



1.5 Concept Generation

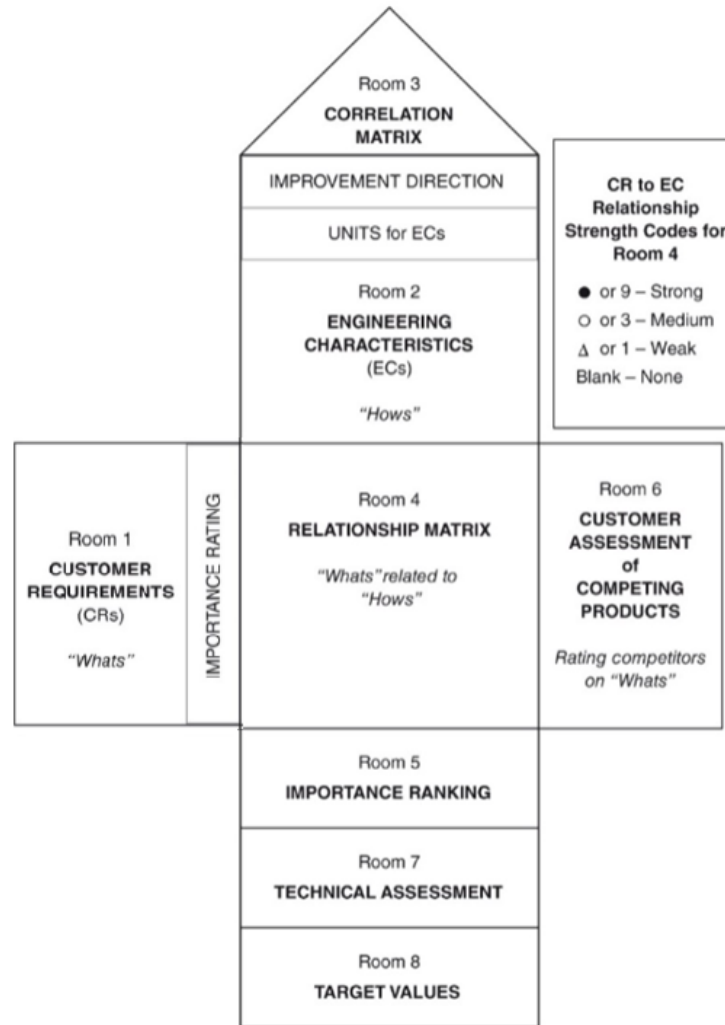


Figure 3: *House of Quality, Dr. McConomy*

Through using the House of Quality provided by Dr. McConomy we based the quality functional deployment off of the information. Each room in the House of Quality houses information that is essential to the process of design. The relationships are as follows:

Room 1 relates to table 1

Room 3 is table 3

Room 4 is table 4



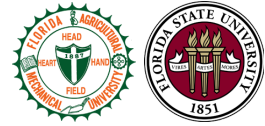
Room 5 relates to table 1 and table 6
Room 6 and 8 relate to tables 5 through 9

Our team started with a binary pairwise comparison to decide the importance rating of the customer requirements. The results are shown in table 1 below.

Customer Need Number	Customer Need
CN1	Needs to fit in space
CN2	Easy to operate
CN3	Accurate
CN4	Visually pleasing
CN5	Approved by other family members
CN6	Can mix two fluids
CN7	Can be stored away when not in use
CN8	Safe to use

Table 3: Customer Needs

From these needs, ideas were created of devices our team could make that would meet the customers requirements.



Morphological Chart

Dispensing	User interaction	Compactness	Measuring the liquid	Additional features
Gravity based	Mobile phone	Collapsible	Time based	
Air pressure	Touch screen	Splits into two machines	Weight sensor	Carbonated Beverages
Liquid Pump	Buttons	foldable	Flow rate sensor	Cooling down the liquid
Vacuum suction	Wireless Remote	Modular	Measuring liquid using a tank	Mixing liquid in the cup
	Wired Remote		Pressure sensor	

Table 4: Morphological Chart

#1-50 are Morphological Chart, all other forms of Concept Generation are listed.

Number	Concept
1	A beverage dispensing machine that will dispense beverages with gravity and will measure the volume using time. The user will use a mobile phone to place the drink order.
2	A beverage dispensing machine that will dispense beverages with air pressure and will measure the volume using time. The user will use a mobile phone to place the drink order.
3	A beverage dispensing machine that will dispense beverages with a liquid pump and will measure the volume using time. The user will use a mobile phone to place the drink order.
4	A beverage dispensing machine that will dispense beverages with a vacuum suction and will measure the volume using time. The user will use a mobile phone to place the drink order.
5	A beverage dispensing machine that will dispense beverages with gravity and will measure the volume using a weight sensor. The user will use a mobile phone to place the drink order.
6	A beverage dispensing machine that will dispense beverages with air pressure and will measure the volume using a weight sensor. The user will use a mobile phone to place the drink order.
7	A beverage dispensing machine that will dispense beverages with a liquid pump and will



	measure the volume using a weight sensor. The user will use a mobile phone to place the drink order.
8	A beverage dispensing machine that will dispense beverages with a vacuum suction and will measure the volume using a weight sensor. The user will use a mobile phone to place the drink order.
9	A beverage dispensing machine that will dispense beverages with gravity and will measure the volume using a weight sensor. The user will use a mobile phone to place the drink order.
10	A beverage dispensing machine that will dispense beverages with air pressure and will measure the volume using a flow rate sensor. The user will use a mobile phone to place the drink order.
11	A beverage dispensing machine that will dispense beverages with a liquid pump and will measure the volume using a flow rate sensor. The user will use a mobile phone to place the drink order.
12	A beverage dispensing machine that will dispense beverages with a vacuum suction and will measure the volume using a flow rate sensor. The user will use a mobile phone to place the drink order.
13	A beverage dispensing machine that will dispense beverages with gravity and will measure the volume using time. The user will use a touch screen on the machine to place the drink order.
14	A beverage dispensing machine that will dispense beverages with air pressure and will measure the volume using time. The user will use a touch screen on the machine to place the drink order.
15	A beverage dispensing machine that will dispense beverages with a liquid pump and will measure the volume using time. The user will use a touch screen on the machine to place the drink order.
16	A beverage dispensing machine that will dispense beverages with a vacuum suction and will measure the volume using time. The user will use a touch screen on the machine to place the drink order.
17	A beverage dispensing machine that will dispense beverages with gravity and will measure the volume using a weight sensor. The user will use a touch screen on the machine to place the drink order.
18	A beverage dispensing machine that will dispense beverages with air pressure and will measure the volume using a weight sensor. The user will use a touch screen on the machine to place the drink order.



19	A beverage dispensing machine that will dispense beverages with a liquid pump and will measure the volume using a weight sensor. The user will use a touch screen on the machine to place the drink order.
20	A beverage dispensing machine that will dispense beverages with a vacuum suction and will measure the volume using a weight sensor. The user will use a touch screen on the machine to place the drink order.
21	A beverage dispensing machine that will dispense beverages with gravity and will measure the volume using a weight sensor. The user will use a touch screen on the machine to place the drink order.
22	A beverage dispensing machine that will dispense beverages with air pressure and will measure the volume using a flow rate sensor. The user will use a touch screen on the machine to place the drink order.
23	A beverage dispensing machine that will dispense beverages with a liquid pump and will measure the volume using a flow rate sensor. The user will use a touch screen on the machine to place the drink order.
24	A beverage dispensing machine that will dispense beverages with a vacuum suction and will measure the volume using a flow rate sensor. The user will use a touch screen on the machine to place the drink order.
25	A beverage dispensing machine that will dispense beverages with gravity and will measure the volume using time. The user will use a mobile phone to place the drink order. The machine will refrigerate the user's beverages.
26	A beverage dispensing machine that will dispense beverages with air pressure and will measure the volume using time. The user will use a mobile phone to place the drink order. The machine will refrigerate the user's beverages.
27	A beverage dispensing machine that will dispense beverages with a liquid pump and will measure the volume using time. The user will use a mobile phone to place the drink order. The machine will refrigerate the user's beverages.
28	A beverage dispensing machine that will dispense beverages with a vacuum suction and will measure the volume using time. The user will use a mobile phone to place the drink order. The machine will refrigerate the user's beverages.
29	A beverage dispensing machine that will dispense beverages with gravity and will measure the volume using a weight sensor. The user will use a mobile phone to place the drink order. The machine will refrigerate the user's beverages.
30	A beverage dispensing machine that will dispense beverages with air pressure and will



	measure the volume using a weight sensor. The user will use a mobile phone to place the drink order. The machine will refrigerate the user's beverages.
31	A beverage dispensing machine that will dispense beverages with a liquid pump and will measure the volume using a weight sensor. The user will use a mobile phone to place the drink order.
32	A beverage dispensing machine that will dispense beverages with a vacuum suction and will measure the volume using a weight sensor. The user will use a mobile phone to place the drink order. The machine will refrigerate the user's beverages.
33	A beverage dispensing machine that will dispense beverages with gravity and will measure the volume using a weight sensor. The user will use a mobile phone to place the drink order. The machine will refrigerate the user's beverages.
34	A beverage dispensing machine that will dispense beverages with air pressure and will measure the volume using a flow rate sensor. The user will use a mobile phone to place the drink order. The machine will refrigerate the user's beverages.
35	A beverage dispensing machine that will dispense beverages with a liquid pump and will measure the volume using a flow rate sensor. The user will use a mobile phone to place the drink order. The machine will refrigerate the user's beverages.
36	A beverage dispensing machine that will dispense beverages with a vacuum suction and will measure the volume using a flow rate sensor. The user will use a mobile phone to place the drink order. The machine will refrigerate the user's beverages.
37	A beverage dispensing machine that will dispense beverages with gravity and will measure the volume using time. The user will use a touch screen on the machine to place the drink order. The machine will refrigerate the user's beverages.
38	A beverage dispensing machine that will dispense beverages with air pressure and will measure the volume using time. The user will use a touch screen on the machine to place the drink order. The machine will refrigerate the user's beverages.
39	A beverage dispensing machine that will dispense beverages with a liquid pump and will measure the volume using time. The user will use a touch screen on the machine to place the drink order. The machine will refrigerate the user's beverages.
40	A beverage dispensing machine that will dispense beverages with a vacuum suction and will measure the volume using time. The user will use a touch screen on the machine to place the drink order. The machine will refrigerate the user's beverages.
41	A beverage dispensing machine that will dispense beverages with gravity and will measure the volume using a weight sensor. The user will use a touch screen on the machine to place



	the drink order. The machine will refrigerate the user's beverages.
42	A beverage dispensing machine that will dispense beverages with air pressure and will measure the volume using a weight sensor. The user will use a touch screen on the machine to place the drink order. The machine will refrigerate the user's beverages.
43	A beverage dispensing machine that will dispense beverages with a liquid pump and will measure the volume using a weight sensor. The user will use a touch screen on the machine to place the drink order. The machine will refrigerate the user's beverages.
44	A beverage dispensing machine that will dispense beverages with a vacuum suction and will measure the volume using a weight sensor. The user will use a touch screen on the machine to place the drink order. The machine will refrigerate the user's beverages.
45	A beverage dispensing machine that will dispense beverages with gravity and will measure the volume using a weight sensor. The user will use a touch screen on the machine to place the drink order. The machine will refrigerate the user's beverages.
46	A beverage dispensing machine that will dispense beverages with air pressure and will measure the volume using a flow rate sensor. The user will use a touch screen on the machine to place the drink order. The machine will refrigerate the user's beverages.
47	A beverage dispensing machine that will dispense beverages with a liquid pump and will measure the volume using a flow rate sensor. The user will use a touch screen on the machine to place the drink order. The machine will refrigerate the user's beverages.
48	A beverage dispensing machine that will dispense beverages with a vacuum suction and will measure the volume using a flow rate sensor. The user will use a touch screen on the machine to place the drink order. The machine will refrigerate the user's beverages.
49	A beverage dispensing machine that will dispense beverages with gravity and will measure the volume using time. The user will use a mobile phone to place the drink order. The machine will mix the beverage before dispensing the beverage into the user's cup.
50	A beverage dispensing machine that can hold 12 bottles of liquor, with 24 mixers and has a conveyor belt that the user places their drink on to. The conveyor belt will move the user's drink through the drink making process. The liquid dispensed into the user's cup will be measured using liquid level sensors and the machine will be controlled through a mobile app. The machine will cool the users drink and place ice into the users cup.
51	A robot with multi-axis joints, actively picks up bottles of liquor and mixer and mixes the drink, robot would also be able to scoop ice
52	BIOMIMICRY: A waterfall type structure, gravity and surface roughness would take care of mixing and steadying the flow



53	BIOMIMICRY: Very small pipes would fill the drink via a capillary action, similar to tree cells that bring up water, sucking the liquid and depositing into the cup
54	Pumps that are powered via hand crank, the user would flip switches and levers and then the hand crank would pump liquid into the cup
55	BIOMIMICRY: An elephant trunk type suction that moves from bottle to bottle sucking up the liquid and depositing in the cup
56	BIOMIMICRY: A pather because they are silent and sleek. The device
57	FORCED ANALOGY: Cup is placed diagonally to reduce spilling, a high pressure jet is used to fill up the cup extremely quickly, a odd shaped cup can also be used to reduce the splash of the jet
58	FORCED ANALOGY: All the bottles begin pouring at the same time, a combination of a conveyor belt and a network of pipes is used to maneuver the cup to collect multiple channels of the spray
59	FORCED ANALOGY: The bottles are held up on the spinning turntable of a microwave. When a certain liquor is required, the turntable spins around to line the bottle up with the cup, the liquor is then dispensed.
60	The bottles are held diagonally in a tall cylinder. To pour, the liquor runs down the individual channels and into the cup, the inside of the cylinder is chilled with a refrigeration unit placed on top.
61	A special cup is used with a magnetic flip top on the bottom. All the liquor and mixers are kept in the bottom. The cup is placed a specific spot, the fluid that flows from the bottom thru the magnetic flip top
62	A machine that stores cups, hidden from view, inside the machine, the cup circulates around from bottle to bottle and then moves out on a conveyor belt
63	BIOMIMICRY: The bottles are held in a vertical semicircle, (think setting sun, halfway below horizon) the liquid flows down a chilled ramp into the cup, like waves moving towards shore.
64	Liquor and Mixer is held right side up along the top of the machine, when required a motor would flip the bottle over and actually pour into the cup.
65	FORCED ANALOGY: Liquor and mixer is held in tubs, a robot arm would grab the cup and dip into whatever tubs the drink requires, like a punch bowl at a dance.
66	FORCED ANALOGY: Components of the drink are held in a refrigerator with pumps



	pumping the liquid out of the refrigerator into a cup. Similar to a pony kegerator. with a nozzle.
67	Artificial intelligence that when you input the drink tells you when to start and stop pouring. A soda machine with whatever components you want along the top. When you order your drink, the computer makes an audible “ <i>Liquid 1...start.</i> ” It will then sense how much liquid is in the cup and audibly tell you to stop pouring.
68	When you put the components into the machine, the machine pre-makes the drinks into compartmentalized sections within the machine. When you want a specific drink, user clicks go and the entire drink pours into your cup fast.
69	A machine that looks like a coffee maker with two bottles on the top, on the sides there are boxes of mixers, small submersible pumps pump air in and the liquid into the cup through a nozzle.
70	A bartender service that you rent per hour, a bartender comes to your house and tells you how to make the drinks that you order.
71	The components are held sideways so as to not require a large pumping force. The nozzle points sideways so put on a little show like when bartenders raise and lower the bottle when they pour.
72	User sets the cup in a compartment, the cup moves away like a drive through bank teller system, collects all the liquor and mixer and then whisks back to the user.
73	BIOMIMICRY: A water wheel system like ‘Swiss Family Robinson’ that collects the liquid in specifically sized containers and deposits into the cup.
74	A refrigerator that freezes the mixer into ice. The liquor is pouring into the cup, then mixer ice cubes are dropped into the cup to melt and turn into a mixed drink
75	FORCE ANALOGY: Nozzles that fit onto bottles, these nozzles perfectly measure out how much volume to pour into the cup. This option would come with a menu to give you the proportions of your favorite drinks
76	BIOMIMICRY: The components of the drink would flow along a ‘river’ that was chilled. Would chill the drink and would thoroughly mix the drink
77	A supercharged squirt gun, the machine would fill the gun with the right proportions. The gun would scan and find where your cup is. It would than shoot into the user’s cup from afar.
78	A wind powered water wheel. You would set this outside, the wind would blow the wheel around. The wheel would collect certain volumes of drink and deposit them into the cup.



79	This mixing machine would be connected to your phone and wifi to obtain background information about its user and suggest new (or the same) drinks and have them made or being made when it assumes its user would want to drink.
80	A mixing machine that has all of the liquid ingredients stacked vertically and mixes the ingredients by allowing them to be poured into the cup from a set distance.
81	A solar powered mixing machine that is intended to be left outside and will have weather proof materials.
82	A machine that will mix the liquid ingredients by pouring them into a specifically designed cup and that will be able to be enclosed and gripped by the machine by vibrating
83	A home delivery bundle that comes to your home each month and gives you the ingredients to make different drinks and cocktails from around the world.
84	A drink mixing machine that is not a standard appliance but instead is a bar of arms that scans the room and can make drinks based upon the integrated found.
85	A drink mixing machine that cools drinks down by utilizing geothermal (so this would be a stationary device).
86	A drink mixing machine that changes its menu based on the ingredients available to drinks that have been most popular for a given time frame ie, day, week, month.
87	A machine that inside does not mix but has premade mixes and used the individual ingredients to change the drink based upon the customers preference
88	A Machine that operates by having fans inside the individual containers of liquids and pushing those liquids out when those ingredients are requested.
89	A machine that has a set list of beverages that it can make and you select which item you want and it will make it within an enclosed frame. It also has an arm that will extend to do swirls and mixes.
90	The machine has a bottom open frame that sits 7 inches off the surface and on the surface is instead a plate where a cup would sit and this plate would have the ability to move in the x and y positions to move the cup under the correct ingredient
91	The machine operates by having a air-tight vacuum sealed grip to a specially designed cup and guides the cup to locations of all the individual items needed and could mix and; add drizzles and specialties to drinks with the movement of the cup
92	A mixing machine that operates by selecting your drink and options via remote control similar to a tv remote



93	A briefcase that can fold open to reveal an automated bar where you just connect some extended tubes to the bottles that are needed and it will automate the process.
94	A mixing machine that can also provide speciality ice cubes similar ie. cubbed, square, star shaped, sphere, hollow, ect.
95	A drink mixing machine that will do cocktail art onto your drinks.
96	A mixing machine that not only mixes but can also add carbonation to a selected number of the items through their mixing route.
97	A beverage mixing machine that does not hold its liquid within itself but holds a separate tank for each of the individual components
98	A beverage mixing machine that mixes by integrating glass work designs that all eventually feed into the cup which is placed in a designated area.
99	The cup is placed onto a designated area and the bottles sit above the cup in a ball shape. It would then spin the needed ingredients to the drink and dispense them.
100	The bottles are stationary and the cup moves down a conveyor belt track where it passes under the containers and is filled with the requested items

Table 5: List of 100 Concepts

High Fidelity Concepts

1. **A machine that looks like a coffee maker with two bottles on the top. On the sides of the machine there are boxes of mixers, small submersible pumps that pump air in. The air then pumps the liquid into the cup through a nozzle.** - This machine would look very similar to the picture below. The main difference is there would be a platform on the bottom to house our electronics and the pumps. Two bottles would be sticking out of the top, so you could see the ‘model’ of the liquor. This would serve a double purpose, users would also be able to see when the liquid is flowing out. Since the pumps are located in a box at the bottom, we could also include soundproofing to make the pumps quieter. The benefits of this design is that it would be quieter, faster, and would allow for multiple drinks to be ordered at the same time. This design would be smaller than some of the other options our team came up with. This is also a design that consumers are comfortable with already. A drawback is the limited carrying capacity of liquor and modifiers. Another detriment is that this design requires pumps for each container, increasing the odds of the machine failing.



Figure 4

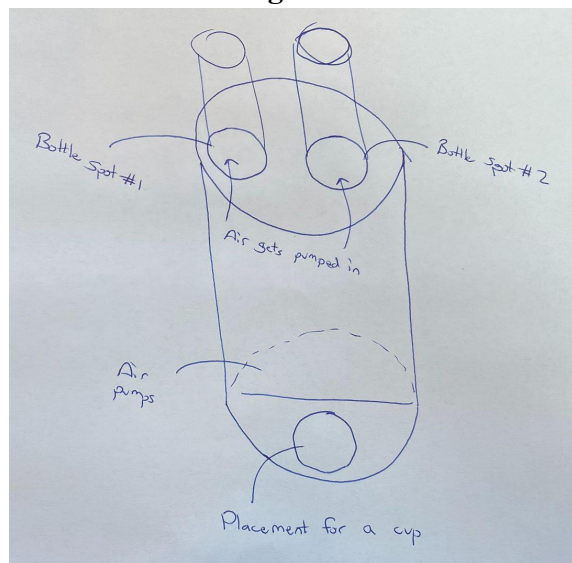


Figure 5



- 2. The bottles are stationary and the cup moves down a conveyor belt track where the cup passes under the containers and is filled with the requested ones** - This design would be rectangular, more similar to the original prototype. However instead of having a stationary cup, you would set the cup down at the designated starting location. When the user ordered a drink, the cup would start moving down the conveyor belt. The liquor bottles and the modifiers would be flipped upside down along the top of the machine. The pumps needed would require a lot less power because gravity would help the liquid flow into the cup as it moved along the line. The benefits of this design is that it offers more of a 'show' for the users. It also would most likely have much more carrying capacity. This concept is also more conducive to including bitters or splashes of mixer, or even some forms of garnishes that couple be included at the end of the assembly line of the drink. The detriments would be that it would take longer to make a drink, also the mixing of the drink would be lackluster because one would be put in at a time. It is also subject to disruptions from the cup falling over or being removed. This machine also might make more of a mess depending on how high the nozzles of the bottles are.

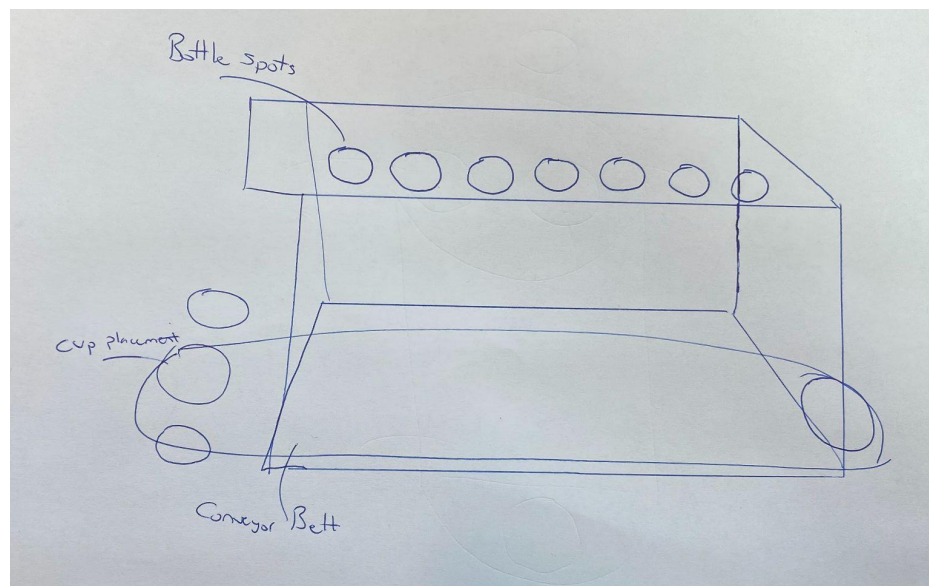


Figure 6



- A machine that has a set list of beverages that it can make and you select which item you want and it will make it within an enclosed frame. It also has an arm that will extend to do swirls and mixes** - This would have a clear acrylic door to open an enclosed rectangular area where the drink would be mixed and filled. The bottom of this area will have a mount where a specially designed cup will sit not to have any give or vibrations. The drinks will be made by pouring the individual ingredients into the cup and then having an arm extending from the enclosed area with a stirring rod. After the drink has been made the door will unlock allowing the user access to it. The benefits of this design is that any spill would be contained within the compartment allowing it to be cleaned very easily, also, The cup could not be taken out mid drink so there is no chance of a major spill from the cup being removed.

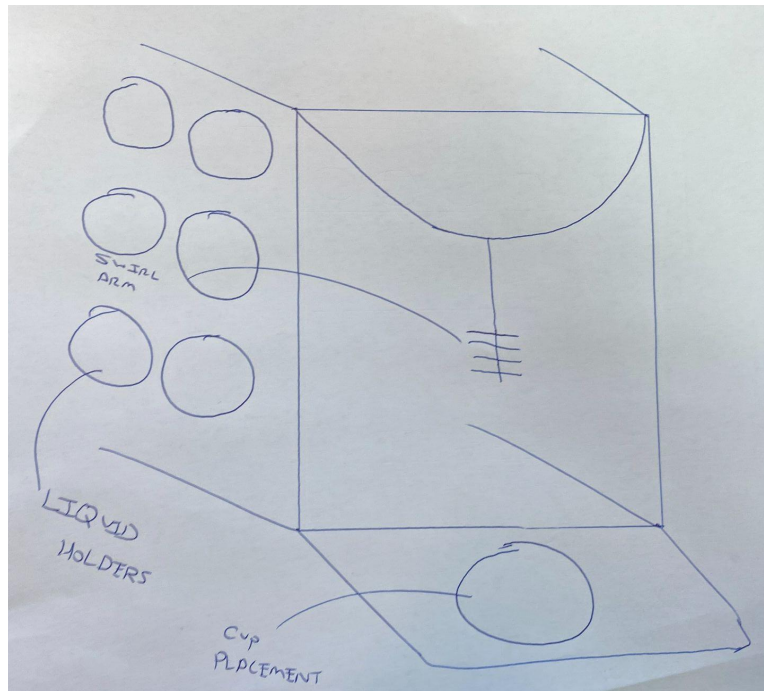


Figure 7

Medium Fidelity Concepts

- Pumps that are powered via hand crank, the user would flip switches and levers and then the hand crank would pump liquid into the cup** - This idea would open the bottles at set intervals to achieve the right proportions of the drink. The orientation of the liquor bottles and mixer is very up for debate with this concept because the power source allows for a lot of flexibility. The main benefit of this concept is the flexibility. The user doesn't need a power source so you can bring it anywhere. Depending on the customer



needs, it could be any size really because you wouldn't have to worry about extra parts. A detriment is that no one wants to work when they drink. Some people may not be strong enough to generate the pressure differential required to power the pump. Another con is that it's not 'sexy.' One of the primary goals of this project is for the machine to be aesthetically pleasing. A hand pump is not cool.

2. **FORCED ANALOGY: Components of the drink are held in a refrigerator with pumps pumping the liquid out of the refrigerator into a cup. Similar to a pony kegerator, with a nozzle to dispense.** - The concept is a refrigerator with a couple holes in the top that go into a nozzle with a control panel on it. The user would order the drink, set the cup down and then the drink would dispense into the cup. Inside, multiple hoses would be able to connect to many different bottles and still pump. If the user had smaller bottles, the user could fit more in. The benefits of this concept is that the drinks would be chilled, it would look sleek, and would work like a regular refrigerator when not in use. This design is also flexible because you can fit many small bottles or a few large bottles. The detriments to this design is that you don't see what exactly is going into your cup like HF #1 and #2. Also, a new user may mistake it for an actual kegerator and expect beer to come out instead of a cocktail. This is not an item that you could put on a countertop which is one of Team 519's customer needs. However, to compensate for this, it is multi-use. When not in use, it can act as a refrigerator for beer, seltzers, wine, or even food items.
3. **BIOMIMICRY: An elephant trunk type suction that moves from bottle to bottle sucking up the liquid and depositing in the cup** - This machine would have a roboting arm that could connect to multiple different bottles. The arm would have to move in three dimensions to account for different bottle heights and locations. A connector could be made so when the arm meets the bottle an airtight seal could be made so that a suction force could develop. The benefits of this concept is that only one pump would have to be used. This could allow for a stronger, more reliable pump to be used. The carrying capacity would also be bigger because you could use more 2D space than other concepts like HF #2 (High Fidelity #2) that only has containers in a straight line. The detriments are that the motor required to pump the liquid would have to be decently strong with a strong chance of it burning out. This would be a drain on the battery life as well if we decided to go with that concept. Also, this concept would take a while to fill one cup.
4. **FORCED ANALOGY: The bottles are held up on the spinning turntable of a microwave. When a certain liquor is required, the turntable spins around to line the**



bottle up with the cup, the liquor is then dispensed. - This would be similar to HF #1, meaning it would look similar to a Keurig coffee machine. The main difference is that it would have a rotating dish on top that would hold all of the liquor bottles. When a specific drink is called, the dish would rotate around and allow liquor to flow into the cup. The mixers would flow in separately through a different nozzle. The benefits of this design is the relatively high ratio of carrying capacity to volume of machine. Also would only require one pump to regulate the flow from all the liquor bottles. It also is a little 'showy' which is a desired quality. The user could also see exactly what was going into their drink by just looking at the front bottle. They would not have to look for bubbles coming up through the nozzle. The detriments are that when the liquor bottles are in the back the label would be hidden. Another detriment is that engineering moments in three directions is hard, especially when the loads vary. If one liquor bottle was empty and another was full that would cause a bad stress on the support of the turntable. Another detriment is that it would take a while as the bottles spun around.

- 5. A special cup is used with a magnetic flip top on the bottom. All the liquor and mixers are kept in the bottom. The cup is placed in a specific spot, the fluid that flows from the bottom thru the magnetic flip top** - This design is inspired by a video that was seen on Youtube. This concept uses specifically designed cups that look like a plastic cup with a magnet on the bottom. These cups are then placed on a nozzle that fills up the cup from the bottom. When you remove the cup, the magnet snaps back into place not allowing any fluid out. The benefits are that this is possibly the 'showiest' of all the options. The idea of filling a cup from the bottom is extremely novel. The bottles can still be placed in a very visible place and requires the least amount of power to pump. This concept has not been tested in person. This idea could spill a not insignificant amount of fluid. Before this concept is selected Team 519 would have to measure this characteristic of the concept.
- 6. A machine that has the capacity of four beverages. The beverages will be placed into the machine upside down. The bottles will dispense liquid that will be pumped through the machine and mixed. The machine will be compact and fit on top of a kitchen countertop. Additionally, the machine will be compact enough to be stored away inside of kitchen cabinets. The machine will be powered through a standard US wall outlet.**