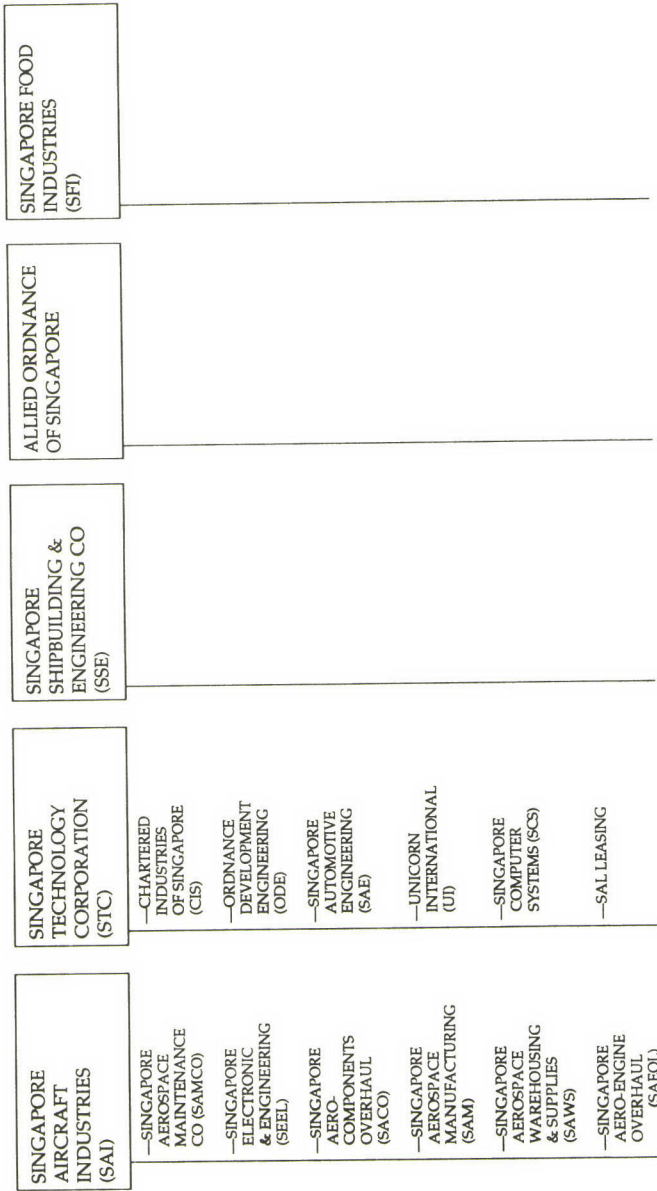
Singapore Technology Corporation

This was the largest company among the defence industries following the reorganisation in 1982. As a parent company, it had six subsidiaries: the Chartered Industries of Singapore (CIS), Ordnance Development and Engineering (ODE), Singapore Automotive Engineering (SAE), Unicorn International (UI), Singapore Computer Systems (SCS) and Singapore Automotive Leasing (SAL) (see Figure 2). The two primary arms of the STC were the CIS and ODE, with the former as the star performer of the entire ordnance group.

CIS was incorporated in 1967 to address the basic defence needs of newly independent Singapore. It started with producing small-arms ammunition, then branched into production of mortar bombs, M-16 rifles as a Colt licensee and then into medium-calibre ammunition. In the mid-1970s, it began production on a indigenously designed assault rifle (which is a derivative of the Armalite AR-18 developed by Sterling Armament), the SAR-80 and a light machine-gun, the Ultimax-100. CIS has not developed in isolation, as it managed to establish close links with other arms producers in the world. Hence, it had licence agreements with many weapons producers of the world, such as Dynamit Nobel of Sweden, General Dynamics of the United States, Rascal of Britain and Oerlikon-Bührle of Switzerland. The growth and diversified nature of the CIS was best testified by the fact that by 1984 it had 'thirteen subsidiary companies occupying a land area of more than 59 hectares and with a total workforce of 2500'.⁶

⁶ See 'The Singapore Technology Corporation', *The Pointer*, Vol.11, No.1, October-December 1984, p.16.

FIGURE 1
 ORGANISATIONAL STRUCTURE OF THE SINGAPORE DEFENCE INDUSTRIES, 1982 - APRIL 1989
 MINISTRY OF FINANCE
 (MINDEF)
 SHENG-LI HOLDING COMPANY PTE LTD



Source: Compiled by the author.

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FIGURE 2
SINGAPORE TECHNOLOGY CORPORATION

Chartered Industries of Singapore:	Develops and manufactures infantry arms and a broad range of calibre of ammunitions; designs and produces military connections and electronic equipment; plans and constructs industrial facilities and provides automational manufacturing consultancy as well as industrial testing services.
Ordnance Development and Engineering Company:	Specialises in the overhaul, development and manufacture of medium to large calibre weapons.
Singapore Automotive Engineering:	Specialises in the designing, modifying, manufacturing, rebuilding, upgrading and testing of vehicular mechanical systems for both military and commercial vehicles.
Unicorn International:	Marketing arm of the Singapore Defence Industries.
Singapore Computer Systems:	Provides information technology to the STC. Provides total system solution of every phase of a computerisation project; and consultancy services for requirement planning, specification, development, implementation and operation of information systems to supplying clients with the right combination of hardware and software products.
SAL Leasing:	As the leasing arm of the STC, it leases vehicles as well as a variety of construction and industrial equipment and through its subsidiary, Robot Leasing Consultancy, is spearheading the robotics and automation movement in the country.

Source: Compiled by the author.

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ODE was incorporated in 1973 as a sister company of the CIS to produce small amounts of weapons for the Singapore Armed Forces (SAF). In the words of Sir Laurence Hartnett, the first adviser to CIS,

quite early Dr Goh [Keng Swee, the then Defence Minister], who always was looking towards expansion to meet growing domestic demands and establish new export markets, saw the need for a second company to concentrate on smaller volume production of weapons not needed in great numbers, like field guns. As a result ODE came into being.⁷

Since then, ODE has expanded its operations to include the production of the 7.62 mm infantry and coaxial machine gun, the M203 40 mm grenade launcher, mortars of 60 mm, 81 mm and 120 mm range and, most impressive of all, the domestically designed FH-88 155 mm howitzer. After ten years' experience in operating and maintaining the 155 mm guns, the Ministry of Defence decided to develop an improved version of the weapon and in 1983 the task was assigned to the ODE. In November 1988 (that is, within five years) the FH-88 was publicly unveiled by the Minister for Trade and Industry and the Second Minister for Defence (Services), Brigadier-General Lee Hsien Loong, with a glowing compliment in the following words:

The FH-88 has undergone rigorous field trials under realistic conditions, to verify and improve the design. It has exceeded the expectations we had when we embarked on this project.⁸

SAE was initiated in 1971 with the task of modifying and upgrading armoured personnel carriers (APC) and tanks for the SAF. In addition to upkeeping armoured vehicles for combat readiness, the SAE has the capability to redesign and modify existing equipment; for example, vehicle retrofit including the installation of surface-to-air missile system on V200 APC and surveillance radars on 10 ton trucks. In this regard, SAE has undertaken a major programme to rebuild AMX13 light tanks as well as retrofit RBS 70 surface-to-air missiles on

⁷ Sir Laurence Hartnett, 'Operation Doberman', p.12.

⁸ Cited in *The Straits Times*, 24 November 1988.

Cadillac Gage V200 4x4 armoured vehicles, transforming these essentially from a ground to air defence role.

UI was incorporated in 1978 to serve SDI's needs to market its products in the highly fluid and competitive arms market. Its primary function is to handle exports and sales of defence materials and supporting services provided by Sheng-Li's six main companies, viz. the CIS, ODE, SSE, SEEL, SAE and SAMCO. In addition to its sales function, UI also assists MINDEF to source for equipment required by the different services of the SAF as well as to bring together foreign customers and capabilities of foreign manufacturers. UI pursues an 'aggressive marketing policy for the STC' and 'over the years, inroads have been made to every continent through exhibitions and demonstrations'.⁹

SCS was formed in 1981 from two existing computer centres in CIS and SAE. Today, it is the largest software developing house in Singapore, leading the high-technology movement in the country.

SAL was started as a subsidiary of SAE in 1982. Originally, its main function was to lease commercial and passenger vehicles. Since then, it has grown to include office equipment, robots, computers and office machinery.

In addition to the six subsidiaries of the STC which were involved with ordnance-related products, the Allied Ordnance Company of Singapore (AOS), which was established in 1973 with forty per cent equity participation by Bofors of Sweden, was also involved in the production and marketing of a wide variety of weapons and ammunition, including naval and field guns, anti-tank, anti-aircraft and anti-missile systems. The company was directly under the Sheng-Li group. AOS manufactured the Bofors 40 mm LJ70 anti-aircraft ammunition such as HE-T (High Explosive with Tracer), Practice Tracer and PFHE-T (Proximity Fuzed High Explosive with Tracer). As far as weapon systems are concerned, the AOS manufactures the 40 mm BOFI-R anti-aircraft gun, the new-generation 57 mm L/70 MK2 naval gun, illumination and electronic countermeasure chaff and flare rockets, FH77B 155 mm field howitzer

⁹ 'Unicorn International (Pte) Limited', *The Pointer*, Vol.11, No.1, October-December 1984, pp.28-30.

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and the Bofors SR375 anti-submarine weapon.¹⁰ An AOS wholly-owned subsidiary, the Allied Engineering of Singapore, specialises in the maintenance and assembly of ordnance systems, especially the anti-aircraft guns. In mid-1988, Sheng-Li bought the forty per cent Bofors' share to make it a 100 per cent government-owned company, following the embarrassing revelations that Bofors had given the AOS General Manager (Mr Tan Kok Cheng) kickbacks to the value of S\$600,000 between March 1984 and February 1987.¹¹

On the whole, STC's principal ordnance companies, namely, CIS, ODE, SAE and to some extent AOS, produce a large range of products from small-arms weapon systems, medium-calibre weapon systems, large-calibre ammunitions, mortar systems, vehicle systems, aircraft accessories, military radios, explosives and pyrotechnics, to make Singapore a major ordnance manufacturer in the Southeast Asian region (see Figure 3).

Singapore Aircraft Industries

SAI was the aviation wing of the SDI involved in depot-level maintenance, manufacture of aircraft parts and assemblies, systems design and integration. SAI was formed in February 1982 by the amalgamation of two government-owned companies, the Singapore Aerospace Maintenance Company (SAMCO) and Singapore Engineering and Electronic (SEEL). The formation of SAI was primarily intended to make available in Singapore and Southeast Asia a comprehensive and integrated range of capabilities and services in aircraft and aeroengine maintenance, overhaul and manufacturing, which would be able to meet the anticipated growth of the aerospace industries in the 1980s. In mid-1983, SAI had five operating subsidiaries and two associate companies. Other than SAMCO and SEEL, these are Singapore Aero-Components Overhaul (SACO), Singapore Aerospace Manufacturing (SAM), Singapore Aerospace Warehousing and Supplies (SAWS), Singapore Aero-Engine Overhaul (SAEOL) and SAMERO Company. The six operating companies (see

¹⁰ 'Allied Ordnance of Singapore (Pte) Limited and its Subsidiary', *The Pointer*, Vol.11, No.2, January-March 1985, pp.71-72.

¹¹ See *The Straits Times*, 27 September 1988.

FIGURE 3
PRODUCTS OF SINGAPORE TECHNOLOGY CORPORATION

SMALL ARMS WEAPON SYSTEMS	MEDIUM CALIBRE WEAPON SYSTEMS	LARGE CALIBRE AMMUNITION	MORTAR SYSTEMS
<ul style="list-style-type: none"> • Ultimax 100 5.56 mm Light Machine Gun System. • SR 88 5.56 mm Assault/Single-shot Rifle Systems. • 5.56 mm Ball M193, Ball SS109 Ball Special, Tracer M196 Cartridges. • 5.56 mm Plastic Blank. • 7.62 mm General Purpose Machine Gun (Infantry, Co-axial) Systems. • 7.62 mm Ball M80, Tracer M62, AP M61 Cartridges. • 7.62 mm Metal Blank. • 0.5" Heavy Machine Gun (Infantry, Co-axial) Systems. • 0.5" Ball M33, Tracer M17, APIM48, APIT M20, APHC Cartridges. • Small Arms Battlefield Realistic Engagement Simulator (SABRES). • Spares and Refurbishment of Small Arms Weapons. 	<ul style="list-style-type: none"> • 40 mm Grenade Launcher. • 40 mm HEDP M433 Grenade. • 20 mm TP M55A2, HEI M56A2, API M53A1 Cartridges. • 20 mm TP MK105, HEI MK 107 Cartridges. • 30 mm EP (Practice) HEI. • Spares and Refurbishment of Medium Calibre Weapons. 	<ul style="list-style-type: none"> • 75 mm HE, HET, Cannonister (AMX 13 tank gun). • 155 mm HE M107 Projectile. • 155 mm HE ERFB Projectile c/w BB. • 155 mm Propellant Charge M4A2. • EF 723 Artillery Ammunition Proximity Fuze. • EF 784 Artillery Ammunition Electronic Time Fuze. 	<ul style="list-style-type: none"> • 60 mm Infantry, Commando Mortar. • 60 mm HE, Smk (TIC1) Mortar bombs. • 81 mm Mortar. • 81 mm HE, Smk (TIC1), WP Mortar Bombs. • 81 mm HE ER, Smk ER Mortar bombs. • 120 mm Mortar. • 120 mm HE, Smk (TIC1) WP Mortar Bombs. • 120 mm HE ER, Smk ER Mortar Bombs. • Mortar Trainer. • Spares and Refurbishments of Mortars. • A2 Mortar Bomb Fuze. • EF 722 Mortar Bomb Proximity Fuze.

FIGURE 3
PRODUCTS OF SINGAPORE TECHNOLOGY CORPORATION (continued)

VEHICLE SYSTEMS	AIRCRAFT ACCESSORIES	MILITARY RADIOS	EXPLOSIVE AND PYROTECHNICS
<ul style="list-style-type: none"> * Repair, Rebuilding, Refurbishing and Modernisation of Military Vehicles; Examples are - M60 Tank, M113 APC, Commando V200/100 APCs, LARC V Amphibian, Land Rovers, Unimog, Mercedes Benz, Bedford, M.A.N. Trucks. * Custom Design and Construction of Special Purpose Vehicles. Examples are - Class 30 Ambulance; Field Hospital (various modules); Field Kitchen; Field Generators; Field Power Distributors; Armoured Security Vehicles; Fuel Tankers, 25 to 60 Ton Tank Transporters. * Undertake Turnkey Project and Consultation in Setting-up of Automotive Maintenance Workshops; Vehicle Inspection Centres; Mechanised and Computerised Warehouse Systems. * Spares Support for Military Vehicles. 	<ul style="list-style-type: none"> * 25 lb Aerial Fracture Bombs, Low/High Drag BAP-33. * 500lb (250kg) HE Aerial Bomb Mk 82. * Bomb Pre-Loading Trolley. * Ejection Seat Stand for Martin Baker Type (4 seats). * Trolley Accumulator. * Dummy Training Swoop - 1000 lb Bomb, Launcher LAU-10 AIM9P; MATRA Rocket Launcher. 	<ul style="list-style-type: none"> * HRC 732 Handheld Radio. * VHF 800 Vehicular and Manpack Radio Systems. * PRC 840s Manpack Radio. * VRC 840s Low Power Vehicular and Manpack Radio Systems. * VRC 846s High Power VRC 847s Dual Fit, VRC 848s Triple Fit Vehicular Radios. * Spares and Refurbishment of Military Radios. 	<ul style="list-style-type: none"> * Pre-Fragmentation Hand Grenade. * Smoke Hand Grenade. * Thunderflash. * Artillery Simulator. * TNT Blocks 1/4 kg, 1/2 kg. * Shaped Charges. * Bangalore Torpedo. * Anti-Personnel Mine. * Anti-Personnel Mine. * Jumping Mine. * Trip Flare.

Source: *Unicorn International* (Singapore: Singapore Defence Industries, April 1987).

FIGURE 4
ACTIVITIES OF SINGAPORE AIRCRAFT INDUSTRIES

Singapore Aerospace Maintaining Company:	Undertakes the maintenance, structural work, assembly, avionics retrofit, systems integration and major modification of civil and military aircraft.
Singapore Aero-Components Overhaul:	Overhauls and repairs different types of civil and military aircraft components and accessories.
Singapore Aerospace Manufacturing:	Specialises in engineering and manufacturing of quality aircraft and aero-engine components such as blades and vanes, fuel tanks, bomb-racks and spares.
Singapore Aero-Engine Overhaul:	Specialises in overhauling and repairing civil and military aircraft engines and industrial gas turbines.

Source: Compiled by the author.

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Figure 4), excluding SAMERO, undertake mostly military-related tasks, especially for the Republic of Singapore Air Force (RSAF). SAI accounts for half the aerospace workforce. SAI's expansion has coincided with the growth of the aerospace industry in Singapore which, according to one account, is taking off at an incredible speed.¹² The Singapore Government has identified the aerospace sector area of economic growth, as well as aiming to make the Republic the regional aircraft servicing centre. The SAI's major customers have included the Singapore Ministry of Defence, RSAF, the United States Navy and the Marine Corps.

The expansion of the aircraft industries in Singapore up to April 1989 is best understood by discussing the activities of the different companies under SAI.

SAMCO was the leading subsidiary of SAI, with the bulk of its workforce and turnover. It began operations in April 1976 and has been the principal contractor of the RSAF. It has been described as the largest commercial aircraft maintenance facility in Southeast Asia. As the core of the then SAI, it could refurbish, modify and maintain both civilian and military aircraft including the C-130 Hercules transport planes. Its main programme over the last few years had been to refurbish and modify the US Skyhawks to A-4S-1 planes for the RSAF. For example, in February 1982, the first batch of refurbished Skyhawks was handed over to the RSAF. Since then, SAMCO has played a leading role in upgrading the Skyhawks into the new F-404, dubbed the Super Skyhawk. As of March 1989, SAMCO had re-engined 21 such planes, with two more squadrons (each with twenty aircraft) scheduled for similar upgrading. It has also converted A-45 to TA-45 Trainers. Over and above its duties for MINDEF, it has undertaken projects for overseas clients such as depot-level maintenance for the US Navy and Marine Corps' C-130s based in the Western Pacific.

SEEL, the oldest subsidiary of SAI, was incorporated in 1969, in the wake of the British withdrawal. Its primary function was to

¹² Michael Richardson, 'Singapore's Aviation Industries Set for Take-off', *Pacific Defence Reporter*, August 1983, pp.22-25; 'Singapore's High Flying Aircraft Industry', *The Pointer*, Vol.11, No.2, January-March 1985, pp.59-70.

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market products in the fields of telecommunications, defence electronics, avionics and electronic instrumentation.

SACO was founded in 1982 to service, maintain, overhaul and repair different types of civilian and military aircraft components and equipment.

SAM was formed in 1983 to manufacture high-performance aviation components such as engine compressors, turbine blades, vanes, external fuel tanks and bomb racks. It also produced and stored spare parts for the A-4S-1 Skyhawks.

SAWS was started in 1983 to purchase, store and supply a comprehensive range of airframe, engine and general spares and raw materials to support SAI's maintenance and overhaul activities and for sales.

SAEOL was the product of a partnership between SAI and Singapore Airlines. As a company, it started in 1974 to undertake overhaul and repair work on civilian and military aircraft engines. All RSAF engines are repaired by SAEOL. The company has also refurbished engines for the Royal Malaysian Air Force.

On the whole, until its reorganisation in April 1989, SAI had a fairly massive, complex and integrated aircraft industry which undertook a wide range of activities including aircraft maintenance and overhaul services, aircraft component repair and overhaul services, aircraft engine repair and overhaul services, aircraft spares and accessories and electronic system services (see Figure 5), to make Singapore one of the leading centres of aircraft maintenance in the Asia-Pacific region.

Singapore Shipbuilding and Engineering (SSE)

The company was incorporated in May 1968, in the wake of the British withdrawal, to take over the British dockyards as well as to meet the needs of the burgeoning navy. In 1968, MINDEF brought together a group of local businessmen and, with the government as a minority shareholder, started the SSE. With the navy assessing its immediate requirements to be fast patrol craft, the SSE, to acquire missile gunboat technology, signed a Technical Cooperation

FIGURE 5
SERVICES OF SINGAPORE AIRCRAFT INDUSTRIES

AIRCRAFT MAINTENANCE AND OVERHAUL SERVICES	AIRCRAFT COMPONENTS REPAIR AND OVERHAUL SERVICES	AIRCRAFT ENGINES REPAIR AND OVERHAUL SERVICES	AIRCRAFT SPARES AND ACCESSORIES	ELECTRONIC SYSTEMS SERVICES
<p>Depot-level maintenance, major structural repairs, airframe modification, system integration, avionics retrofit, stripping and painting of the following fixed and rotary wing aircraft:</p> <ul style="list-style-type: none"> - C-130 Hercules. - A-4 Skyhawk. - F5E/F Tiger II. - Short Skyvan. - BAe Hunter and Strikemaster. - SIA Marchetti S360. - SIA Marchetti S211. - Cessna 150 and 172. - L-188 Electra. - Beechcraft King Air. - BAe BAe 119. - B-24D. (UJ14), 205A-1, 206L-1 and 212 Helicopters. - Aerospaiale Alouette III. - Eurocopter and Super Puma. 	<p>Repair and overhaul services on over 6,000 types of aircraft components and accessories. Components overhauled are categorised under the following headings:</p> <ul style="list-style-type: none"> - Radar. - Navigation / Communication Equipment. - Instruments. - Electrical Equipment. - Constant Speed Drive. - Continental and Lycoming Engines. - Hamilton Standard, Hartzell and Maccauley Propellers. - Helicopter Dynamic Components. - Hydraulic/Pneumatic Components. - Flexible Fuel Cells. 	<p>Overhaul of the following GAS turbine engines and their related accessories:</p> <ul style="list-style-type: none"> - P & W JT-8D. - Allison T36/501/J33. - Lycoming 133. - C-E J65. - Wright J65. - Rolls Royce Avon 207 and Typer 505. - Solar Saturn and Centaur. <p>Repair Station Approvals: DGAC (Indonesia) 58/06/0/1; DA (Thailand) 14/25/5; BAT (Philippines) 132.F; CAA (United Kingdom) A1/8736/81; CAA (Singapore) AWT/34.</p>	<p>Spares Support for Aircraft:</p> <ul style="list-style-type: none"> - Multiple Ejector Racks. - Triple Ejector Racks. - Underswing Accessory Pods. - 275 and 300 Gallon External Fuel Tanks. 	<p>Engineering services such as electronic system integration, calibration of precision equipment, repair and overhaul of the following types of equipment:</p> <ul style="list-style-type: none"> - Communication Centre for Ground-to-Air Operations. - Fire Control Systems. - Flight Simulators. - Building Automation. - Airfield Lighting and Flight Display Systems. - Communication and Navigation Equipment. - Radars. - Command and Control Systems. <p>Repair Station Approvals: CAA (Singapore) AWT/17.</p>
<p>Repair station approvals: DCA (Malaysia) A09/SAMCO; DGAC (Indonesia) 58/4820; BAT (Philippines) 132.F; CAA (Singapore) AWT/32.</p>	<p>Repair Station Approvals: FAA (United States) 651/5F; CAD (Malaysia) A09/SACO; DGAC (Indonesia) 58/6300; BAT (Philippines) 134.F; CAA (Singapore) AWT/59.</p> <p>Authorised Services Centre for: SBERNA: Hydraulic Research Tertron: Bendix, Rockwell, Collins; JET; Lear Siegler; King Radio; AIM and Ferranti.</p>			

Source: Unizom International (Singapore, Singapore Defence Industries, April 1989).

Agreement with a German shipbuilding company - Luerssen Werft - to establish local capability in the construction of naval patrol craft. In 1969, the Singapore Navy awarded SSE-Luerssen Werft a contract to build six missile gunboats. The first two vessels were built at Luerssen Werft shipyards at Vegesack, West Germany in 1972 and the other four at the SSE yards at Benoi Basin in Jurong, Singapore in 1974.

While the SSE acquired the relevant technologies, the Republic of Singapore Navy (RSN) did not develop or expand in the same manner as did the SAF or the RSAF, and this had a major dampening effect on the expansion of the SSE. After the successful buildup of the missile gunboats, SSE built three 45 m Coast Guard Patrol Vessels for Thailand between 1974 and 1976. However, between 1974 and 1979, the RSN did not place any new orders with the SSE and, to survive, the company had to commercialise its activities, moving into tug-boat construction, building of barges, sophisticated vessels, Liquid-Petroleum-Gas tankers and container ships.

SSE has also moved into designing its own ships, including the 14.5 m Fast Patrol Boats and the 62 m Corvettes. In 1979, 12 units of 22.7 m Fast Patrol Boats were built for the RSN. The SSE built eleven 14.5 m Fast Patrol Boats for the Singapore Marine Police in the period 1983-1985, seven units for the Brunei Marine Police between 1985 and 1987, and eight more units for the Singapore Marine Police in 1988. In 1986, the SSE also delivered two 45 m Coast Guard Patrol Vessels to India. In June 1988, Luerssen Werft launched the first of the six 62 m Missile Corvettes in Germany and, on its arrival in Singapore in December 1988, the First Deputy Prime Minister, Mr Goh Chok Tong, announced at the launching ceremony that a strong navy was vital to keep the lifelines of the Republic open. For this, the government would be investing in an effective naval capability.¹³ While the first Missile Corvette was built in West Germany, the remaining five would be built locally by SSE by 1989. With state-of-the-art sonar and torpedoes, the Missile Corvettes would have an up-to-date anti-submarine warfare capability and, armed with US-made Harpoon surface-to-surface missiles and the Italian-made 76 mm Oto Melara Rapid-Firing Guns, they would also have the features of a fast attack naval craft. More importantly, the orders from the RSN for five Missile Corvettes would keep SSE busy throughout 1989.

¹³ See *The Sunday Times*, 11 December 1988.

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Together with the acquisition of higher technologies and diversification into civilian and other defence-related areas, such as bridging systems, Ramp Powered Lighters and Hovercraft, over the years - especially when the SSE was not performing well financially and with Sheng-Li's capital injection - the SSE has become largely government-owned, with the government controlling 87 per cent of its equity. After more than twenty years of existence, SSE has acquired the expertise to perform major sophisticated maintenance (see Figure 6) for the RSN and, to that degree, the SSE has been able to undertake maintenance work on naval and commercial vessels as well as maintain engineering equipment (see Figure 7). In many ways, SSE has become the leading shipyard in the Southeast Asian region. Presently, it employs 800 people directly and another 400-500 indirectly.

Compared to the STC and SAI, the SSE has been a far smaller component of the SDI. It suffered from many handicaps, the most important being: the lack of demand from the RSN and the generally limited demand for naval and commercial vessels in the country; the very fierce international and regional competition, especially when the shipping market was very depressed; political reasons, when neighbouring countries preferred to develop their own commercial and military shipping industry even though it would have been cheaper to build in Singapore; and finally, the country's maritime security and defence needs being able to be more economically met by the use of aircraft and helicopters.

One of the lower profile companies, but an important component of the country's defence, is that organising the logistics of food supply to the SAF. The Singapore Food Industry (SFI) is part of the Sheng-Li Holding Company, created to cater for this need. SFI is capable of supplying a complete range from fresh food to specialised military specifications combat rations to MINDEF. It also supplies to hospitals and prisons in the country.

The SDI Since April 1989

On 19 April 1989, the group of companies under Sheng-Li Holding came to be officially known as Singapore Technologies (ST) (see Figure 8). Under the new name, all the defence and

**FIGURE 6
ACTIVITIES OF SINGAPORE SHIPBUILDING AND
ENGINEERING LIMITED**

Shipbuilding:	Ability to build coast guard vessels, naval patrol craft, missile gunboats and mini-corvettes.
Ship repairing:	Provides broad range of ship-repair capabilities, backed by facilities like a versatile syncrolift docking system, covered workshops for naval and commercial repairs, diesel workshops to overhaul engines up to 6000 bhp, systems for integration of weapons into naval craft and comprehensive range of support services.
Military fabrication:	Ability to produce aluminium and steel bridging and ferry systems.
Technical Management Services:	Transfer technology and other sources to other countries through the supply of design data, production drawings, material packages and the complete shipbuilding support package.

Source: Compiled by the author.

FIGURE 7
PRODUCTS OF SINGAPORE SHIPBUILDING AND ENGINEERING COMPANY

NAVAL VESSELS	COMMERCIAL VESSELS	ENGINEERING EQUIPMENT
<p>Custom Design and Construction of:</p> <ul style="list-style-type: none"> - Patrol Boats in Aluminium or Steel hull - Fast Strike Missile Gunboats - Offshore Patrol Vessels. - Landing Ships. - Assault Boats. - Mini-Corvettes. 	<p>Custom Design and Construction of:</p> <ul style="list-style-type: none"> - Container Ships up to 500 TEU. - General Cargo Vessels up to 8000 DWT. - LPG Tankers. - Offshore Supply Boats. - Landing Craft. - Passenger Ferry Vessels. 	<p>Floating Folding Bridge Systems.</p> <p>Vehicle Trackways.</p> <p>Other Engineering Fabrication to Customer Designs.</p>
<p>Established Capability in:</p> <ul style="list-style-type: none"> - 14.5M, 17.0M, 22.5 M, 25.0M, 33.0M, 45.0M Patrol Boats. - 100.0M Landing Ship. - 32.0M RPL Landing Craft. - 62.0M Mini-Corvette. 	<p>Spares, Maintenance, Repair and Overhaul of Commercial Vessels.</p>	
<p>Spares, Maintenance, Repair and Overhaul of Naval Vessels.</p>		

Source: *Unicorn International* (Singapore: Singapore Defence Industries, April 1987).

FIGURE 8
STRUCTURE OF THE SDI SINCE APRIL 1989
SINGAPORE TECHNOLOGIES - SHENG-LI HOLDING COMPANY

SINGAPORE TECHNOLOGIES INDUSTRIAL	SINGAPORE TECHNOLOGIES ORDNANCE	SINGAPORE TECHNOLOGIES AEROSPACE	SINGAPORE TECHNOLOGIES MARINE
SINGAPORE TECHNOLOGIES INDUSTRIAL CORPORATION	CHARTERED INDUSTRIES OF SINGAPORE	SINGAPORE AEROSPACE	SINGAPORE SHIPBUILDING AND ENGINEERING
Advanced Computation Centre Aero-Engine Manufacturing of Singapore Automation Leasing and Consultancy CDC Construction and Development Chartered Electronics Industries Chartered Machine Tools Chartered Microwave Chartered Precision Foundry Chartered Semiconductor Chartered Tarnos Design Computer Engineering Systems Methuen Singapore Origen International Reliance Contractors SAFE Travel and Enterprises SAL Industrial Leasing Singapore Computer Systems Singapore Electronic and Engineering Singapore Engineering Software Singapore Food Industries Singapore Mint Vertex Management	Allied Ordnance of Singapore Chartered Chemical Industries Chartered Composite Technology Chartered Firearms Industries Chartered Materials and Services Chartered Metal Industries Chartered Pyrotechnic Industries Ordnance Development and Engineering SAE Inspection Services SAE Supplies Singapore Assay Office Singapore Automotive Engineering Singapore Commuter Singapore Ordnance Engineering Singapore Test Services Unicorn International	Singapore Aero-Components Overhaul Singapore Aero-Engine Overhaul Singapore Aerospace Maintenance Company Singapore Aerospace Manufacturing Singapore Aerospace Warehousing and Supplies	

Source: Singapore Technologies (Singapore: Singapore Technologies, n.d.).

defence-related companies are grouped under four sectors: Industrial, Ordnance, Aerospace and Marine. According to the official brochure titled *Singapore Technologies*, the need for a new identity was brought about by the changing nature of SDI's business: 'No longer are we involved solely in defence work'. Also, 'from the inception of our first company in 1968, we have continued to grow in size and have expanded into areas that include industrial products and services'.¹⁴ In addition to reflecting the changing nature of the defence industries, which have gone beyond their original defence-oriented tasks, an important goal of the new establishment is to 'expand and grow into a major international group. A group that's at the leading edge of the industries we are involved in'.¹⁵ Under the reorganisation, the most fundamental restructuring has taken place in the companies which were previously under the STC, with the industrial sector now commanding the largest number of establishments. In the main, the industrial division is now organised under the parent company called Singapore Technologies Industrial Corporation (STIC), the ordnance division under the parent company called Chartered Industries of Singapore (CIS), the aerospace division under the parent company called Singapore Aerospace (SA), and the marine division remains unchanged under the SSE. No substantial change has taken place with regards to the aircraft and shipbuilding industries, except for the former's change in name. However, a major revamp was instituted for the ordnance division, as well as the constitution of a new industrial division.

While the ordnance division under the previous parent company STC had six main companies (see Figure 1), under the new CIS arrangements there are sixteen companies (see Figure 8) involved in ordnance production, as follows: Allied Ordnance of Singapore, Chartered Chemical Industries, Chartered Composite Technology, Chartered Firearms Industries, Chartered Materials and Services, Chartered Metal Industries, Chartered Pyrotechnic Industries, Ordnance Development and Engineering, SAE Inspection Services, SAE Supplies, Singapore Assay Office, Singapore Automotive

¹⁴ *Singapore Technologies*, (Singapore: Singapore Technologies, n.d), n.p.

¹⁵ Cited in *Your Guide to the New Corporate Identity*, (Singapore: Singapore Technologies, n.d.), n.p.

Engineering, Singapore Commuter, Singapore Ordnance Engineering, Singapore Test Services and Unicorn International. In the brief write-up in *Singapore Technologies*, it was argued that:

The Ordnance-based companies of Chartered Industries of Singapore have become synonymous with our pre-eminence in the field of sophisticated arms, ammunition, weapon systems engineering and manufacturing.

Through the incorporation of the latest in electronics and advanced technology, efforts are continually directed towards upgrading the sophistication and range of the group's products.

Included within this range are small, medium and large calibre weapons and ammunition, mechanical and electronic fuzes, explosives and pyrotechnics, military electronics, mortars, anti-tank weapons, artillery guns and howitzers.

It has also capability for the design, refurbishment, modification, rebuilding and upgrading of military vehicles and vehicular mechanical systems including tanks, trucks and weapon systems.¹⁶

By far the largest group of companies under the new structure is that under the STIC, covering twenty-one companies. It is the industrial arm of the SDI, and its stated goal 'is to develop into a quality technology based engineering and service organisation headquartered in Singapore'.¹⁷ Within the STIC, primary activities have been organised under four main fields: electronics, engineering, support services and start-ups (see Figure 9). Under electronics, there are five companies: Chartered Electronics Industries Pte Ltd, Chartered Telmos Design Pte Ltd, Computer Engineering Systems Pte Ltd, Singapore Computer Systems Pty Ltd and Singapore Electronics and Engineering Pte Ltd. Under support services there are five companies: CDC - Construction and Development Pte Ltd, Reliance

¹⁶ Cited in *Singapore Technologies*, n.p.

¹⁷ Cited in *Singapore Technologies Industrial*, (Singapore: Singapore Technologies, n.d.), n.p.

FIGURE 9
INDUSTRIES OF
SINGAPORE TECHNOLOGIES INDUSTRIAL CORPORATION PTE LTD (STIC)

Electronics

Chartered Electronics Industries Pte Ltd
Chartered Telmos Design Pte Ltd
Computer Engineering Systems Pte Ltd
Singapore Computer Systems Pte Ltd
Singapore Electronics and Engineering Pte Ltd

Services

CDC - Construction and Development Pte Ltd
Reliance Contractors Pte Ltd
SAFE Travel and Enterprises Pte Ltd
SAL Industrial Leasing Pte Ltd
Singapore Food Industries Pte Ltd

Precision Engineering

Aero-Engine Manufacturing of Singapore Pte Ltd
Chartered Machine Tools Pte Ltd
Singapore Mint Pte Ltd

Start-up Companies

Chartered Microwave Pte Ltd
Chartered Precision Foundry Pte Ltd
Chartered Semiconductor Pte Ltd
Methus Corporation (USA)
Methus Singapore Pte Ltd
Origen International Pte Ltd
Vertex Investments Pte Ltd
Vertex Management Pte Ltd

Source: *Singapore Technologies Industrial* (Singapore: Singapore Technologies, n.d.).

Contractors Pte Ltd, SAFE Travel and Enterprises Pte Ltd, SAL Industrial Leasing Pte Ltd and Singapore Food Industries Pte Ltd. Under precision engineering, there are three main companies: Aero-Engine Manufacturing of Singapore Pte Ltd, Chartered Machine Tools Pte Ltd and Singapore Mint Pte Ltd. Finally, under the start-up companies, covering venture capital start-ups and joint ventures, there are eight companies: Chartered Microwave Pte Ltd, Chartered Precision Foundry Pte Ltd, Chartered Semiconductor Pte Ltd, Metheus Corporation (USA), Metheus Singapore Pte Ltd, Origen International Pte Ltd, Vertex Investment Pte Ltd and Vertex Management Pte Ltd.

Together, STIC capabilities include electronics, computer technology, precision engineering, metal fabrication, automotive engineering, construction and development, marine engineering, robotics and automation, leasing services, chemical finishing, heat treatment and test services.¹⁸

With the reorganisation, it is hoped that 'the synergy of these individual business units [would] form the base for a coordinated thrust into new areas of advanced automation and new age technologies'.¹⁹

The Research Dimension of the SDI

The quality of a country's defence industry is very much dependent on the quality of its research and development. In the Singapore case, while the SDI is a complex organisation, the research content is very much centralised in the hush-hush organisation called the Defence Science Organisation (DSO). While very little is known about this organisation (although recently some publicity was given at the opening of its \$S12 million complex), on the whole, the DSO is the research and development wing of the SDI. This is so even though organisationally it does not come under direct control of the Singapore Technologies group. Rather, direct control is exercised by the Ministry of Defence.

¹⁸ Stated in *Singapore Technologies Industrial*, n.p.

¹⁹ Cited in *Singapore Technologies*, n.p.

The origins of the DSO go back to 1972, when Dr Goh Keng Swee established the ETC (believed to stand for Electronics Testing Center) under the direction of Dr Tay Eng Soon. In 1977, the DSO was formally established with a small core of hand-picked engineers. This has gradually grown into an organisation with more than 300 engineers and scientists, including the best scientific brains in the country, believed to be the largest research and development team in Singapore. According to Brigadier-General Lee Hsien Loong, the role of the DSO, the Ministry of Defence's research and development organisation, is 'to ensure that the SAF keeps up technologically with the demands of the modern battlefield'.²⁰ According to Brigadier-General Lee, the DSO has to add 'value to our purchases, and make every defence dollar spent on hardware count. This is what defence technology is about'. It is also the arcane and secret aspect of defence technology:

It involves understanding the scientific principles underlying weapon systems, doing research and development on them, and using the knowledge acquired to improve them, or even to produce new and secret weapons.²¹

Among others, the DSO is said to have helped in the following:

- a. Developing special software for the air force's 'eyes in the sky' planes, the E-2C Hawkeye.
- b. Developing electronic equipment aimed at minimising electromagnetic interference for the navy's new missile corvettes.²²

In this context, the DSO must be regarded as the invisible partner of the SDI, and the defence industry's success must to some extent be attributed to the research and development undertakings of the DSO. Together with the independent research work undertaken by the different agencies of the SDI, Singapore has build up over time quite a formidable expertise in defence science and technology, and this -

²⁰ See *The Straits Times*, 28 October 1989.

²¹ Cited in *ibid.*

²² *Ibid.*

more than anything else - will see the industry through the next phase of development.

CHAPTER THREE

IMPERATIVES AND INCENTIVES FOR THE SINGAPORE DEFENCE INDUSTRIES

From Chapter Two it is clear that Singapore has developed a relatively sophisticated and mature defence industry, with a good standing in the Third World (see Table I). Beginning with a modest infrastructure in 1968, the SDI has undergone two major reorganisations, the first in 1982 and the second in April 1989, to reach where it is today. Different countries have converging and conflicting reasons for undertaking defence industrialization. According to Gregory Copley, the Editor-in-Chief of *Defense and Foreign Affairs*, countries industrialise in the defence sectors for the following reasons: to ensure operational readiness; to meet unique requirements; to ensure foreign exchange savings; to make foreign exchange earnings; to assist domestic employment; to benefit from technological spin-off; to create national pride; to adapt imported systems to local needs and conditions; to undertake upgrading instead of buying from abroad; to utilise existing civil-sector capacity; and finally, to co-produce with other states to achieve political and technological goals.¹

Surveying the development and progress of the SDI, it can be posited that the combination of three factors was principally instrumental in motivating the establishment of defence industries in the Republic; namely, political, military and economic considerations.

Political

Defence industries are in many ways the political industries of a country. They reflect both the political thinking of a country and its leadership as well as the particular problems a state may be confronting. Defence industries are also established to satisfy the various politically related goals of a country. An important goal is to attempt self-sufficiency with the object of reducing dependency on foreign suppliers. This goal is all the more critical if conflicts have

¹ Cited in Gregory Copley, 'The Road to Self-Sufficiency', *Defense and Foreign Affairs*, December 1987, p.24.

arisen in the past with such suppliers. It also enhances political independence by reducing or negating political strings that may be attached to arms imports. Another goal could be to enable bargaining for more liberal terms for advanced countries' arms technology or licensing schemes. For countries which are subject to international or unilateral arms embargoes, a local defence industry is more often than not inevitable in order to circumvent embargoes or potential embargoes. For countries interested in projecting their power, arms industries - and especially the large-scale export of weapons - are important instruments for exerting political pressure on client states. In the Singapore case, a number of political factors played a key role in early defence industrialization.

In many ways, the political factors which led to the establishment of a national defence capability were also crucial in the founding of a defence industry in the country. The suddenness of independence, brought about by the country's eviction from Malaysia after only 23 months of acrimonious marriage between Singapore and the Federation of Malaysia, which also saw the explosion of two racial riots in Singapore, created a 'survival crisis' for the Chinese-dominated People's Action Party (PAP) leadership, the governing party of Singapore since 1959.²

One of the many responses of the PAP in overcoming the 'survival crisis' was to establish a viable defence capability,³ and with that was implanted the seeds of a local defence industry. The 'shock' of independence,⁴ together with the ongoing hostilities with Indonesia

² See Chan Heng Chee, *Singapore: The Politics of Survival, 1965-1967*, (London: Oxford University Press, 1971), pp.1-28.

³ See Bernard Chen, 'The Singapore Armed Forces: A Total Perspective', in *The Singapore Armed Forces*, (Singapore: Public Affairs Department, Ministry of Defence, Singapore, n.d.), pp.10-14.

⁴ It was a 'shock' because prior to this the PAP leadership had argued that an independent Singapore could not survive. For instance, in March 1957, Lee Kuan Yew, then a leading member of the opposition in the Legislative Assembly, argued that the idea of an independent Singapore was 'a political, economic and geographical absurdity'. Quoted in *Colony of Singapore, Legislative Assembly Debates*, Vol.2, 5 March 1957, Col.1471.

(which began in 1964, caused by Sukarno's 'konfrontasi'), prompted the Republic's leadership to build a defence force to safeguard the newly gained political independence. The British decision to withdraw their forces from the Republic at short notice, first given officially in 1966, merely accentuated the 'survival crisis', adding an impetus to fill the military vacuum being left by the departing British troops. In other words, the withdrawal of external security guarantees played an important role in influencing the Singapore government to invest in a local defence industry. It is these 'political environmental' factors that are stressed by Sir Laurence Harnett, the consultant to the Singapore government for the establishment of the first two locally owned defence industries. The 'political urgency' was made imperative because 'the Republic was standing alone, having withdrawn from the Malaysian union not long previously'. Also, 'the departing British had left behind little more than a couple of thousand outdated small arms and some engineering equipment... To make matters worse, Singapore was still facing the hostility of Indonesia'.⁵

The generally unstable political environment of Southeast Asia, often called a 'political and military cockpit', also influenced the leadership to develop a viable defence capability in the quickest possible time. That this fact of constant and total vulnerability has not changed was clearly alluded to by Prime Minister Lee Kuan Yew in his 1988 National Day Rally speech, when he warned: 'Remember, this is Southeast Asia and storm clouds can gather quickly. So, please have an umbrella ready'.⁶ The rivalries, interference and intervention of Great Powers (then involved in the Indochina War in Southeast Asia) warned and reminded the Singapore leadership that a weak city-state, especially in a hostile 'Malay Sea', could be easily manipulated and destabilised by Great Powers, especially if it had no defence capability of its own. Singapore, being strategically located astride sea lanes of the region, was exceptionally sensitive to the need to avoid Great Powers' interference. However, the phenomenal cost of maintaining a full-time standing army and the manpower shortage of the Republic - labour was also required for the civilian economy - forced the leadership to opt for a National Conscript Citizens' Army; through it, the Republic hoped to achieve its goal of political survival through the

5 Cited in Sir Laurence Harnett, 'Operation Doberman', p.10.

6 See *The Straits Times*, 15 August 1988.

strategy of deterrence.⁷ In this regard, the defence industries were seen as necessary to support the country's defence effort. The facts that the conscript army had to be serviced and that defence weapons and services are sensitive and closely guarded national secrets made it only natural to develop government-owned defence establishments.

The non-aligned orientation of the PAP leadership after independence in 1965 was also instrumental in the decision to develop a rudimentary defence capability, at least, to sustain the basic needs of the Singapore Armed Forces (SAF). As in most Third World states, the political leadership was sensitive to and jealously guarded its newly gained political independence and did not want to be dictated to, or be seen to be dictated to, by Western or Eastern bloc arms suppliers. In other words, it was partly to safeguard its political independence and avoid political strings which might be attached to weapon purchases that a local arms industry was initiated. It was aimed at minimising interference in the internal affairs of the Republic by foreign big business, either defence companies or other high-technology-based corporations. At the same time, the leadership did not want to be beholden to any one supplier, especially from among the Great Powers, or get its newly recognised non-aligned status tarnished by dependence on a single Western or Eastern supplier. Sir Laurence Hartnett alluded to this when he argued that

from the start the Singapore leaders were determined to avoid political alignment with foreign nations, and this was particularly true in the matter of arms supply from abroad which might have political strings attached. Implicit in this approach was the heavy emphasis placed on self-reliance, a policy which has paid enormous dividends.

That Singapore is a small city-state also played a part in the establishment of a defence industrial infrastructure. It has been argued that, for small countries, the development of an integrated and credible defence industrial base is part of an attempt to be accepted as an equal, especially by larger neighbours. In this context, the SDI can be seen as a strategy adopted by the Singapore government to equalise its power

⁷ See Bernard Chen, 'The Singapore Armed Forces'.

⁸ Sir Laurence Hartnett, 'Operation Doberman', p.11.

and overcome its 'midget psychosis' with regards to its difficult Malay neighbours. At the same time, how a country's political leadership views the role of the defence industries is critical for the establishment of such industries. They can be viewed as political industries, to buttress the power and image of the political regime. That it requires strong political will to see through the development of defence industries makes this political factor all the more determinant.

Finally, the political leadership must also have calculated that it would reap long-term political benefits by having a homegrown defence industry as this would not only enhance its independence but, more importantly, could augment its national power and, in times of crisis, might strengthen its bargaining power. In short, it would symbolise real political independence as well as the confidence of the leadership and people, even though Singapore was only a small and vulnerable island-city state.

Military

The need to satisfy military-related requirements of the Republic can be posited as one of the more important motivating factors for the establishment of the local defence industry. Even though the Ministry of Finance owns the SDI, MINDEF provides the policy inputs for the defence industries. This is mainly because the object of the SDI is to enhance the defence capability of the country and make it credible by meeting its operational needs in peacetime and in crisis.⁹ SDI is to acquire the relevant technologies for the defence forces; to respond to specific defence needs of the Republic; to achieve local maintenance capability for all the arms of the country's defence; to tailor to local needs (for instance, the development of the Singapore Fragmentation Grenade I, which could fit with a smaller Asian frame); to be in a position to provide all or most of the essential war materials; to develop and improve on weapon systems to enhance the national defence capability: here, an important function is to extend the life-span of military equipment, which could not only save cost but upgrade the performance of the weapon system at the same time; to

⁹ See Lim Hock Gin, 'The Defence Industries', *The Pointer*, Vol.11, No.1, October-December 1984, p.4.

achieve self-sufficiency in basic defence needs in order to avoid dependence for critical combat and service needs on foreign sources; to adapt the military hardware to changing threat scenarios. In the long run, it is to create a capability to support the SAF in time of hostilities and to ensure continuous supply of critical materials. In addition to maintaining a constant state of operational preparedness for all the armed services, it would also, during peacetime, provide the necessary skills for upgrading and modernising existing equipment to meet potential threats. According to a staff member from the Defence Materiel Organisation, MINDEF, Lim Hock Gin, a local defence industry would also perform three additional military roles:

1. form part of the SAF supply system in time of hostility;
2. enable a minimum stock of ammunition to be kept during peacetime and reduce the maintenance effort and cost required for such a stockpile; and
3. provide the 'warning period' to meet the anticipated threat.¹⁰

The military significance of the SDI can therefore not be underestimated. This is all the more so when one realises that the concept of deterrence lies at the heart of Singapore's strategic thinking. The state being small and vulnerable, with a dominant ethnic Chinese composition in a 'Malay Sea', Singapore's deterrent policy is calculated at inducing adversaries to refrain from undertaking actions which Singapore regards as undesirable by threatening penalties for non-compliance. In this regard, Singapore adopted the Israeli model of deterrence: this was partly influenced by the belief that Singapore and Israel share certain broad similarities. Both are surrounded by proportionately large Islamic neighbours, both are small in terms of land area and population, and both are confronted with the problem of political, military and economic survival. It was in this regard that Singapore undertook a massive programme of defence build-up in order to become a 'poisonous shrimp'; namely, to be in a position to punish an adversary and therefore make an attack on Singapore costly and unattractive. This led to adoption of an Israeli-style conscript army backed with well-trained reservists; focus on combined-arms

¹⁰ *Ibid.*

training doctrine; investment in early-warning and intelligence-gathering structures to gather and process information quickly; emphasis on forward strategy and mobility; emphasis on air and armoured power; development of a unified central command system with a single Chief-of-Staff commanding all the military units; continued outlay on defence; emphasis on Total Defence and, finally, investment in friendly alliances. Israel has also developed military industries with the aim of maximising self-reliance and self-sufficiency in basic weaponry and ammunitions. In the same vein, the establishment of Singapore should be seen as part of the country's defence strategy and an important part of its military defence. A well-developed defence industrialised structure would make its deterrent posture all the more credible and may prove to be critical, especially if embargoes are envisaged.

Economic

In view of the political-military exigencies which confronted the Republic after independence in 1965, it is obvious that economic viability and profit orientation were not uppermost in the minds of the political leadership in establishing the defence industries.¹¹ Dr Goh Keng Swee, the Defence Minister, who was principally instrumental in establishing the defence industries in Singapore and can therefore be regarded as the 'father of SDI', first raised the idea of a domestic arms industry in 1966.¹² Despite serious climatic problems caused by humidity and lightning, as well as the lack of an appropriate supporting industrial base, Dr Goh, against the advice of Sir Laurence Hartnett, the consultant employed to advise the government on SDI matters, determinedly pushed for the local defence industry in order to supply the internal needs of the SAF;¹³ the rationale being, 'it was strategically and militarily a necessity'.¹⁴ Initially, Dr Goh was not keen on the industry being export-oriented, fearing this might antagonise Singapore's neighbours, who might accuse the Republic of

11 This was confirmed by the writer's interview with a senior official from the SDI.

12 *Ibid.* See also Sir Laurence Hartnett, 'Operation Doberman'.

13 Interview with a senior official from the SDI.

14 *Ibid.*

following the footsteps of Israel. Equally important was the general lack of confidence on the part of the leadership in Singapore's ability to produce defence products and services that could meet the high international standards.

Over time, however, the huge expenditure that was initially incurred to establish a viable defence capability for land, air and naval forces was a heavy drain on the country's limited resources. For instance, between 1968 and 1989, defence expenditure has varied between a quarter to a third of government expenditure.¹⁵ For the fiscal year 1989-1990, the defence budget of Singapore amounted to S\$2,915.7 million, forming twenty-three per cent of total government spending for the year.¹⁶ As defence capability improved, it was painfully clear that the import of high-value-added weapons and ammunitions was a heavy burden on the foreign exchange of the country and ways had to be found to reduce or halt the hard currency outflow. This goal was partly achieved by the expansion and diversification of the SDI. With the establishment of a sophisticated defence industry, there was always the hope that it could assist in the industrialisation and economic growth of the country through the application of advanced technology. In other words, defence industrialisation could have spill-over effects on the civilian economy. In this regard, the rationalisation of the SDI in 1982 and 1989 was mainly aimed, through the pooling of its research and development resources, at spearheading the high-technology movement in the country. In the words of the promotion brochure *Singapore Technologies*, the rationale behind the globalisation exercise is obvious: 'as a clearly defined corporate identity becomes an essential element in the establishment of a firm position in the international market place'.¹⁷ In the words of the then Minister of State (Defence), presently the Second Defence Minister, Dr Yeo Ning Hong,

¹⁵See Chin Kin Wah, 'Singapore: Threat Perception and Defence Spending in a City-State', in Chin Kin Wah (ed.), *Defence Spending in Southeast Asia*, (Singapore: Institute of Southeast Asian Studies, 1987), pp.203-212.

¹⁶ Cited in *The Straits Times*, 16 March 1989.

¹⁷ Cites in *Singapore Technologies*, n.p.

MINDEF's role in Singapore is obvious to all Singaporeans - to look after the interests of Singapore, to ensure peace and security and hence contribute to the prosperity of our island Republic and to enable a high standard of living and a better quality of life for all citizens.¹⁸

The latter objectives can be achieved in part through a technological revolution, hopefully with spin-offs from the defence industries.

At the same time, the small market in the Republic could not justify the huge investments and production of defence materials, and it was in the late 1970s that a serious decision was taken to enter the international arms market with profit as an important motive and goal. This was principally because the basic needs of the armed forces in the country had been met and the excess capacity had to be put to better use. For example, M-16 rifles produced at the CIS were not allowed to be sold to third parties by the United States-owned Colt Industries. By the late 1970s, the Republic's defence industries, especially the unit at CIS, succeeded in acquiring enough relevant technological skills to produce a new assault rifle and a light machine-gun which were both cheaper and more reliable. The result of this success was the production of the SAR-80 and the Ultimax-100, which placed Singapore on the world's arms market and led to the high-profile posture of the SDI.

The establishment of Unicorn International in 1978 as the marketing arm of the SDI manifested the Singaporean interest in joining the ranks of arms suppliers. This is not to say that Singapore had not been exporting its defence products earlier; rather, what is meant here is that large scale production for export only commenced in the early 1980s. In other words, an arms export policy had been synchronised by this time. According to Sir Laurence Hartnett, within a short space of time 'Singapore was producing far more 5.56 mm high velocity ammunition than it needed, leaving considerable volume for export to approved countries'.¹⁹ According to a senior defence industry official from the CIS, the first export of ammunition took

¹⁸ *Singapore Monitor*, (Singapore), 15 June 1983.

¹⁹ Sir Lawrence Hartnett, 'Operation Doberman', p.12.

place between 1969 and 1970.²⁰ In his article on the SDI, Sir Laurence Hartnett has also quoted an Australian Major-General who highly praised the quality of the Singapore-produced ammunition in the following terms:

God bless Singapore. If it hadn't been for the five million rounds of 5.56 mm ammunition supplied by Singapore to the Australian troops in Vietnam, they would have been in a very bad way. Moreover, the ammunition was of excellent quality and was almost the envy of the Americans. Not a single faulty round was ever revealed.²¹

For a small country like Singapore, and one which had just began defence production a few years earlier, this was indeed a great compliment and recognition of its defence industry.

While the government has so far been reticent about its export policies (namely, about its customers and the export value and volume), the reorganisation of the defence industry in 1982 and 1989 was a clear indication of the profit motive becoming an important factor for the SDI. The heavy investment in the SDI and the fact of its having met the major SAF needs led to a clear orientation towards exports. Belatedly, too, the SDI was gradually diversifying into civilian industry. This was best manifested in the aerospace industry, as well as in the establishment of Singapore Technologies Industrial in 1989. This, however, is not in the least to say that the principal political-strategic motivations have been lost. Only that, having achieved a respectable domestic capability to meet national needs, it is only logical that excess production should be exported to earn foreign exchange.

There were also other motivations to keep the production lines running in peacetime. With production continuing at the present rate, defence materials will be at hand as and when needed. It also means retaining highly skilled manpower and permits the SDI to keep in touch with suppliers of raw materials, as well as keep up with new technologies. This means the continuous upgrading and build-up of

²⁰ Interview with a senior official from the SDI.

²¹ Sir Laurence Hartnett, 'Operation Doberman', p.11.

the national defence production capability (and, in case of emergency or crisis, the capability and skills can be put to good use) rather than depending on foreign sources which may not be made available when needed.

As far as weapons exports are concerned, the need to break into the competitive international arms market has called for the production of cheaper and better weapons. This could be seen in the introduction of the SAR-80 assault rifle, the Ultimax-100 light machine gun, high-performance General Purpose Machine Gun, a 60 mm commando mortar, a pod containing two machine guns developed for the air force and the FH-88 155 mm howitzer. In an interview in February-March 1983, Mr Lai Chun Loong, the General Manager of CIS, said that 'the only restriction we have is that all orders go through the Ministry of Defence (which must approve buyers)...we only sell our arms and guns to friendly countries. We do not deal with communist countries, for example'.²² Singapore also does not sell to countries which are under United Nations embargo. In 1983, Mr Lai maintained that the sales position of the SDI was 60 per cent for local needs of MINDEF and 40 per cent for non-MINDEF needs and exports. The final goal was to produce a 50-50 per cent split.²³

It is therefore clear that, over the years, the continuation of political, military and economic objectives have shaped the directions and philosophy of the SDI. The corporate ideology of the SDI, as explained to the author by a senior defence industry official, clearly laid down the philosophy of the government with regard to the defence industries supporting the defence of the country as its primary and foremost goal, with MINDEF determining the direction of the defence industries. Most importantly of all, the SDI has come to be seen as 'an essential element in the Total Defence of Singapore'.²⁴ Hence, while commercialisation is to be encouraged, mainly to maintain the SDI's efficiency and also to profit from the massive infrastructure and investment, the bottom line is that the defence industries must be in a position to meet the needs of the country's defence as and when required. In other words, in addition to the SAF,

22 Cited in Gregory Copley's interview with Lai Chun Loong, *Defence and Foreign Affairs*, January-February 1983, p.25.

23 *Ibid.*

24 Interview with a senior official from the SDI.

RSAF, RSN and Civil Defence, the SDI can be seen as the fifth arm of total defence. The other four arms' performance and morale would be affected by the ability and capacity of the SDI. In a nutshell, over the years the role and function of the SDI have become critical for the country's defence capability.

CHAPTER FOUR

DECISION MAKING IN THE SINGAPORE DEFENCE INDUSTRIES

Reaching definitive conclusions about how decisions are made in the defence industry of any country is a difficult and hazardous exercise. To a large degree, it depends on the system of government and nature of policy making in a particular country. This is very much true in the case of Singapore.

Here, just as in most aspects of public life, it is clear that the apex of power provides the central direction for the defence ministry. In Singapore, this apex has been held by Prime Minister Lee Kuan Yew and shared with a few other individuals in some areas. As long as Dr Goh Keng Swee was the Defence Minister, the fate of the defence ministry and the defence industries was in his hands. He was closely and keenly involved with starting the defence industries and took a personal interest in testing and 'dirtying his hands' with the products of the SDI. At the same time, he was able to convince the Cabinet of its necessity and, being a strong-willed personality, usually had his way on matters related to the country's defence. It is less clear how decisions pertaining to the defence industries are made since the departure of Dr Goh, but one can conclude with a fair degree of confidence that it is still largely a top-down process. This was clearly alluded to by Mr Lai Chun Loong in an interview in 1985. He described the CIS's relations with MINDEF in the following terms:

The Company [STC] is under the supervision of the Ministry of Defence. The Ministry appoints a Board of Directors to establish the policy and guidelines for the Company. In this way, the Government does not interfere with the day-to-day affairs of the Company.¹

In the present reorganised structure of the SDI, this means that the Ministry of Finance is formally in control of Sheng-Li Holding Company, but in reality it is the Ministry of Defence which guides the actual direction and operations of the SDI. This has been officially

¹ Cited in 'Supply the Forces: Singapore Technology Corporation', *Military Technology*, No.4, 1985, p.4.

acknowledged in the Ministry of Communications and Information publication *Singapore: Facts and Pictures 1987*, where it was clearly stated that the 'Ministry of Defence is responsible for ... the management of Government-owned defence companies.'² While SDI is directly under the Minister for Defence, Mr Goh Chok Tong, the actual person responsible for the policies of the SDI appears to be the Second Minister for Defence (Services), Brigadier-General Lee Hsien Loong. Brigadier-General Lee's involvement and prominence in the defence industries is clearly manifested publicly in his role as the key spokesperson on matters relating to the SDI. Hence, as a Guest-of-Honour at the Defence Technology Training Award Presentation Ceremony on 2 April 1988, Brigadier-General Lee made known the government's rationale for the establishment of the defence industries:

If the SAF is to fulfil its mission, it cannot only buy expensive equipment. It must put together weapon systems well adapted to SAF use, suited to our soldiers, and to our operating environment. We need defence engineers to understand our operational requirements, to work out solutions. The best solution is sometimes to develop a new weapon ourselves - e.g. the FH-88. Often, we do better by adapting and customising off-the-shelf hardware - e.g. F-16s; or upgrading an old equipment to fulfil a new role, e.g. A-4S1/F404. Choosing which path to take is a major decision. Whether we develop, buy or modify, we still need a strong technological team to manage the project and make sure that we get value for money.

Furthermore, the SAF cannot look at individual purchases in isolation. It has to combine different weapon systems into one integrated whole ... Then only will we get full value out of the aircraft or computers which we buy. This system integration can only be done by MINDEF itself, and cannot be bought off the shelf. That means our Defence Technology

² See *Singapore: Facts and Pictures 1987*, (Singapore: Ministry of Communications and Information, 1987), p.22.

Group (DTG) engineers, working together with the SAF.³

Brigadier-General Lee also commissioned the FH-88 155 mm gun, on 23 November 1988 at the 23rd Battalion of the Singapore Artillery, where he was once the Commanding Officer. Here, he once again stressed the need to build up a local arms industry wherever it was necessary and possible:

Because the SAF is so small, it is out of the question for us to develop all our armaments ourselves. We must buy most of our weapons from others, and we must buy⁷ intelligently, so that we get what we need for our purposes and not just what is most expensive and eye-catching.

At the same time the Second Minister for Defence made it clear that it was not an easy matter to make decisions on arms production locally, with specific reference to the FH-88:

The decision to develop our own 155 mm gun was a bold one and not without risk ... MINDEF weighed the odds, decided to accept the risks and went ahead. The result is a weapon we can all be proud of.⁴

In the same manner, Brigadier-General Lee made a key policy speech supporting the upgrading programme of the RSAF when he inaugurated the 143rd 'Phoenix Squadron', the first to receive twenty-one of the re-engined A-4s, dubbed the Super Skyhawks, on 1 March 1989. In his speech he again made it clear that the decision to upgrade was made by MINDEF, and here the defence planners had two options: either phase out the Skyhawks or modernise them and use them for another 15 years. According to Brigadier-General Lee, 'the RSAF could not wish away the A-4 fleet. Buying a whole new fleet of aircraft overnight was out of question. It was not only exorbitantly expensive, but also politically insensitive'. MINDEF decided on upgrading even though it was not by any means cheap.

³ Cited in *Defence News Supplement*, (Singapore: Ministry of Defence, 1988), Issue No.6/88, 070488.

⁴ *The Straits Times*, 24 November 1988.

Within a year of this decision, we had a spate of accidents involving the older A-4s. The difficulties we experienced tracking down the faults confirmed the correctness of our decision to upgrade the engine. Although we eventually overcame the problems, it became quite clear that the remedies we had taken to solve the difficulties were temporary fixes. The long term solution was the new F-404 engine, which would be more reliable and easier to maintain.

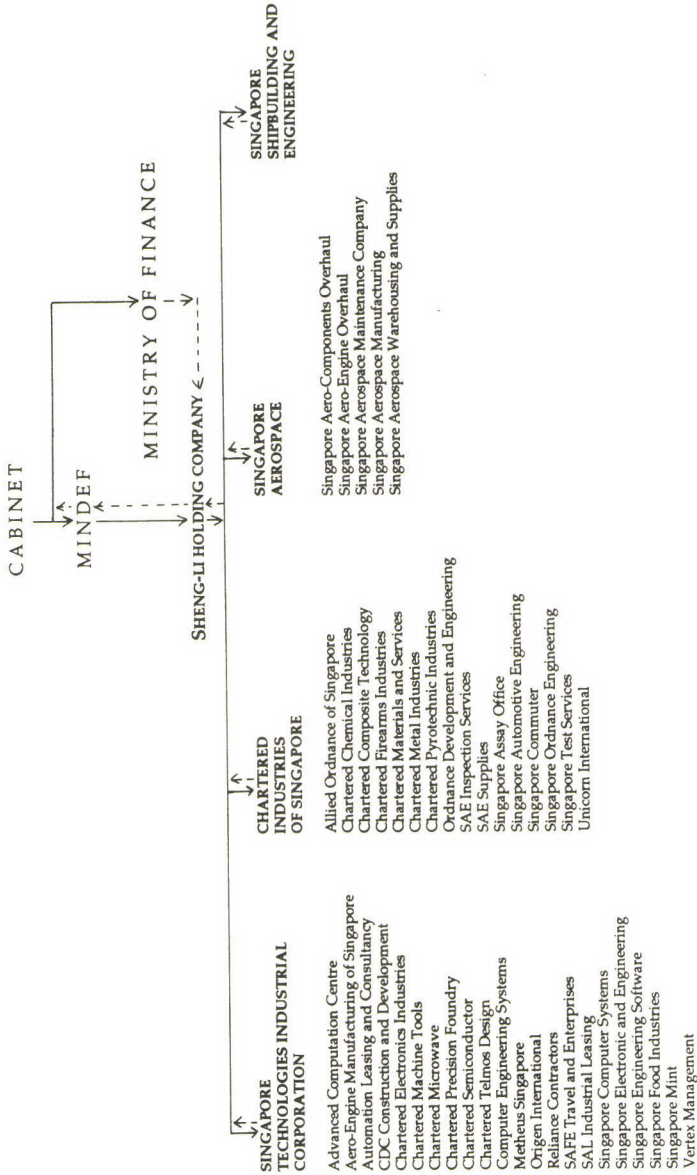
The upgraded Super Skyhawks are not only more fuel efficient, more powerful and can carry heavier payloads, but are lighter, have a 30 per cent increase in thrust and a better rate of climb.⁵ Confirming the belief that Brigadier-General Lee is the key personality behind the SDI, he also opened the DSO building on 27 October 1989 and for the first time publicly showered praise on the role of the 'invisible hand' behind the success of the SDI, making a 'significant contribution to the SAF's operational capabilities'.⁶

It is therefore amply clear that key policy inputs as far as the SDI is concerned emanate from MINDEF, with Brigadier-General Lee playing a pivotal role since 1987. The role of the SDI is to support the Ministry of Defence, its policies and its strategies. On any key decision, the flow of policy inputs is from the top downwards. While key decisions are made in MINDEF, for efficiency and economy the day-to-day operations of the SDI are left to the individual companies, which must strive economically and technologically to survive. While effective control is exercised from MINDEF on key policies, at the same time there is much leeway on how a particular company attempts to achieve the goals that are set for it. Here, the role of individual personalities comes into play. The more established companies, such as CIS and ODE under the previous structure of STC, tended to exercise this leeway to a greater degree than any other defence companies. This was well reflected by the fact that the CIS, after failing to convince MINDEF of the economies of the SAR-80 Assault Rifle, was able to produce it successfully and it was only much later that MINDEF adopted the weapon, though not on a large scale. This was the main reason why the Ultimax-100, a MINDEF-initiated

5 *Ibid.*, 2 March 1989.

6 Cited in *The Straits Times*, 28 October 1989.

FIGURE 10
DECISION MAKING IN THE SDI



Key: ——— Dominant policy inputs
 - - - - Secondary policy inputs

Source: Compiled by the author.

project, was viewed as a much more successful indigenously produced weapon than the SAR-80.

Irrespective of this aberration, in the main the dominant policy inputs come from MINDEF to Sheng-Li Holding, and are then transmitted to the appropriate defence companies for implementation (see Figure 10). At the same time, there are secondary policy inputs which usually come from the different defence companies, and these are usually sent up for approval and then implemented on the basis of the decision from MINDEF. What Figure 10 demonstrates is that the SDI is, relatively speaking, a tightly controlled and organised bureaucratic structure which is able to respond to the needs of MINDEF as and when required. This also means that while MINDEF can claim credit for many of the successful policies, it must ultimately also reap the blame for any major failures. That the SDI is largely a 'closed company' makes assessment of its successes and failures difficult.

CHAPTER FIVE

IMPACT OF THE SINGAPORE DEFENCE INDUSTRIES

After more than twenty years, the SDI has attained a respectable level of capability to meet the Republic's defence needs. The combined capacity of the STIC, CIS and SSE is able to produce the basic weapons and ammunition needs of the SAF, RSAF and RSN. In a way, the Republic has attained a certain level of self-sufficiency, especially in meeting its peacetime needs. It should, however, be stressed that complete self-sufficiency is not an immediate or medium-term goal because of its grossly uneconomic nature. For instance, the Defence Minister and First Deputy Prime Minister, Mr Goh Chok Tong, answered an inquiry about the Republic attaining self-sufficiency in arms production as follows:

... we can, but we have to be very practical about the whole matter. We cannot be producing missiles and airplanes and so on. Where is our capability? Where are our manpower resources? Even though we can do this because of our technical ability, is the cost worth it? There is a cost of producing for the service, and a very small market. So the cost of production will be very high and you have to weigh that cost against the possibility of not being able to procure the equipment when you need it. Singapore is not Israel anyway. I think we have a more open policy and we have more friends around the world.¹

Arguing along the same lines, in November 1988 Brigadier-General Lee maintained that 'because the SAF is so small, it is out of the question for us to develop all our armaments ourselves'.²

To date, the SDI has performed a valuable role in meeting the SAF's immediate needs and in case of crisis, when supplies can be cut off or delayed - especially if a state is dependent on foreign suppliers - the Republic's defence forces can rest assured of a basic supply of

1 Quoted in *The Pointer*, Vol.11, No.1, October-December 1984, p.10.

2 *The Straits Times*, 24 November 1988.

small and medium weapons and ammunitions. Its net result has been to build up the country's defence capability and confidence, and it therefore forms an important component of the Republic's concept of total defence, especially in sustaining the military component of total defence. The efficiently managed defence industry is also able to meet MINDEF's short and long-term needs, and change and adjust its production lines according to changing threat scenarios and environment, perceptions and evaluations.

While the economic goal was not immediate or primary in establishing the defence industries in Singapore, economic implications have been paramount. First, SDI has provided direct employment to more than 11,000 people, and its multiplier effect in this arena should not be underestimated. That the employment is for highly skilled, specialised and professional workers makes this contribution all the more significant. Second, the defence industries form the backbone of Singapore based and owned technology-oriented industries. While there are many other high-technology-based industries, the majority of them are owned by multinational corporations or foreign-owned. At the same time, while there are many locally owned industries, most of them can be classified as manufacturing and electronics in character. Only the SDI group of industries can be identified as high-technology based and oriented industries, and that they are government-owned means that they can be activated to perform tasks or operations in accordance with national needs. In this connection, the defence industries perform the very critical role of grooming engineering and technological skills for the country, which in itself is an important national resource and asset, especially for a small city-state devoid of natural resources.

Also, SDI's spin-off effects are considerable. First, is the import of high technologies into the Republic. The great success of STIC, CIS and SSE in undertaking high-level maintenance work on sophisticated weapon systems is an important yardstick by which to measure this success. Next, the industry's ability to bring out indigenously designed production which is highly competitive internationally shows the high level of achievement in this area. Here, the Republic is not just an importer of technology but has become an innovator. This is clearly shown by SA's quality control approval by the RSAF, United States Navy, CAA Singapore, GAC Indonesia, Malaysia DCA, Brunei DCA and the Philippines BAT. At the same

time, the spin-off of the arms technology into the civilian area is important. That there was a need to establish the Singapore Technologies Industrial wing under the new rationalised structure of the SDI is an indication of this. While Singapore is an important industrial centre in Southeast Asia, its growing ascendancy in the high-technology area has been given a great boost and is often spearheaded by the STIC, CIS and SSE, which are primary utilisers, either as importers or exporters, of modern high-technology-based products. Also, their impact on the civilian economy is important. Their role can be seen directly in the defence industry's production of high-technology-based non-military products, either by its own subsidiaries or sub-contracted out. In other words, the SDI has acted as a catalyst for the growth of the civilian sector.

In addition to providing employment and being the base of high-technology-based industries in Singapore, the defence industries have saved the country valuable foreign exchange by their ability to meet a large proportion of its basic defence needs. While the defence budget is still very high, it would have been very much higher had it not been for the SDI, which has helped to meet some of the basic needs of MINDEF more economically. Not only that. Its growing role as an exporter of defence materials and services has earned the country valuable foreign exchange. In fact, the rapid expansion and growth of the various defence companies is largely due to the success of the various defence companies in becoming self-financing: expansion has taken place with profits from the initial capital being ploughed back into the industry. As a rule, the defence companies which started with initial capital from the government do not depend on government subsidy for survival and expansion. In this way, the defence industries have been able to contribute economically to the country and yet have the capability and capacity to perform their main role; that is, to militarily back up the country's defence capability as and when called upon. This contrasts sharply with many defence industries in the Third World, which survive mainly on government subsidy and protection.

While the political cost-benefits are difficult to quantify, that they are there cannot be denied. First, politically, it must be satisfying for the leadership to know that the country has developed a highly successful locally based defence industry without harming other sectors of the economy. That the defence industry is highly successful

can be gleaned from what the international press - specialised or general - say about the SDI. People have come to know about the SDI and its highly competitive and reliable products. That the United States Navy elite commando force, the Seals, have opted to use the Ultimex Light Machine Gun produced in Singapore speaks well of the achievements in the area of arms production.³ As a small supplier, Singapore is a worthy competitor, and for this to be achieved within twenty years is indeed a remarkable achievement. Also notable is the fact that the defence industries have developed without unduly complicating relations with the country's touchy neighbour. Politically, it is also comforting and satisfying to know that in the area of basic armaments, especially small- and medium-calibre weapons and ammunitions, Singapore has achieved a basic degree of self-sufficiency. Not only does this reduce dependency, but in time of crisis the government will be confident of the availability of the necessary equipments. It is also part of the national asset and hence provides bargaining power with regard to foreign countries, especially in times of hostilities. This must also have enhanced the country's prestige and can be regarded as one of its many laudable achievements. While Singapore is certainly not in the big league of arms producers, it is apparent that it has fast joined the second division of the world arms manufacturers. For a small, vulnerable, resourceless city-state, this is no mean feat. In the words of Sir Laurence Hartnett:

... the Republic of Singapore has done an amazingly good job in developing the capacity to make a full and adequate supply of small arms, anti-aircraft and other artillery ammunition, and a considerable range of weapons, largely within its own control. The Republic is not obligated to foreign countries, it has benefited financially, and in the case of war, knows that it has its own production capacity for essential arms and ammunition.⁴

Hence, one can detect many favourable consequences for the small Republic brought about by the establishment of defence industries.

³ Reported in *The Straits Times*, 25 October 1989.

⁴ Sir Laurence Hartnett, 'Operation Doberman', p.32.

CHAPTER SIX

LIMITS CONFRONTING THE SINGAPORE DEFENCE INDUSTRIES

To date, Singapore's emphasis on the production of weapons and ammunitions domestically has not been disastrous or produced negative consequences, either in the economic or political arenas. There have been no major setbacks or political problems with neighbours or third parties, except for the Swedish government's decision to place an embargo on the sale of arms to Singapore in April 1987 following the discovery of arms diversion to the Middle East of weapons destined for Singapore. This, however, had nothing to do with the SDI or the Singapore government's arms export policies *per se* except that the culprit, the then General Manager of AOS, was involved in corrupt dealings and that the AOS was 60 per cent owned by Sheng-Li Holding. A major reason for the relative absence of controversy as far as the SDI is concerned is MINDEF's policies: just as in Sweden, Singapore's weapons production has been guided by what Ingemar Dorfer calls 'suboptimization'; that is, using known technologies and design principles and refusing to make a product in advance of anyone else.¹ This, more than anything else, has so far prevented the production of 'failure products'. At the same time, it also means that the SDI is less adventurous and ambitious. The relatively tight control exercised by MINDEF over the defence industries has given them a sense of direction and a degree of flexibility in line with what the MINDEF planners would consider to be the new directions in the international arms trade.

For a small country with limited and scarce resources, the main concern in the long run is to make the defence industry viable. The SDI has to grapple with many problems and limitations. In the first place, MINDEF and the SAF are not obliged to purchase exclusively from the local defence industries but, rather, the SDI has to competitively tender for MINDEF contracts on par with other commercial arms producers. For example, the SAR-80 was principally a CIS initiative in anticipation of MINDEF operational requirements.

¹ Ingemar Dorfer, *System 37 Viggen*, (Oslo: Universitetsforlaget, 1973), p.18.

The fact that the SAF has not adopted the weapon on a large scale makes it difficult to sell the rifle in the international market. This is because the main question a potential customer would ask is, why has not the Singapore government or MINDEF adopted the weapon? No matter what the explanation, the fact that the weapon is not adopted locally will make it very difficult to sell as there would always be lingering doubts about its reliability in combat situations. For a local defence industry to be successful and relevant it must work closely with MINDEF; that to a large degree ensures its usefulness and importance in the country's defence strategy. In the Singapore context, the SDI has no choice but to work with MINDEF: if MINDEF were to fail in any way, that would sound the deathknell of the SDI.

From a longer term perspective, the SDI can be said to have just passed the first phase of defence industrialisation and be quickly moving into the next, intermediate stage. While the initiation phase is easy to undertake and justify, either in terms of security, autonomy, protection against embargoes, foreign exchange generation, technological spin-offs and even psychological-prestige considerations, difficulties will ultimately arise leading to questioning of the entire rationale of defence industrialisation at the middle phase. More often than not, it is the economics of the entire defence industrialisation, and its negative consequences for the other sectors of the economy or country, that causes the need for a country's domestic arms production to be called into question.

If defence industries hide behind the emblem of national security, being regarded as 'sacred cows' even if badly managed, the macro-economy of a country might become undermined. This can lead to waste and inefficiencies, with the economy being artificially overheated. If a country attempts to achieve self-sufficiency in arms production at all costs, the country might increase its dependence on foreign credits or, worse still, even increase its foreign debt. If disastrously managed, the correlation between defence industrialisation and economic growth might result in negative consequences, with the emphasis on 'guns' taking precedence over 'butter'. A lesson worth bearing in mind is that once a Third World country, such as Singapore, achieves self-sufficiency in conventional weapons and ammunitions, there is usually the problem of capacity utilisation. How to utilise and sustain the excess capacity without harming the domestic economy and arms industry and without

complicating relations with the suppliers of technology becomes the principal concern and, if this is undiplomatically managed, new types of problems that could undermine a country's arms industry might result.

This is principally because it is easier to initiate a defence industry than to sustain it. While it is easy to receive external support to undertake defence industrialisation for self-sufficiency and domestic use, it is altogether another proposition to seek assistance in order to export and ultimately compete with the supplier of arms technology in what is already a very crowded international arms market. This is mainly due to the new kind of dependence that results from defence industrialisation by small countries such as Singapore. While Singapore can acquire the relevant know-how to produce weapons and ammunitions, as far as technologies and components are concerned Singapore is still very much dependent on foreign suppliers. In short, there is a new kind of dependency, one based on technology and spare parts, and this is often the new 'colonialism' by which the advanced countries attempt to influence countries such as Singapore in the Third World. For instance, the United States, with which Singapore has close defence relations and many licensing agreements, has two Acts, the United States Arms Exports Control Act and the International Traffic in Arms Regulations, which have placed brakes on the sales of weapons and ammunitions that are produced with American assistance. It was by the application of these Acts to the Singapore case that in the 1970s the Republic was forbidden to export its excess M-16s, produced by the CIS under licence from Colt Industries.

In view of the new types of problems which usually emerge with the successful crossing of the first bridge in defence industrialisation, the question which a Third World country such as Singapore must ultimately ask is, for what purpose is arms production being undertaken? Is it solely to satisfy domestic needs or is it for the international market? If it is for the extra-national market, then problems relating to third-country sales must be taken into account and ways of succeeding in encounters with suppliers of technologies and components given topmost priority. If this is not done, defence industrialisation and the country's exports might entangle a country like Singapore in new types of foreign policy problems with the advanced countries - countries which are also the close economic

partners of Singapore and its close political friends. Being a small state with limited resources and being only a very marginal arms producer in the world, there is indeed a very low margin for error. At the same time, the arms export business is a high-risk undertaking which, in the words of Aaron Klieman, operates on the principles of 'high competition and low ethics'.² In view of this, and at a time when protectionism and fair (rather than free) trade are the dominant winds blowing from the United States and the European Economic Community, it would be extremely difficult and hazardous for Singapore (which has received American assistance especially) to export its defence products in competition with American arms companies. The alternative would be to produce the weapons and related products indigenously, but the limited research and development commitment, even in a high-technology country like Singapore, makes this possibility more apparent than real. To these problems can be added the perennial dilemmas of apportioning the use of scarce resources; the conflict between 'technology at all costs' and cost factors; the need to continue importing raw materials and skills to keep the defence industries functioning; and the possibility of changing national priorities. All could pose new threats to the national defence industries.

While Singapore has not so far been compromised by any adverse publicity about its arms exports and it is a business where morality is never a primary consideration, a country's arms exports policies can affect its reputation and ultimately its destiny. In a game where astute salesmanship and discretion is critical, the SDI has been fortunate in that the local or international media have not found it wanting. If anything, the SDI has come up stronger and with a positive image. There is, however, always the factor of uncertainty which clouds the future of any country's arms industry; more so, if it is a small and vulnerable country. The steep competition, the fluctuating market, the unreliability of customers and the sensitive nature of the trade means that a country must always guard against unexpected bad times. Ultimately, the decision to engage in the arms trade is a political act which will have wide-ranging political, economic and military implications. How a country manages its arms diplomacy is

² Aaron S. Klieman, *Israel's Global Reach: Arms Sales As Diplomacy*, (Washington: Pergamon Press, 1985), p.198.

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therefore critical for the survival of that country's defence industries. Being small and only a marginal actor in the arms trade more often than not, the SDI (just as the Republic) is at the mercy of changing demands and technologies, and its survival will to a large degree be determined by its ability to keep up with change. The limits confronting the SDI can in part be overcome if the newly reorganised defence industry is able to live up to its stated goal: 'To expand and grow into a major international group ... [Be] at the leading edge of the industries we are involved in'.³

³ Cited in *Your Guide to the New Corporate Identity*, n.p.

CHAPTER SEVEN

FUTURE PROSPECTS

Answering the question of what its future direction would be, *Singapore Technologies* stated:

At Singapore Technologies, we believe the perceptive management of new and evolving technologies is our best opportunity to enhance our competitive edge. An advantage based on the skills of our people, the resources of our business sectors and a shared commitment to meet the challenges of tomorrow.¹

Ambiguous as it is, this does not point to future directions except possibly the need to adopt and adapt to new technologies. For an industry based on modern technology, this may have answered the question far more deeply than might appear at first glance. This is because, for a small country like Singapore, the strides it has made in defence industrialisation have been very impressive by all counts. Having succeeded in building the infrastructure and then 'taken off' in the ordnance, aerospace and marine industries, and having build up the technological base to absorb high technologies for defence and strategic needs, where does it go from here? One of its primary directions would be to continue the progress it has made in all sections of the defence industry. Not only must it sustain the present levels of defence production but, more critically, it must upgrade to keep abreast of new technologies. This would keep the production lines open, keep the industry in contact with the suppliers of strategic raw materials and, at the same time, maintain the skills of the specialised labour force, especially of the Defence Technology Group, needed to produce high-quality defence products and services.

As the SDI matures, it will need to move up-market, especially in terms of technologies. As more and more Third World countries with ready access to strategic raw materials and a cheap pool of skilled labour undertake defence industrialisation, Singapore's competitive edge in the production of simple and basic weaponry and services

¹ Cited in *Singapore Technologies*, n.p.

could be lost. To avoid SDI being overtaken and rendered redundant, new areas of development would need to be looked into.

Equally relevant, for the SDI to be self-supporting, it must not only produce weapons and services cost-effectively and efficiently but, more importantly, they must be professionally marketed - an area where the SDI has not made great strides, partly because it is under strict MINDEF direction. Many of the most lucrative arms deals are made 'under-the-table', and how the SDI is able to compete effectively with experienced and world-class 'arms salesmen' remains to be seen.

From whatever angle one reflects on the future of an arms industry, particularly one from the Third World, it is difficult to ascertain its future. There are many problems, dilemmas and uncertainties confronting it. At the end of the day, it is obvious that a small country cannot go on producing small arms: if the domestic market is big, then it has a greater leeway in sustaining a reasonable defence industry. But once the basic needs were met, the problem of what and how much to produce would affect the future of the defence industry. As exports are not a natural outlet due to the highly competitive international market, the high standards demanded and the difficulties of approval from licensors, the stark alternative would be to scale down production or to divert resources to new products, particularly non-defence-related products.

An alternative which many Third World states such as Singapore can contemplate is to develop 'double-barrel industries'; that is, industries which can produce defence products and services and at the same time be an integral element of the civilian economy, producing non-military goods and services. In short, the thin line between military and non-military products might need to be extinguished. While this is more easily said than done, this option could be taken into consideration during the reorganisation and modernisation phase of the country's defence industries. It is quite apparent that the April 1989 reorganisation of the SDI had this goal in mind, even though it remained unstated. As it is highly unlikely that Singapore's defence industries would be in a position to produce cutting-edge goods, the alternative would be to concentrate on small, high-scale and low-technology products in demand locally and, more importantly, to be in a position to sustain the local defence industries. Failure to come to terms with this would mean a country would have

two options: run the defence industry at a loss and over-produce products that are not in demand, or simply scale down - and possibly close down - the defence industry. In other words, the future of any defence industry, especially that in Singapore, would be determined by astute planning and anticipation of the 'sunset' and 'sunrise' products and services.

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