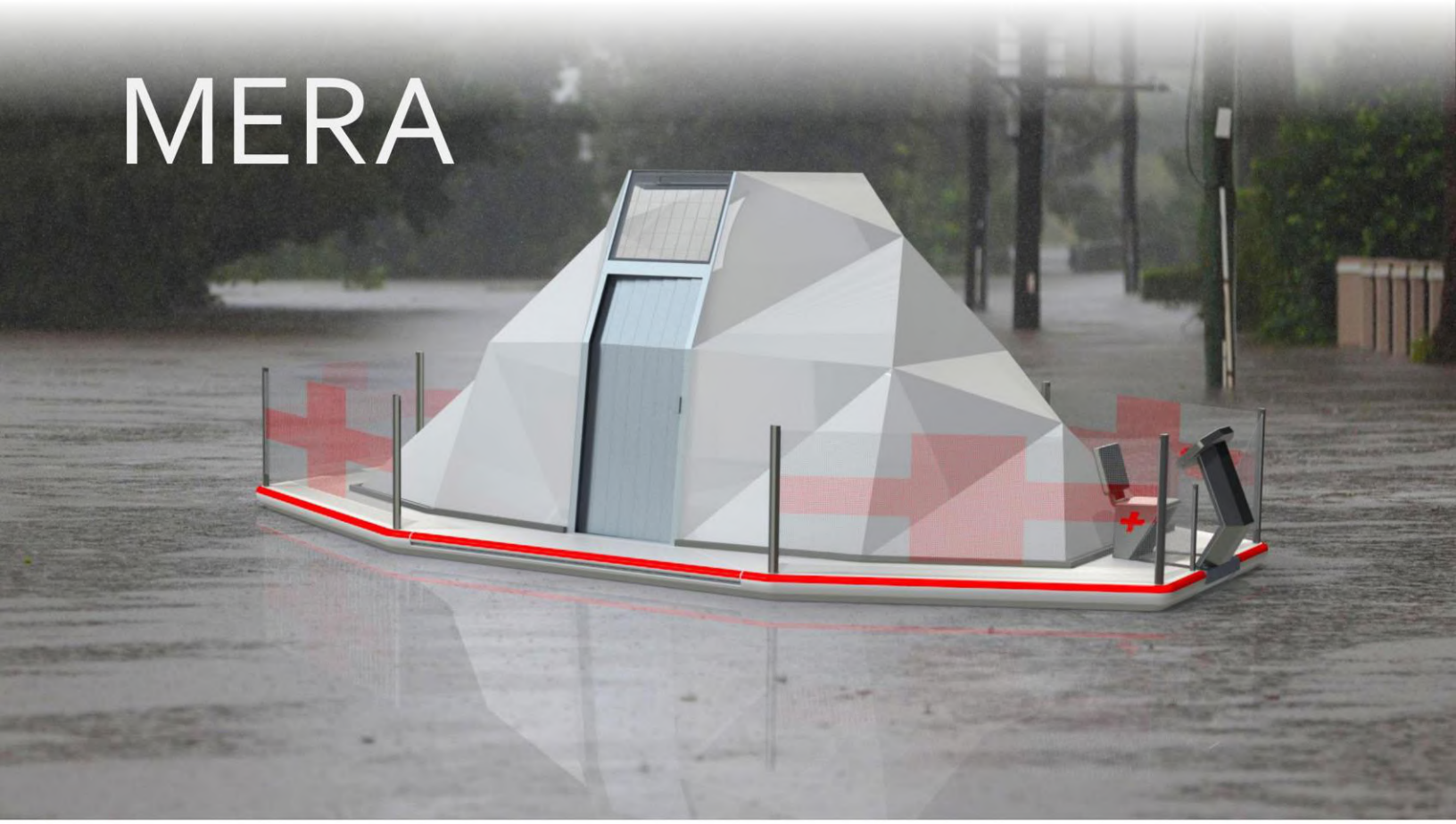

Mobile Health Care Facilities for Post Flood Disasters

Industrial Design Thesis Report 2021

By Emilie Fung

How May We Improve Healthcare Facilities in Regions that Experience Flood Disasters?

by

Emilie Fung

Submitted in partial fulfillment of the requirements for the degree of

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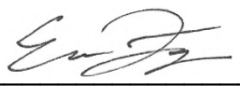
Student Signature : 

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How May We Improve Health Care Facilities in Regions that Experience Flood Disasters?

Emilie Fung

Bachelor of Industrial Design

Faculty of Applied Sciences &Technology
Humber Institute of Technology and Advanced Learning

2021

Abstract

Flooding is the most frequently occurring natural disaster in the world and has resulted in loss of lives, serious injuries, and spread of disease within many regions worldwide. Between 1995 and 2015, 2.3 billion people have been affected by flood disasters, which have only become more frequent because of climate change.

Masses of people endure illnesses and injuries after experiencing the effects of flood disasters, requiring immediate medical attention to survive. Resources during flood disasters also become limited due to damages to hospital infrastructure and medical equipment. An increased influx of patients often causes overcrowding in hospitals which can lead to loss of control over communication and organization systems, inefficient treatment, and care for patients, and spread of disease within the hospital. These factors can further negatively affect health care staff and patients, reducing efficiency within the hospital and chances of patient recovery.

Research investigations will be conducted for this report through surveys, interviews, and articles to determine supporting documents and information regarding health care facility improvements and solutions to overcrowding hospitals. Professional views and advice will be

considered in designing a solution for problems and challenges faced in a healthcare facility environment.

Improving health care facilities in certain regions to withstand or adapt to the effects of flood disasters would benefit and enhance the human lifestyle through the increased availability of medical treatment for many ill and injured disaster victims. This report will address the issues faced by hospitals in regions that experience flood disasters and provides the opportunity to apply full-bodied human interaction, ergonomics, and social responsibility regarding the primary, secondary, and tertiary users.

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CHAPTER 1 –
Problem Definition

Chapter 1 frames the problem definition of this thesis project. The addressed needs of the user are determined and investigated through interviews and surveys to support the rationale and significance of this thesis topic. Investigative approaches are taken through researching targeted users and existing products. A further investigation into the background, history, and social context of big picture trends that affect the user will aid in determining user benefits.

1.1 Problem Definition

Flooding is the most frequently occurring natural disaster in the world and has resulted in loss of lives, serious injuries, and spread of disease within many regions worldwide. Many regions do not have enough available health care facilities to care for and treat injured patients during flood disasters as hospitals can become damaged, overcrowded, and may lack adequate health care equipment to treat all patients. The availability of health care needs to be improved to help treat ill or injured people in regions that experience flood disasters. If health care can expand beyond existing hospital facilities and can accommodate for the people who need medical care in distant areas, the death rate that occurs due to flood disasters each year can be greatly reduced.

1.1.1 Problem Finding

To begin developing a solution to address the problem defined above, problems that target the primary, secondary, and tertiary users must be determined. A survey will be conducted to search for possible healthcare professionals that are able to share their expertise regarding their careers. Once an expert or experts are found, they will be interviewed to determine any pain points or challenges they experience daily. Secondary users may also be surveyed or

interviewed to gain insight on their experiences as the interactions between the primary and secondary users will be considered within the design process for this thesis project.

1.1.2 Problem Framing

A set of survey questions is created and sent to a Facebook group that has been formed to help others through providing advice and inquiries for any health care related concerns. A further in-depth set of interview questions is also created, and an interview is conducted to gain more insight on the experience of a healthcare professional and any possible pain points or challenges they face regarding their work and work facilities.

1.2 Rationale & Significance

An investigative approach is taken through interviews, surveys, and online research that will help determine any key information that should be considered and key questions that need to be asked.

1.2.1 Key Information to be Determined

Key information that needs to be determined and considered in the development of this project to improve healthcare facilities are the primary, secondary, and tertiary users, and current pain points experienced by both healthcare professionals and patients in current healthcare facilities. Statements from these primary and secondary users will give important insight on firsthand experiences of occurring problems and challenges in current healthcare facilities.

1.2.2 Key Questions to be Answered

Key questions must be answered to determine any key information that will be helpful throughout the design and development process of this thesis project. Important questions within surveys and interviews will include identifying careers and job duties, problems and

challenges faced in a workday, and equipment and tools they may use to perform important tasks. The interview with an expert will have more in-depth questions to determine the lifestyle of the user, a walkthrough of their workday including what they do, see, hear etc., more specific pain points, and their interactions. The problems and challenges faced by secondary users such as patients must also be considered throughout the design process to accommodate for all users.

1.2.3 Investigative Approach Planned

Interviews, surveys, and online research provide important information that are considered in development of this thesis project. Healthcare professionals are the primary users within a healthcare facility while patients are the secondary users. An analysis of user behavior of both healthcare professionals and patients determines problems that the users face including inefficient facility layouts and high stress environments. Efficiency within healthcare facilities regarding layout and space would be beneficial to both healthcare workers and patients as travelling between departments and overcrowding would be eliminated.

1.3 Background/History/Social Context

The big picture trends including demographic, lifestyle, media, and product trends greatly affect the user. These trends are investigated to determine their background, history, and social context for considerations in this thesis project.

1.3.1 Demographic Trends

Internet searches and statistical data were used to discover that health care workers range in ages between mid-20s- and middle-aged persons and consist of both male and female roles.

According to health care worker statistics, a higher percentage of men work as physicians, while a higher percentage of women work as nurses. An educational background of University level is most likely the form of education a healthcare worker will have studied. Depending on the education, occupation, and role of the healthcare worker, different wages are distributed accordingly.

1.3.2 Lifestyle Trends

The lifestyle of health care workers can be determined through user observations. As healthcare professionals care for others daily to help improve the world, it is evident that they are very caring and moral people. Therefore, they are always willing to help others whether in the workplace or outside of it. Since healthcare professionals also spend many hours each day and week at work, they may take interest in spending quality time with their families and friends or enjoy relaxing activities on their time off.

1.3.3 Media Trends

Internet searches and further statistics were used to discover certain factors in understanding the user. The media's understanding of healthcare professionals involved employment conditions rather than their behavioral characteristics. The most determining categories for user understanding were work hours, collaboration and interactions with others, income level, and location of work.

1.3.4 Product Trends

Information from research, interviews, and surveys contributed to determining product trends for alternative healthcare facilities including ambulances, life rafts, emergency response units, and mobile health clinics.

CHAPTER 2 – Research

Chapter 2 focuses on the initial research of this thesis project. Through online searches, interviews, and surveys, results for user research and benchmarking products are determined. User profiles, observations, and current benchmarking products are analyzed to aid in the design process regarding full-bodied human interaction and materials and manufacturing.

2.1 User Research

User research is conducted through internet searches, interviews, surveys, and user observation methods to determine possible user behaviours, practices, and empathy mapping. Important information obtained from user research is considered in the design and development of this thesis project. Further research on existing products to determine human factors and health and safety is important in understanding necessary factors of full-bodied human interaction which is focused upon in this project.

2.1.1 User Profile - Persona

As Asian regions are most prone to flood disasters, healthcare workers in Asia are the focus of the research conducted to aid in creating a user profile. To better understand how to improve healthcare facilities a User Profile of an urgent care worker in Asia is assessed. An image search is conducted to collect information on the primary user along with literature searches to better understand the user's behavior and demographic. The targeted demographic criteria focused upon in this report to determine characteristics and relevant information, includes age, gender, ethnicity, location, and education.

The user profile of a primary user is created after conducting images and literary searches for user demographic data and user behavior. The profiled user is a male or female between 25

and 50 years of age who earns an upper-class income level with a university level educational background in healthcare. The user works as a healthcare professional daily, working an average of 40 to 60 hours per week, collaborating with other healthcare workers in a hospital environment within a community.

Persona

Name: Maria Lee

Age: 38

Occupation: Physician

Income: RM 110 000 (CAD $35 000) / year

Education: Master's degree - Medicine

Relationship Status: Married, 2 kids

Location: Sabah, Malaysia

Career/ Volunteer: Career

Years of Service: 8

Social: Works with many other healthcare professionals

Frequency of Activity: Works daily shifts, 8-10 hours

Hobbies: Spending time with family, shopping, social gatherings.

Figure 1– Hospitals & Health Systems. [Image] Retrieved from https://www.cerner.com/solutions/health-systems

Profile

Maria Lee is a 39-year-old Asian female. She attended university to receive her master's degree in Medicine, completing her education before beginning her job as a physician at a local hospital. She earns an annual salary of RM 110 000 (CAD $35 000) and has been working as a physician for a total of 8 years so far. Maria began her medical studies at the age of 20 and underwent 9 years of schooling before obtaining a career in medicine. She strives to make the world a better place through her contributions in both the hospital and outside of work.

2.1.2 User Observation – Current User Practice

A series of interview questions are prepared to gain insight into the user's goals, experiences, and attitudes. A user observation is conducted, and those results are analyzed through creation of an empathy map.

The mapping process helps collect research observations to reveal deeper insights about a user's needs through asking specific questions based off 7 main empathy questions:

1. WHO are we empathizing with?
2. What do they need to DO?
3. What do they SEE?
4. What do they DO?
5. What do they SAY?
6. What do they HEAR?
7. What do they think and feel (PAINS & GAINS)?

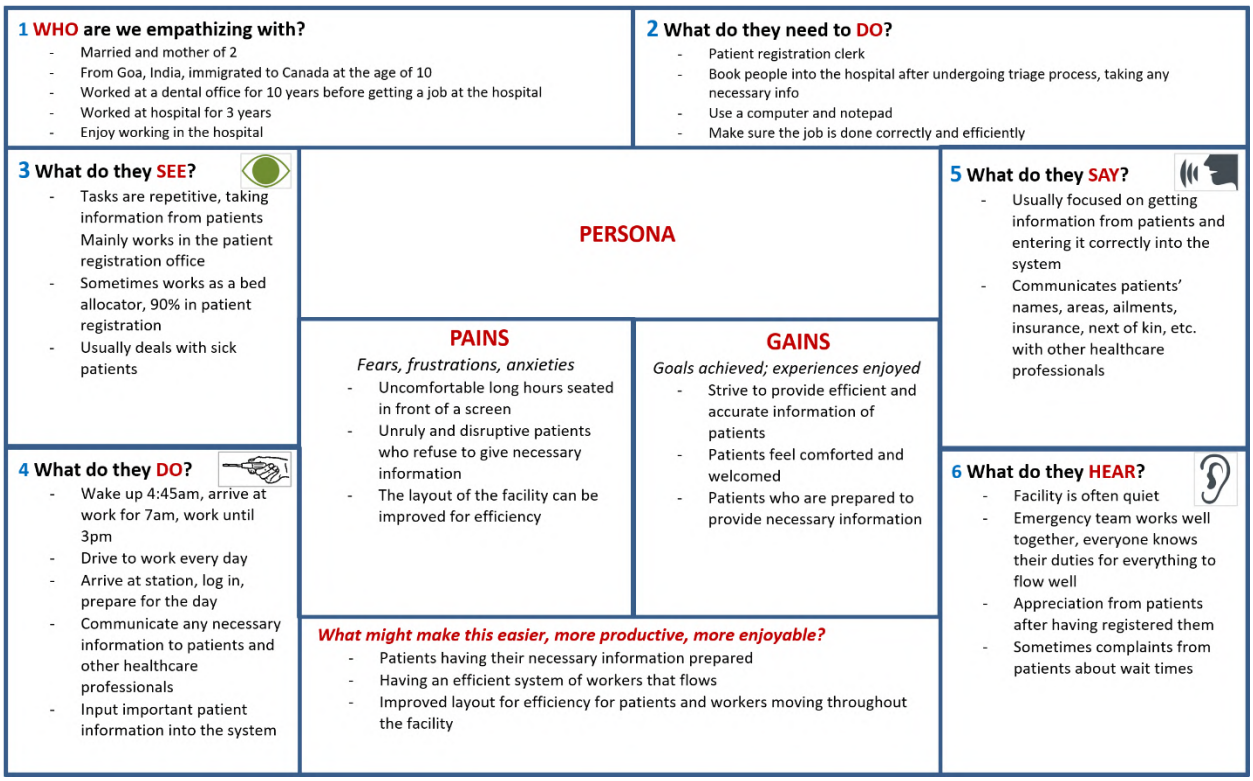


Figure 2 – Empathy Map

Hospitals have many different departments and sectors that are operated by healthcare workers of different specialties and job duties. Within an emergency department, there are different sectors containing healthcare workers who contribute to the workflow of the department to aid and treat their patients efficiently. Patients in the emergency department undergo a process throughout their visit to receive treatment, entering different sectors of the emergency department along the way of their hospital experience. The process of an emergency room visit consists of mainly 3 steps including triage, registration, and treatment which keep the hospital organized and operating smoothly.

As the interviewee for this empathy map works in the patient registration sector, she would interact with the patient near the middle of their emergency room experience. Patients in the triage sector are organized into specific categories depending on their condition and the urgency of care needed. Once categorized, patients are sent to the registration sector where

they give all necessary information to be inputted into the system to prepare for their next step in the process, which is treatment.

The interviewee typically works an 8-hour day shift, driving to work daily. She works in the patient registration sector, where she interacts with nearly everyone who enters the hospital. This includes patients, doctors, nurses, administrators, etc. As her job duties is to collect important information from all patients, she is situated at a desk with a computer. 10% of the time she may also work as a bed allocator, a healthcare worker who oversees moving patients around.

She feels that in her main duties, improvements can be made to maximize efficiency including the layout of the department, more comfortable seating, and the cooperation of patients. As she plays a role in the hospital's systems of operation, she strives to provide efficient and accurate information to her fellow workers regarding patients, and make patients feel comfortable and welcomed into the facility.

The emergency department has different sectors with many healthcare workers of different job duties that work together to create an operating system. Each duty is important in the workflow of the hospital and must be considered in the design process of this thesis project.

2.1.3 User Observation – Activity Mapping

An observational video is prepared and shared with a user to gain insight into the user's goals, experiences, and attitudes. The chosen video shows a walkthrough of a patient's experience in an emergency department and what you should expect throughout the process and steps that the patients take to treat an illness or injury. The video helps the secondary user remember or relive their emergency room experience and determine any possible pain points that they might have had during their hospital experience. The remote user observation will also aid in the

design and ergonomic considerations in the design process of this thesis project. A user observation is conducted, and those results are analyzed through creation of a User Journey Map.

	Stage 1 Concerns	**Stage 2** Entering the ER	**Stage 3** Triage	**Stage 4** Registration	**Stage 5** Treatment	**Stage 6** Completion
User Goals	Going to the ER to determine cause	Easy navigation through the ER	Determine severity of the condition	Provide necessary information	Run tests, provide medicine, etc.	Leaving the ER with effective treatment
User Actions	- Driving to ER	- Welcomed into ER by a greeter - Directed to the triage lineup and wait to see a triage nurse	- Enter a triage nurses office - Blood pressure taken - Temperature is taken - Oxygen level is taken - Goes back to waiting room	- Called to registration from the waiting room - Provide necessary information (health card, etc.) - Sent back to waiting room to wait to be called on again	- Called into the ER from the waiting room - Tests are run (blood test, urine analysis, EKG, X-rays, CT scans, etc.) - Tests may determine conditions that need operation for treatment	- Once treated and discharged, patient can leave the ER - Sometimes, patients leave without knowing what the cause of their health concern was
Storyboard/Photos						
User Experience (Rate 1 – 5 1-Good, 5-Bad)	5	5	4	4	2	1
Problems	- Having a health concern that may or may not be serious - Needing to travel to the hospital in a bad condition	- Waiting for long periods to be seen by a nurse - Not knowing where to go when initially entering the facility	- Feeling uncomfortable or pain - Uncomfortable seating or bedding - Further waiting for instruction	- Getting up from seating and travelling to a separate office for registration - Further having to wait before treatment	- Travelling to another area in the facility - Tests can take long - Uncomfortable seating or bedding - Further waiting for test results and treatment	- Leaving without being treated - Leaving without knowing the cause of your condition
Ideas/Takeaways	- Non-serious injuries can be treated outside of the hospital - Eliminate the need for ill or injured patients to commute to the hospital	- A more efficient facility layout that is easy to follow	- Wait times can be long and uncomfortable seating would worsen a patient's ER experience - More ergonomic seating and bedding for comfort	- Minimize the need to travel to other offices and departments	- Minimize the need to travel to other offices and departments - More ergonomic seating and bedding for comfort - Non-serious illnesses and injuries can be treated faster - More serious illnesses and injuries may need further treatment such as operations or long-term treatment	- Non-serious illnesses and injuries can be treated more effectively

Table 1 – Experience Activity Mapping

After taking multiple trips to the emergency room for different health concerns, the user was able to determine certain details and challenges that they had often experienced during their time at the ER.

The process of their entire emergency room experiences consists of the same or similar steps for every visit. These steps included being seen by the triage nurse, registering into the hospital, and getting the necessary treatment needed for their condition.

Wait times depend on the severity of a patient's condition as serious life-threatening illnesses or injuries will be treated immediately while non-serious injuries will be treated after. The observed

user sometimes experienced wait times that were relatively long (between 30minutes to 2-hours) as other patients visiting the emergency room had more serious conditions that have a higher priority to be treated. These long waits spent sitting in the waiting room can be quite uncomfortable and frustrating.

When called upon to register into the hospital system, the user then must leave the waiting room to register in the patient registration office. Then after registering, return to the waiting room in hopes of obtaining a seat again if the waiting room is busy that day. A busy emergency room or triage sector can be crowded on a busy day which can worsen a patient's hospital experience.

After waiting for a period, patients are called into the emergency room where tests are performed, and possible treatment is given to patients. As there are so many different departments at the hospital, a lot of travelling occurs between different departments by both healthcare workers and patients, which may not be ideal for patients who are ill or injured. Test results help doctors to determine what steps to take next in treating the patient. These could lead to minor treatments or more serious ones such as surgeries.

Minor treatments and medicine would be able to be given to the patient faster than major surgeries which would keep the patient at the hospital for an extended period. The user has experienced an emergency room visit that had lasted about 1.5-2 hours including wait times and treatment. This was believed to be a condition that seemed to have been a pre-stroke, but causes were unknown, and the patient left without much treatment done. Although, another one of their emergency room experiences had lasted approximately 27 hours, which was for appendicitis and required a surgery to be performed.

2.1.4 Human Factors – Research of Existing Products

Through researching existing products, human factors and ergonomics can be assessed and applied to this thesis project. Determining how people interact with current products available on the market can provide insight on different methods of use and aid in the development of full-bodied human interaction in the final product. Ergonomic system diagrams of the user in context of component layouts or vehicle packaging for both the product stream and vehicle stream may be considered in this thesis project to show size, space, and volume restrictions.

2.1.5 Safety and Health – Research of Existing Products

Researching existing products is important to determine current safety and health measures taken to ensure the protection of the user from any possible harm associated with the product. Understanding the safety and health regulations and methods used in existing products can aid in creating a user-safe product for this thesis project. Further investigation into safety and health of products is conducted to determine possible methods that can be applied to the final thesis product. External variables that may cause any safety or health concerns are also considered and investigated to reduce danger for users.

2.2 Product Research

Product research is conducted through internet searches for benchmarking products related to the focus of this thesis project. Examples of comparable products are chosen to analyze and compare regarding features and benefits, functionality, appearance, materials and manufacturing, and sustainability of each product.

2.2.1 Benchmarking – Benefits and Features

The benefits and features of comparable benchmarking products are analyzed through the comparison of 4 chosen products. Promotional material for each of the 4 products are collected along with the highlighted benefits and features and organized into word frequency tables.

Benefits	Sort #1	Sort #2
From Promotional Material	Data on Menu Bar	Groups Like Catergories
on the water	adventure	comfortable
favourite	amazing	spacious
favourite	appropriate	spacious
under the stars	at the lake	stability
on the water	available	stability
sleep	casual fishing	large, dry area
no tent poles	coastal or offshore cruising or fishing	no tent poles
stands up	comes with	appropriate
without a problem	comes with	available
doubles as	comfortable	comes with
easy	convenient and fun	comes with
easily	doubles as	doubles as
good	durable	durable
coastal or offshore cruising or fishing	easily	encounter real conditions
available	easily	good
encounter real conditions	easily and freely	great
appropriate	easy	great
provide	easy	great
easily	easy access	included
stability	easy to use	protect
in the air	easy transportation	provide
on the ground	encounter real conditions	provides
on the water	favourite	provides
support	favourite	stands up
provides	float on water	strength
float on water	good	support
provides	great	easily
amazing	great	easily
great	great	easily and freely
at the lake	ice fishing adventure	easy
casual fishing	in the air	easy
spacious	in the air	easy access
easy to use	included	easy to use
durable	large, dry area	easy transportation
included	nice and clear	simple
strength	no tent poles	without a problem
on the ground	on the ground	adventure
in the air	on the ground	amazing
on water	on the water	at the lake
comes with	on the water	casual fishing
protect	on the water	coastal or offshore cruising or fishing
large, dry area	on water	convenient and fun
simple	protect	favourite
ice fishing adventure	provide	favourite
adventure	provides	float on water
convenient and fun	provides	ice fishing adventure
great	simple	in the air
comfortable	sleep	in the air
easy access	spacious	nice and clear
easy transportation	spacious	on the ground
stability	stability	on the ground
comes with	stability	on the water
easily and freely	stands up	on the water
great	strength	on the water
nice and clear	support	on water
spacious	under the stars	sleep
easy	without a problem	under the stars

Comfort **5**

Style **2**

Efficiency **19**

Ease **10**

Experience **21**

Table 2 - Word Frequency Table for Comparable Product Benefits

Features	Sort #1	Sort #2
From Promotional Material	Data on Menu Bar	Groups Like Categories
inflatable	2 zippered doors	attach and detach
floating	3-person hammock	D-rings
tent topper	4 roll-up windows	heavy-duty hook and loop
inflatable	air chambers	stakes and cord loops
air chambers	anchor attachment	carry bag
inflate	attach and detach	three equipment packs
high-pressure floor	built-in insect mesh	trolley bag
D-rings	carry bag	2 zippered doors
anchor attachment	central hatch	4 roll-up windows
waterproof tent topper	chamber	built-in insect mesh
attach and detach	D-rings	rainfly
heavy-duty hook and loop	floating	self-erecting canopy
three equipment packs	heavy-duty hook and loop	tent topper
two stacked tubes	high-pressure floor	transparent PVC material
chamber	inflatable	waterproof fabric
inflatable boarding ladder	inflatable	waterproof tent topper
self-erecting canopy	inflatable boarding ladder	air chambers
triangular or rectangular ballast bags	inflatable SUP base	anchor attachment
large drogue	inflate	central hatch
3-person hammock	large drogue	chamber
inflatable SUP base	play structure	high-pressure floor
sunbathing deck	popup	inflatable boarding ladder
play structure	rainfly	inflatable SUP base
trolley bag	self-erecting canopy	large drogue
webbing reinforced floor	sleeping bay	sleeping bay
sleeping bay	stakes and cord loops	sunbathing deck
built-in insect mesh	sunbathing deck	triangular or rectangular ballast bags
rainfly	tent topper	two stacked tubes
central hatch	three equipment packs	webbing reinforced floor
waterproof fabric	transparent PVC material	3-person hammock
4 roll-up windows	triangular or rectangular ballast bags	floating
2 zippered doors	trolley bag	inflatable
stakes and cord loops	two stacked tubes	inflatable
carry bag	waterproof fabric	inflate
transparent PVC material	waterproof tent topper	play structure
popup	webbing reinforced floor	popup

Usability **7**

Assembly **4**

Accessories **3**

Tent Top **9**

Base **13**

Table 3 - Word Frequency Table for Comparable Product Features

A total of 10 benchmarked products are chosen to analyze and compare features.

Comparable Products	
Revere Survival Coastal Commander Life Raft	Kampa Croyde 6 Classic Air Canopy
Corral Shelter	Shoal Tent
Portable Ice Fishing 8-Person Tent	POD Tent Maxi Elite
Flexotent	Viking RescYou ISO 9650-1/ISAF Life Raft
ShelterLogic Round Shelter	Universe 5-Person Three-Element Tent

Table 4 - EXAMPLE of Ten Benchmarked Products

A table comparing the main features for all 10 comparable products is then constructed. The main features chosen for comparison are:

1. Fabric Material
2. Frame Material
3. Base type
4. Accessories
5. Size and Capacity
6. Cost
7. Packaging
8. Stability

#	Item Name	Ft. 1	Ft. 2	Ft. 3	Ft. 4	Ft. 5	Ft. 6	Ft. 7	Ft. 8
1	Revere	Polyester	Synthetic rubber	Inflatable	Yes	Compact, 6 people	$1799.99	Valise	Anchorable
2	Corral	Polyethylene	Powder-coated steel	Open	Yes	Large	$449.00	Box	Not anchored to ground
3	Portable	Composite	Fibre tube	Open	Yes	Compact, 8 people	$395.99	Folded, carry bag	Anchored
4	Flexotent	N/A	N/A	Platform	Yes	Medium, 3-4 people	Customize	Collapsed	Not anchored to ground
5	ShelterLogic	Polyethylene	Steel tubing	Open	N/A	Large	$897.49	Box	Anchored
6	Kampa	Polycotton	Airframe beams	Open	Yes	Medium	$479.64	Folded, carry bag	Anchored
7	Shoal	PVC coated fabric	N/A	Inflatable	Yes	Compact, 2-3 people	$1999.00	Rolled, carry bag	Anchorable
8	POD	Polyester/nylon	Aluminum / steel	Fabric	Yes	Compact, modular	$899.00	Disassembled, carry bag	Anchored
9	Viking	Silicone-coated Nylon	Natural Rubber	Inflatable	Yes	Compact, 4 people	$3199.99	Valise	Anchorable
10	Universe	Polyester	Aluminum	SUP board	Yes	Medium, 5 people	$1999.0	Packed, trolley bag	Anchorable

Table 5 - Comparing Main Product Features

The comparable products are categorized into groups according to the related features of base and frame types.

Figure 3 - Comparable Products Grouped Using an X-Y graph relating to Features: No Base-Base and Inflatable/Flexible Frame-Hard/Stationary Frame

Most of the comparable products have similarities in the base and frame types as most of the products have bases that are constructed with inflatable or flexible frame structures. Other comparable products have either no base but have an inflatable or flexible frame structure, or have no base and are constructed with hard, stationary frames. The least number of products contain a base and a hard, stationary frame. The chosen products also fall around the same size range between medium to large size and can accommodate for several people. As the compared products are collapsible or can be disassembled, many of them come with accessories including a carry bag for portability and storage.

Portable shelters are growing in popularity in the outdoor lifestyle market and have a high degree of differentiation. Major key features for product selection includes cost, materials, portability, ease of use and comfort. Many of these portable shelters are specific towards certain user needs and vary in price depending on the materials used, included accessories, and complexity of the product. Although cost is not a focus within this product comparison analysis, it is a major factor in the product selection and decision-making aspect of the market.

2.2.2 Benchmarking – Functionality

All the chosen benchmarked products to be compared and analyzed are portable outdoor shelters, although they are not all used for the same functions. The products are all collapsible portable shelters that have a range of versatility in their functionality. The uses of the compared products range from camping, survival, recreational activities, and storage. Similarities found between all the chosen products include the materials and parts as they all feature water resistant fabric material as a shelter method and contain types of collapsible or removable framework. Functional features such as water resistance and collapsibility add to the overall purpose of the products, making them efficient, easy to use, and versatile.

2.2.3 Benchmarking – Aesthetics and Semantic Profile

The research conducted to compare benchmarking products help to determine current products and trends. As products were chosen regarding the focus of this thesis project, all the comparable products fall under the category of outdoor shelters. The products are categorized into an X-Y graph according to the form and scale of each product.

Figure 4 - Comparable Products Grouped Using an X-Y graph with Comparator Dimensions relating to Form and Scale: Short-Long and Compact-Large

Many of the benchmarking products are used for recreational activities or for safety and survival purposes and appear to be bright and colorful. Most of the comparable products fall within the Short-Compact sectors while some fall within the Long-Compact sectors. Some also fall within the Long-Large sectors while the least number of products are short and large. The framework and structure of each outdoor shelter are mainly constructed of geometric or angular shapes. All the chosen products for comparison function with fabric covers mainly of polyethylene or polyester material to form a shelter. The covers are soft and smooth in texture as they take the form of the product structures and may have an added water-resistant coating. Any graphics that can be seen on many of the comparable products are usually logos or names of brands that sell the product. Some of the shelter frameworks are inflatable and made of rubber while other hard framework is made of steel or

aluminum. All the chosen comparable products do not contain any electronic features or functions, although some may need electronics to aid in setting up the product.

2.2.4 Benchmarking – Materials and Manufacturing

Through the comparison of 10 chosen benchmarking products, similarities in materials and parts can be seen. All the products contain a framework and a cover for shelter. Some may also include a base depending on the intended functionality of the product. The framework of these outdoor shelters most often uses steel or aluminum materials. Other product framework may use rubber for an inflatable frame feature. The covers are most often a polyethylene or polyester fabric material as they are designed to fit over and take the shape of the framework. Other materials that are used for the covers include polycotton, composite, and nylon. As not all the benchmarking products have a base, those that do are often used to separate the user from the ground elements. Some of the benchmarking products are used in the water, therefore they have either inflatable bases made of rubber or floatable bases made of SUP board material. Other benchmarking products that also have a base have either a platform or fabric base made from similar materials as the framework and covers.

2.2.5 Benchmarking – Sustainability

Investigation into the sustainability of benchmarking products can help determine possible sustainability initiatives to take in this thesis project. Using sustainable materials, manufacturing processes, and the disposal of materials, the initiatives for sustainability can be determined. Further investigation is needed regarding benchmarking products or companies and their sustainability efforts.

2.3 Summary

The initial research for this thesis project was conducted through internet searches, interviews, and user observation methods. These methods were used to determine factors for the user profile persona, user observations of current practices and activities, and the comparison of benchmarking products related to this thesis project. Analyzing the user and benchmarking products help to determine possible human factors and ergonomics along with full-bodied human interaction methods that will benefit and enhance the human lifestyle.

Internet image searches and literature searches were used to determine the user profile for this thesis. As Asia experiences the most flood disasters, the data collected focused on healthcare professionals in Asia. The average age of healthcare professionals in Asia was determined to range between 25 and 50 years of age being both male and female workers. Although there is evidence that more male workers work as physicians while more female workers work as nurses. The research has also shown that healthcare professionals most likely have a university level educational background and work 40 to 60 hours per week in collaboration with other healthcare workers.

User observation was conducted through interviews and a remote observation including an observational video for the user to view. The interview consisted of in-depth questions that were discussed with a healthcare professional to determine what they do, say, hear, think, and feel when carrying out their daily tasks in a health care facility. The user shared that they often collaborate with other healthcare workers who all complete their assigned job duties to have a function system of operation. They also interact with patients, who are the secondary users, on a regular basis. Challenges and pain points that were also discussed during this interview included the layout of the emergency room department, seating comfort, and efficiency. The remote user observation consisted of a shared observational video that was shown to an experienced emergency room patient or secondary user. Discussions were made regarding their experience and what they did,

think, and feel during their time spent at the hospital. As the video shows a walkthrough of an emergency room experience, the user stated any details and concerns about their own experience. The challenges and pain points discussed throughout this observation included long wait times, uncomfortable seating, overcrowding, and having to travel back and forth between departments.

By researching existing products, current human factors and safety and health regulations can be found. Existing product can help to determine the ergonomics of the products and how they are applied for increased comfort and usability for its users. Safety and health measures can also be found through researching existing products to determine how dangers can be eliminated or reduced through different safety methods.

Product research was conducted through internet searches for 10 comparable products related to this thesis project. These products included outdoor shelters that can accommodate for several people. Each product was analyzed using promotional material shared online and the specifications of each product. Features and benefits were highlighted and categorized into frequency tables to determine the similarities and differences between all 10 products. The products were also categorized into X-Y graphs depending on the form and scale of each and the similar features seen within each product. The concluding benefits included comfort, style, efficiency, ease of use, and experience, while the features included assembly, accessories, tent top, base, and usability. Most of the comparable products are short and compact and include a base feature and inflatable or flexible framework. Many of these compared products feature a cover made from polyethylene, polyester, or nylon fabric and are bright and colorful in appearance. The framework for most of the comparable products are made from steel, aluminum or rubber and the base materials are either rubber, SUP board or fabric. The manufacturing methods of different parts for each product must be investigated further to determine processes and sustainability initiatives.

CHAPTER 3 –
Analysis

Chapter 3 frames the research analysis for this thesis project, including current product needs and usability. The human factors and aesthetics of the focused product will also be analyzed through the study of anthropometric measurements and styling exploration. The sustainability, feasibility, and viability aspects of the product is determined through current product analysis.

3.1 Analysis – Needs

Health care facilities are important to the care and survival of flood disaster victims in regions prone to the effects of disastrous flooding. Hospital and rescue services are fundamental for aiding in the recovery of ill and injured victims. As flood disaster victims may have difficulty seeking medical care depending on their condition and distance from available health care facilities, their needs need to be addressed in the design development of this project.

The needs analysis covers research of current products, focusing on the needs and benefits not met by those products. This research determines the latent needs of existing products and is then analyzed and categorized accordingly.

3.1.1 Needs/Benefits Not Met by Current Products

Size and Capacity

Many products related to portable shelters that are currently on the market are designed to accommodate for different numbers of persons depending on their functions of use. As some comparable products may be smaller in size and accommodate for a smaller amount of people within the structures, modularity can be beneficial for the accommodation for more individuals. There has not been much consideration for the expansion of size and capacity for many current products available on the market to fit more people into the sheltered spaces.

Comfort/Ergonomics

Current benchmarking products related to this thesis project are mainly smaller structures that can only accommodate for 2 to 6 persons, depending on their use. Most of these products are used as temporary emergency shelters or temporary tents for camping and other recreational activities. These temporary shelters often do not include any interior factors for storage, seating, or other equipment. Space within these shelters is limited and restrict the movement of individuals within the space as they only accommodate for a certain amount of people for temporary periods. As the structures are small and temporary, individuals are often seated or laying down within the space rather than standing and moving around. Occupants often must bend down or crouch to enter the shelters through small entrances which may cause stress on one's body. The interior of many comparable products are empty spaces with no ergonomic space to rest or leisure.

Cost

Portable or temporary shelters currently on the market range in cost depending on multiple factors including popularity, materials and manufacturing, and accessories. Some comparable products are more affordable, listed between $300 - $500, while other higher priced products cost between $800 - $3200.

Efficiency

Some of the researched benchmarking products are portable or temporary shelters that can collapse or disassemble for storage and transportation purposes. Although, most of the collapsible shelters are small and compact, some of the shelters that can accommodate for more people are larger more stationary structures. Some of the larger shelters need to be assembled initially for use but require time and effort to be disassembled using specific tools if necessary.

3.1.2 Latent Needs

The latent needs for this thesis project can be connected to Maslow's Hierarchy of needs which frames the 5 models of psychological human needs. These levels include the basic needs including physiological and safety needs, psychological needs including emotional and esteem needs, and self-fulfillment needs.

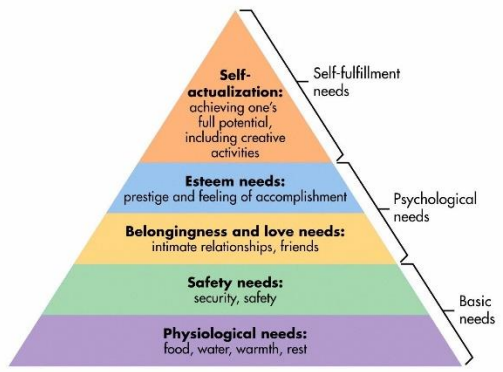


Figure 5 - Hierarchy of Needs

Benefit	Fundamental Human Needs	Level of Need
Comfort/Ergonomics	Physiological, love and belonging	Strong
Health and Safety	Safety, physiological, love and belonging	Strong
Efficiency	Safety, self-actualization	Strong
Aesthetics	Esteem	Moderate

Table 6 - Hierarchy of Needs

3.1.3 Categorization of Needs

This thesis project focuses on the user's fundamental needs that enhance their product experience. The focused product incorporates factors to improve ergonomics and ensure psychological health to provide a comfortable experience for health care providers and patients.

Wishes/Wants

- Sterile environment
- Organization
- Comfort experience
- Personal Space
- Healing

Immediate Needs

- Ergonomic, comfortable
- Efficient, collapsible, modular, adjustable
- Privacy, space
- Available equipment, medicine, tools
- Transportation

Latent Needs

- Aesthetics
- Efficiency of use (set-up/take down)
- Health and safety

3.2 Analysis – Usability

Product usability is analyzed through workflow and experience mapping. The product is tested and used to determine the functionality and usability of the product and user experience.

3.2.1 Activity – Workflow Mapping

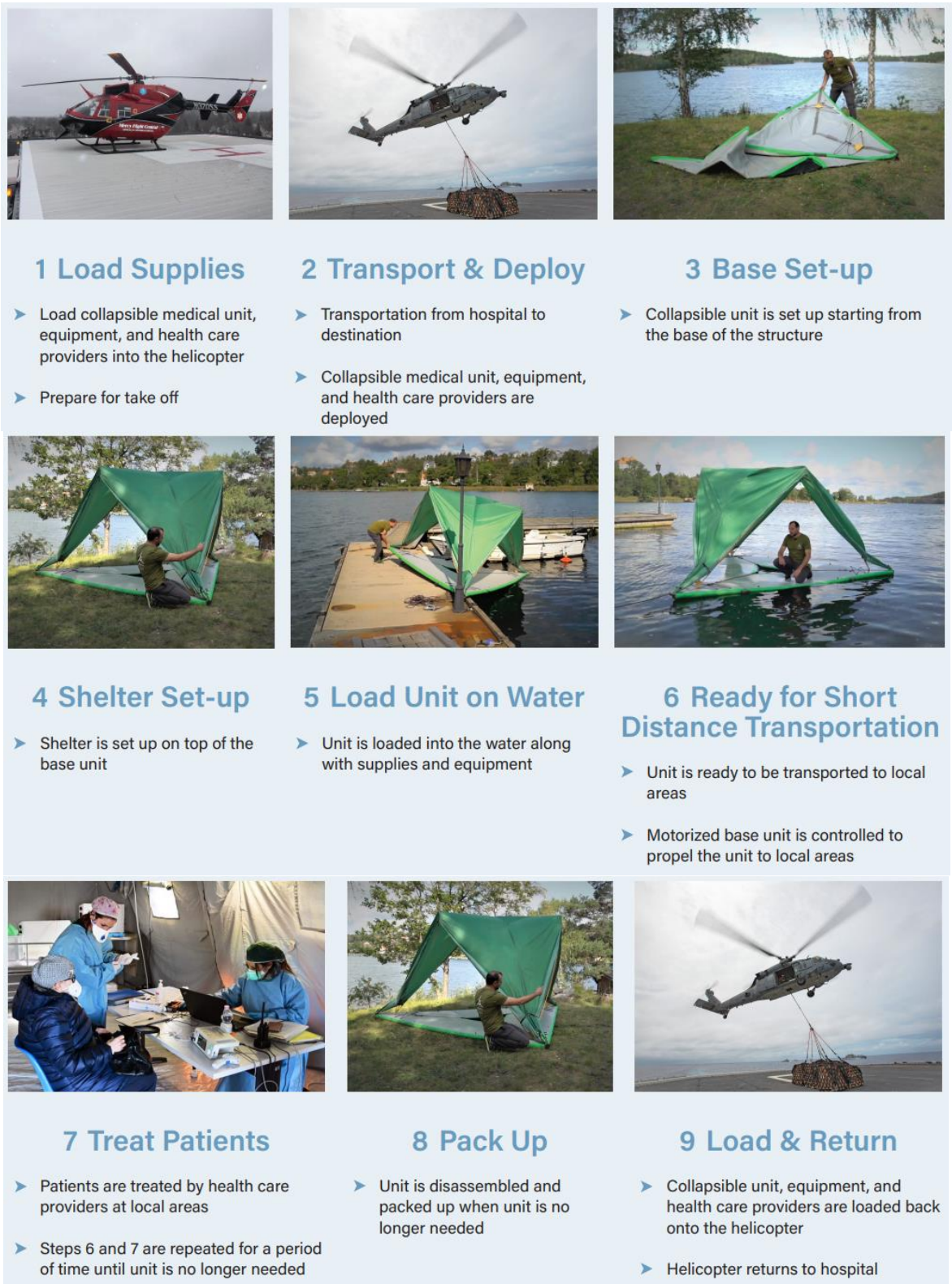


Figure 6 – Workflow Mapping

3.2.2 Activity – Experience Mapping

An observational video is prepared and shared with a user to gain insight into the user's goals, experiences, and attitudes. The chosen video shows a walkthrough of a patient's experience in an emergency department and what you should expect throughout the process and steps that the patients take to treat an illness or injury. The video helps the secondary user remember or relive their emergency room experience and determine any possible pain points that they might have had during their hospital experience. The remote user observation will also aid in the design and ergonomic considerations in the design process of this thesis project. A user observation is conducted, and those results are analyzed through creation of a User Journey Map.

	Stage 1 Concerns	**Stage 2** Entering the ER	**Stage 3** Triage	**Stage 4** Registration	**Stage 5** Treatment	**Stage 6** Completion
User Goals	Going to the ER to determine cause	Easy navigation through the ER	Determine severity of the condition	Provide necessary information	Run tests, provide medicine, etc.	Leaving the ER with effective treatment
User Actions	- Driving to ER	- Welcomed into ER by a greeter - Directed to the triage lineup and wait to see a triage nurse	- Enter a triage nurses office - Blood pressure taken - Temperature is taken - Oxygen level is taken - Goes back to waiting room	- Called to registration from the waiting room - Provide necessary information (health card, etc.) - Sent back to waiting room to wait to be called on again	- Called into the ER from the waiting room - Tests are run (blood test, urine analysis, EKG, X-rays, CT scans, etc.) - Tests may determine conditions that need operation for treatment	- Once treated and discharged, patient can leave the ER - Sometimes, patients leave without knowing what the cause of their health concern was
Storyboard/Photos						
User Experience (Rate 1 – 5 1-Good, 5-Bad)	5	5	4	4	2	1
Problems	- Having a health concern that may or may not be serious - Needing to travel to the hospital in a bad condition	- Waiting for long periods to be seen by a nurse - Not knowing where to go when initially entering the facility	- Feeling uncomfortable or pain - Uncomfortable seating or bedding - Further waiting for instruction	- Getting up from seating and travelling to a separate office for registration - Further having to wait before treatment	- Travelling to another area in the facility - Tests can take long - Uncomfortable seating or bedding - Further waiting for test results and treatment	- Leaving without being treated - Leaving without knowing the cause of your condition
Ideas/Takeaways	- Non-serious injuries can be treated outside of the hospital - Eliminate the need for ill or injured patients to commute to the hospital	- A more efficient facility layout that is easy to follow	- Wait times can be long and uncomfortable seating would worsen a patient's ER experience - More ergonomic seating and bedding for comfort	- Minimize the need to travel to other offices and departments	- Minimize the need to travel to other offices and departments - More ergonomic seating and bedding for comfort - Non-serious illnesses and injuries can be treated faster - More serious illnesses and injuries may need further treatment such as operations or long-term treatment	- Non-serious illnesses and injuries can be treated more effectively

Table 7 - User Journey Map

After taking multiple trips to the emergency room for different health concerns, the user was able to determine certain details and challenges that they had often experienced during their time at the ER.

3.3 Human Factors

Flooding is the most frequently occurring natural disaster in the world and has resulted in loss of lives, serious injuries, and spread of disease within many regions worldwide. Masses of people endure illnesses and injuries after experiencing the effects of flood disasters, requiring immediate medical attention to survive. But many people in flooded regions have little to no access to available healthcare to aid in their recovery or survival. To improve the availability of healthcare in regions that experience flood disasters, a temporary collapsible clinical unit was designed to provide areas with access to healthcare to treat minor injuries and illnesses. This unit includes inflatable and foldable features that allows large parts to be easily deployed in flooded areas. The ability for these parts to be manually collapsed and packed for air transportation allows for accessibility and efficiency when needed. A 1:1 3D model of this collapsible clinical unit was created to aid in this ergonomic study to determine key human interaction factors and ergonomic features. As a result of conducting this ergonomic study the key findings that were determined were that the set-up process of the unit requires two people to set up the shelter onto the base due to its size. The short distance travel method may need further considerations for safety and security for the driver as the rear view is obscured by the shelter.

Literature Review

This ergonomic analysis study was conducted about the human percentile studies presented in Henry Dreyfuss' Measure of Man. The references for 2.5th percentile females and 97.5th percentile males were taken to assess the anthropometric measurements and limitations of these percentiles. References for seat dimensions and positions were also taken from diagrams in the Measure of Man human factors literature. These diagrams showed the average seat height, depth, and angle for the best seat comfort and ergonomics which was considered during the modelling stage of this evaluation. Shelter size and multiple user accommodations were referenced from online design and architectural resources including Sina Architectural Design and The Ontario Building Code. Average ceiling heights and entrance dimensions discussed within these articles were considered within the 1:1 scale model to determine the shelter dimensions. Information for lifting height, positions, and weight were also taken from references from Henry Dreyfuss' Measure of Man as well as The

Health and Safety Authority guidelines. The differences between lifting heights and lifting positions between the 2.5th percentile female and the 95th percentile male were assessed to determine limitations for the deployment and removal of the collapsible unit.

Methodology

Objective(s)

The purpose of this ergonomic evaluation is to determine the challenges of full-bodied human interaction when using the collapsible clinical unit. This assessment will focus on three major body part areas that interact with the product during its use to determine a full-bodied human interaction. The evaluation method will be used to determine ergonomic challenges and further necessary considerations that will benefit the final concept.

Decision(s) to be made

The necessary full-bodied human interaction aspect of design is addressed in this ergonomic analysis through the interaction with three major human body part areas. This evaluation will aid in improving the human experience regarding the use of the collapsible clinical unit, through the necessary processes:

1. Manual Inflation of the base (feet, legs, hands, and arms)
2. Setting up the folding shelter (hands and arms)
3. Attaching the motor (hands and arms)
4. Interacting with short distance travel controls (rear, back, legs, arms, and hands)

Description of Users

As the highest percentage of flood disasters occur within Asian countries, the targeted demographic that this report focused on were male or female healthcare professionals in Asia. These users range between 25 to 50 years and earn an upper-class income level with a university level educational background in healthcare. They work as healthcare professionals daily, working an average of 40 to

60 hours per week, collaborating with other healthcare workers in a hospital environment within a community.

Evaluation Process

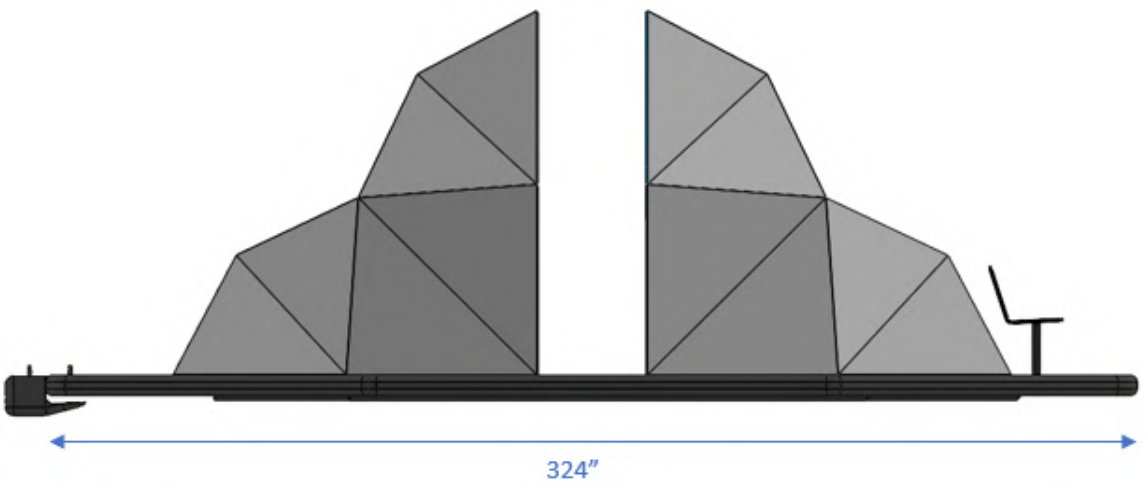
The evaluation process consisted of designing and creating a full 1:1 scale ergonomic model representing all aspects of the concept. This model helped to determine ergonomic challenges and considerations for further concept development through observing the following:

1. Deploying collapsible parts (set-up and take-down)
2. Short distance travel driver's field of view
3. Shelter size and accommodations (4-6 people)
4. Identifying human factors including dimensions and limitations regarding the product

Description of User Observation Environment Used in this Study

This thesis project is focused on the deployment of a temporary collapsible unit which accommodates for approximately 4-6 people. As this unit is large scale with multiple working parts that come together, a 1:1 scale 3D computer aided design (CAD) model was created using the SolidWorks program instead of a physical model. CAD models of scaled human figures were used to replicate the 5th percentile female and 95thpercentile male users. These scaled models were positioned and observed at each step of the process to mimic the user interacting with the product.

Results



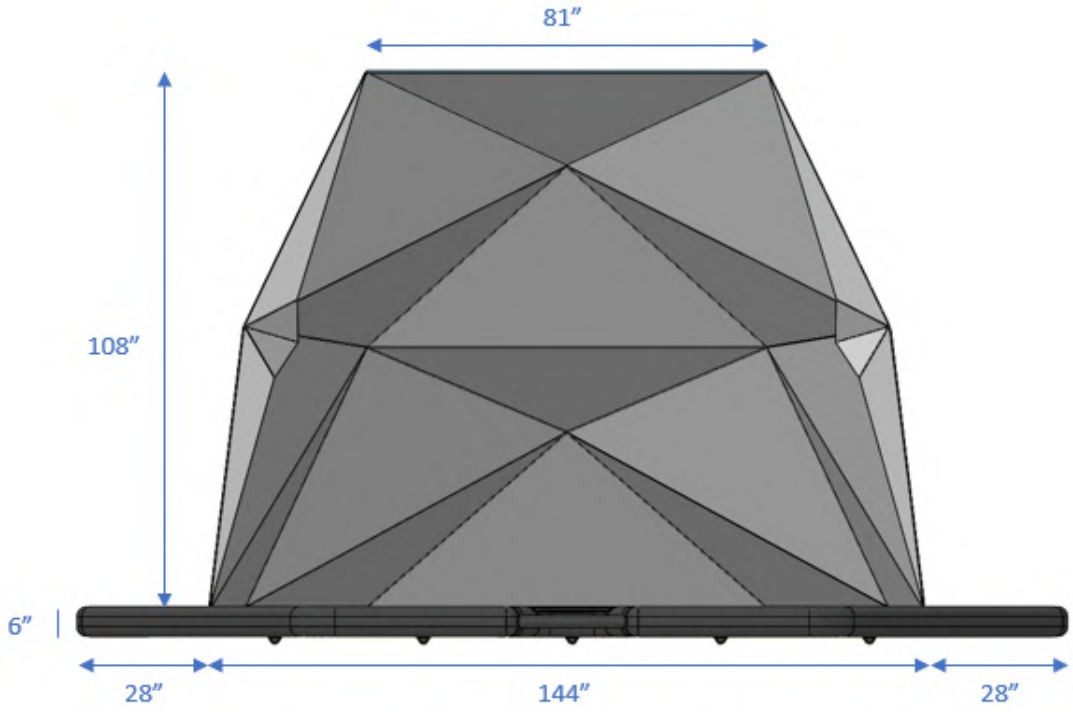


Figure 7 – Collapsible Medical Shelter Measurements 1

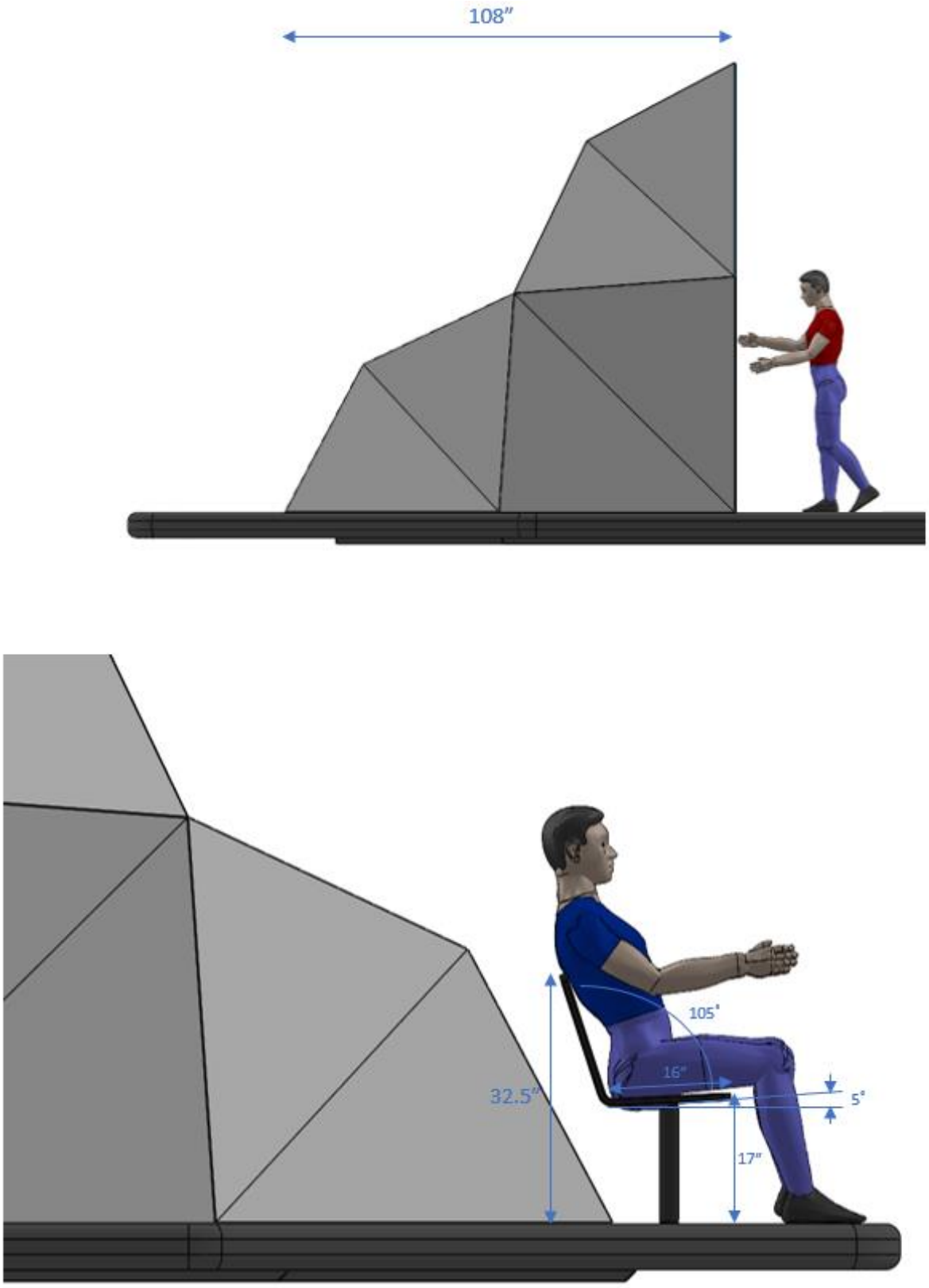


Figure 8 – Collapsible Medical Shelter Measurements 2

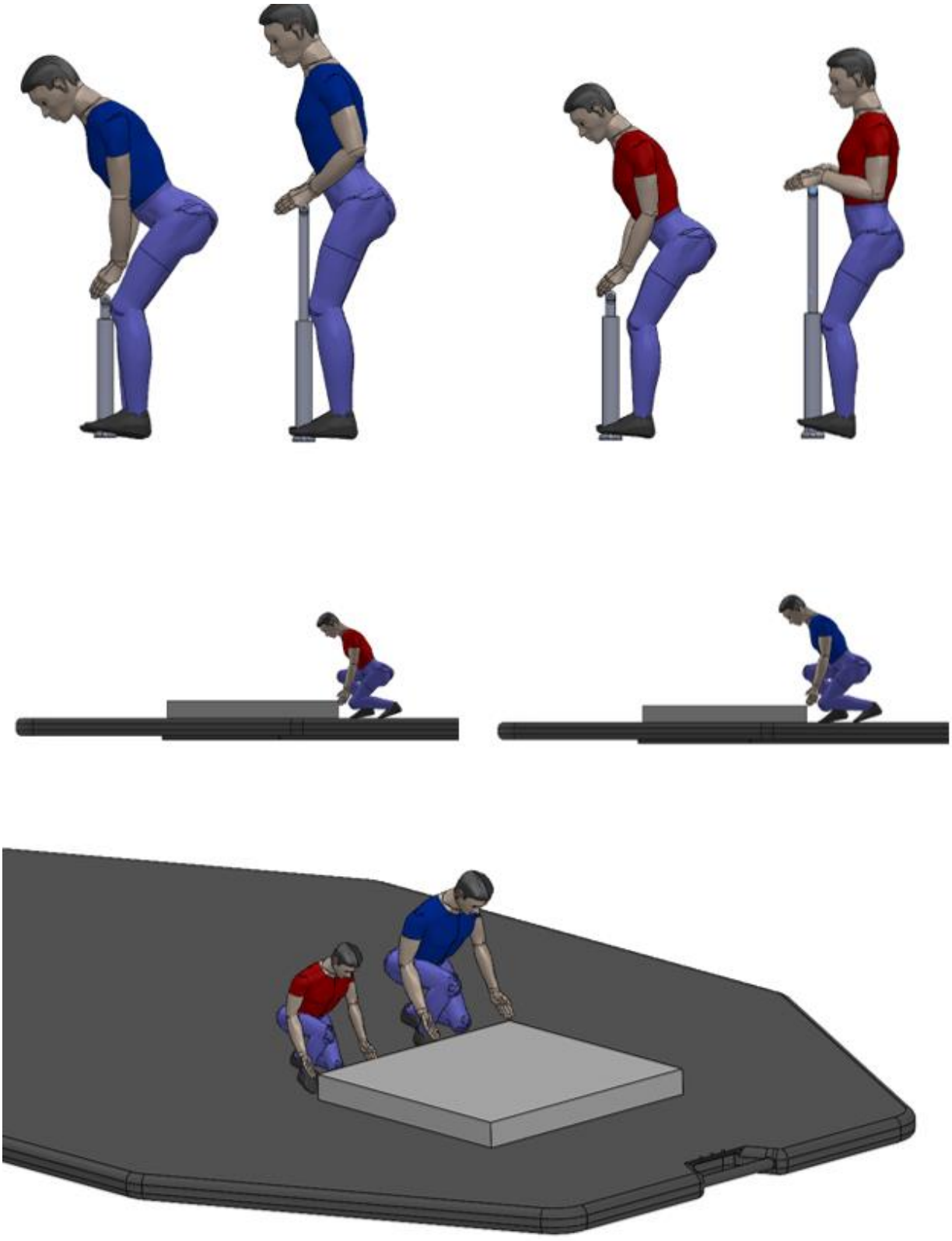


Figure 9 - Product Collapsibility and Assembly 1

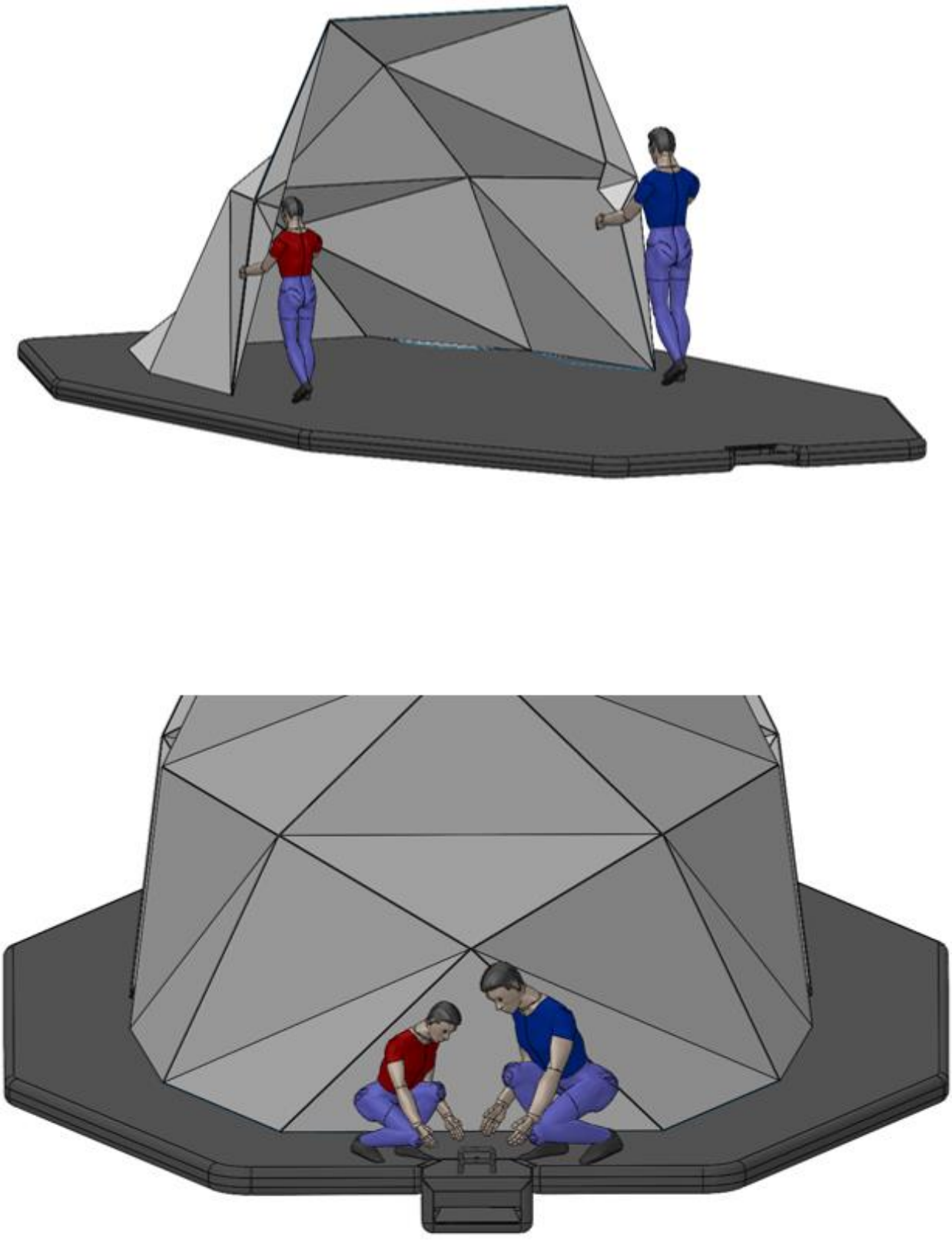


Figure 10 - Product Collapsibility and Assembly 2

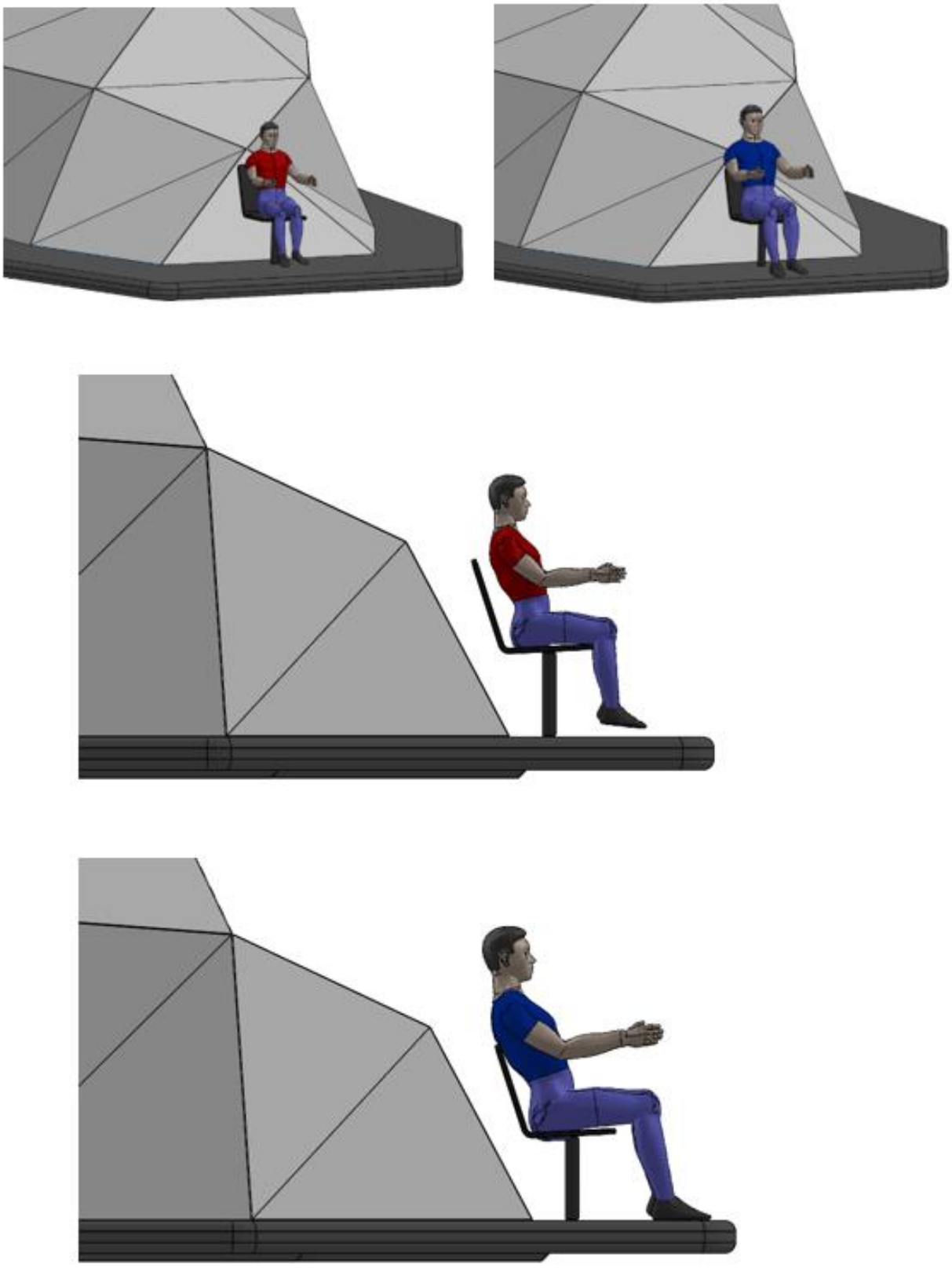


Figure 11 – Product Use

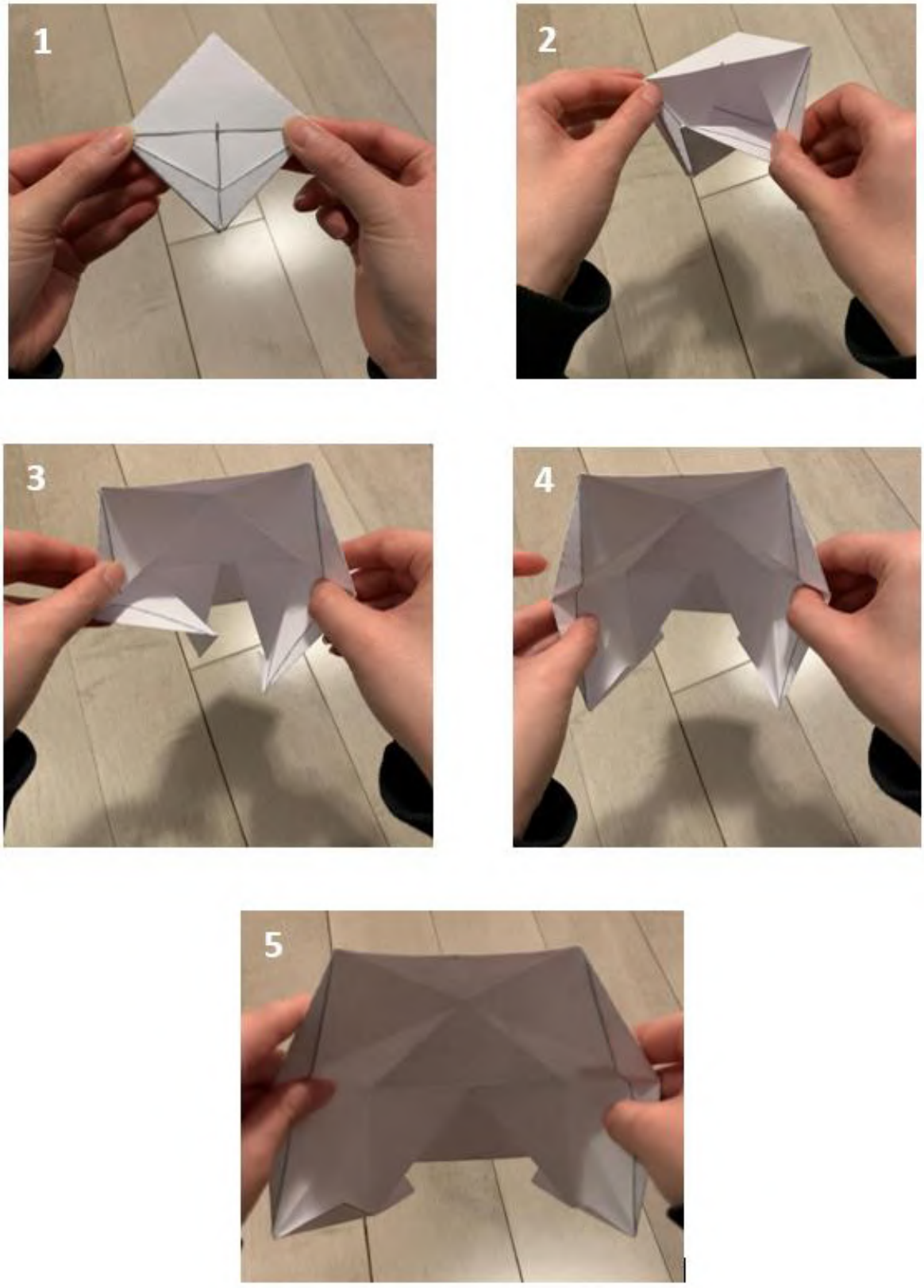


Figure 12 – Collapsible Origami Pattern Mock-up

Analysis

The 1:1 ergonomic scale model was modeled using the SolidWorks 3D modelling software. Scaled human figures were specifically positioned in different areas and sections of the collapsible unit to represent the different steps taken throughout the product deployment process. Human interaction and ergonomics were observed as the scaled human figures are positioned replicating the each of these steps in the process:

1. Inflating the base
2. Unfolding the shelters
3. Attaching the motor
4. Short distance travel

Inflating the Base

The inflatable base is a large platform that inflates into a rigid base that floats on top of a body of water. This platform is designed to support two collapsible origami shelters that connect and attach onto the base. A motor attachment feature is built into the base at the rear end of the platform to support and secure the motor for short distance travel. As this base is necessary for supporting the two shelters, motor, and up to six people, it is a large 324” x 200” platform. This platform size allows the necessary space for the shelters to accommodate four to six people within as well as deck space around the sheltered area for people to access the motor and control seating. The platform deck is approximately 34” wide to accommodate for users travelling to different sections of the unit.

Unfolding the Shelters

The collapsible shelters are foldable origami patterns that fold into a half dome from a single folded 58.5” square. From the folded position on the platform, two people are needed to fully unfold the pattern into the large room sized shelters. The origami folded shelters are sized according to the standard ceiling heights for homes as well as the building codes of Ontario, which are between 8’ and 9’ (Standard Ceiling Heights for Homes, n.d, Building Code Requirements, 2019). The folded

origami square unfolds into a large shelter with the base dimensions of 144” x 108” and a height of 108” to accommodate for tools and supplies as well as space for the users. The unfolded origami shelters are placed and secured in the center of the platform at 32” apart to allow users to enter and exit the sheltered area. According to the Ontario Building Code Requirements, entryways must be a minimum of 32” (Building Code Requirements, 2019). The 32” space between these shelters would be covered by a water-resistant fabric material that forms a fully enclosed shelter allowing the entrances to be opened or closed for privacy.

Attaching the Motor

The motor attaches to the rear of the platform to propel the unit through the body of water in which it is situated during short distance transportation. It secures onto a locating feature on the platform base and needs to be screwed on for extra security. The motor itself may be larger than other motors as it needs the necessary strength to propel the large unit through bodies of water. It is dimensioned at 24” x 23.5” and features two carrying handles on the top side of the motor for easy transportation and assembly. The two handles are spaced 12” apart for easy maneuvering and angling of the motor for ease and efficiency when securing the motor onto the platform.

Short Distance Travel

The collapsible unit can be temporarily deployed in different areas and is able to travel short distances from one area to another if needed. The motor propels the unit from the rear while the operator or driver of the unit controls the speed and direction of the travelling unit from the front of the platform. A seat is situated at the front of the unit for the user to rest while operating the motor over short distances for a short period of time. The seating position is referenced from the conventional straight chair diagram from Henry Dreyfuss’ Measure of Man as this seating feature will only be used for a short period during each use. The seat is 17” high, angled at 5˚, the seat depth is 16”, and the backrest is 32.5” high, angled at 105˚ regarding the seat angle (Dreyfuss, 1966). These

standard seating dimensions would be appropriate for both 5th percentile female and 95th percentile male to use during a short distance travel.

Limitations and Conclusions

The limitations and challenges that limited product use and effectiveness were observed:

1. At least two people are needed to deploy the collapsible unit
2. The origami form of the shelter decreases the amount of effective interior space that can be used
3. The motor operator at the front of the unit does not have a clear rear view

Ergonomic Issues that Are Still Unresolved

Some issues that are still unresolved after conducting this ergonomic analysis report regarded convenience, spatial requirements, and user ergonomics. Due to the large scale of the deployable temporary unit, the origami folding shelters need two people to fully unfold and secure the shelter onto the platform. As the origami folding pattern unfolds from a smaller square unit into a large half dome shape, the half dome has an angular ceiling which decreases the amount of interior space nearing the back of the shelter. If the origami pattern did not have such an angular ceiling or shape, the interior space could be used much more effectively. During short distance travels, the motor operator at the front of the unit is unable to have a clear rear view as the unfolded origami structures obscures any view behind the unit. The origami shelters may need to be collapsed before the unit departs on short distance travels.

Alternate Possibilities for the Future

Based on the current study, possibilities for alternate options that can be conducted in the future to improve product and human observation include creating a 1:1 scale physical model to determine further in depth ergonomic and human interaction observations. A 1:1 physical scale model can help identify more ergonomic issues and challenges observed in the designed concept.

This ergonomic analysis report helped determine interaction and ergonomic challenges that users may experience during each step of the collapsible clinical unit use process. The observations including 5th percentile female and 95th percentile male models were used to represent steps for setting up the unit, taking it down, and operating short distance travel. These observations were able to help establish limitations, convenience of use, and ergonomics regarding the human interaction using three major body part areas. These findings helped to determine further considerations for the final design and development of this thesis project.

3.4 Aesthetics and Semantic Profile

The collapsible medical shelter solution is designed to accommodate for up to four persons including two healthcare workers and two patients. A platform is designed around the shelter to allow for movement to and from the front and rear ends of the base. A driver can access the instrument panel from the platform where short distance travel between areas can be controlled. The platform around the shelter also allows the user to access the motor for assembly and disassembly purposes. The For ease of transportation and deployment, the shelter parts can disassemble and collapse. Throughout the research process of this thesis project, benchmarked products were analyzed to determine possible functions and technologies used for the collapsible medical shelter concept. After testing out multiple origami folding patterns and techniques, a final origami pattern was decided as the best fit option for the collapsible shelter design. Research for different materials was conducted to determine the ideal material for a large-scale origami folding shelter. The inflatable base was inspired by current benchmarked products including floating platforms. A technology called drop-stitch construction was chosen for the inflatable base of the collapsible medical shelter due to its high-rigidity and ability to deflate and fold away for storage purposes. All structural parts are manufactured with aluminum for strength and weather resistance.

3.5 Sustainability – Safety, Health, and Environment

Flooding is the most frequently occurring natural disaster in the world and has resulted in loss of lives, serious injuries, and spread of disease within many regions worldwide. Masses of people endure illnesses and injuries after experiencing the effects of flood disasters, requiring immediate medical attention to survive. But many people in flooded regions have little to no access to available healthcare to aid in their recovery or survival. To improve the availability of healthcare in regions that experience flood disasters, a mobile healthcare unit was designed to provide areas with access to healthcare to treat minor injuries and illnesses. Climate change and global warming from pollution increases the risk of flood disasters. Sustainable initiatives for product development regarding materials and manufacturing methods are necessary to reduce the effects of pollution on the health and safety of people and the environment. Manufacturing materials and methods, usage, and disposal of parts of the deployable mobile healthcare unit are important factors to be considered for the level of safety and sustainability of the overall product.

Literature Review

This sustainability report investigates the purpose for safety and sustainability methods and how taking these initiatives can benefit both user and environment health and safety. Understanding environmental and user health and safety issues are essential to determine sustainable ways to reduce negative effects that are harmful to people and the earth. According to Product Design and Sustainability, the number 1 environmental threat is global warming and climate change due to the rise in temperature from carbon dioxide, methane, and nitrous oxide emissions. The changes in climate produce an increase in natural disaster frequencies and their effects, including flood disasters, along with many other negative effects on the environment (Penty, 2019). Initiatives to reduce harmful emissions through alternative solutions can benefit the health and safety of people and the environment. The use of eco-effectiveness in design and product development is a guide to

living more sustainably as each aspect of a product lifestyle is regarded. Product lifestyle mapping and analysis includes material processing, manufacturing and assembly, distribution and sales, product use, and end of usable life (Penty, 2019). Benchmarked products including the CLAF Bio Fabric, Mission Reef Mat, and Origami Half-Dome Structure were analyzed to determine possible materials. Further research and analysis on each material and their manufacturing processes was conducted using multiple specific references and sites.

3.6 Feasibility and Viability

Materials and Manufacturing

Materials

Most of the components that make up the mobile healthcare facility unit are collapsible parts that can fold and package together for easy transportation and deployment. These parts include the base platform, folding shelter, shelter structure and securing parts, and the safety guard rails. Through benchmarking products, materials were determined that were suitable for the development of each component. An inspired product for the base platform was the Mission REEF inflatable mat, made with 1000D nylon with a drop stitch construction and reinforced seams for durability and rigidity (MISSION, n.d.). The shelter is foldable into a specific pattern and may require living hinges to do so. The most ideal lightweight material to produce living hinges is polypropylene plastic formed into sheets that can be shaped and connected to form the required folding pattern. Structural and securing parts for the mobile healthcare unit would ideally be made from aluminum as its durable and lightweight qualities would be beneficial for ease of transportation and deployment of the unit. The mesh guard rails for safety are often made with high-density polyethylene for water resistance and durability, although there are other more sustainable alternatives for mesh such as bio fabrics (Xingying, n.d.).

Manufacturing

The manufacturing processes for each component is different depending on the materials that are used to produce them. The base platform of the mobile healthcare facility unit is manufactured using a PVC lamination process, applying a woven drop stitch technology to the top and bottom of the inflatable board, and double reinforced seams to create an airtight seal (Starboard, n.d.). The folding structures are injection molded polypropylene, which is ideal to create the functional living hinge features (Plastics Today, n.d.). The manufacturing process used to produce the aluminum structural parts is the sheet and plate process, while the aluminum brackets are casted (The Aluminum Association, n.d.). The safety guard rails are extruded polyethylene (Xingying, n.d.).

Sustainability

Benchmark sustainable initiatives

There are many sustainable initiatives that other companies currently take to make their own products more sustainable. Some benchmark sustainable initiatives regarding similar materials and processes include incorporating recycled nylon into nylon products to reduce greenhouse gas emissions during manufacturing (Patagonia, n.d.). Econyl is nylon taken from waste in landfills and oceans and can be infinitely recycled for production (Truscott, 2020). The use of reusable and recyclable materials such as polypropylene and aluminum are also ideal. Aluminum is considered a sustainable metal as it is 100% recyclable and increases sustainable use of energy (The Aluminum Association, n.d.). An alternative to extruded polyethylene plastic for outdoor mesh safety products is biobased mesh. CLAF manufactures a USDA certified biobased mesh made with resins derived from renewably sources sugarcane plants and is 100% recyclable (CLAF, n.d.).

Health

Product manufacturing often includes processing materials that contain toxic chemicals and gases which are released from the facility causing air, water, and soil pollution. People working within

manufacturing facilities, those outside of the facilities, and the environment are negatively affected by pollution. The health of both people and the environment can be improved by using sustainable materials that do not contain harmful chemicals or produce harmful emissions during manufacturing and disposal processes. Using renewable and recyclable materials such as aluminum reduces the amount of greenhouse gases emitted as it reduces the am0unt of waste sent to landfills, conserves natural resources, prevents pollution, and saves energy.

Safety

Safety measures must be considered to ensure the safety of users when interacting with the mobile healthcare facility unit. As these healthcare units are deployed in regions that have experienced flood disasters, they would be situated on debris filled flood water. Debris in the water can cause injuries while the water may contain bacteria and chemicals that can further infect wounds or cause illnesses and diseases (World Health Organization, n.d.). Safety features including mesh guard rails are incorporated into the mobile healthcare unit to prevent users from falling off the unit and into the dangerous waters. Guard rails are often used to prevent falls over an unprotected edge and are required for safety where one can fall over the edge into a hazardous space or water (CCOHS, n.d.).

Sustainability Statement for Final Design

After conducting research on current benchmarking products, materials, and manufacturing processes, multiple alternative and sustainable solutions were found. Materials made from renewable resources and maximizing the use of recyclable materials will be incorporated into the final design of the mobile healthcare facility unit. Sustainable solutions for the manufacturing of major components of the mobile unit include the use of Econyl recycled nylon material for the base platform. Recyclable polypropylene will be used for the foldable shelters, recyclable aluminum for structure and securing parts, and biobased mesh will be used for the safety guard rails. Sustainable

solutions were taken into consideration for each component of the mobile healthcare facility to maximize the sustainability of the unit and to reduce the carbon footprint created throughout the product's lifecycle.

Conclusion

Investigation of materials and manufacturing methods was conducted to determine possible solutions for design development and production of the mobile healthcare facilities for post flood disasters. Benchmark products were analyzed to determine any current or new materials and manufacturing processes used. When materials and manufacturing processes were determined for benchmark products, further research on sustainable initiatives and solutions was conducted. This investigation resulted in the discovery of biobased fabrics and recyclable material alternatives to reduce carbon emissions and the effects of pollution on people and the environment. Using sustainable materials and processes in the design development process of the mobile healthcare facility unit is considered to benefit the environment throughout manufacturing, product use, and disposal.

3.7 Design Brief

Collapsibility

This collapsible medical shelter project focuses on the easy deployment and transportation of the unit. As this shelter is meant to be used temporarily after flood disasters and stored away when unneeded, it can be disassembled into many different parts. These parts include the floating inflatable base, lightweight aluminum structural supports and brackets, collapsible origami structure, rollable mesh guard rails, motor, seating, and control panel. All parts can be assembled and deployed on-site.

Form Factor

The collapsible origami shelter has a very geometric design language based on the form of the origami shelter pattern. The inflatable base takes the shape of the assembled structures which are offset to one side to allow for walking space and access to different sides of the unit. Structural supports and other aluminum parts including the guard rail posts, control panel, and telescopic beam, are also angular and take a similar shape and form as the origami pattern.

Sustainability

There are many sustainable factors within the collapsible origami medical shelter as most materials can be recycled or are made from recycled materials. The origami structures are made from polypropylene which easily be recycled. Aluminum is 100% recyclable and is used to produce most of the structural supports and brackets. The inflatable base is made from recycled nylon and the mesh guard rails are made of a water-resistant bio mesh made from renewably sourced sugarcane plants.

Safety

Due to the location and environment that the shelter will be deployed in, safety features must be incorporated into the design to ensure the safety of both healthcare workers and patients aboard the floating unit. As flood water can contain bacteria and debris, safety guard rails can be attached to the base to prevent people from falling off the structure.

Transportation

The collapsible origami shelter has an optional motor and controls feature to allow for short distance travels between flooded areas. From the instrument panel, the driver can control the motor and drive the shelter to different short distance locations. The deployment process of the unit also requires the

transportation of the parts through air travel. Parts would be dropped off to specific locations where they would be assembled and deployed into the water.

Efficiency

The collapsible origami shelter is made to be efficient and easy to assemble. Locating features for structural supports, brackets, and fastening parts are incorporated into the base allowing for easy location of parts and assembly. The aluminum support structure in between the origami shelters has a set of sliding aluminum panels which allow easy entry and exit from the shelter. The ability to travel between short distance locations allow the healthcare workers to treat as many ill or injured patients throughout different areas during their duration of deployment.

Ergonomics

Ergonomic considerations are made throughout the design process for the collapsible medical shelter. During the research process, standard dimensions for different factors within the structure were determined. The driver's seat and instrument panel dimensions are based off measurements and ergonomic research from Henry Dreyfuss' Measure of Man. For the shelter structure, the standard building code for ceiling height and doorway dimensions were determined and applied to the design. Measurements for the safety guard rails were determined through safety and construction research for average guard rail heights.

Human Interaction

As everything is collapsible or removable, the assembler is required to move into many different positions while fastening supports and brackets and unfolding parts. After assembly, the healthcare workers and patients can interact with the shelter through the sliding door and window features. The people aboard the unit can also travel around the shelter from the driver's corner to the motor side. The driver of the unit is also able to sit in the driver's seat to adjust speed and direction of travel using the control panel.

Water Resistance

As the collapsible origami medical shelter is situated upon water, water resistance features are incorporated into the design to prevent water from entering the structure or damaging the materials. A rubber seal is attached to the base of the origami structure to prevent water from entering the structure and the inflatable base is made from a water-resistant coated nylon material. The guard rails are made from water resistant bio mesh, and all supports, and brackets are made from aluminum which is a corrosion resistant metal.

CHAPTER 4 –
Design Development

Chapter 4 frames the ideation process for this thesis project, including initial ideation, concept exploration and refinement, and physical and CAD model developments. The ideation process, concept exploration and refinement, processes will be completed through hand sketches and renders. The sketch model will be made and assembled by hand using available materials, while the final physical and render models will be developed in CAD before printing and rendering.

4.1 Idea Generation

The ideation development process for this thesis projects includes exploring aesthetic approaches, brainstorming using a mind mapping method, and producing product sketches of idea exploration.

4.1.1 Aesthetics Approach

Styling and aesthetics for this product is inspired by other benchmarking products according to their functionalities.

4.1.2 Mind Mapping

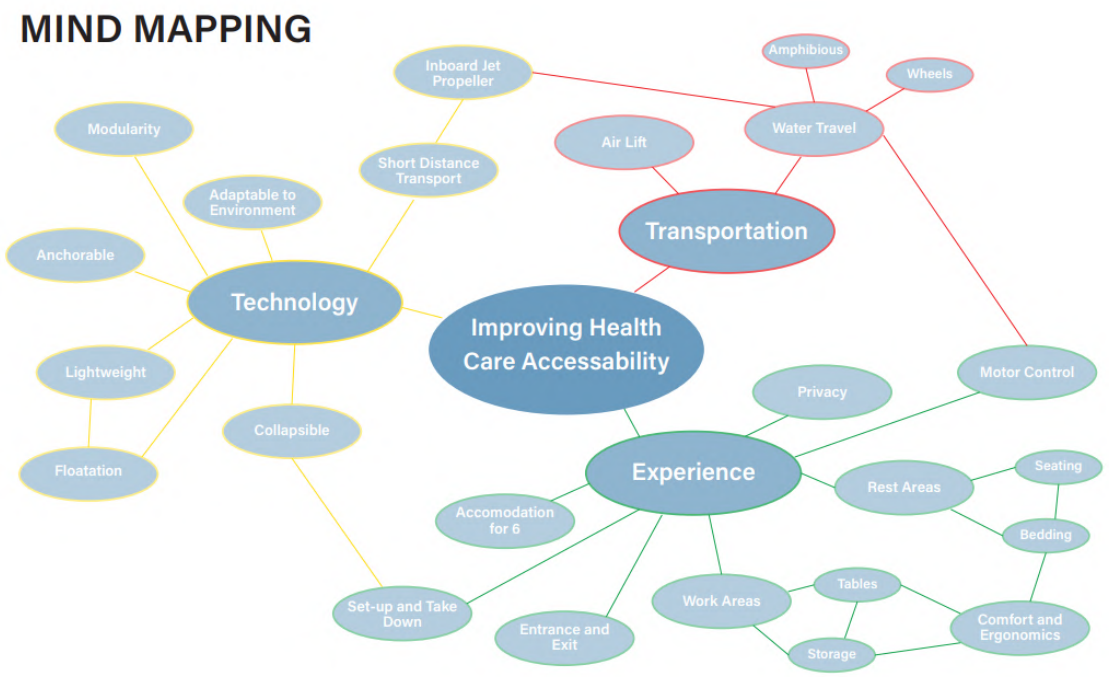
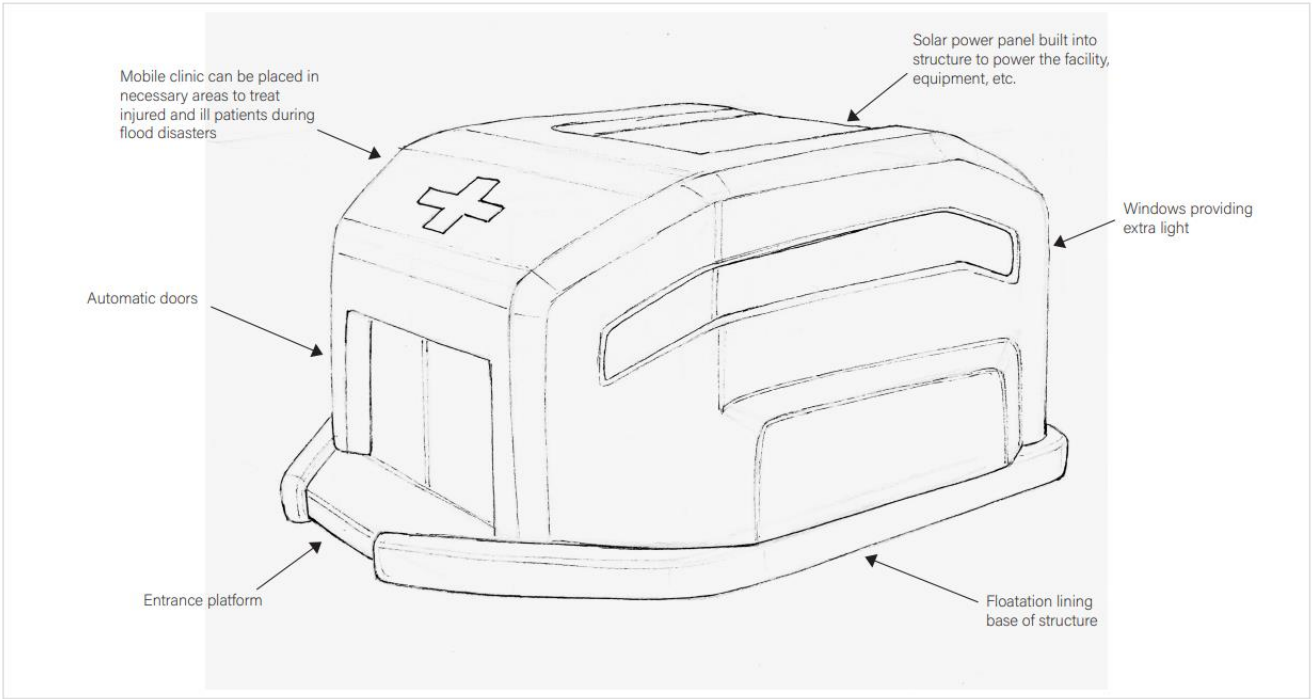


Figure 13 - Mind Mapping

4.1.3 Ideation Sketches

Concept 1 - Mobile Clinic



Concept 2 - Temporary Coastal Clinic

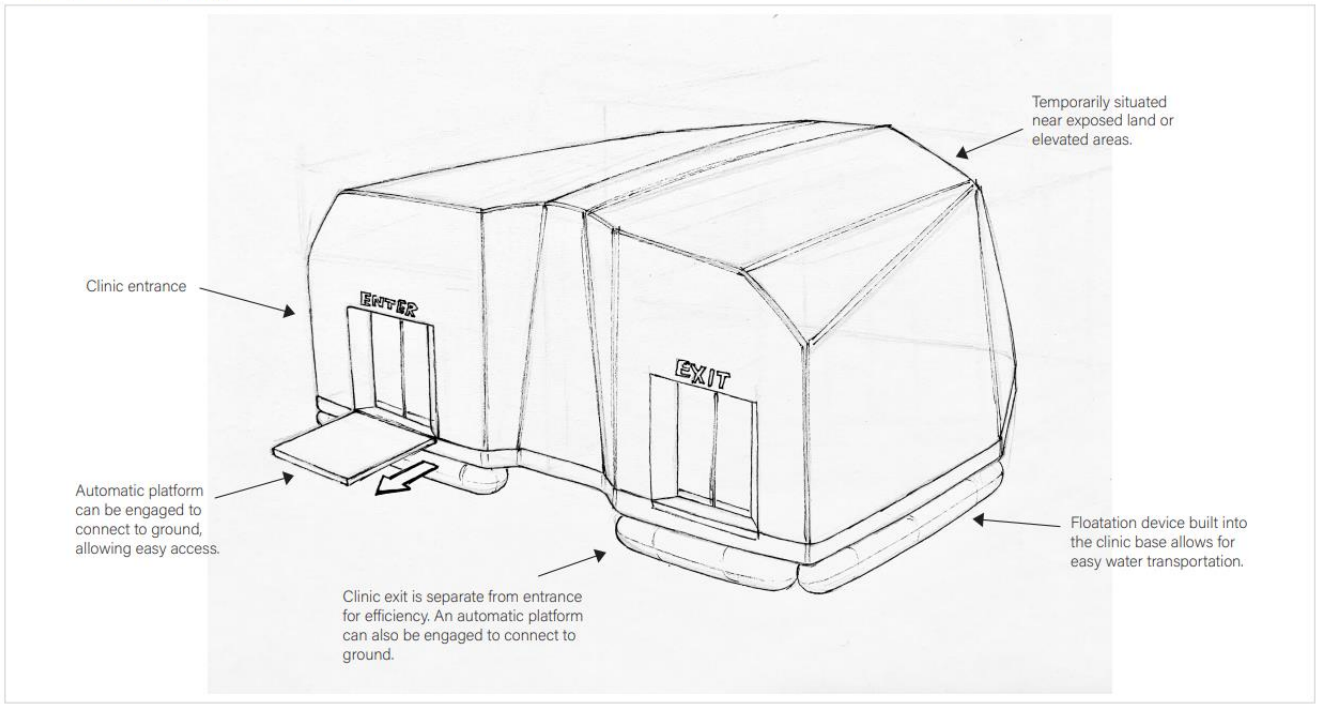
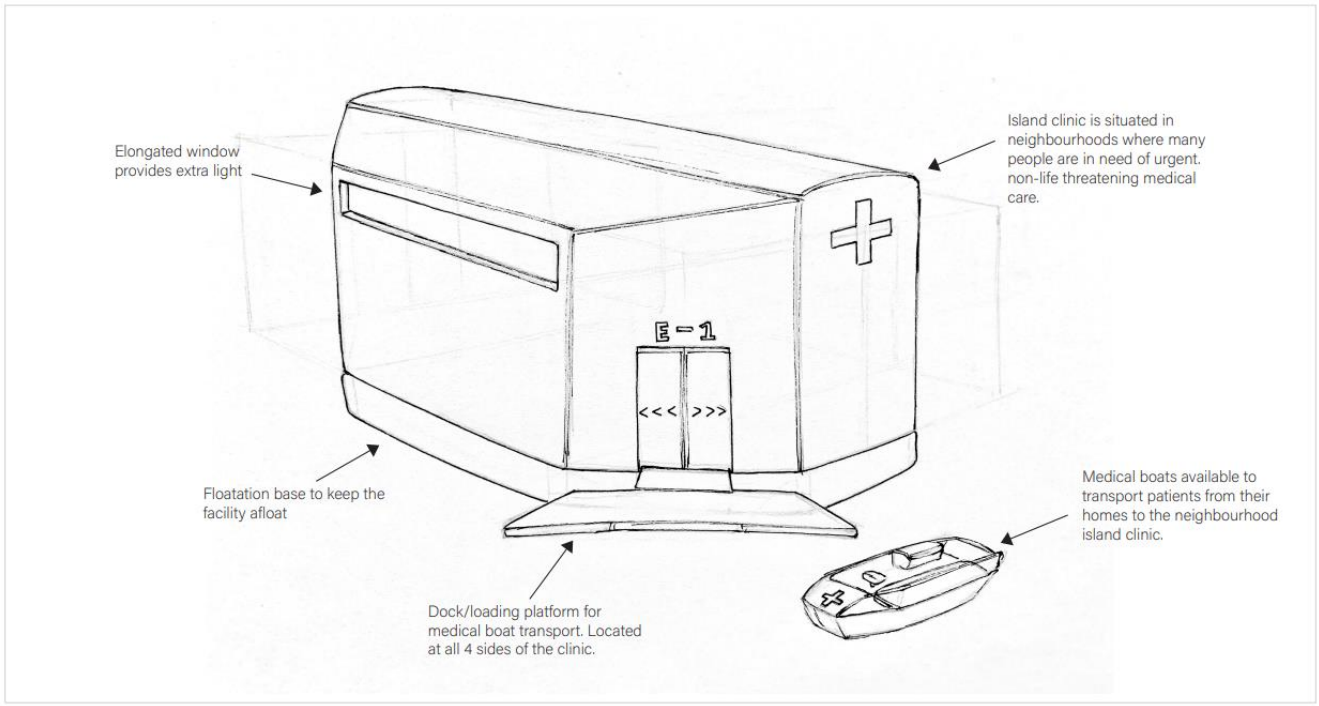


Figure 14 – Idea Generation 1

Concept 3 - Neighbourhood Island Clinic



Concept 4 - Modular Island Clinic

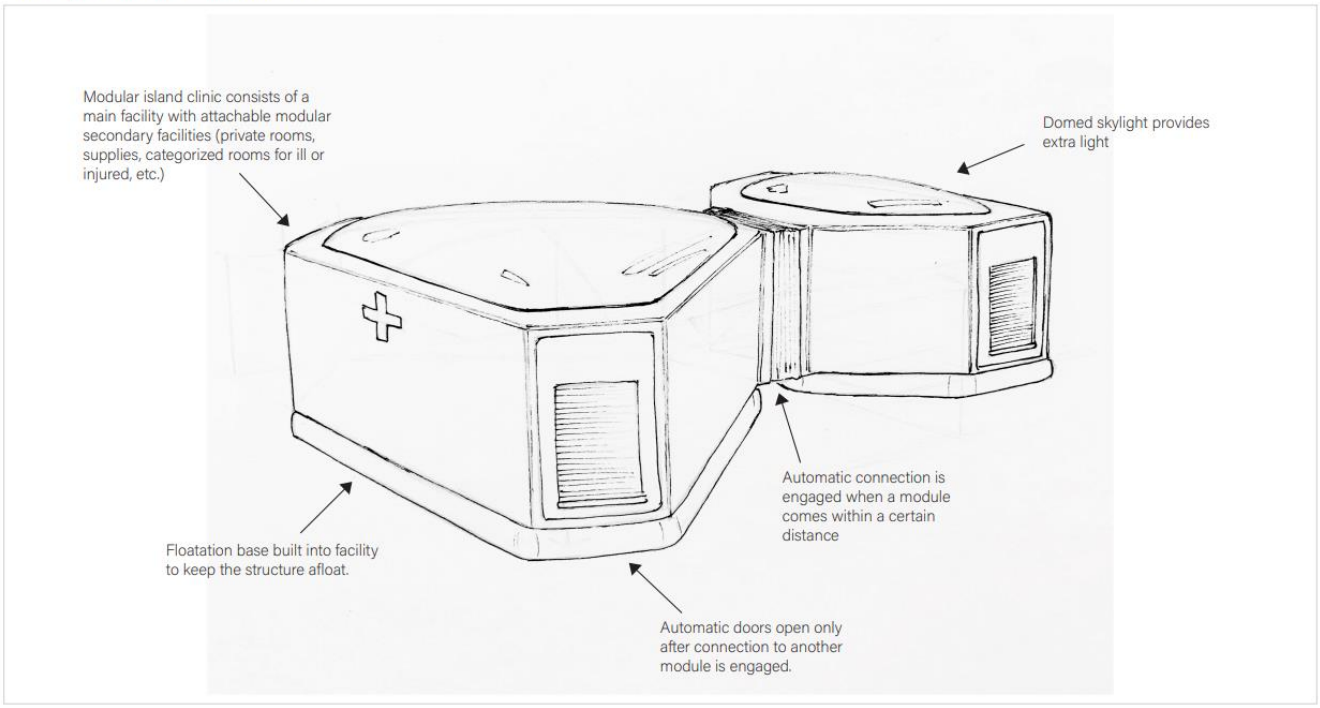
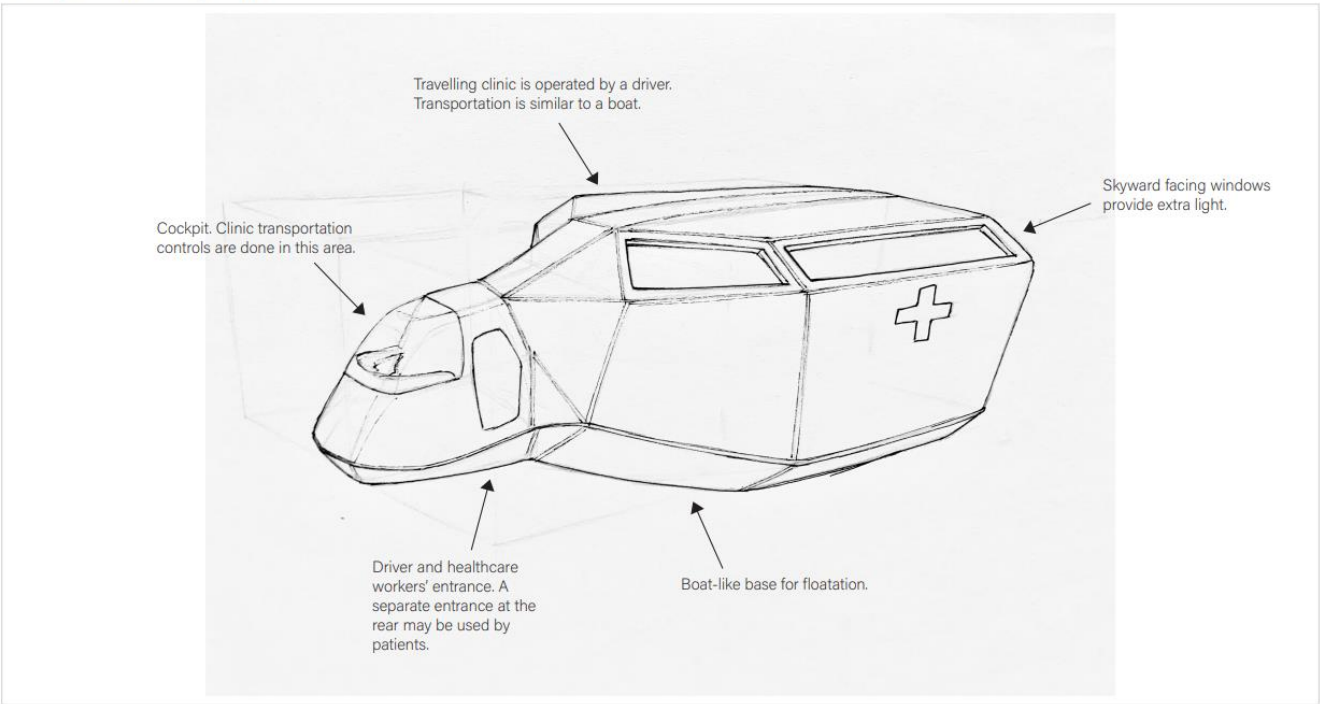


Figure 15 - Idea Generation 2

Concept 5 - Traveling Clinic



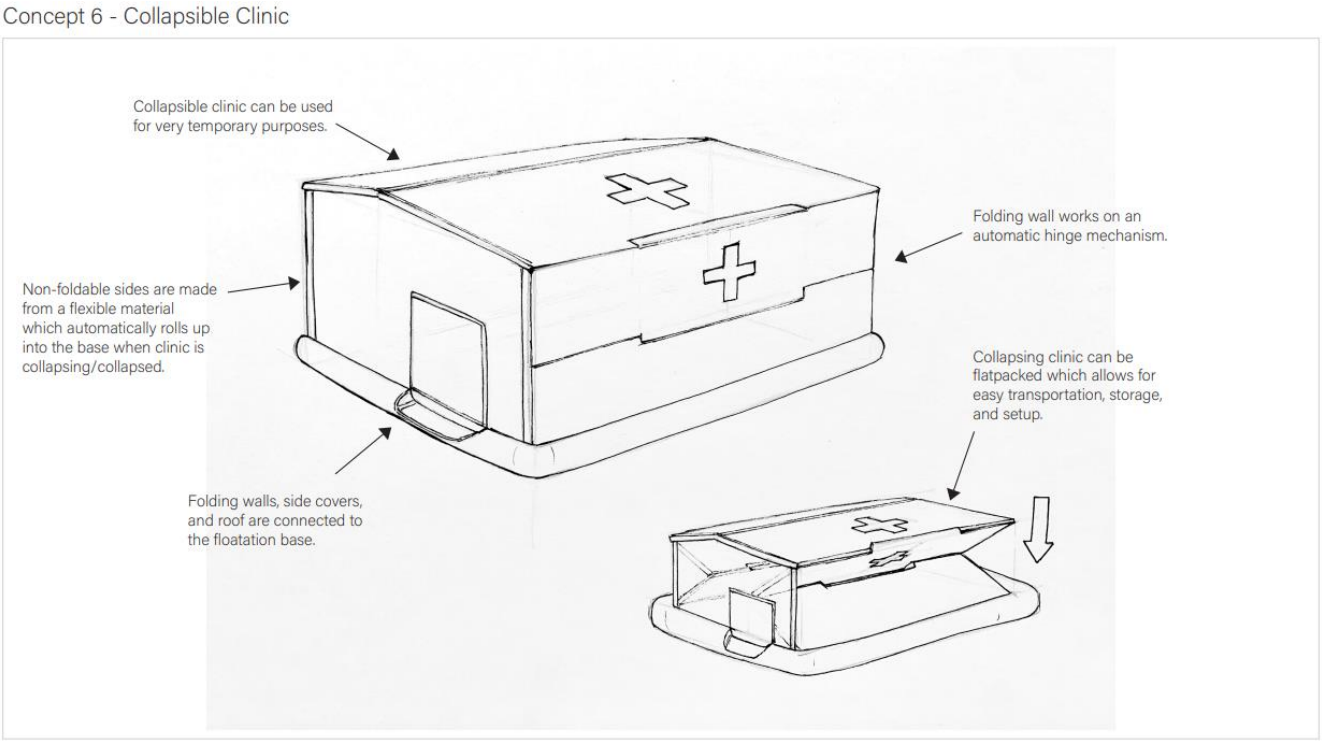


Figure 16 - Idea Generation 3

4.2 Preliminary Concept Explorations

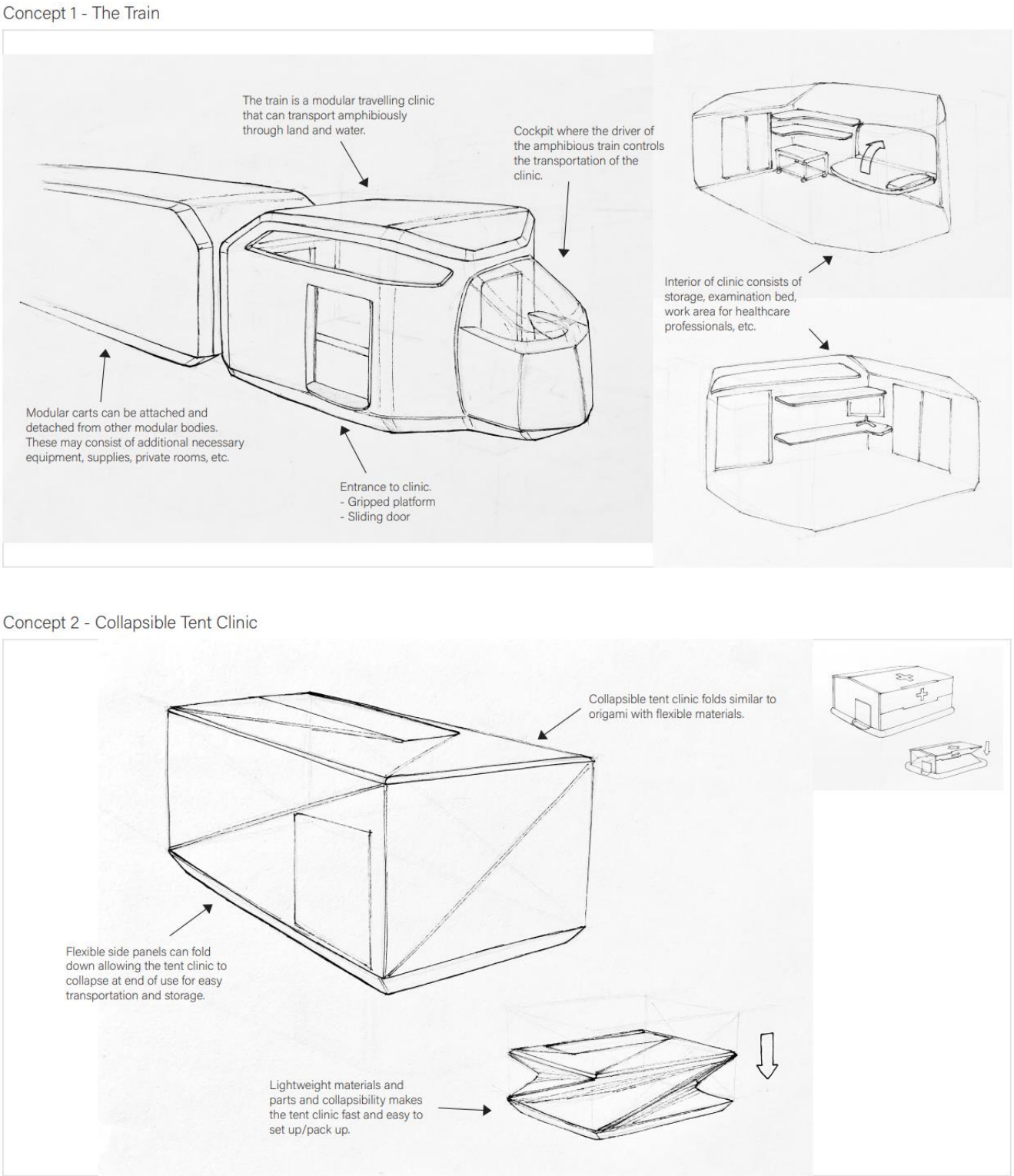


Figure 17 - Preliminary Concept Explorations 1

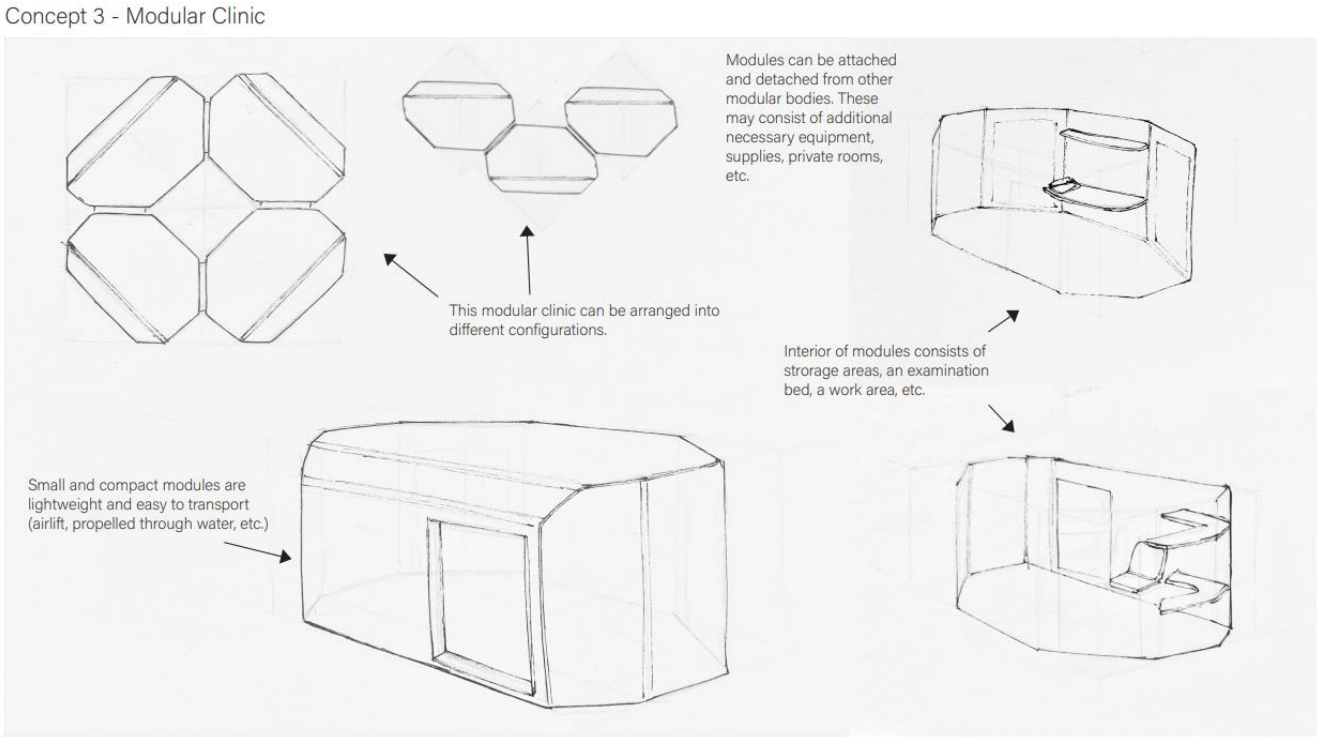


Figure 18 - Preliminary Concept Explorations 2

4.3 Concept Strategy

During this concept development stage, the medical aid shelter is moving toward a collapsible, floating modular type shelter which can assemble and expand in size and space. For ease of transportation and temporary usage, the modules are also able to collapse and disassemble into stackable parts. Each module is designed to accommodate for up to four people including two healthcare providers and two patients.

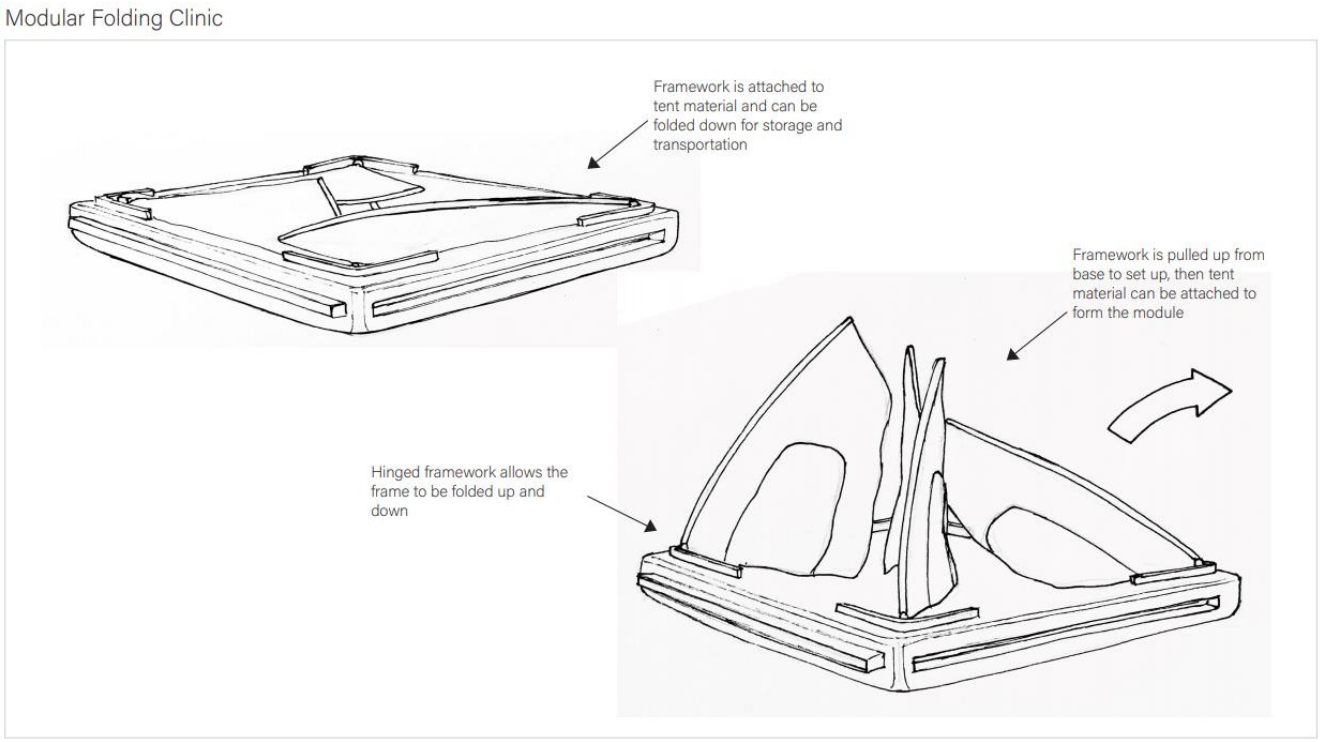
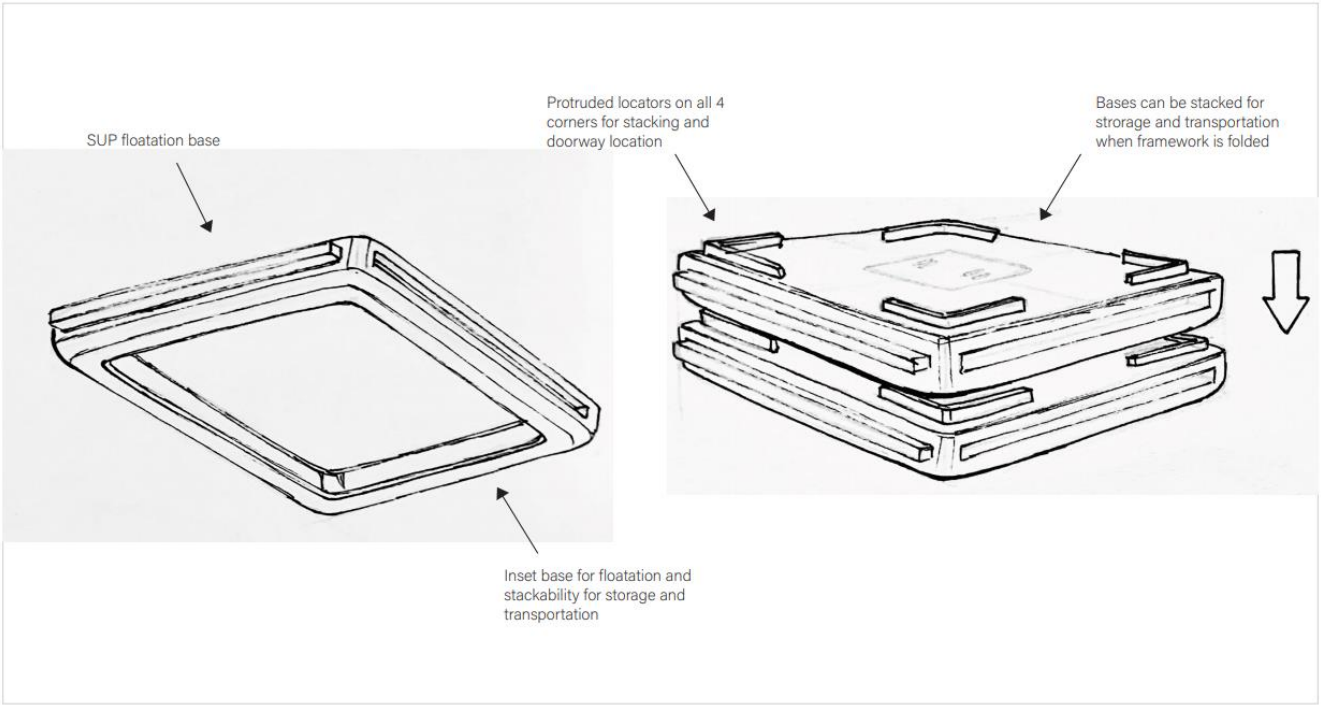


Figure 19 – Concept Strategy 1

Modular Folding Clinic



Product Schematic Concept 1

List of components:	Locations affected by the components:	Configuration Diagram:	Ergonomic Diagram:
- Base - Frame - Cover - Doorway - Folding Hinge	- Interactions - Ergonomics - Functionality - Aesthetics	These diagrams show the possible location of each component that will be included in the product concept. These components will be located based on the function and interaction between the product and user as well as the aethetics of the product.	The purpose of this diagram is to show the size and scale of the product concept. The ergonomic interaction between a 95th percentile male and 5th percentile female are also shown in this diagram.

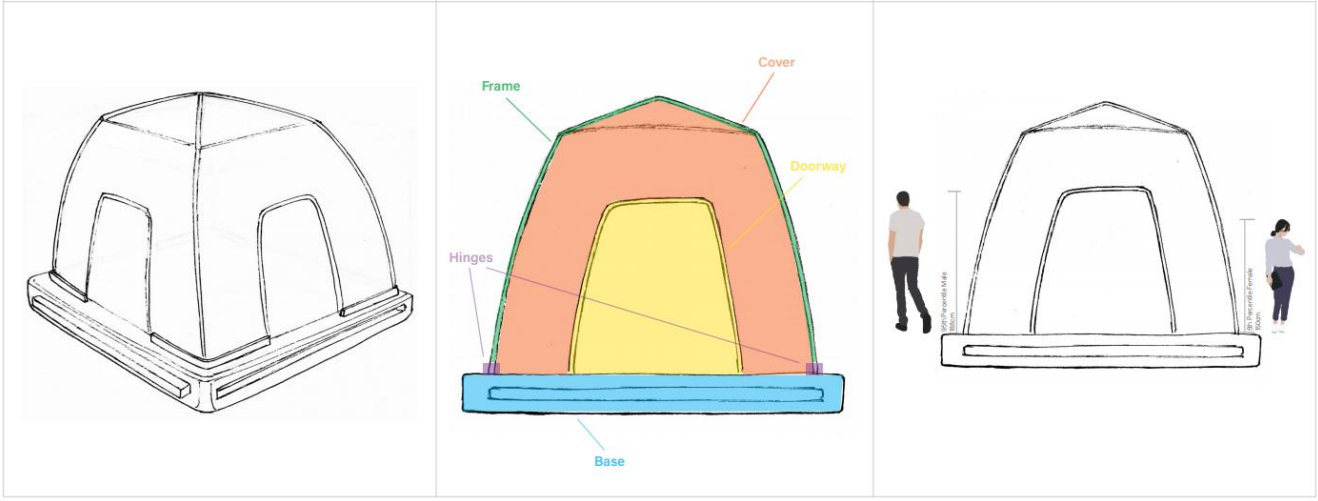


Figure 20 – Concept Strategy 2

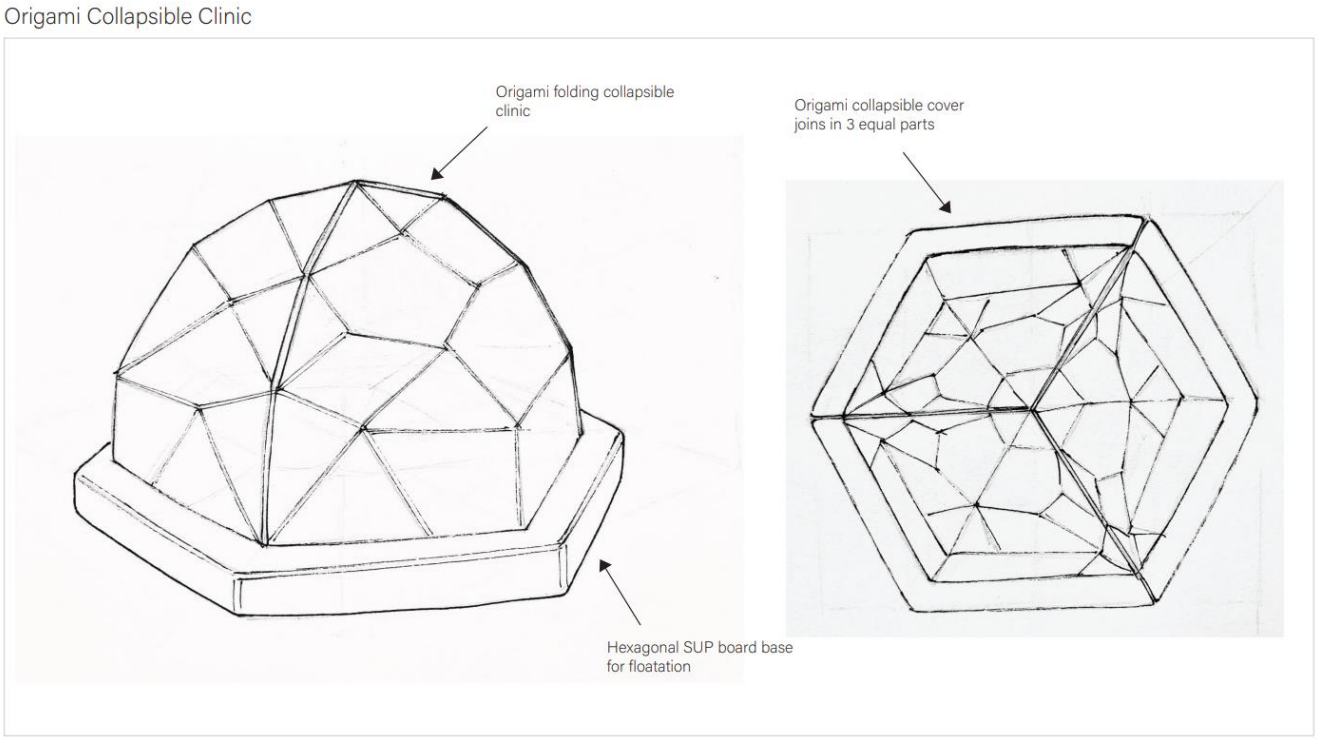
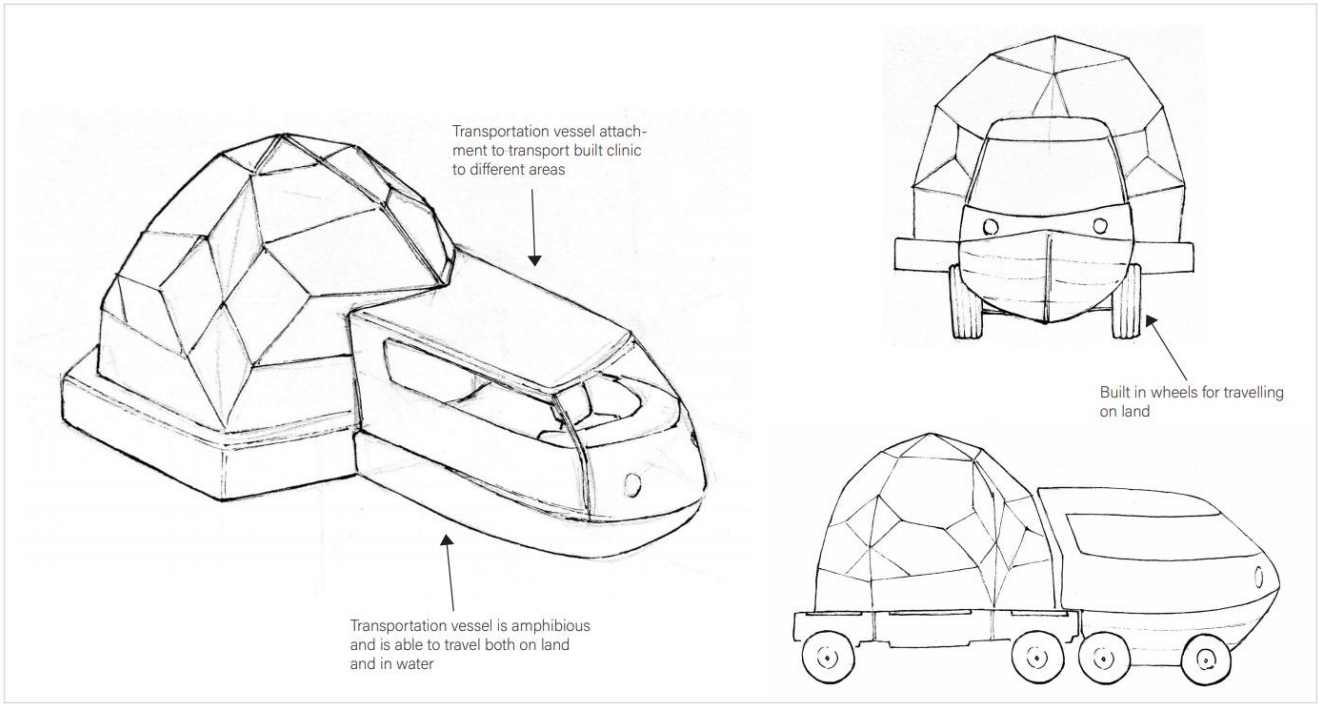


Figure 21 - Concept Strategy 3

Origami Collapsible Clinic



Product Schematic Concept 2

List of components:	Locations affected by the components:	Configuration Diagram:	Ergonomic Diagram:
- Base - Cover - Engine - Wheels - Lighting - Windshield	- Interactions - Ergonomics - Functionality - Aesthetics	These diagrams show the possible location of each component that will be included in the product concept. These components will be located based on the function and interaction between the product and user as well as the aethetics of the product.	The purpose of this diagram is to show the size and scale of the product concept. The ergonomic interaction between a 95th percentile male and 5th percentile female are also shown in this diagram.

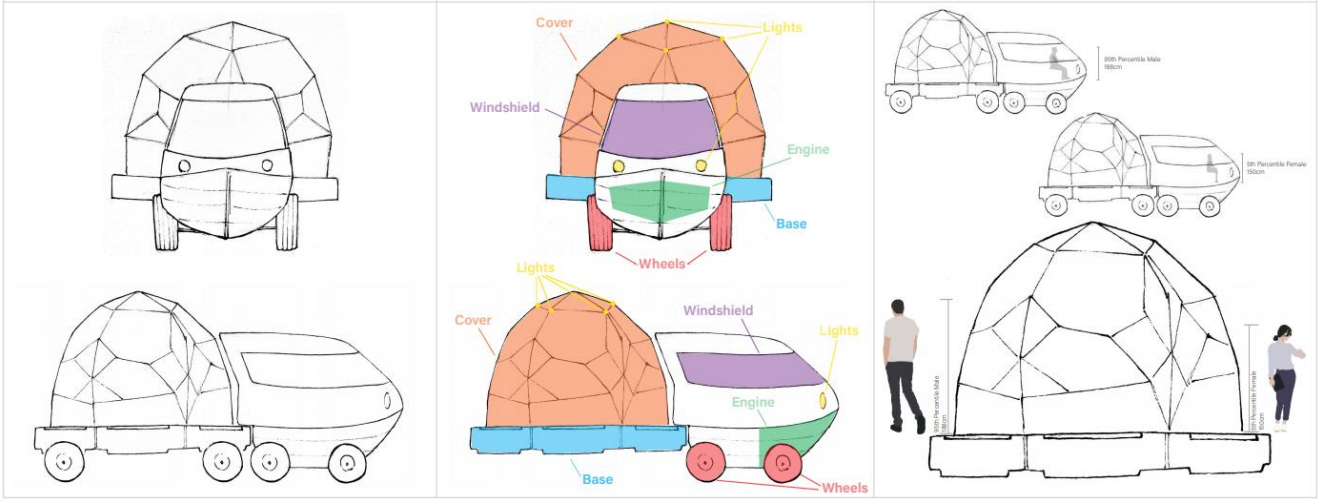


Figure 22 - Concept Strategy 4

4.4 Concept Refinement

During this concept development stage, the medical aid shelter has been further refined to a collapsible, floating origami style shelter which is able to disassemble for easy transportation, deployment, and storage.

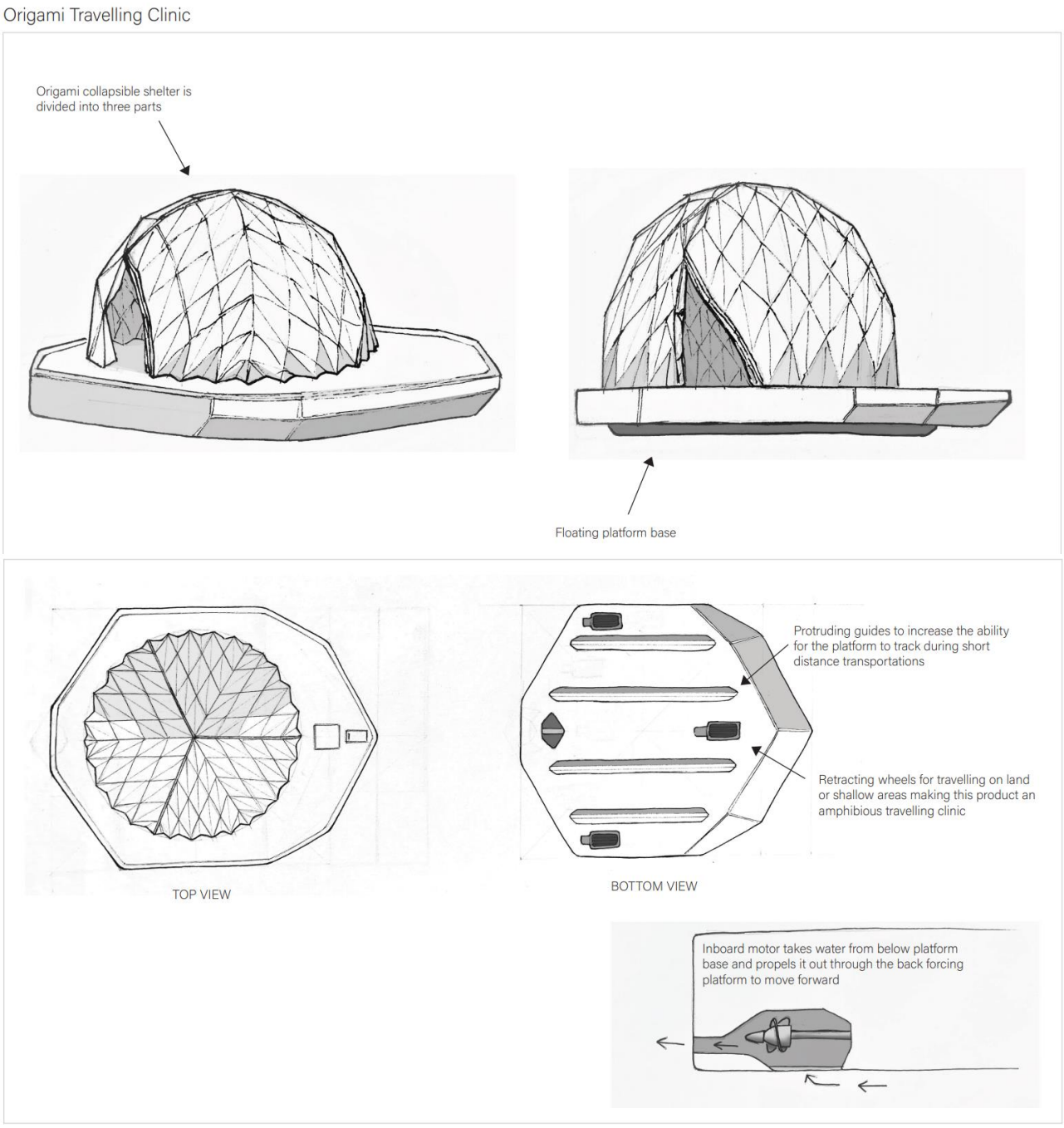
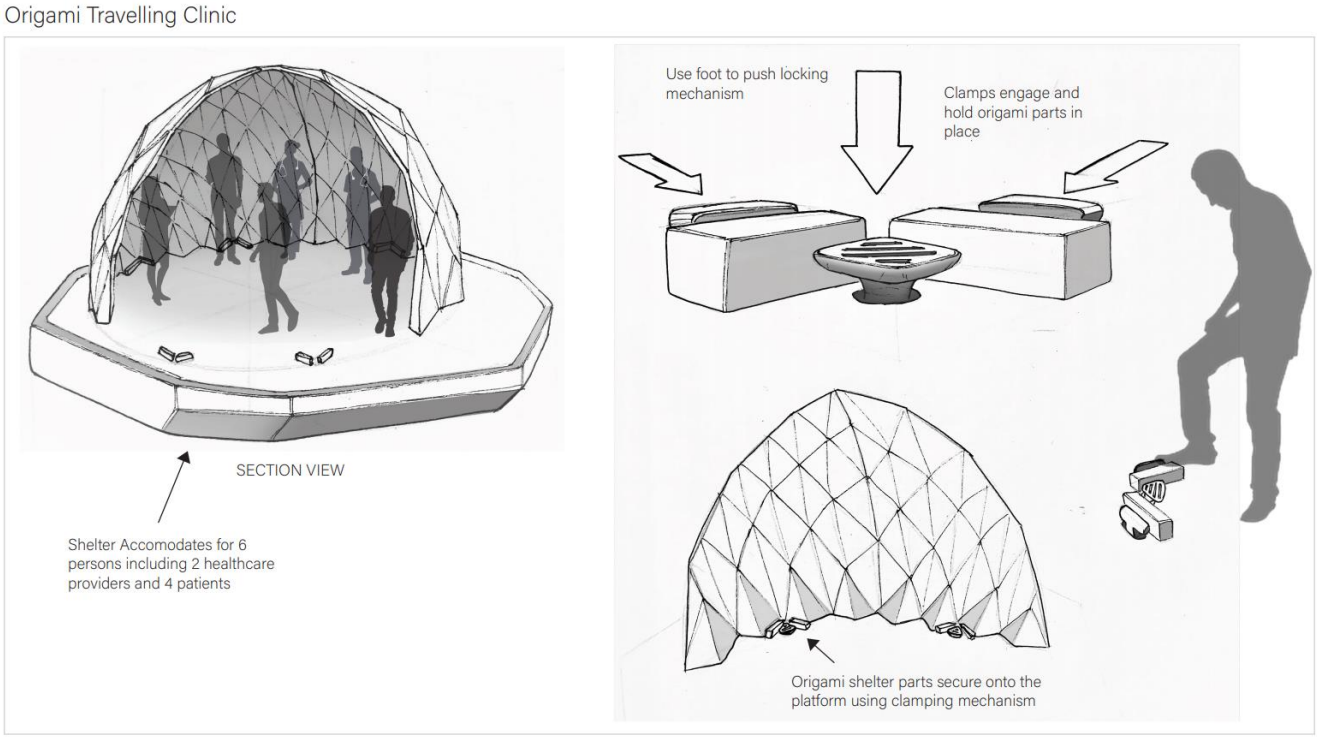


Figure 23 - Concept Refinement 1



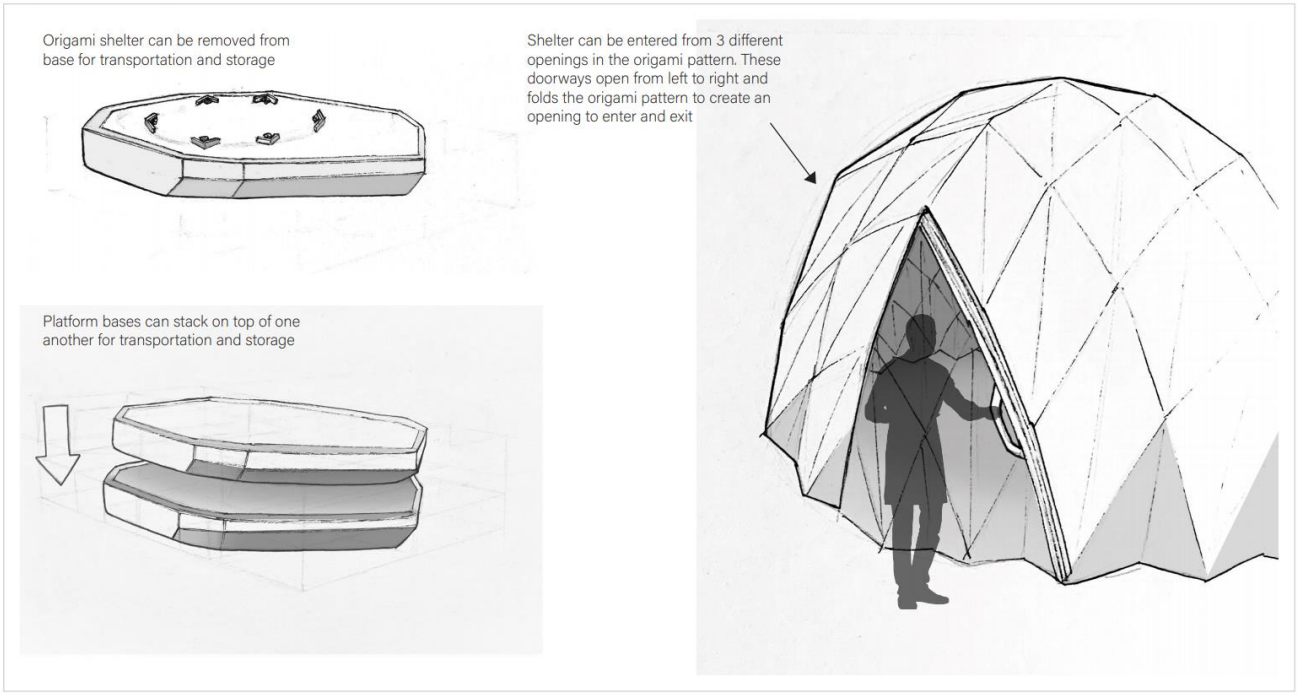


Figure 24 - Concept Refinement 2

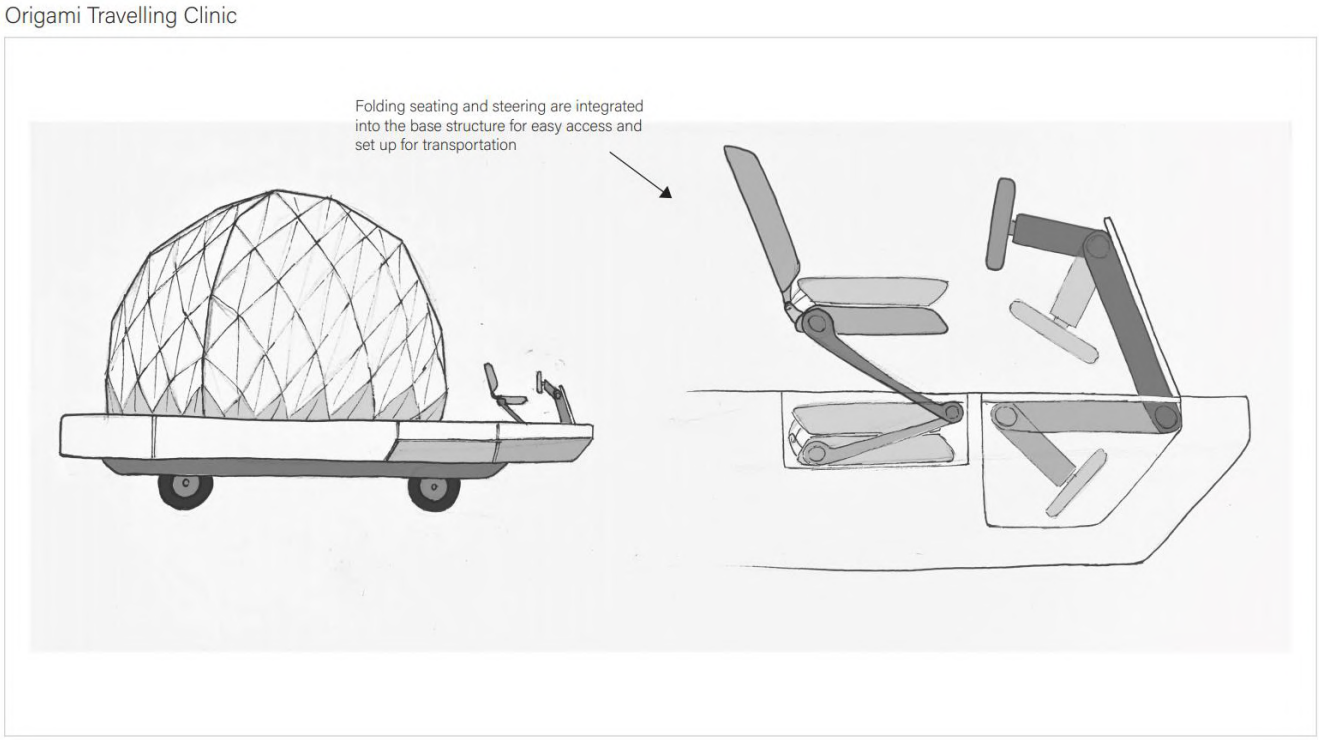
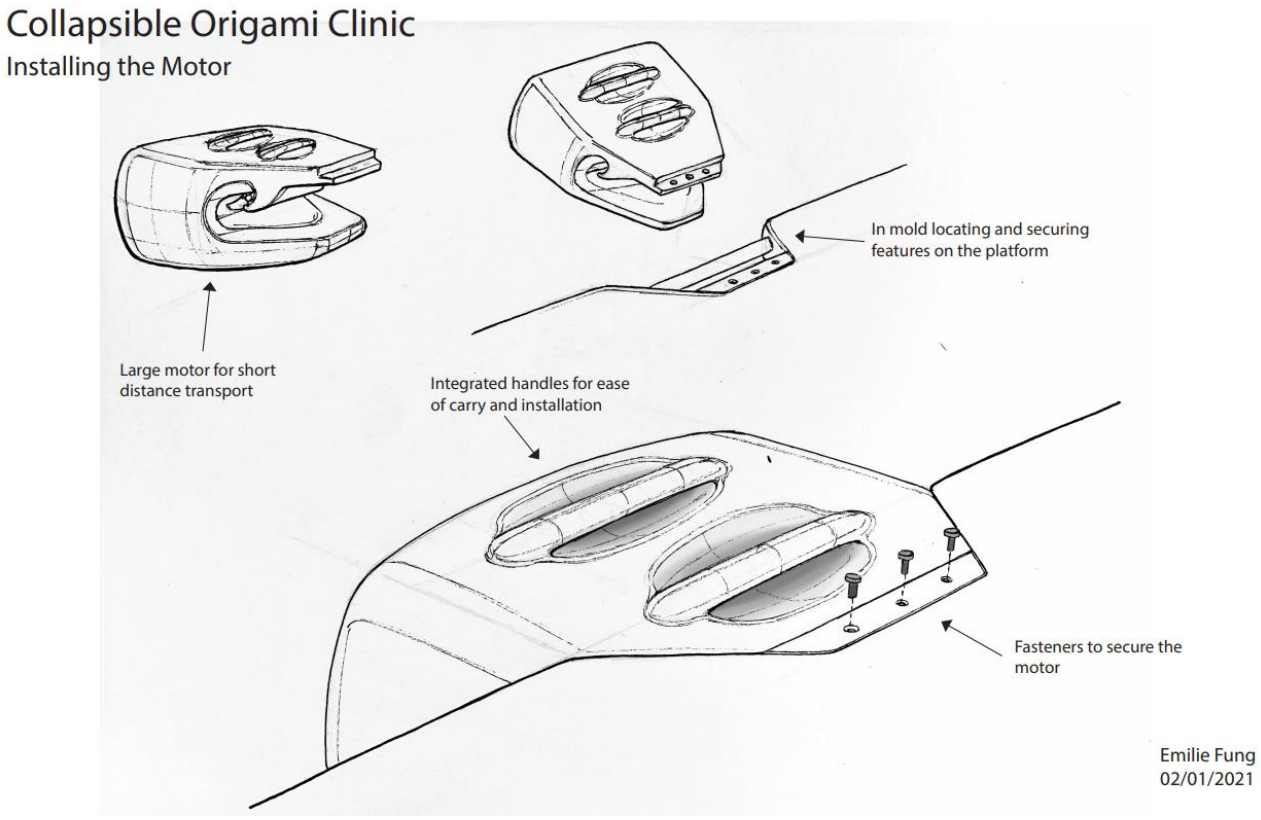


Figure 25 - Concept Refinement 3

4.5 Design Realization

During this design development stage, the concept is refined and beginning to come together. In this step of the process, physical models and product schematics are created to understand the human interaction and prepare for final model development.



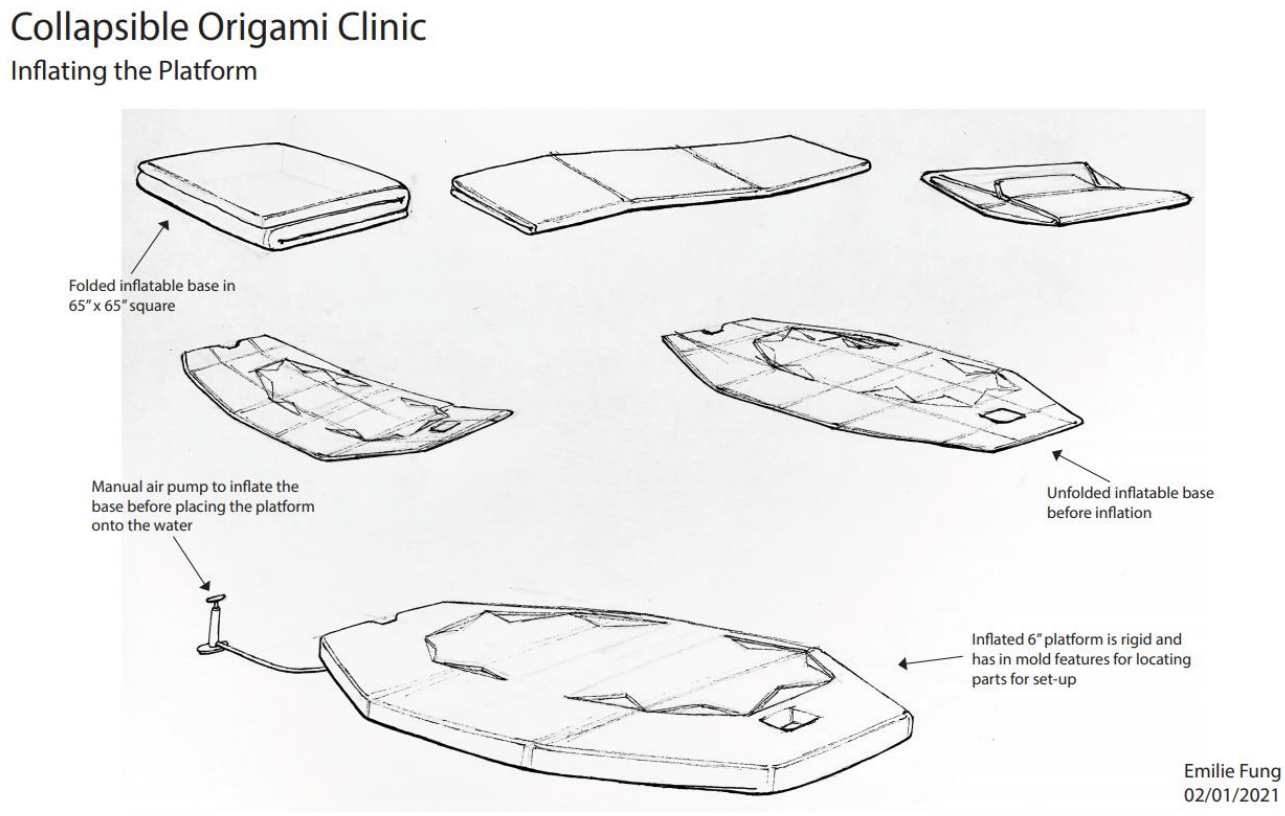
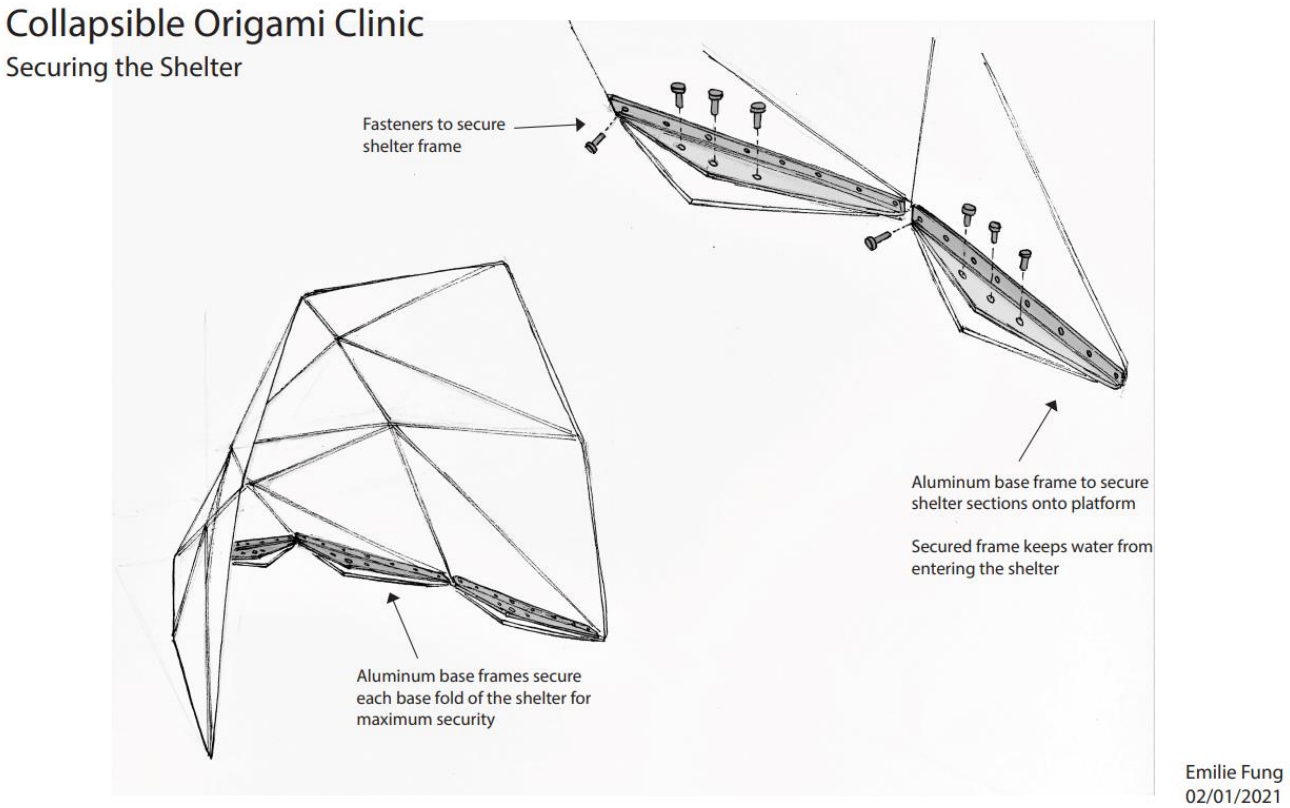


Figure 26 - Design Realization 1



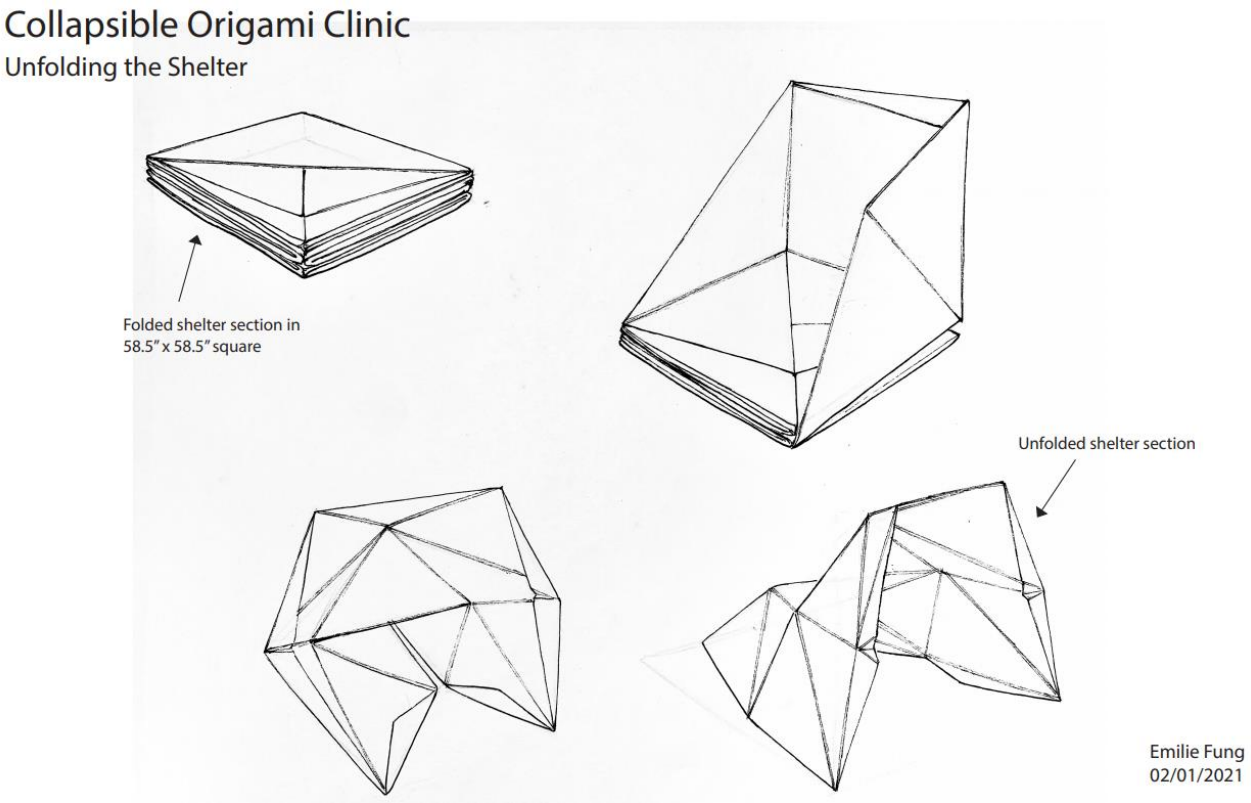


Figure 27 - Design Realization 2

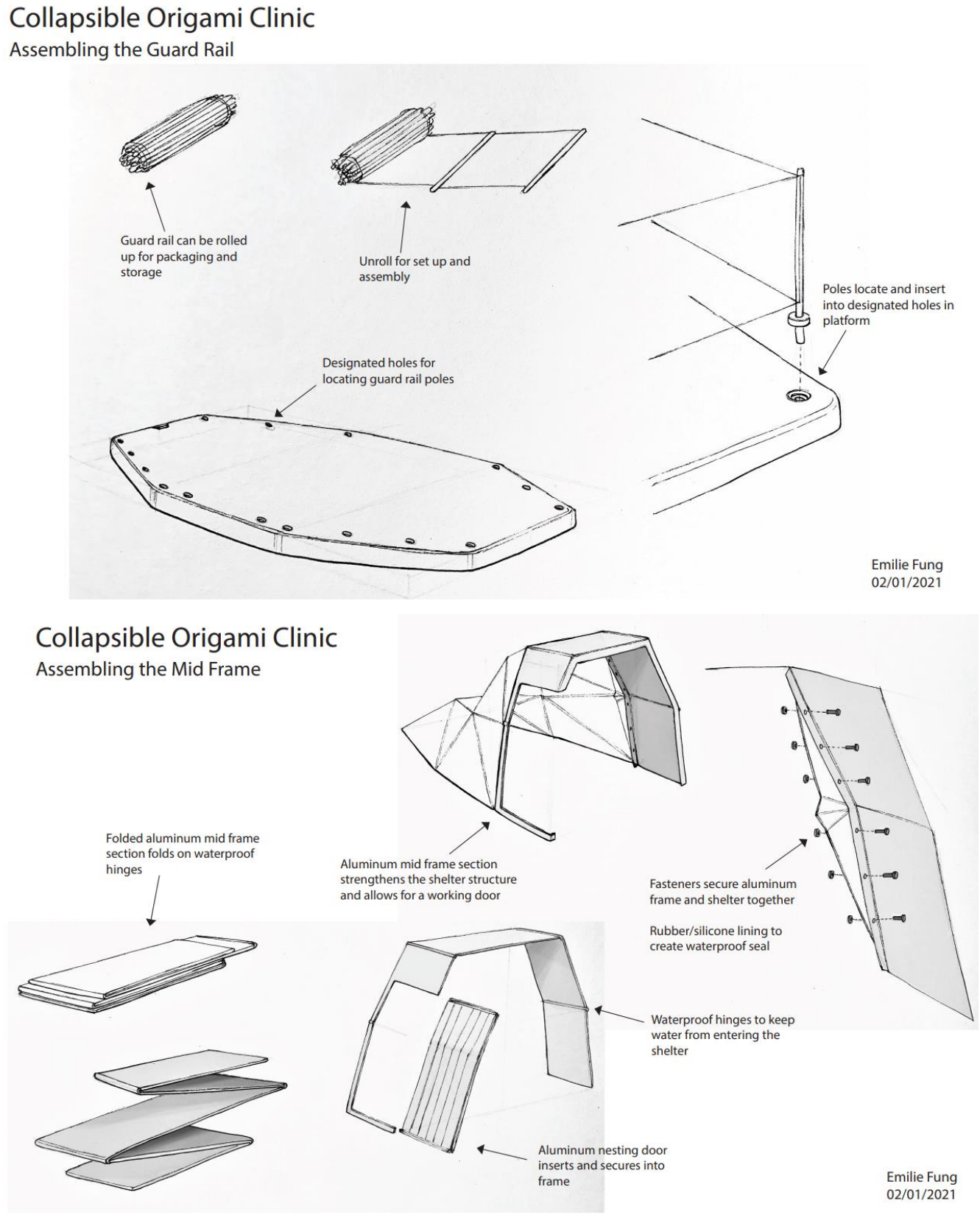


Figure 28 - Design Realization 3

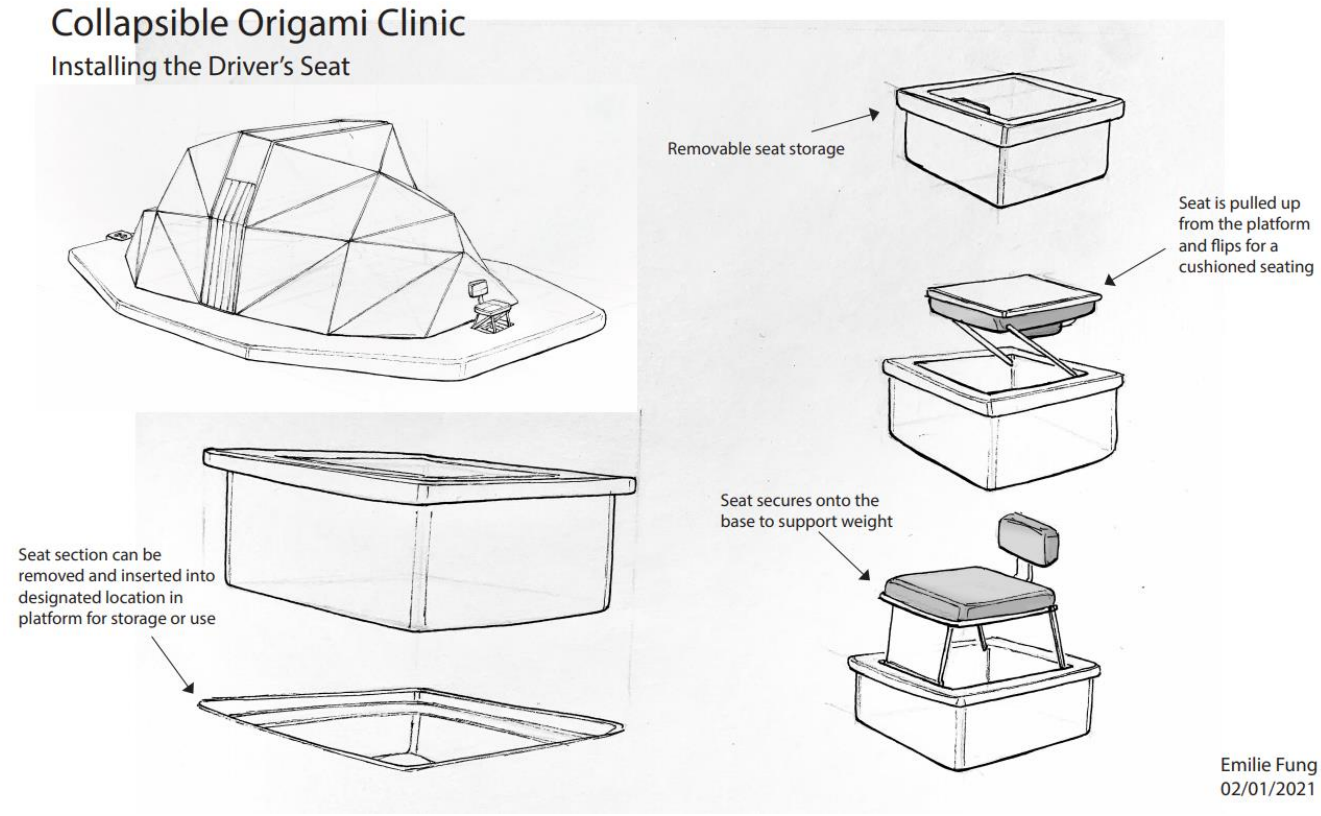


Figure 29 - Design Realization 4

4.5.1 Physical Study Models

During this design development stage, a mock-up physical model is planned out and executed. The size and scale for the final model is considered for ideal quality and model scale. Dimensions for a 1:25 scale model is used to make the sketch model. Different materials are used according to model parts for distinction and accurate depiction of the final product.

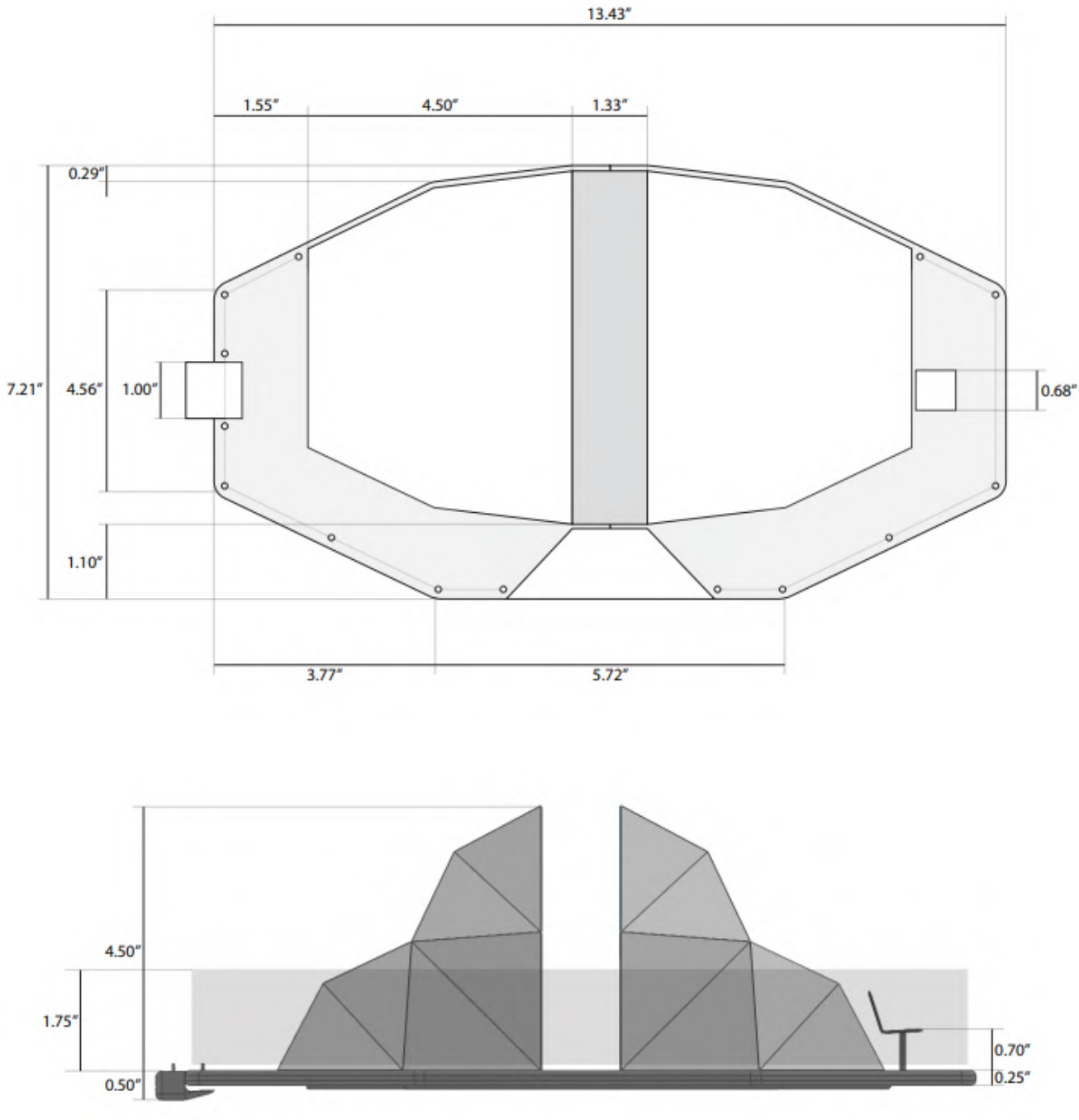


Figure 30 - Configuration 1 Physical Study Model Dimensioning

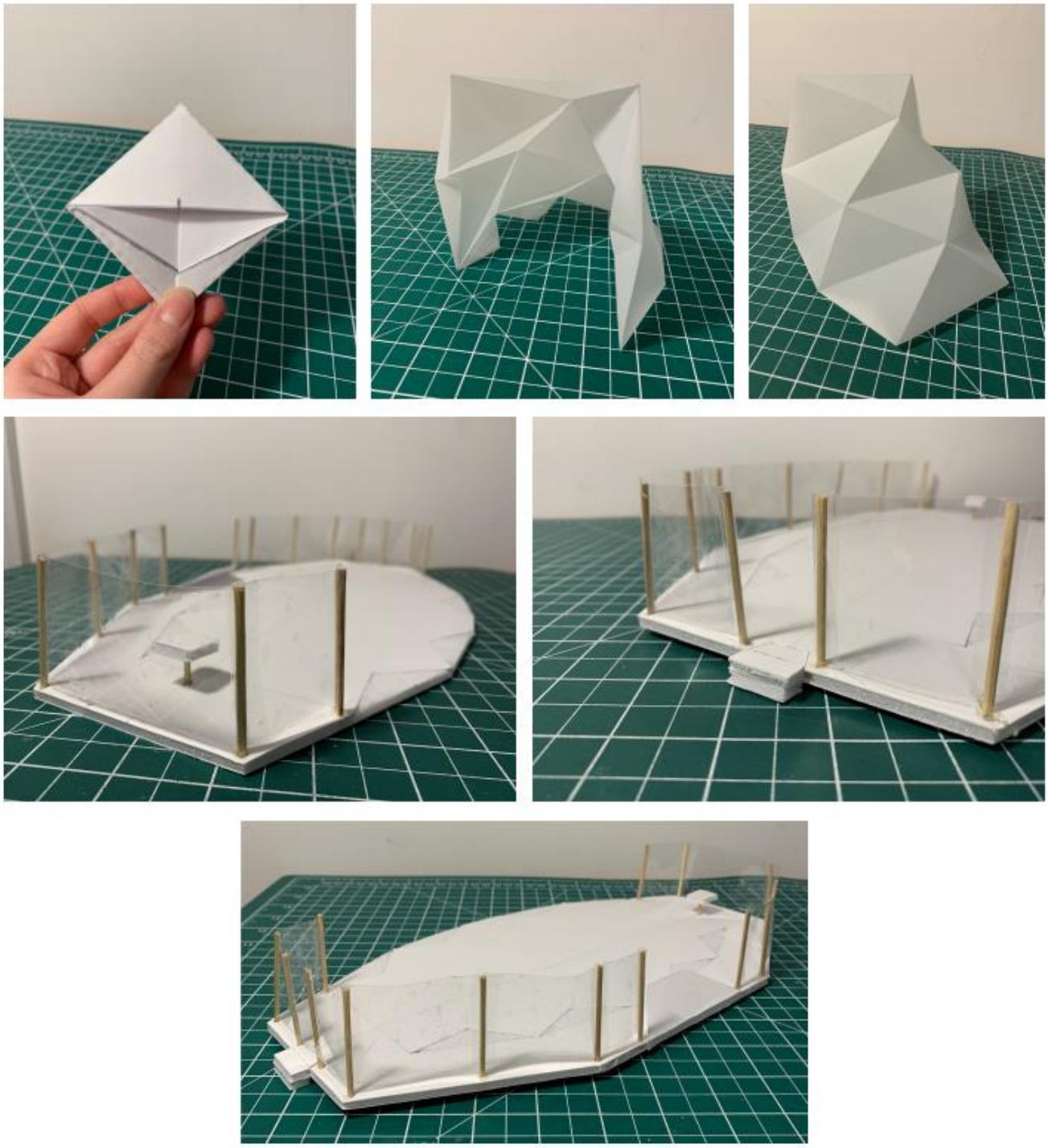


Figure 31 - Configuration 1 Physical Study Model 1

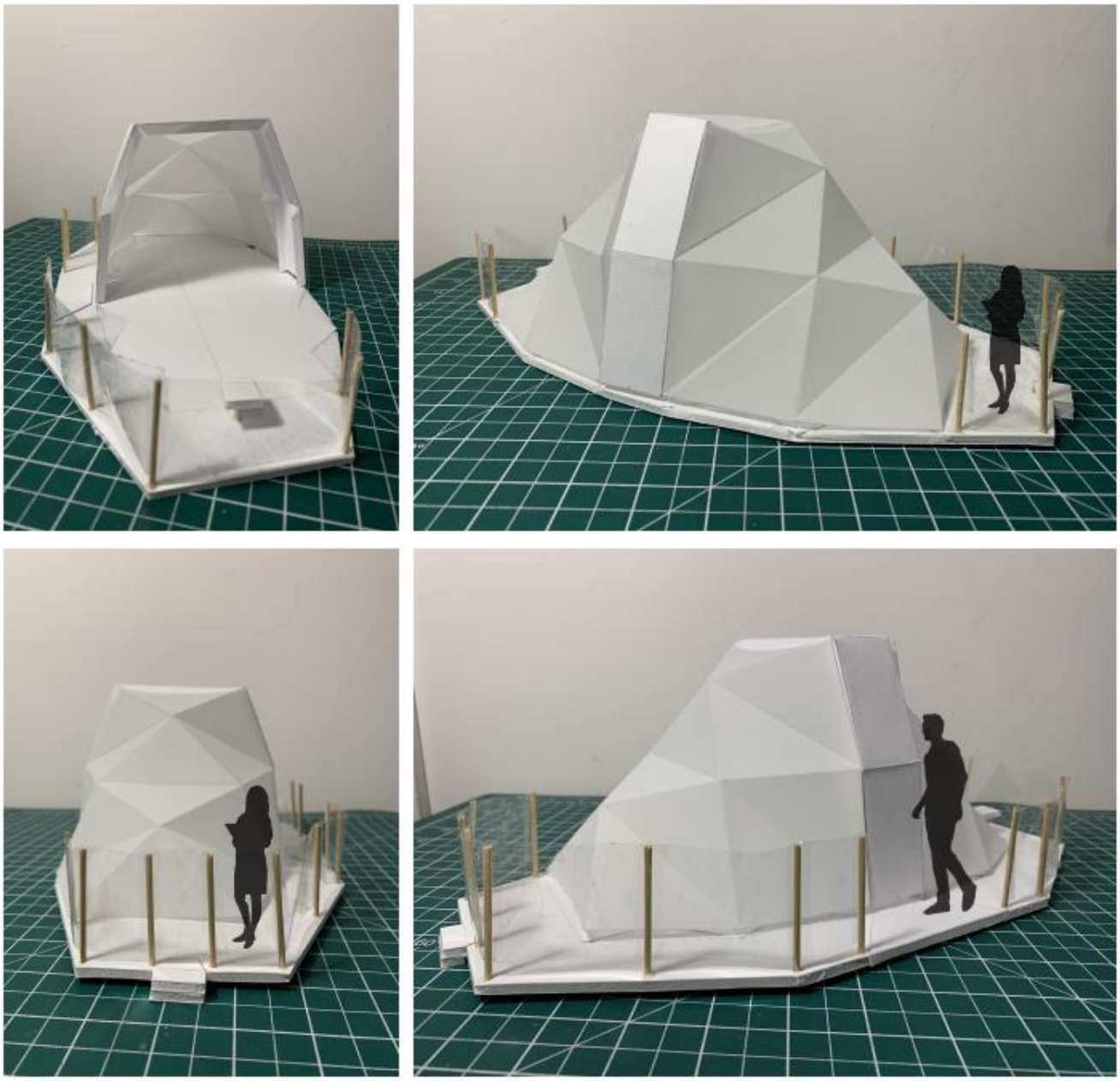


Figure 32 - Configuration 1 Physical Study Model 2

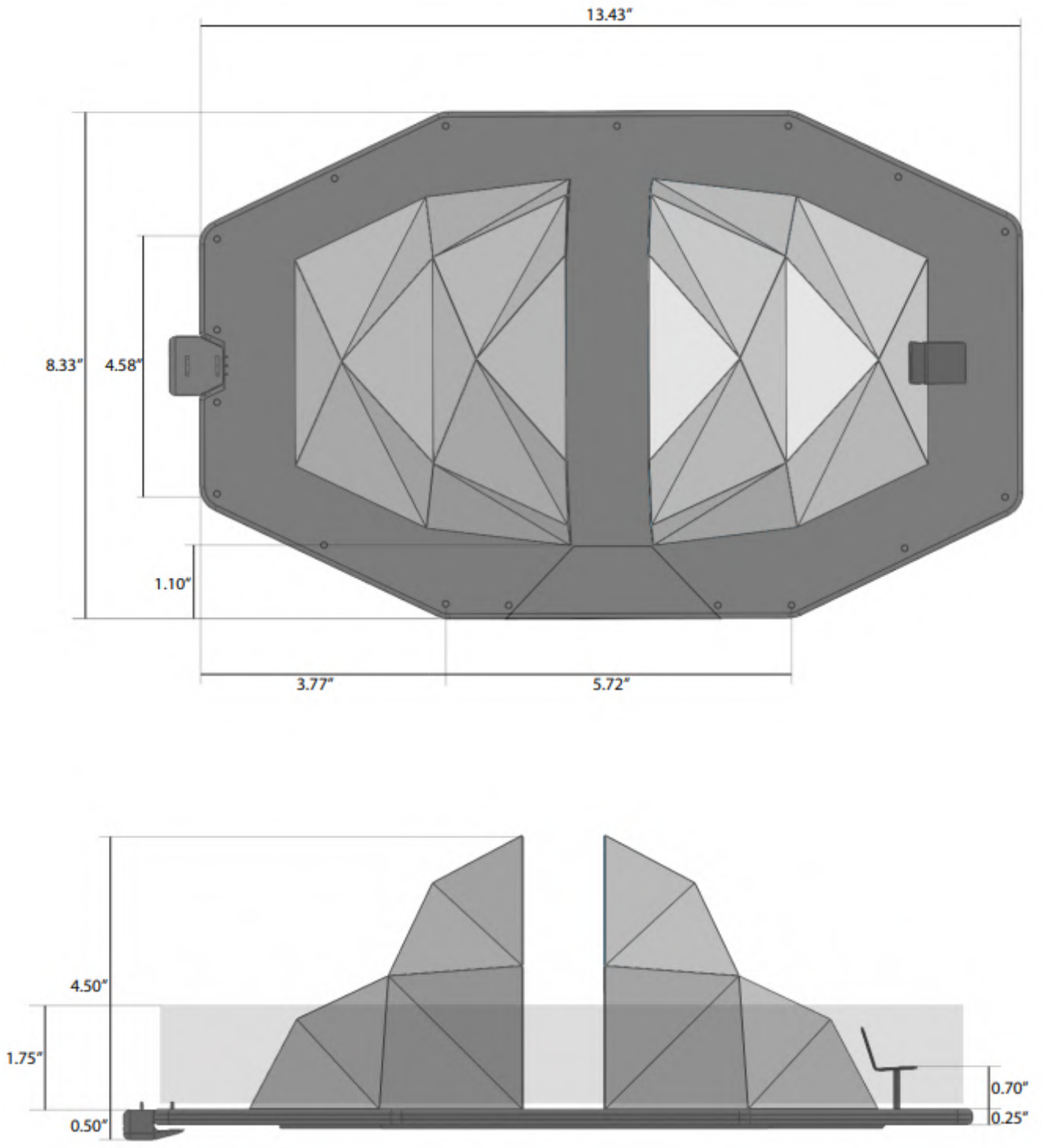


Figure 33 - Configuration 2 Physical Study Model Dimensioning

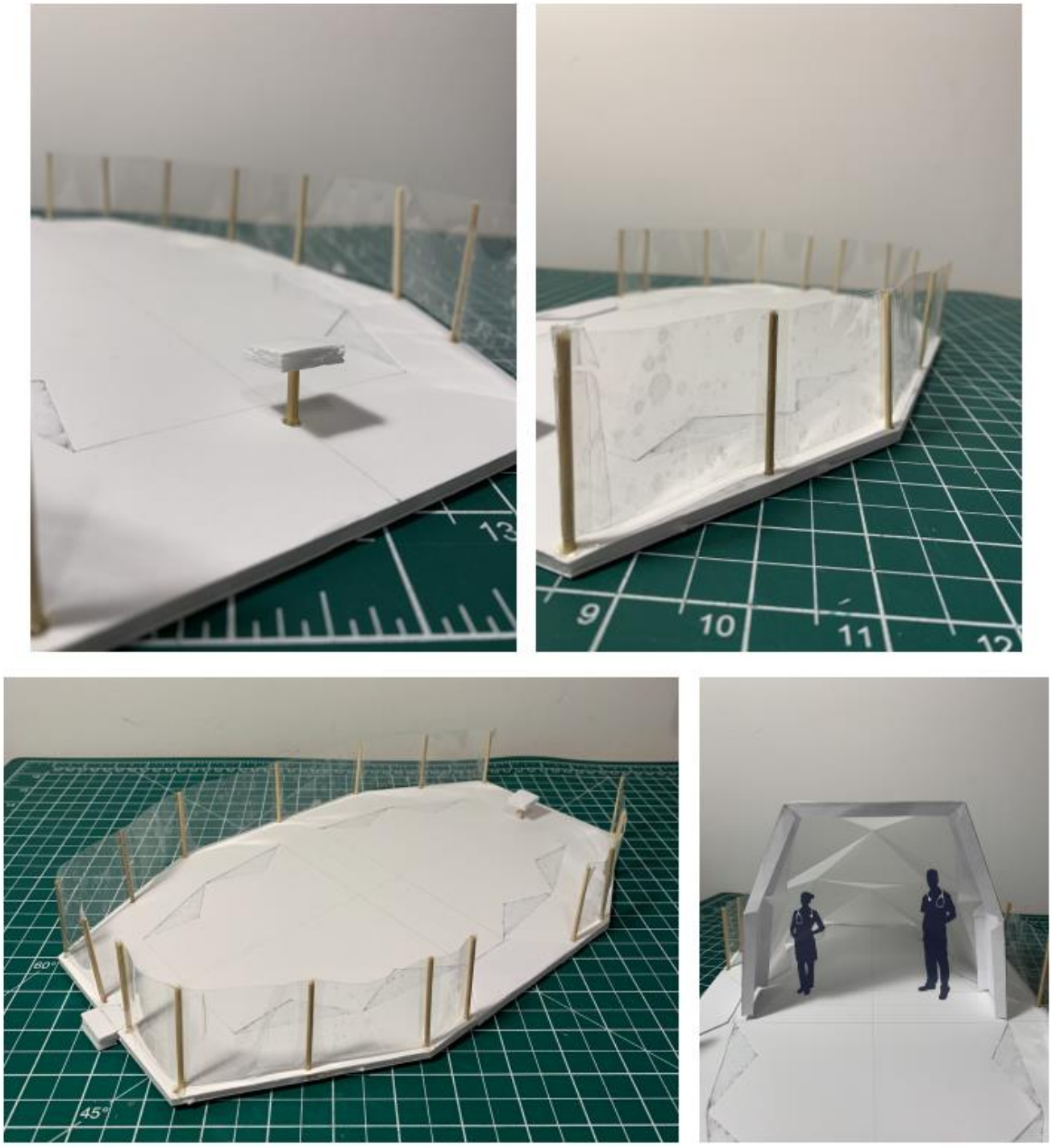


Figure 34 - Configuration 2 Physical Study Model 1

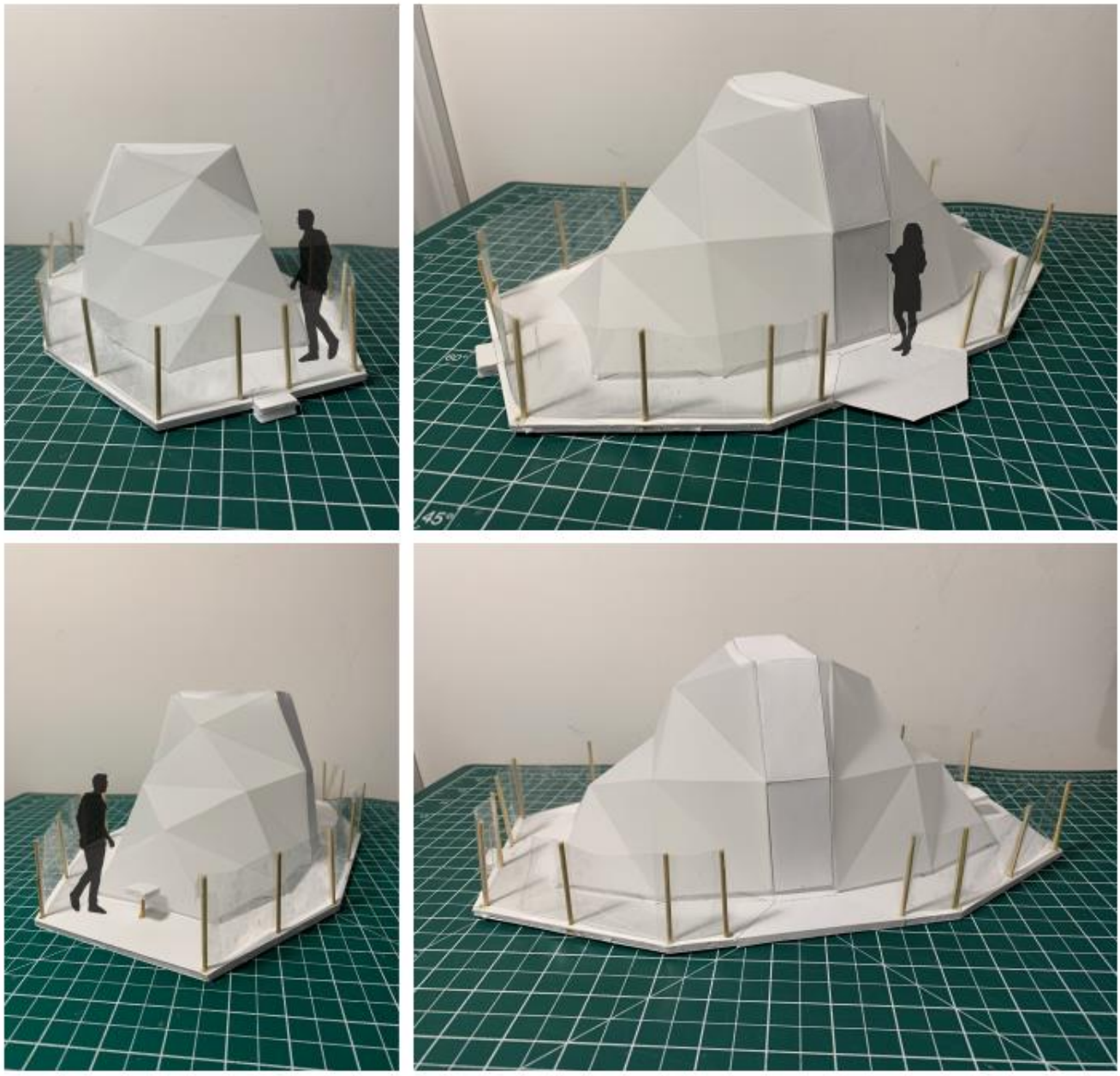


Figure 35 - Configuration 2 Physical Study Model 2

4.5.2 Product Schematic

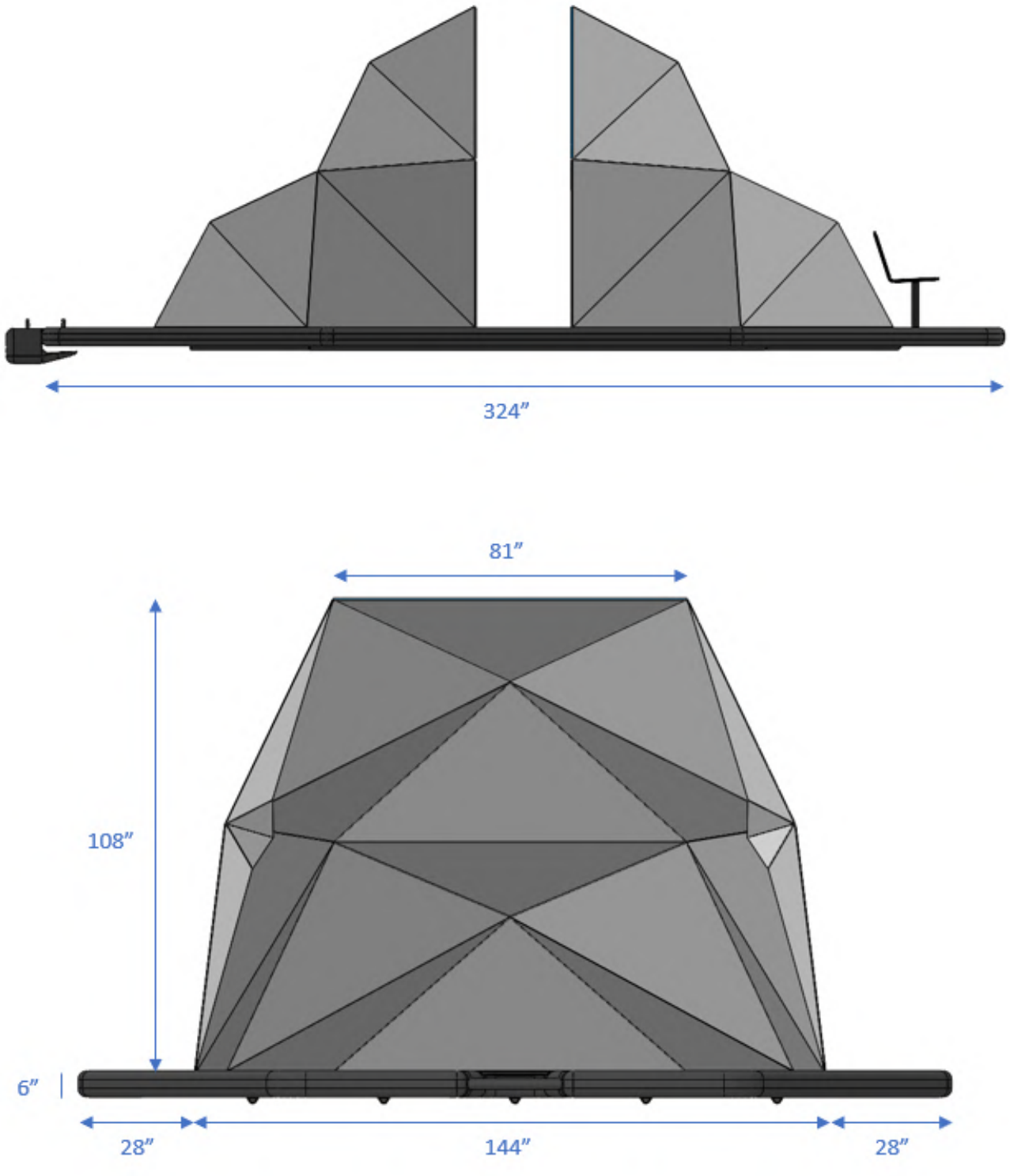


Figure 36 - Product Schematic 1

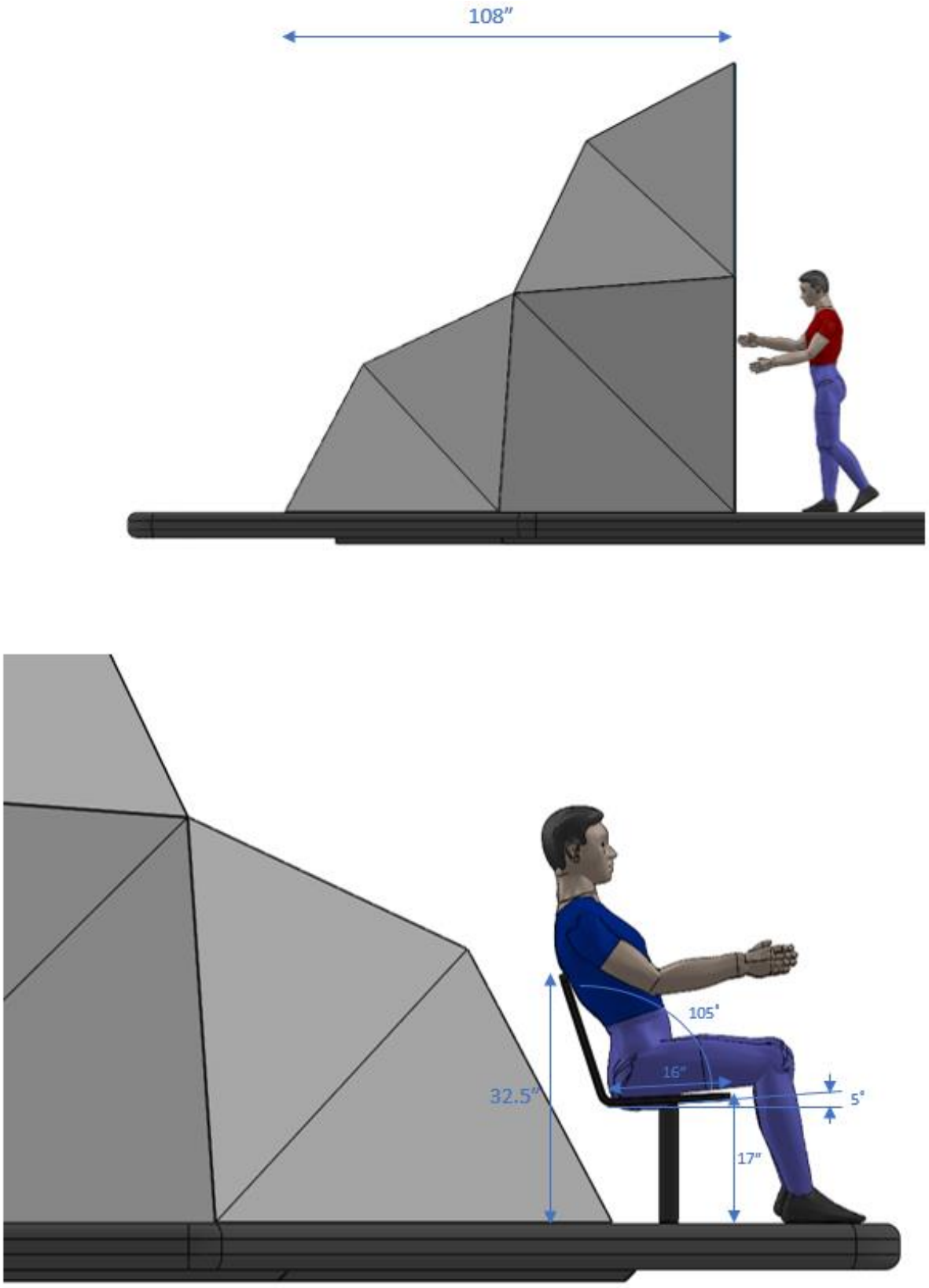


Figure 37 - Product Schematic 2

4.6 Design Resolution

During this design development stage, the concept is further refined, and a CAD model is started to determine model scale and proportions and prepare for development of the final physical and render models.

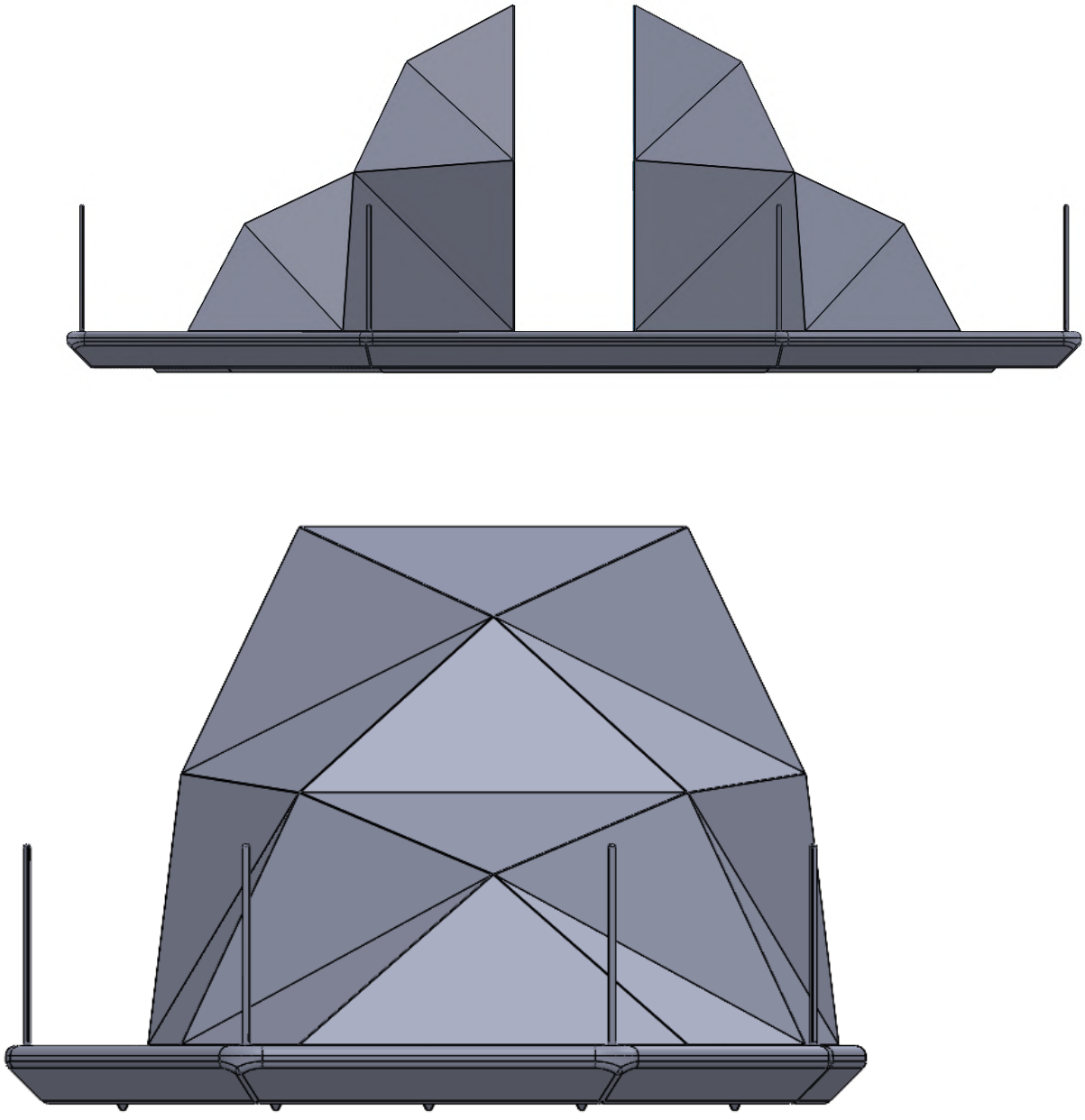


Figure 38 - Design Resolution CAD Model Development 1

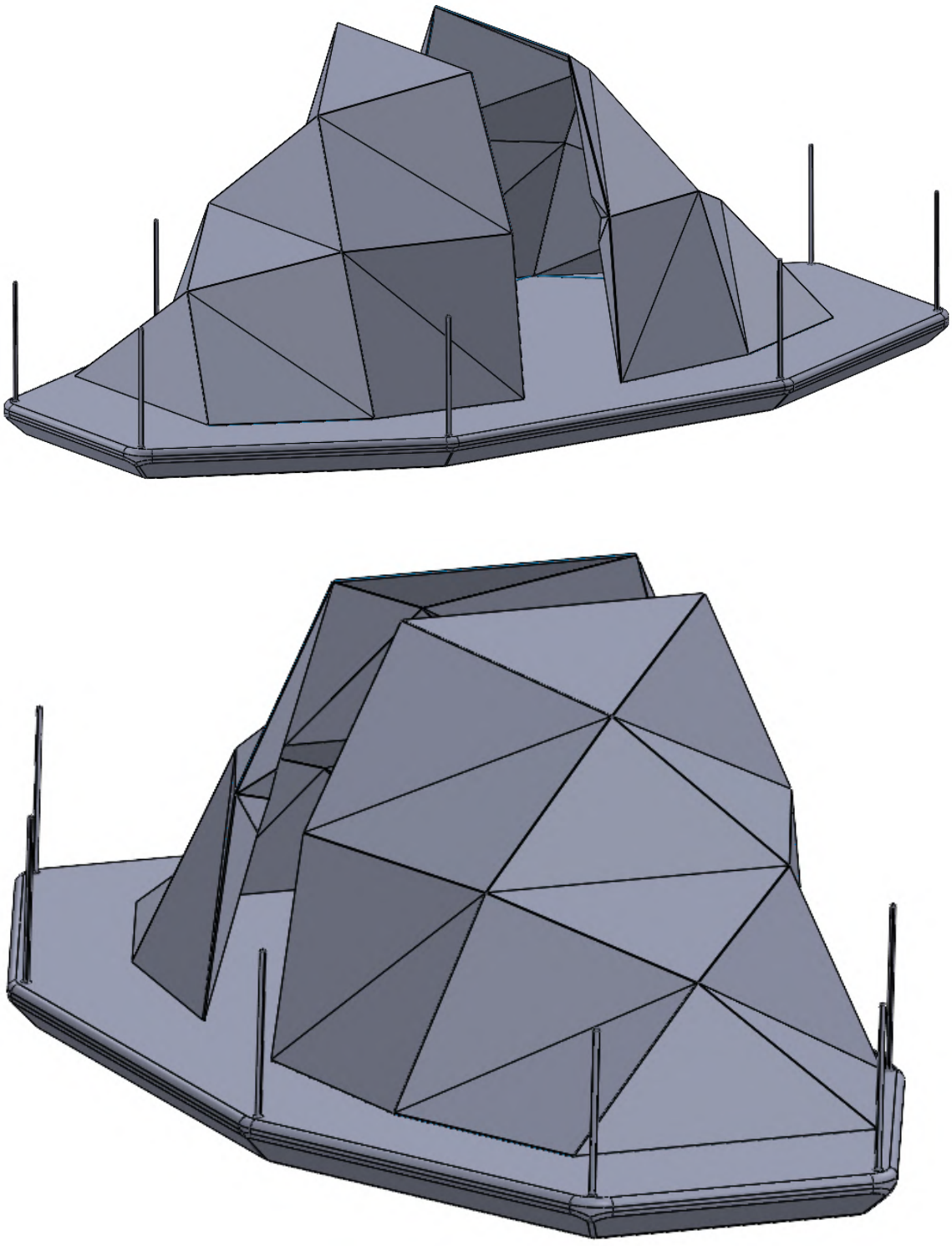


Figure 39 - Design Resolution CAD Model Development 2

4.7 CAD Development

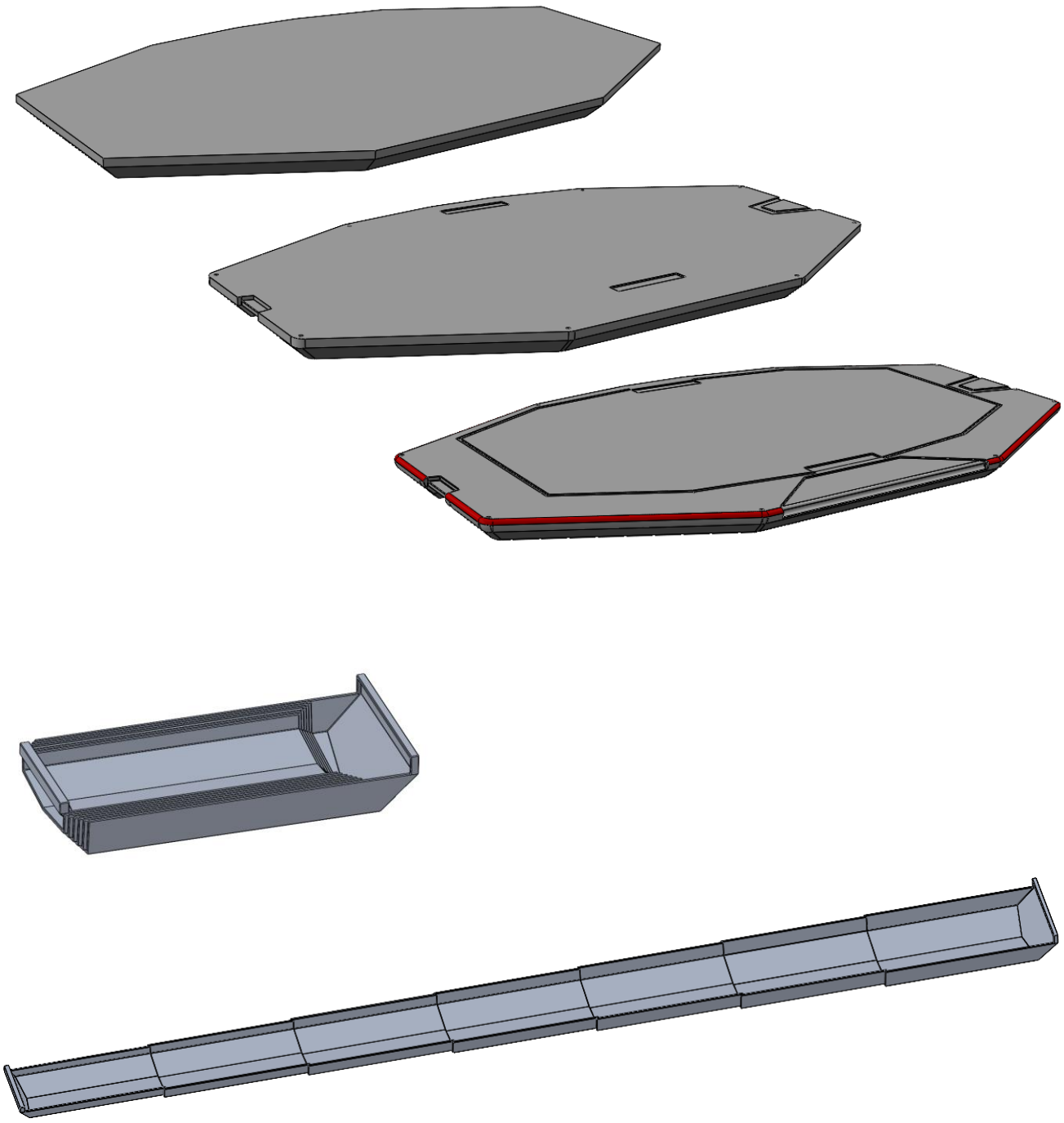


Figure 40 - CAD Development Parts and Assembly 1

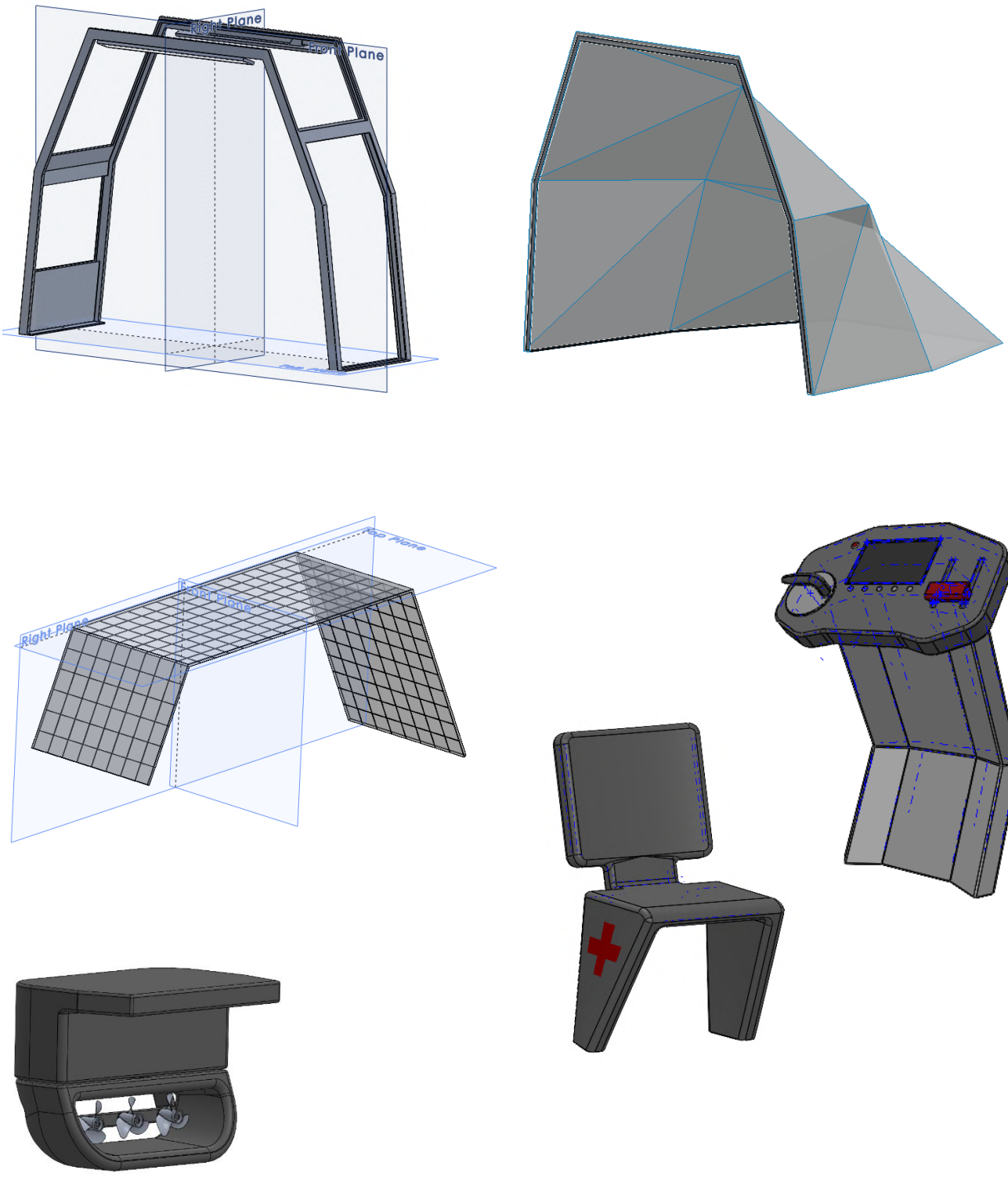


Figure 41 - CAD Development Parts and Assembly 2

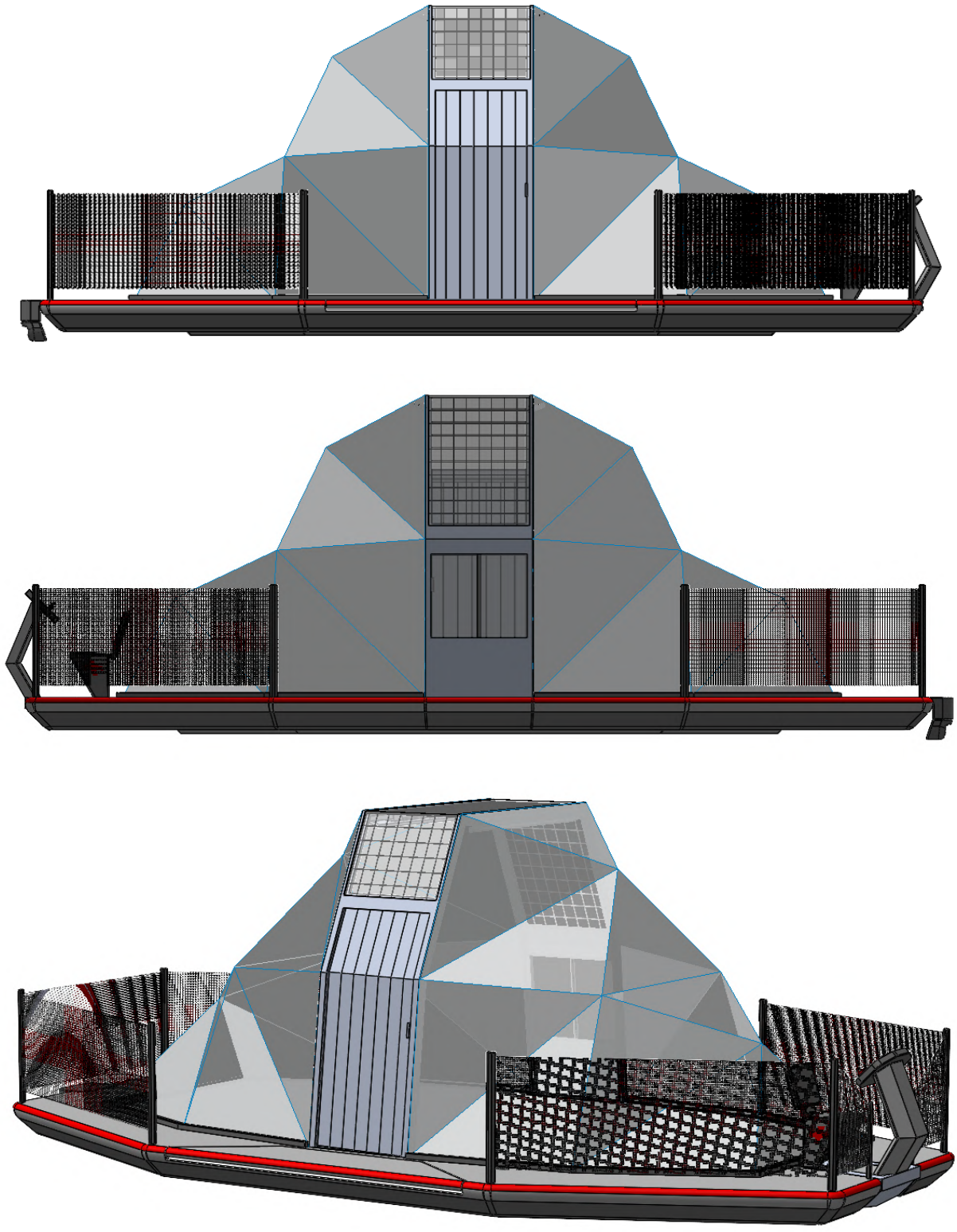


Figure 42 - CAD Development Parts and Assembly 3

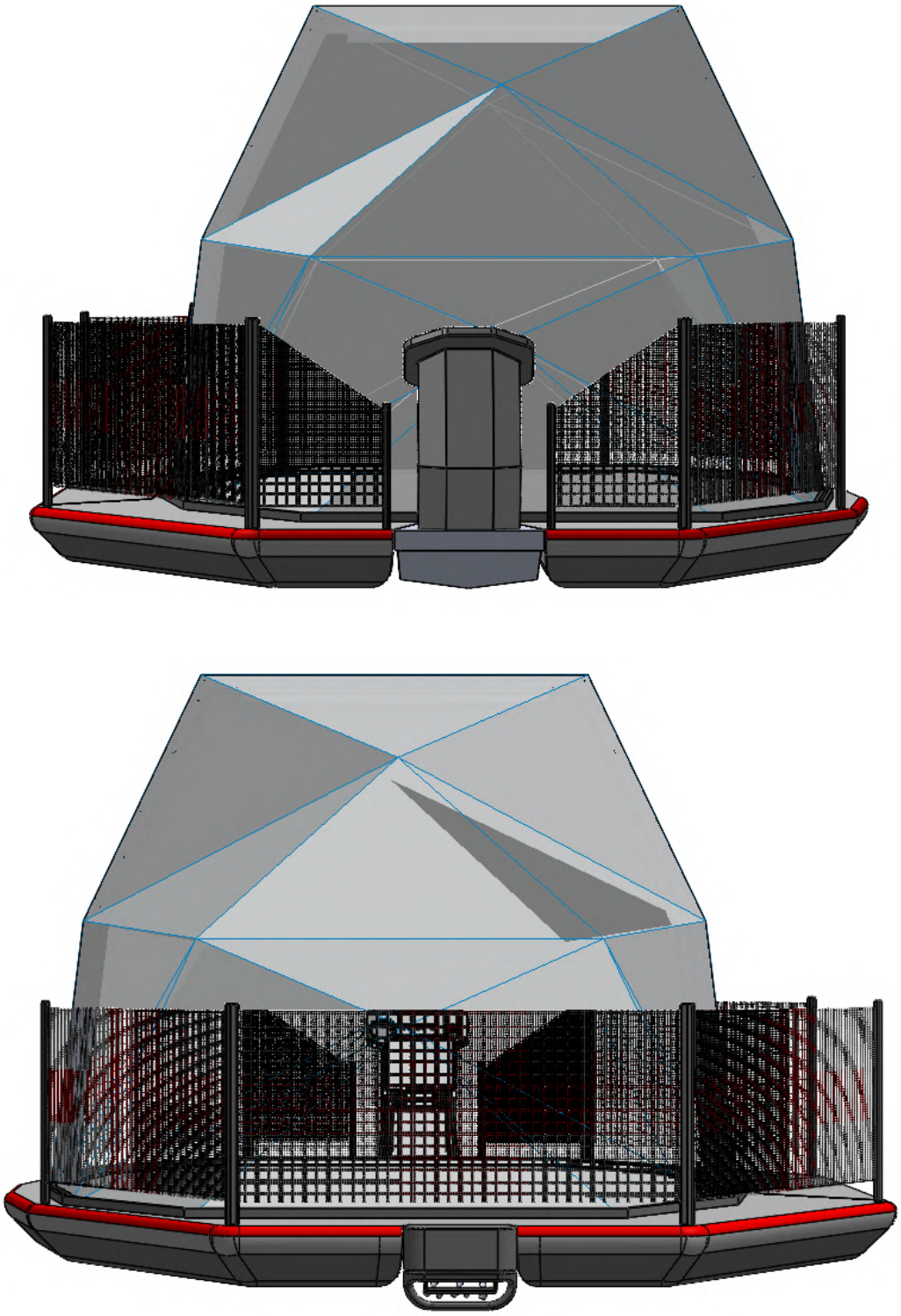


Figure 43 - CAD Development Parts and Assembly 4

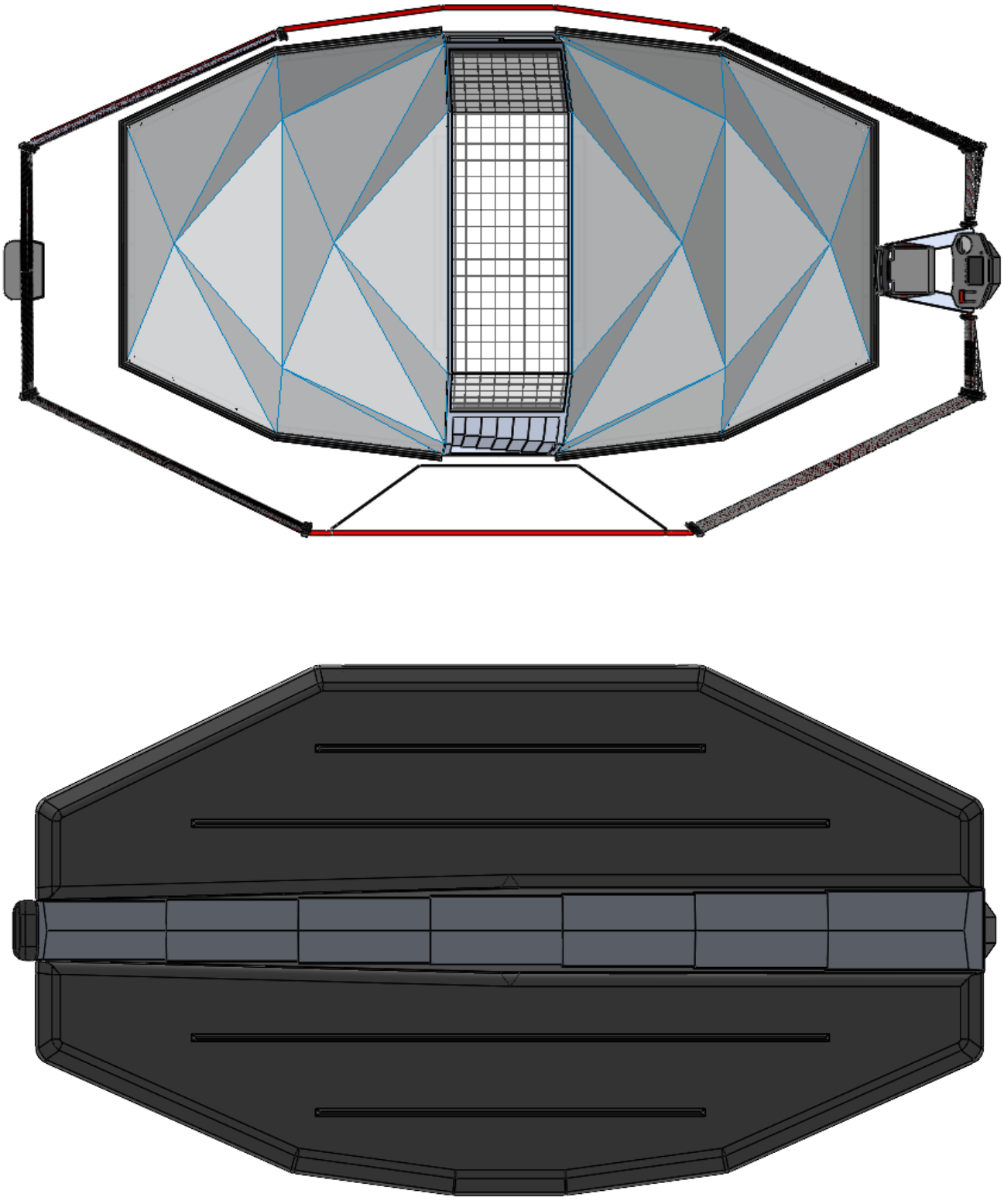
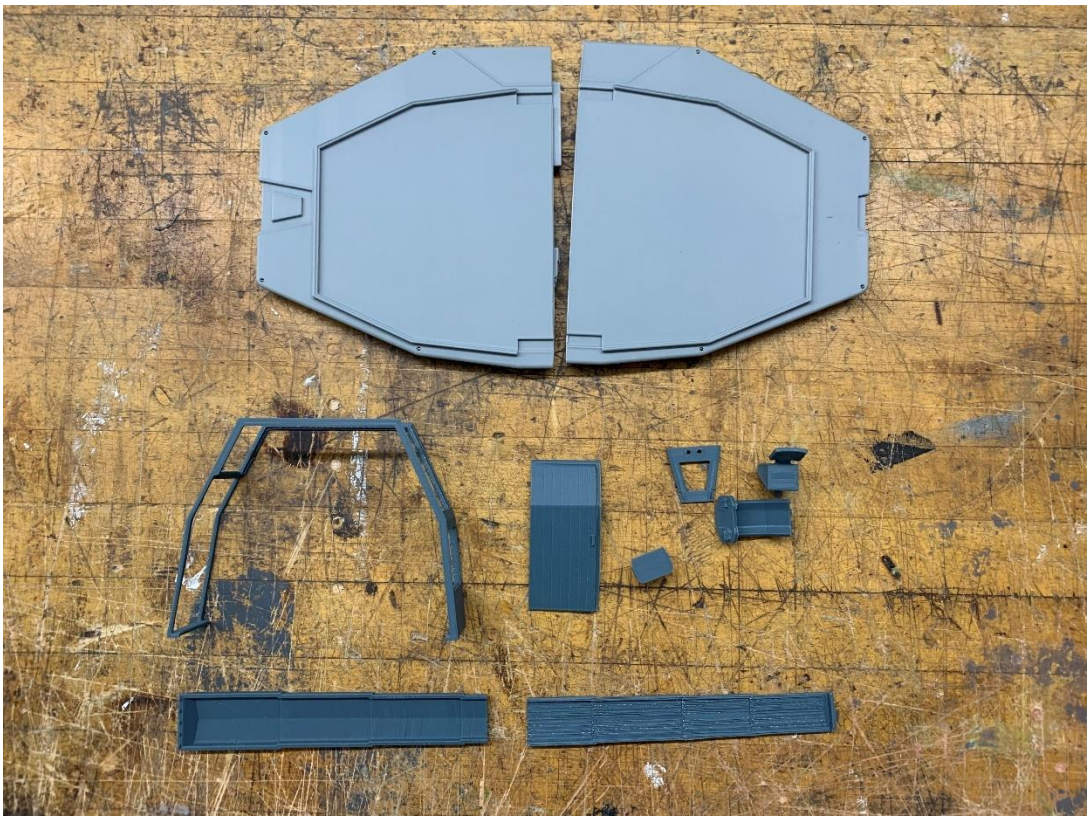


Figure 44 - CAD Development Parts and Assembly 5

4.8 Physical Model Fabrication



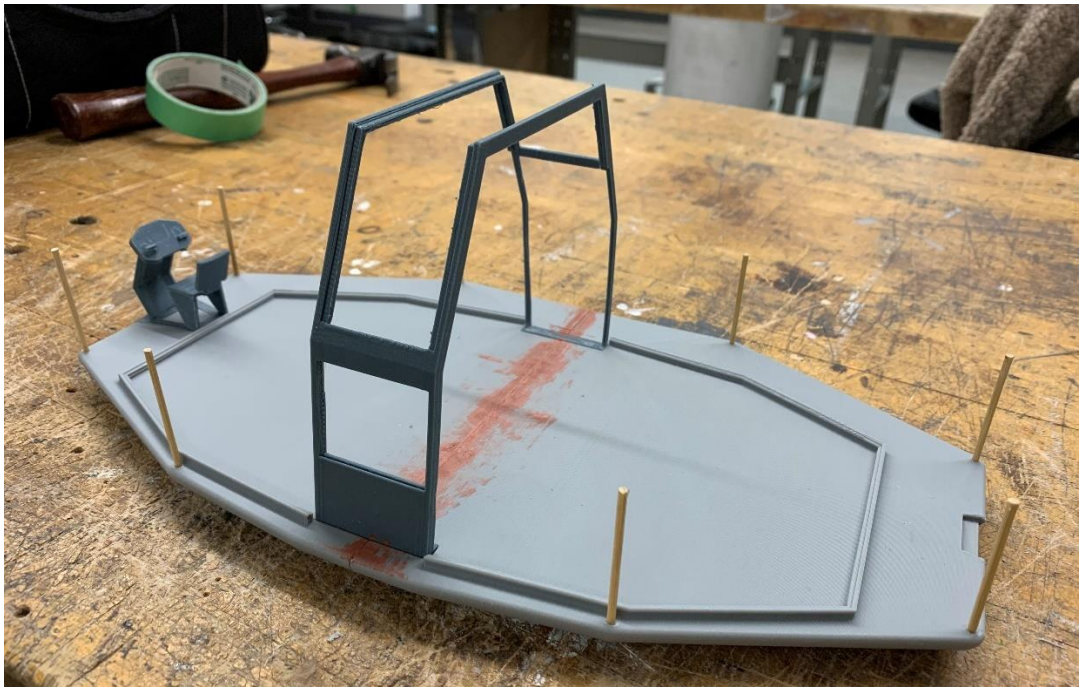
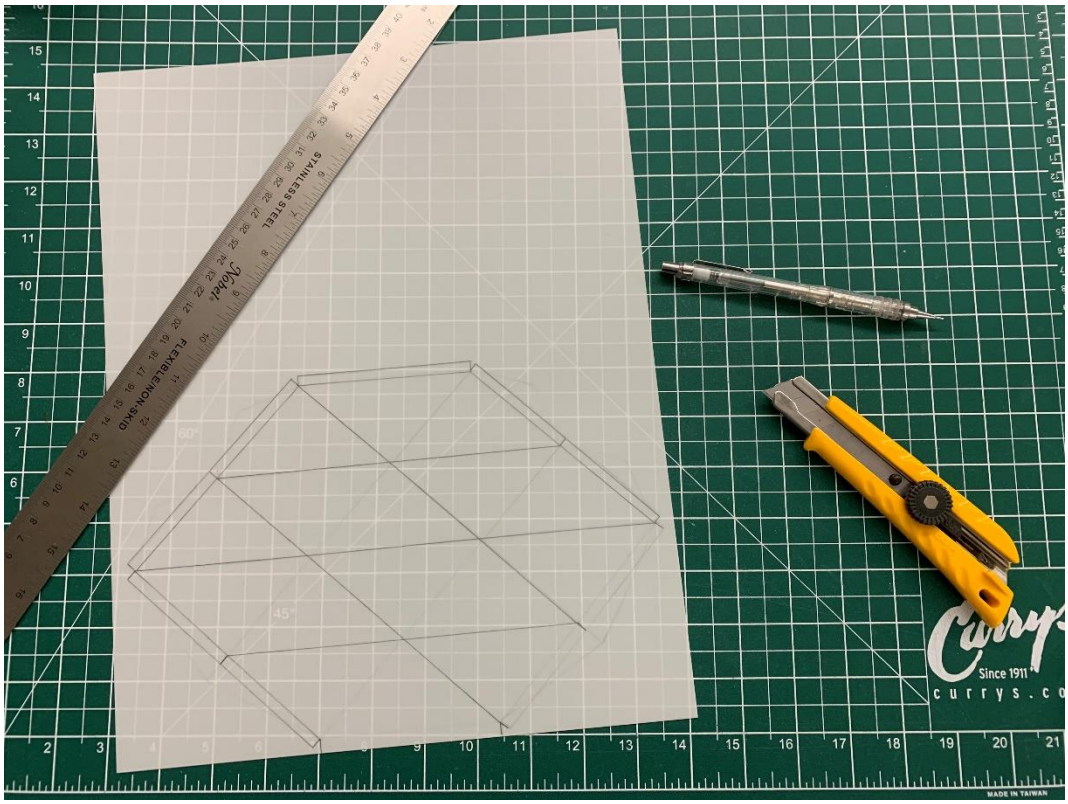


Figure 45 - Physical Model Fabrication 1



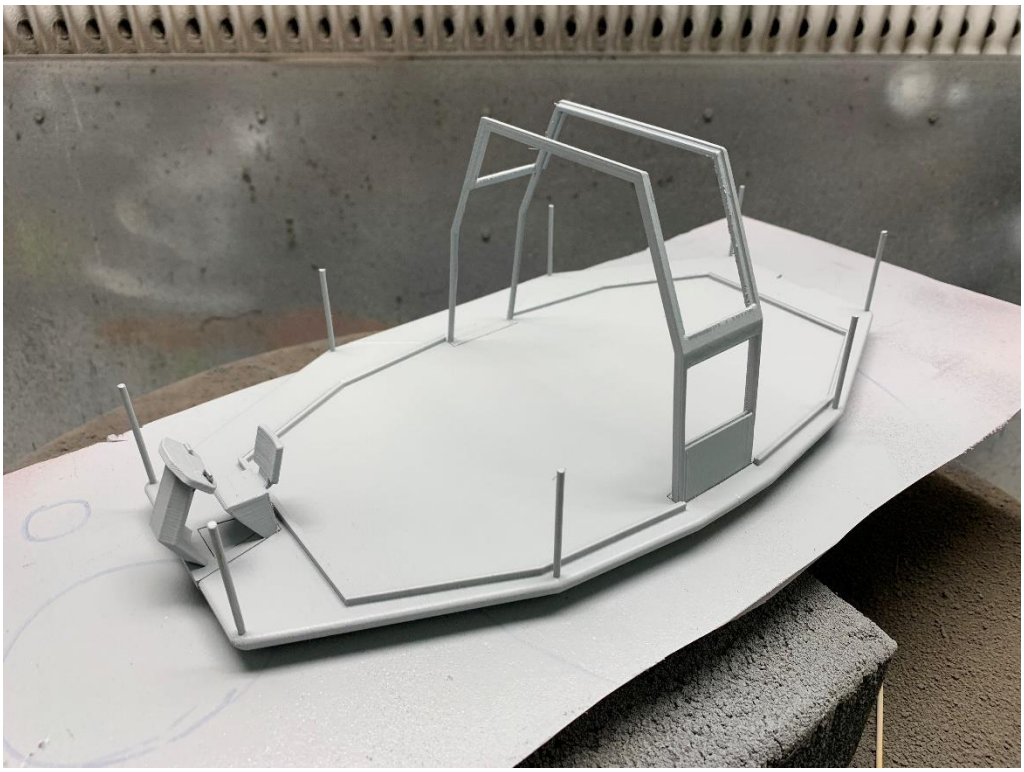
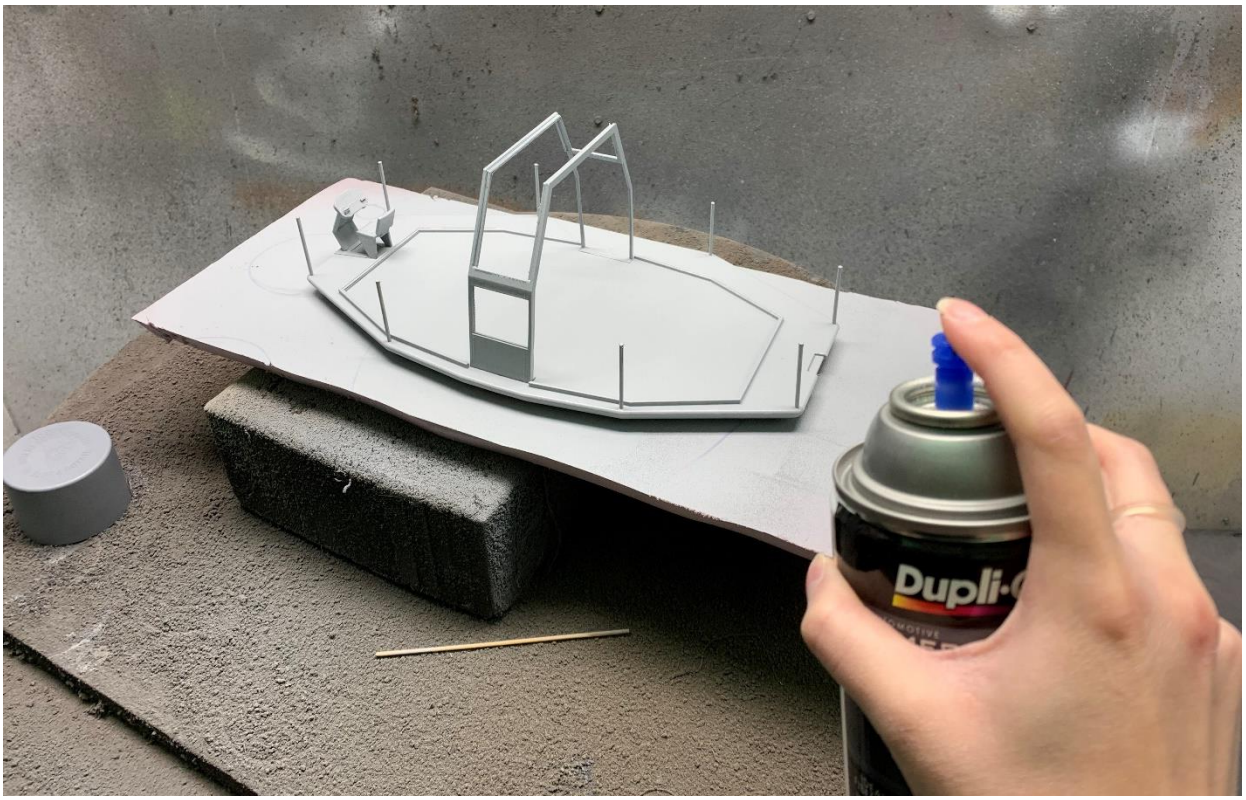


Figure 46 – Physical Model Fabrication 2



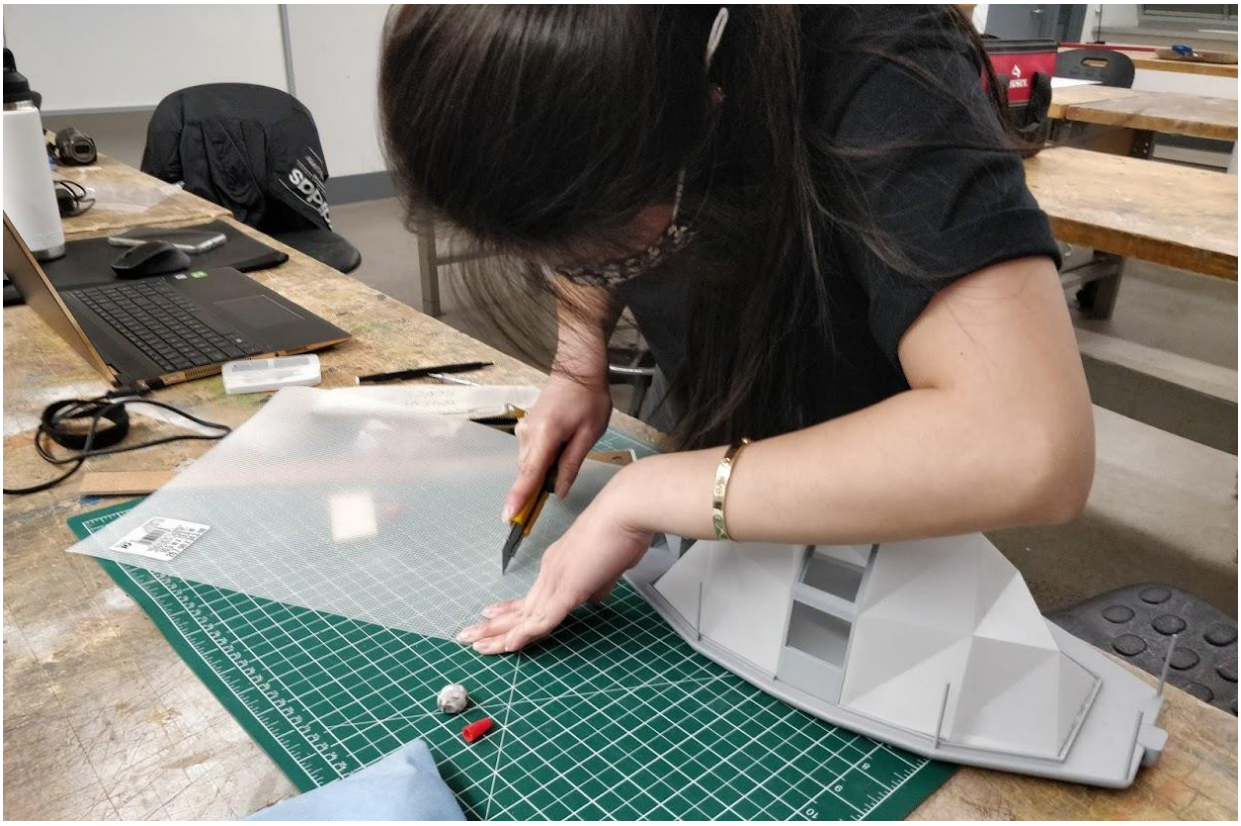


Figure 47 – Physical Model Fabrication 3

CHAPTER 5 –
Final Design

5.1 Summary

Flooding is the most frequently occurring natural disaster in the world and has resulted in loss of lives, serious injuries, and spread of disease within many regions worldwide. Masses of people endure illnesses and injuries after experiencing the effects of flood disasters, requiring immediate medical attention to survive. But many people in flooded regions have little to no access to available healthcare to aid in their recovery or survival.

To improve the availability of healthcare in regions that experience flood disasters, MERA, a temporary collapsible clinical unit was designed to provide areas with access to healthcare to treat minor injuries and illnesses. This unit includes inflatable and foldable features that allows large parts to be easily deployed in flooded areas. The ability for these parts to be manually collapsed and packed for air transportation allows for accessibility and efficiency when needed.

5.2 Design Criteria Met

The following section frames the design criteria that this thesis project meets. Topics discussed within this section include full-bodied interaction, materials and processes, and material list and costs.

5.2.1 Full-Bodied Interaction Design

A major area of this thesis project is the full-bodied human interaction design. This full-bodied interaction occurs when the product has three or more different contact points with the human body. The mobile healthcare unit is a collapsible unit that can be disassembled into multiple parts for transportation and storage. During assembly and disassembly, the builder moves into many different positions to set up and secure structures, supports, and parts. Lifting and assembling parts may

require the builder to use their hands, arms, and feet. During the use period of the collapsible medical shelter, users can sit in front of the control panel to control the direction and travel speed for short distance travels. This interaction with the seating and control panel requires interaction between multiple body parts of the driver and the product through their back, legs, arms, and hands.

The inflatable base is a large platform that inflates into a rigid base that floats on top of a body of water. As this base is necessary for supporting the two shelters, motor, and up to six people, it is a large 324" x 200" platform. This platform size allows the necessary space for the shelters to accommodate four to six people within as well as deck space around the sheltered area for people to access the motor and control seating. The platform deck is approximately 34" wide to accommodate for users travelling to different sections of the unit. The collapsible shelters are foldable origami patterns that fold into a half dome from a single folded 58.5" square. From the folded position on the platform, two people are needed to fully unfold the pattern into the large room sized shelters. A seat is situated at the front of the unit for the user to rest while operating the motor over short distances for a short period of time. The seating position is referenced from the conventional straight chair diagram from Henry Dreyfuss' Measure of Man as this seating feature will only be used for a short period during each use.

5.2.2 Materials, Process and Technology

Most of the components that make up the mobile healthcare facility unit are collapsible parts that can fold and package together for easy transportation and deployment. These parts include the base platform, folding shelter, shelter structure and securing parts, and the safety guard rails. Through benchmarking products, materials were determined that were suitable for the development of each component. An inspired product for the base platform was the Mission REEF inflatable mat, made with 1000D nylon with a drop stitch construction and reinforced seams for durability and rigidity (MISSION, n.d.). The shelter is foldable into a specific pattern and may require living hinges to do so. The most ideal lightweight material to produce living hinges is polypropylene plastic formed

into corrugated sheets that can be shaped and connected to form the required folding pattern. Structural and securing parts for the mobile healthcare unit would ideally be made from aluminum as its durable and lightweight qualities would be beneficial for ease of transportation and deployment of the unit. The mesh guard rails for safety are often made with high-density polyethylene for water resistance and durability, although there are other more sustainable alternatives for mesh such as bio fabrics (Xingying, n.d.).

The manufacturing processes for each component is different depending on the materials that are used to produce them. The base platform of the mobile healthcare facility unit is manufactured using a PVC lamination process, applying a woven drop stitch technology to the top and bottom of the inflatable board, and double reinforced seams to create an airtight seal (Starboard, n.d.). The folding structures are injection molded polypropylene, which is ideal to create the functional living hinge features (Plastics Today, n.d.). The manufacturing process used to produce the aluminum structural parts is the sheet and plate process, while the aluminum brackets are casted (The Aluminum Association, n.d.). The safety guard rails are extruded polyethylene (Xingying, n.d.).

5.2.3 Implementation – Feasibility and Viability

The following chart shows the Bill of Materials (BOM) and the material cost for each part that makes up the MERA origami medical shelter. The chart is divided into two categories which relate to one another and there are six sections determining the information shown below them. These categories include the Bill of Materials and the Material Cost. The information sections include the part number within the product assembly, the part name, part material, quantity or measurement of those parts, the estimated cost per unit, and the total cost of the material.

Bill of Materials				Material Cost	
No.	**Part**	**Material**	**Quantity/Measurement**	**Estimated Cost/Unit**	**Total Cost**
1	Inflatable Base	1000D Nylon	1 (324” x 200” x 12”)	$2500.00	$2500.00
2	Platform	High Density Polyethylene	1 (118” x 25”)	$160.00	$160.00
3	Wiring Support Beam	Aluminum	7	$55.00	$385.00
4	Instrument Panel	Aluminum	1 Panel 1 Support	$120.00 $55.00	$175.00
5	Seat	Aluminum	1	$15.00	$15.00
6	Motor	Varies	1	$1200	$1200.00
7	Guard Rail Post	Aluminum	9	$30.00	$270.00
8	Mesh Guard Rail	Bio Mesh	6 (38” x 95”)	$50.00	$300.00
9	Support Structure	Aluminum	1	$145.00	$145.00
10	Windowpane	Tempered Glass	4 sq ft	$13.00	$52.00
11	Solar Cell	Varies	1	$800.00	$800.00
12	Door Panels	Aluminum	7	$15.00	$105.00
13	Origami Structure	Polypropylene	32	$25.00	$800.00
14	Brackets	Aluminum	20	$12.00	$240.00
15	Fasteners	Steel	100	$1.40	$140.00
				Total	$7287.00

Table 8 – Bill of Materials / Material Cost

5.3 Final CAD Rendering

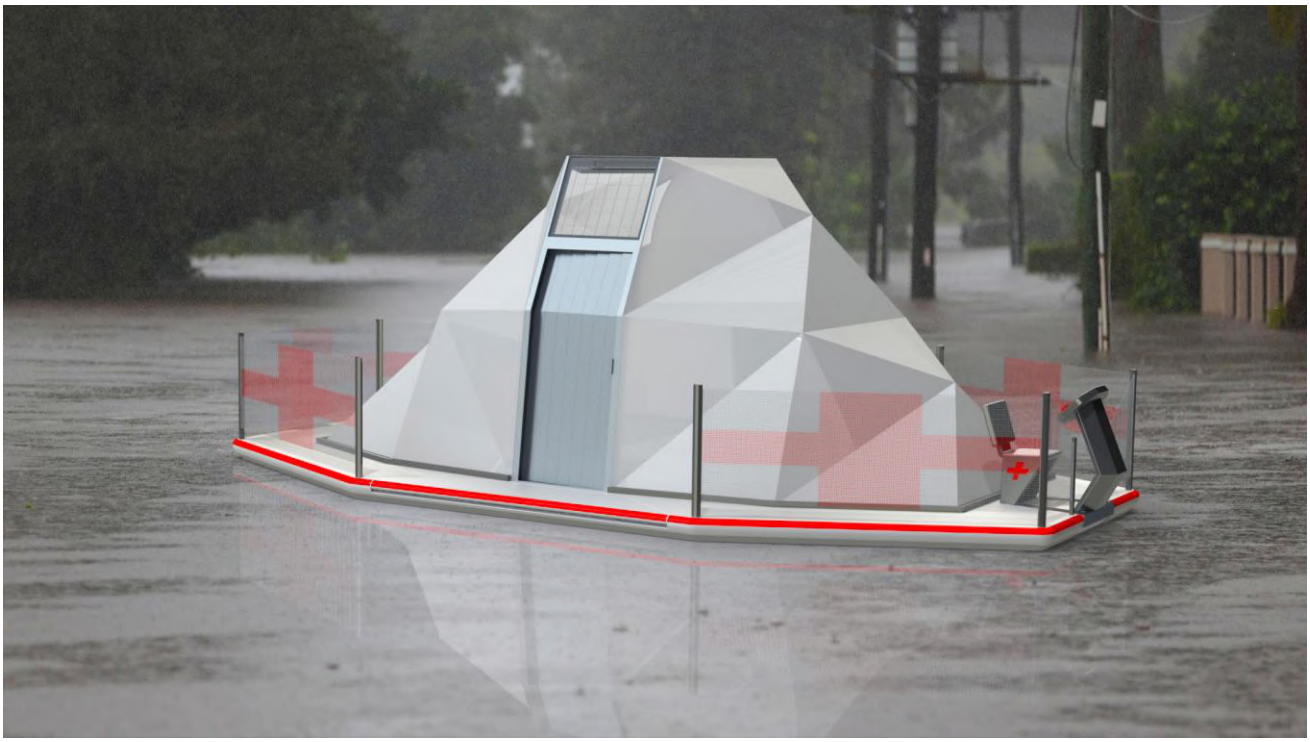
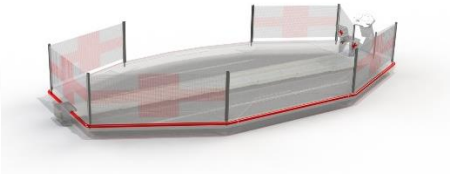


Figure 48 – Final CAD Rendering 1



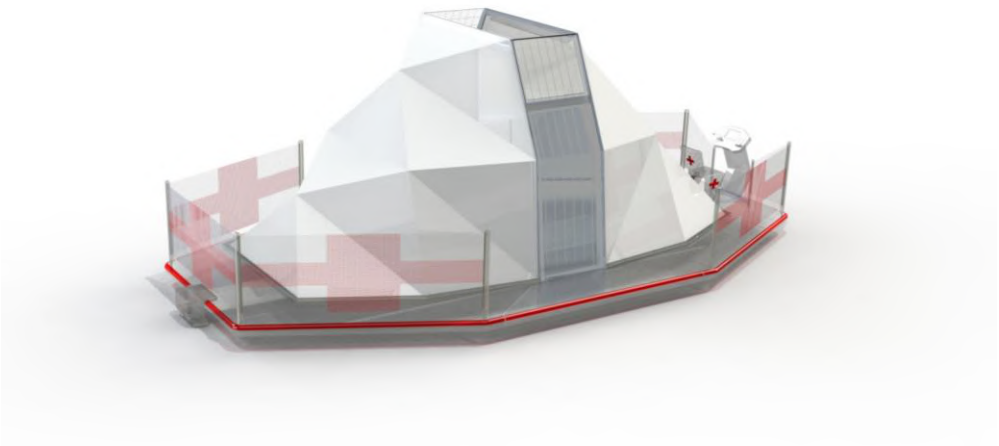
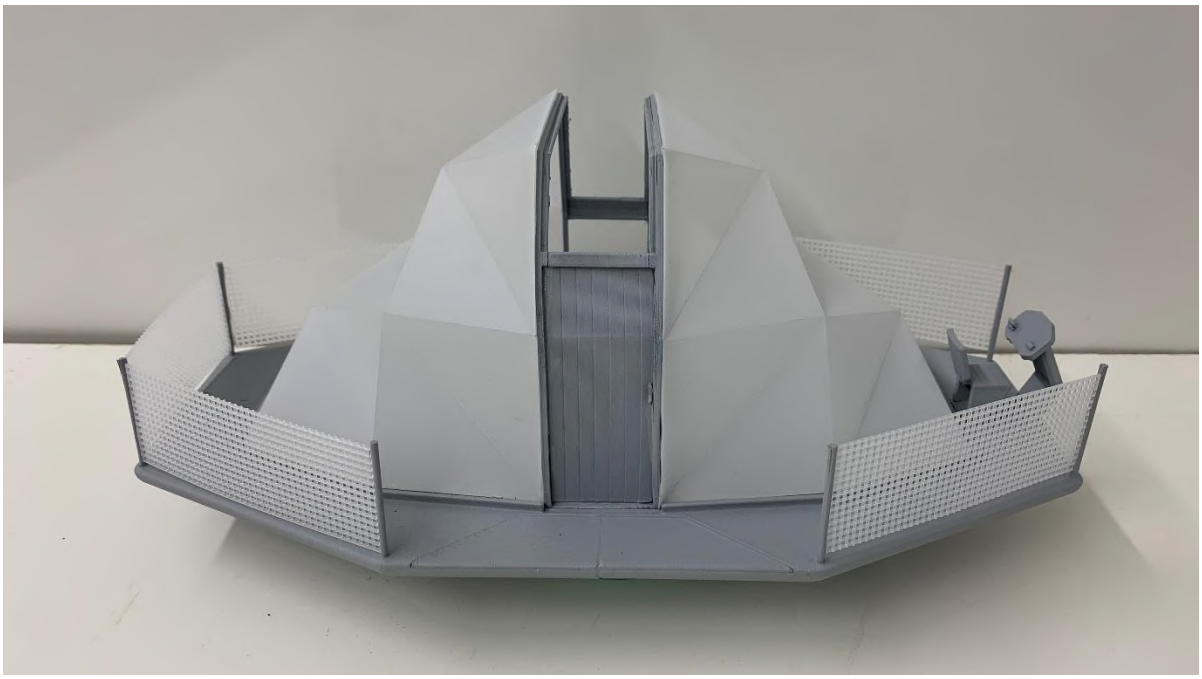


Figure 49 – Final CAD Rendering 2

5.4 Physical Model



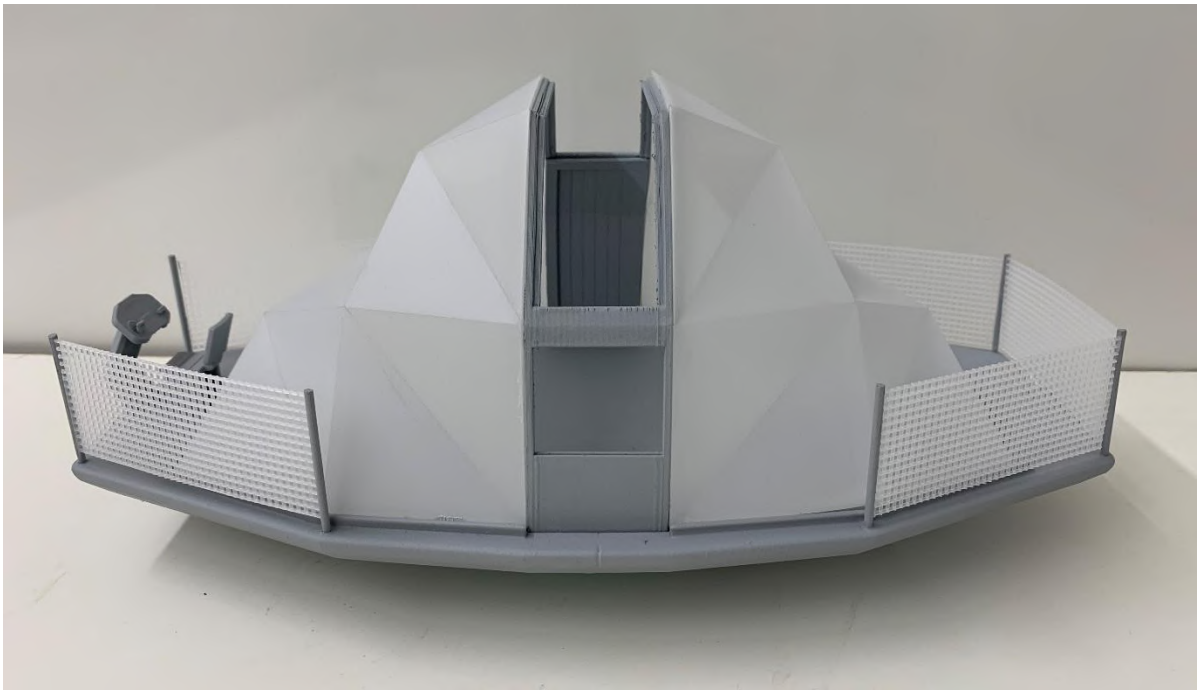
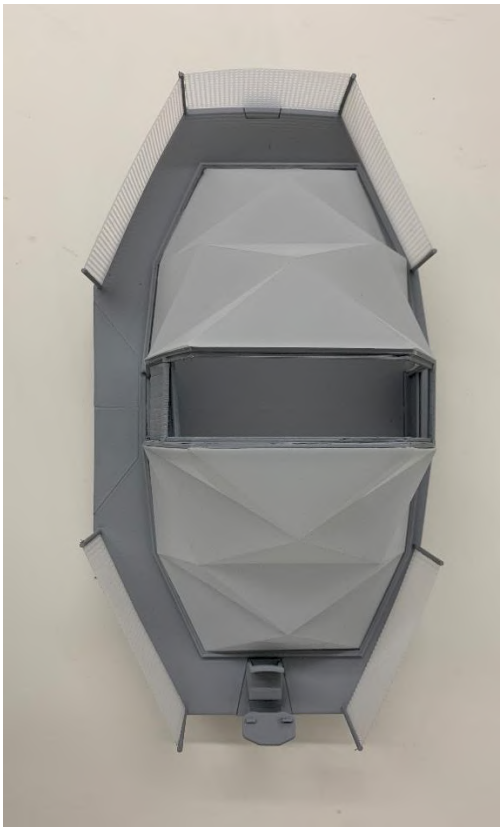
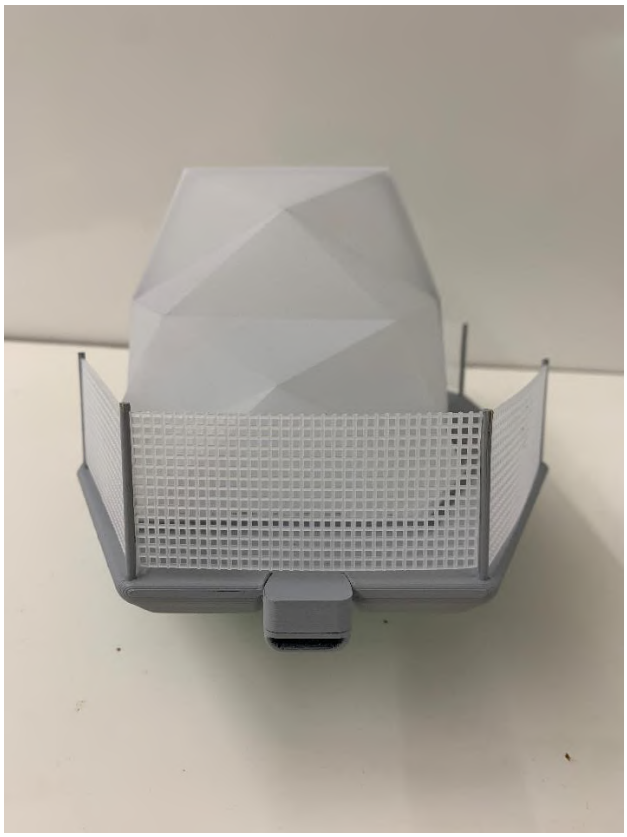


Figure 50 – Physical Model 1





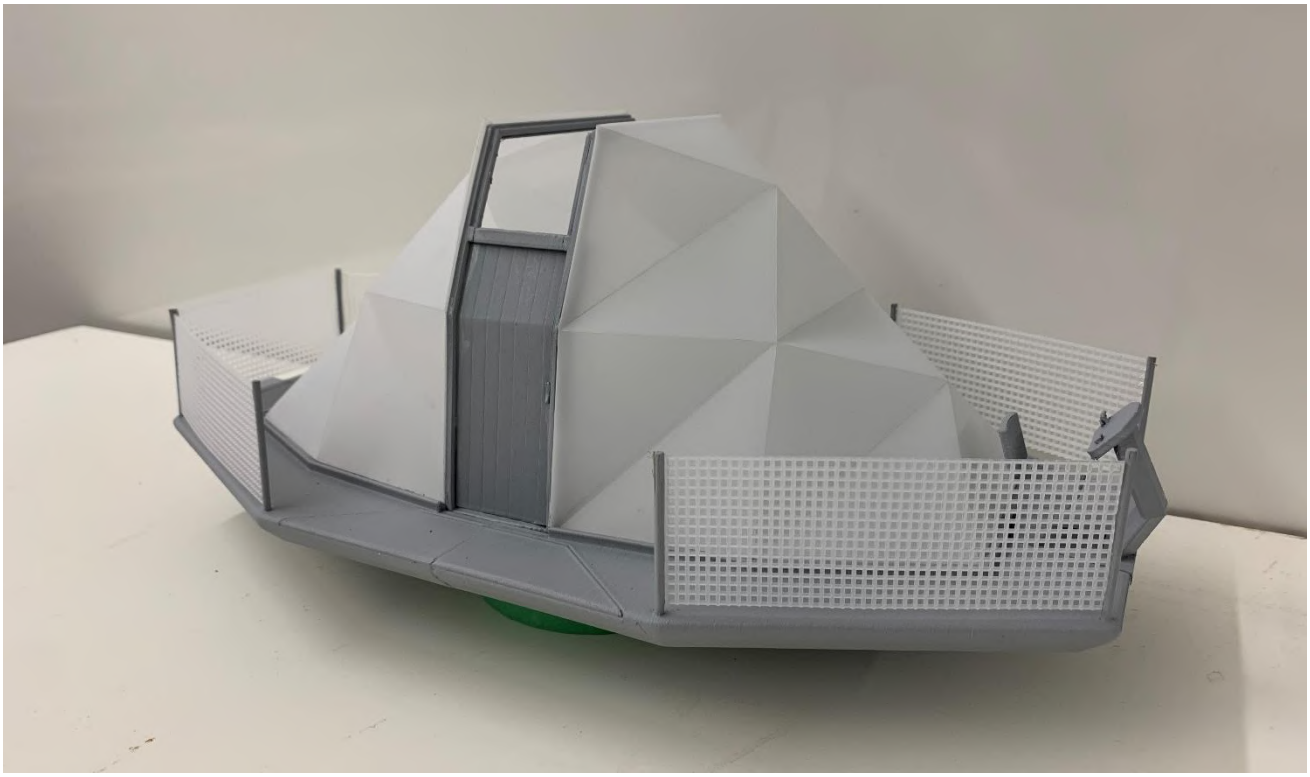


Figure 51 – Physical Model 2

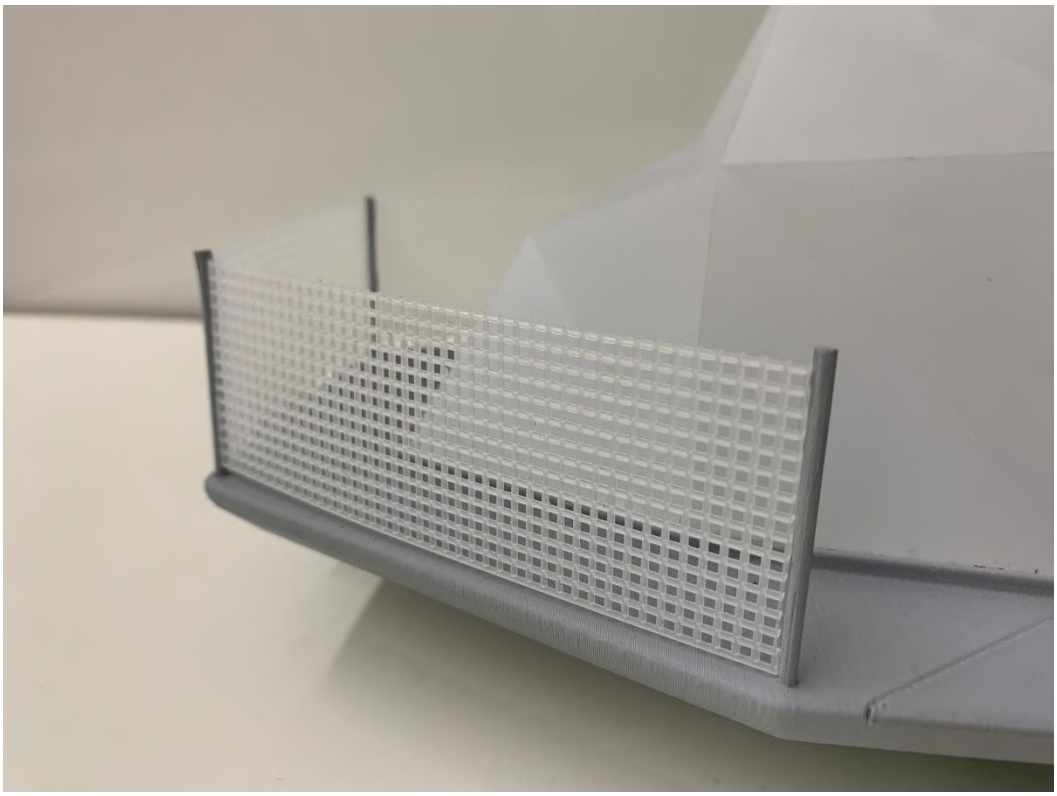
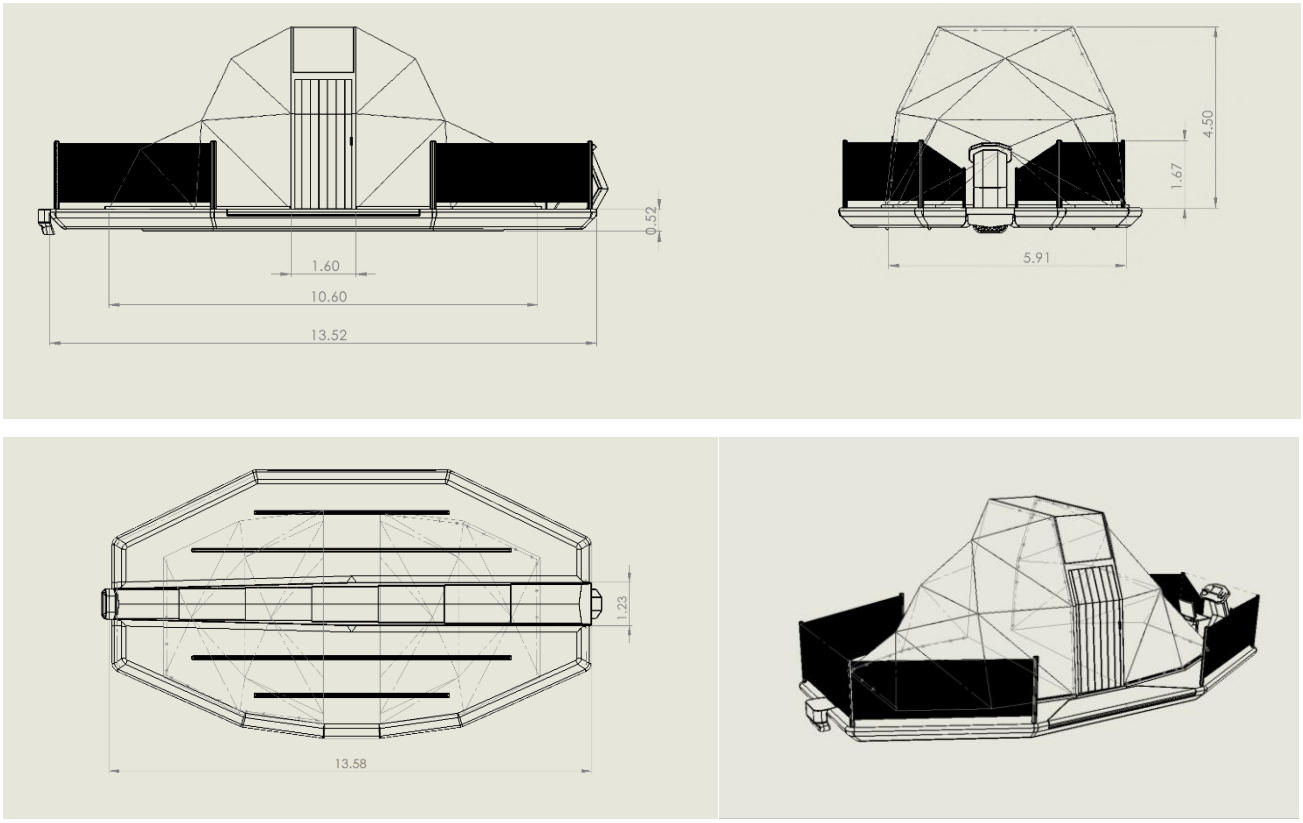


Figure 52 – Physical Model 3

5.5 Technical Drawings



5.6 Sustainability

After conducting research on current benchmarking products, materials, and manufacturing processes, multiple alternative and sustainable solutions were found. Materials made from renewable resources and maximizing the use of recyclable materials are incorporated into the final design of the mobile healthcare facility unit. Sustainable solutions for the manufacturing of major components of the mobile unit include the use of Econyl recycled nylon material for the base platform. Recyclable polypropylene will be used for the foldable shelters, recyclable aluminum for structure and securing parts, and biobased mesh will be used for the safety guard rails. Sustainable solutions were taken into consideration for each component of the mobile healthcare facility to maximize the sustainability of the unit and to reduce the carbon footprint created throughout the product's lifecycle.

CHAPTER 6 – Conclusion

MERA provides flooded regions with access to health care in local areas where health care is limited or unavailable. It is a temporary collapsible unit that can be easily transported and deployed into any flooded region. The assembly of collapsible parts creates an efficient deployment and pack-up process for the user. During the deployment period, short distance water travel to and from flooded areas provides local citizens with available medical aid for minor illnesses and injuries. MERA provides a safe and private space for health care workers to medically treat flood disaster victims.

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Appendix

A Discovery

Background

Many regions around the world do not have enough available health care facilities to care for and treat injured patients during flood disasters as hospitals can become damaged, overcrowded, and may lack adequate health care equipment to treat all patients.

Needs Statement

The availability of health care needs to be improved to help treat ill or injured people in regions that experience flood disasters. If hospitals can operate as well as before the flood occurs and can accommodate for people who need medical care, the death rate that occurs due to flood disasters each year can be greatly reduced.

How is this need being addressed currently?

The necessity for health and medical care for flood disaster victims is currently addressed through the act of hospital preparedness. Although damage to hospitals and medical equipment still occur, hospitals have determined certain procedures to follow when their region is experiencing flood disasters to provide aid for as many flood disaster victims as they can.

Summary Statement 1

1. Health care facilities in developing countries are ill prepared to handle food disasters despite being faced by them annually. They often lack in electricity backup, essential medical supplies, human resources, communication and command systems, effective leadership, and have weak financial structures.
2. Flood disasters greatly impact the health care system, significantly reducing the ability of the system to respond adequately.
3. Challenges the health care system faces when experiencing a flood disaster:
    a. Increased frequency of diseases

   b. Increase in injured victims
   c. New patients seeking care
   d. Minimal resource availability
4. Preparedness is the key to facing the challenges that flood disasters create. Actions to prepare for flood disasters and reduce health impacts include:
   a. Early detection of impeding floods
   b. The availability of countermeasures
   c. Qualified and experienced staff
   d. Identifying vulnerable facilities and populations
   e. Anticipating needs
   f. Investigating the average disruption time
5. Surge capacity – The ability to rapidly meet the increased demand for medical care and absorb the increase in number of patients. It consists of three essential components including staff, supplies, and structure.

Summary Statement 2

1. The health effects of floods such as contact with flood water or indirectly through damage to infrastructure, ecosystems, food and water supplies and social support systems can appear days, weeks, or months after the floods have receded.
2. Effects on people exposed to flood water:
   a. Cardiovascular disease
   b. Drowning
   c. Injuries
   d. Infections
   e. Chemical poisoning
   f. Mental health disorders

g. Overcrowding

3. Factors rendering certain population groups or individuals at risk of suffering the health impacts of flood disasters:

   a. Limited physical capacity and mobility

   b. Reliance on important medication / home care / care at a health facility

   c. Poor flood awareness

   d. Lack of resources and access to information and warnings

4. Health care services may be required to expand beyond normal capacity to meet community demands. To prepare for flood disasters, hospitals should ensure they have:

   a. A well-functioning control and command system

   b. Strategies for effective communication

   c. Safety and security procedures

   d. A mass-casualty triage protocol

   e. Surge capacity

   f. Availability of essential services

   g. Effective human resource management

   h. Ensure continuity of hospital supply and delivery chain

   i. Post-disaster recovery planning procedures

B User Research

User Demographics

The targeted demographic criteria focused upon in this report to determine characteristics and relevant information, included age, gender, ethnicity, location, and education.

Image Search for General Demographic Characteristics

A Google Image Search was conducted to determine what typical healthcare providers in Asia look like. As there are different health care workers who work together in urgent care centers, there was a consideration for different primary users. The following search terms were used:

- “Healthcare Workers in Asia”
- “Emergency Response in Asia”
- “Hospitals in Asia”
- “Urgent Care Facilities in Asia”

Findings

Findings have been collected in a table.

IMAGE	**DEMOGRAPHIC INFORMATION**
 Figure 1 – Hospital in Ludhiana, India. Retrieved from	Age: 25-40 Gender: Female Ethnicity: Indian Location: Ludhiana, India Educational background: University Career: Nurses

https://www.smergers.com/business/hospital-investment-opportunity-in-ludhiana-india/p0fz8/	
 Figure 53 – Healthcare Workers in China. Retrieved from https://www.newyorker.com/news/news-desk/keeping-the-coronavirus-from-infecting-health-care-workers	Age: 28-50 Gender: Male/Female Ethnicity: Chinese Location: China Educational background: University Career: Mixed
 Figure 54 – Healthcare Facility in Indonesia. Retrieved from https://www.worldatlas.com/articles/leading-causes-of-death-in-indonesia.html	Age: 35-45 Gender: Male Ethnicity: Indonesian Location: Indonesia Educational background: University Career: Doctor

Literature Search for Demographic Data

A literature search was also conducted using Google Search Engines to collect data regarding health care workers in Asia. The following search terms were used:

- “Asia Healthcare Worker Statistics”
- “Healthcare Education in Asia Data”
- “Hospitals in Asia Statistics”
- “Asian Doctors and Nurses statistics”

Findings

The findings have been summarized along with data references according to the relevant categories: Age, Gender, Education, and Income.

Age

As seen in the Image Search Findings above, health care workers in Asia range in ages between mid-20s- and middle-aged persons. A higher percentage of people working in the health care industry are younger in age, between 25 and 50. However, a higher percentage of nursing and midwifery personnel are above 60.

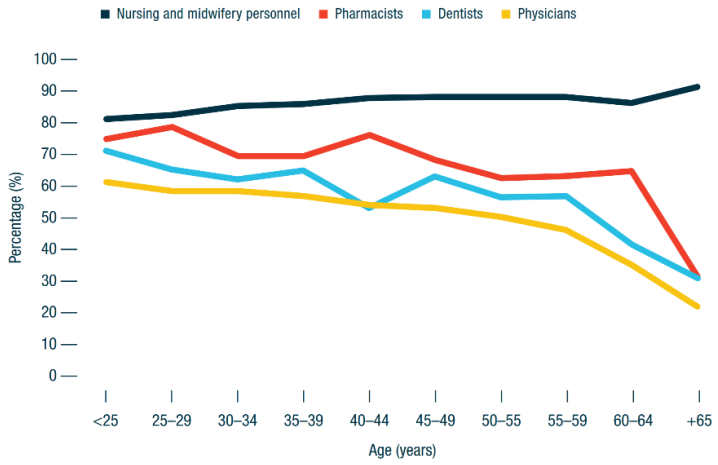


Figure 4 – Age Distribution Amongst Healthcare Workers. [Image] (2019). Retrieved from https://apps.who.int/iris/bitstream/handle/10665/311314/WHO-HIS-HWF-Gender-WP1-2019.1-eng.pdf?sequen

Gender

As viewed in the Image Search Findings above, healthcare workers in Asia consist of both male and female professionals. According to these statistics, a higher percentage of men work as physicians, while a higher percentage of women work as nurses.

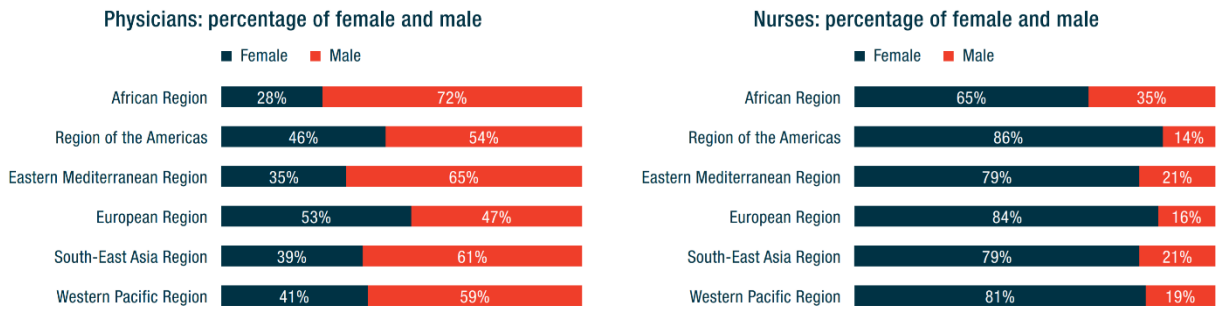


Figure 5 – Gender Distribution Amongst Healthcare Workers. [Image] (2019). Retrieved from https://apps.who.int/iris/bitstream/handle/10665/311314/WHO-HIS-HWF-Gender-WP1-2019.1-eng.pdf?sequen

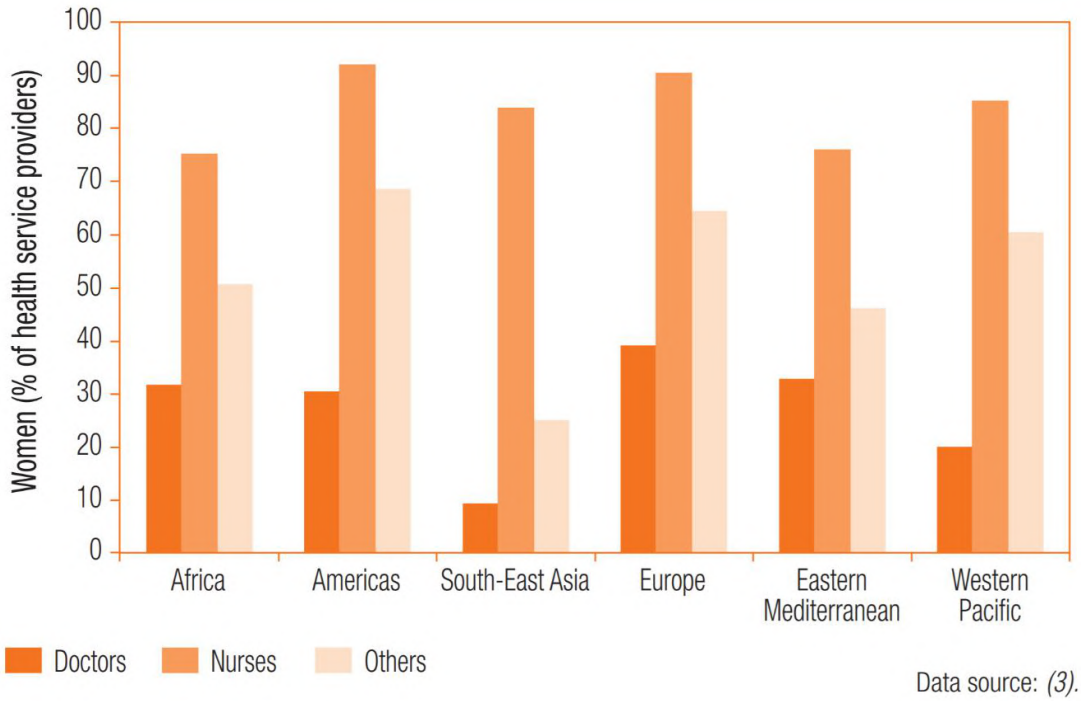


Figure 6 – Gender Distribution Amongst Health Service Providers. [Image] (2014). Retrieved from https://www.who.int/whr/2006/06_chap1_en.pdf

Education

As health care workers deal with medicine, procedures, patients, and equipment, quality education and training are important. University level education is most likely the form of education a healthcare worker will have studied to pursue such an occupation. According to this guide to public health degrees and education, depending on the current education of the healthcare worker, these degree levels are needed to work in public health.

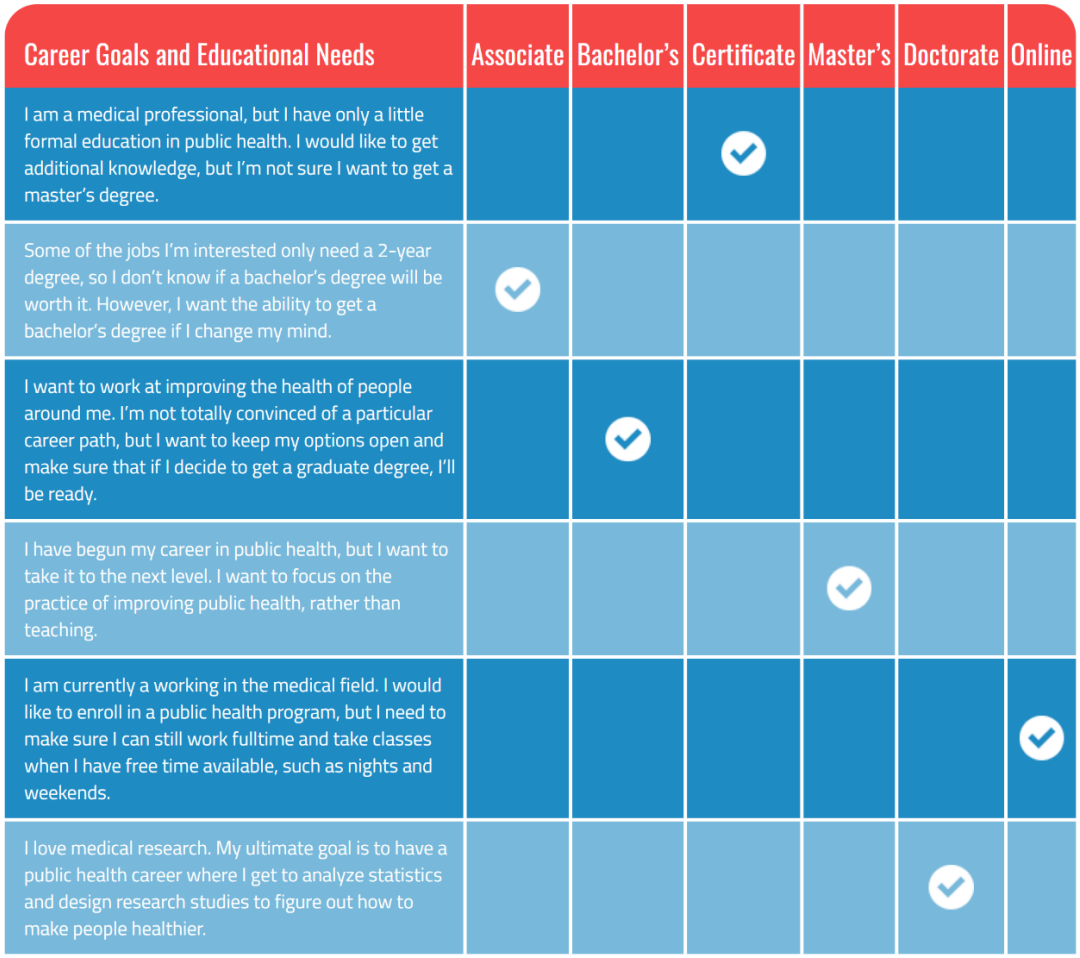


Figure 7 – Pursuing Public Health Degree Levels and Careers. [Image] Retrieved from https://www.learnhowtobecome.org/medical-health-careers/public-health/

Income

As seen in the Image Search Finding above, healthcare workers have many different roles and specializations. Depending on the education, occupation, and role of the healthcare worker, different wages are distributed accordingly. In comparison with US physicians who make between $200k to $440k annually, physicians in Asia often make significantly less, between $70k to $200k annually.

Country	Category	In Local Currency	In USD
US	Average Income for Orthopedics	443,000	443,000
	Average Income for Plastic Surgery	355,000	355,000
	Average Income for Pediatrics & Family Medicine	205,500	205,500
Singapore	Annual Salary Ceiling for Senior Specialist Doctor	300,000	217,517
	Avg Pay for Physician, General Practice	96,499-109,668	70,000-80,000
Korea	Avg Income for Ophthalmologist	225,360,000	200,194
	Avg Income for Plastic Surgeons & Dermatologist	114,840,000	102,016
	Avg Income for Family Doctors	96,000,000	85,280
Japan	Avg Income for Doctors & Physicians	11,540,000	111,573

Figure 8 – Doctors Income in US compared to Asia counterparts. [Image] Retrieved from https://www.valuechampion.sg/average-income-doctors-singapore-vs-other-countries

General Physician Job Average Salary

Country	Net Monthly Income constant 2005 US$ [a] [d]		Notes, Source	Gross Monthly Job Income		Compulsory Deductions	Weekly Hours
U.S. average salary	PPP $ 8,189	$ 8,189	Family and general practitioners, standardized hours (2,080 hours/year), 2005. U.S. Department of Labor, [t].	11,698	dollars	30%	
Taiwan average income	PPP $ 5,388	$ 2,885	Full-time and part-time employees, 2004. National Statistics Republic of China, [9].	112,658	dollars	17%	*40.5*
Japan average salary	PPP $ 4,594	$ 5,401	Excl. overtime and bonus, June 2005. Men only. Private establishments with 10 or more regular employees. Japan Statistical Yearbook [17], [k].	761,000	yens	22%	
Singapore average salary	PPP $ 3,843	$ 3,523	Employees, private sector, 2004. Ministry of Manpower, [9], [t].	7,607	dollars	24%	
Thailand average salary	PPP $ 2,936	$ 937	Men employees, 2005. Women make 25,130 bahts per month. Thailand National Statistical Office, [9], [t], [s].	41,358	bahts	9%	52.0

Figure 9 – General Physicians Job Average Salary Comparison. [Image] Retrieved from http://www.worldsalaries.org/generalphysician.shtml

Discussion / Conclusions

Based on the Image Findings above, a general idea and identification of healthcare workers and what they look like is provided. Through observation of these images, healthcare workers in Asia appear to be between 25 to 50 years of age. The average age of healthcare workers may be influenced by the level of education needed as a longer amount of schooling for certain medical careers is necessary. Although, many healthcare workers continue their studies in health care during their jobs, university education level is still needed to pursue jobs within the medical field. According to the determined statistics, a realistic portrayal of an average healthcare worker in Asia can be seen.

Demographics of Healthcare Workers in Asia	
Age	25-50
Gender	Mix of Male and Female
Ethnicity	Asian
Income	$70k - $200k
Education	University Level, Varying Degrees

Figure 10 - Based on data retrieved from https://apps.who.int/iris/bitstream/handle/10665/311314/WHO-HIS-HWF-Gender-WP1-2019.1-eng.pdf?sequen, https://www.valuechampion.sg/average-income-doctors-singapore-vs-other-countries, and from https://www.learnhowtobecome.org/medical-health-careers/public-health/

In conclusion, most healthcare professionals in Asia fit the criteria of being a 38-year-old man or woman, depending on the medical role within the hospital, and earning around $80k to $175k with a university level degree.

Primary User	Healthcare Professional
Secondary User	Patient
Tertiary User	Visitors (family/friends)

User Behavior

A literature search was conducted using Google Search Engines and the Humber Library Database to discover the traits of healthcare workers relating to user behavior. The following search terms were used:

- “Urgent Care Centres”
- “Hospital Response to Emergency”
- “Hospitals Locations”
- “Healthcare Roles”
- “Health Care Professionals”

Findings

A summary of the literature search findings can be viewed below regarding relevant categories: Activity Frequency, Activity Duration, Collaboration, Lifestyle and Personality, Income Level, and Location,

Activity Frequency

Healthcare workers must respond to multiple situations regarding the health of their patients. Treatments often vary for different health issues and different healthcare providers are needed depending on the specialized field in which they are in. The image below is a visual representation of the types of health issues that hospital patients encounter and the frequency of each. Due to the different frequencies in varying health issues, different healthcare workers deal with these issues regarding their role in the hospital and their specialties. Therefore, the activity frequency of healthcare workers may vary depending on the frequency of the type of health issues and treatments they specialize in.

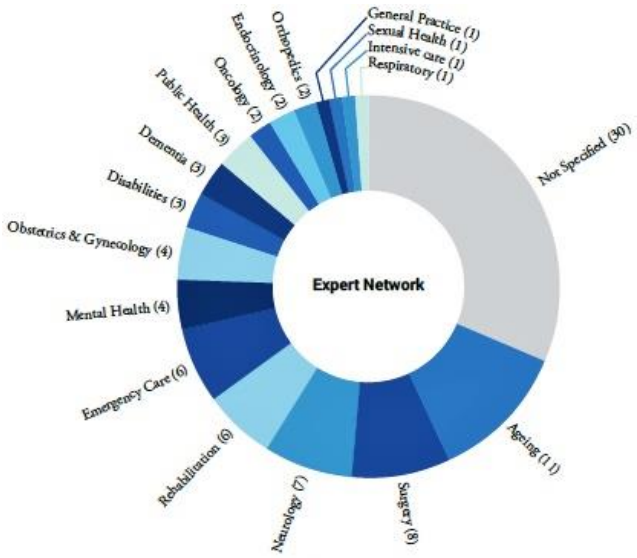


Figure 11 – Clinical Conditions. [Image] Retrieved from https://www.designinhealthnetwork.org/results/clinical-condition/

Activity Duration

Hospitals around the world are typically operating on a 24-hour basis seven days a week. Emergency rooms and urgent care centers are constantly operating as well, therefore necessary healthcare workers are needed to treat incoming patients. As hospitals are open 24 hours,

physicians are present day and night, often working longer hours if necessary. According to AMA Insurance, most physicians work between 40 and 60 hours per week, but nearly ¼ of physicians work between 61 and 80 hours per week (AMA, 2015).

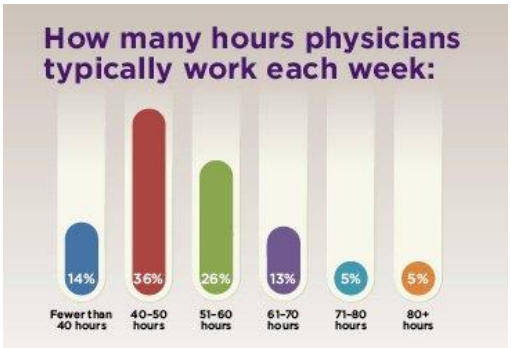


Figure 12 – Average Physician Working Hours. [Image] Retrieved from https://www.ama-assn.org/practice-management/physician-health/how-many-hours-are-average-physician-workweek#:~:text=Most%20physicians%20work%20between%2040,than%2040%20hours%20per%20week.

Collaboration

Healthcare professionals are often assumed in complementary roles within a hospital environment and often cooperatively work together with other healthcare workers. They often share the responsibility to solve problems, make decisions, and formulate and carry out plans to care for their patients (O'Daniel, 2008). Collaboration is important between healthcare professionals to increase the awareness of the type of knowledge and skills that each member has, leading to future improvements in decision making.

Lifestyle and Personality

As healthcare professionals care for others daily to help improve the world, it is evident that they are very caring and moral people. Therefore, they are always willing to help others whether in the workplace or outside of it. Since healthcare professionals also spend many hours each day and

week at work, they may take interest in spending quality time with their families and friends or enjoy relaxing activities on their time off.

Income Level

As healthcare professionals have many different titles and roles within a hospital, it is difficult to determine an income level for them. A hospital consists of several doctors (senior consultants, registrars, residents, interns, and student doctors), nurses (unit manager, practitioners, specialist nurses, registered nurses, and enrolled nurses), allied health professionals (dietitians, therapists, pharmacists, physiotherapists, podiatrists, and pathologists), and other hospital staff (assistants, porters, volunteers, and ward clerks) (BetterHealth, 2015). Health professionals earn different levels of income regarding their titles, roles, and skill level within the hospital.

Location

Hospitals are important facilities that are located within every community. In 2015, there were 53 535 private hospitals located in all areas of the Asian region (Healthcare Asia, 2016). According to the statistics shown below, there are very few doctors and nurses working in hospitals compared to the population in Asia. In comparison to the number of registered nurses staffed in Canadian hospitals, most countries in Asia have less than half the number of available nurses working in hospitals located within those countries.

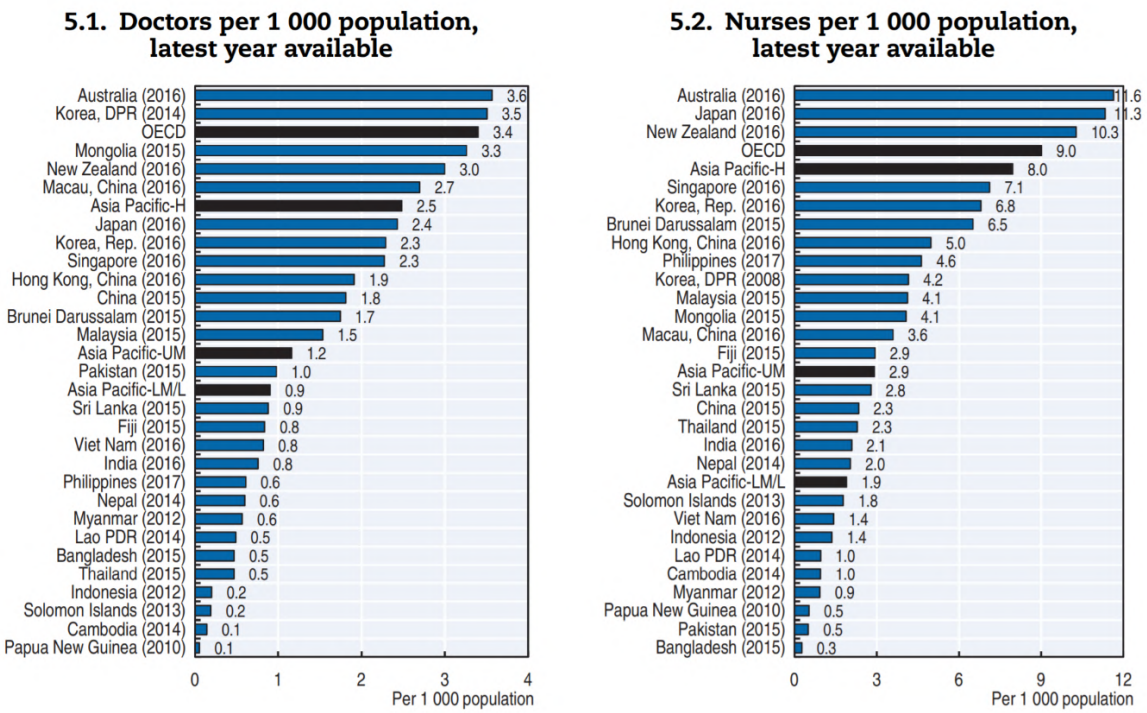


Figure 13 – Number of Healthcare Workers in Asia. [Image] Retrieved from https://www.oecd-ilibrary.org/docserver/health_glance_ap-2018-en.pdf?expires=1602825550&id=id&accname=guest&checksum=EBC14227D63C92FDC73AC36050840DDF

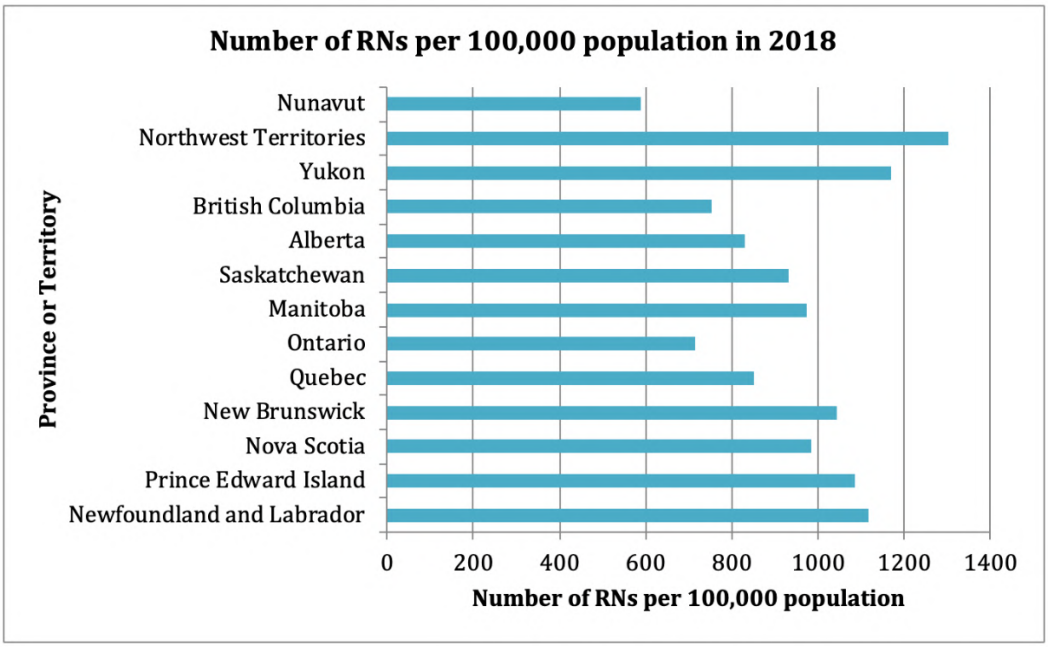


Figure 14 – Number of RNs in Canada. [Image] Retrieved from https://behindthenumbers.ca/2020/03/19/covid-19-nurses-need-support-from-next-weeks-ontario-budget-statement/

Conclusions

Through literary search findings, it has been determined that the factors discovered in understanding the user involved employment conditions rather than the behavioral characteristics of healthcare professionals. The most determining categories for user understanding were Activity Duration, Collaboration, Income Level, and Location.

User Profile Summary

User	Description
Primary	Healthcare Professional
Secondary	Patient
Tertiary	Visitors (family/friends)

Primary User Profile

Demographics		**User Behavior**		**Personality**		**Cognitive Aspects**	
Age	25 - 50	Frequency of Use	Daily	Self-Efficacy	↑	Technical Skill	↑
Gender	Mixed Male and Female	Duration	40 – 60 hours/week	Social	↑	Pre-Requisite Knowledge	↑
Ethnicity	Asian	Collaboration	High	Morality	↑	Determination	↑
Income	Upper Class ($70k - $200k)	Income	Varying	Conscientiousness	↑	Empathy	↑

Education	University Level Degree	Location	Community			Mental Health/Stress	↓

Conclusions

The user profile of a primary user is created after conducting images and literary searches for user demographic data and user behavior. The profiled user is a male or female between 25 and 50 years of age who earns an upper-class income level with a university level educational background in healthcare. The user works as a healthcare professional daily, working an average of 40 to 60 hours per week, collaborating with other healthcare workers in a hospital environment within a community.

Persona

Name: Maria Lee

Age: 38

Occupation: Physician

Income: RM 110 000 (CAD $35 000) / year

Education: Master's degree - Medicine

Relationship Status: Married, 2 kids

Location: Sabah, Malaysia

Career/ Volunteer: Career

Years of Service: 8

Social: Works with many other healthcare

Figure 15 – Hospitals & Health Systems. [Image] Retrieved from https://www.cerner.com/solutions/health-

professionals

Frequency of Activity: Works daily shifts, 8-10 hours

Hobbies: Spending time with family, shopping, social gatherings.

Profile

Maria Lee is a 39-year-old Asian female. She attended university to receive her master's degree in Medicine, completing her education before beginning her job as a physician at a local hospital. She earns an annual salary of RM 110 000 (CAD $35 000) and has been working as a physician for a total of 8 years so far. Maria began her medical studies at the age of 20 and underwent 9 years of schooling before obtaining a career in medicine. She strives to make the world a better place through her contributions in both the hospital and outside of work.

User Behavior

Maria works at a local hospital in her community, responding to any immediate health concerns that patients may have. As there are multiple healthcare staff with different roles and responsibilities in her department, she collaborates with her fellow healthcare workers to provide the necessary treatments for those who need it. Maria is aware that she has particular roles within the hospital and always helps her coworkers in need of her expertise. When providing care to ill or injured patients, Maria keeps a positive attitude as she communicates with them. It is very important that the patient is comfortable with sharing their health concerns with Maria in order for her to diagnose and treat them efficiently. She informs her patients of details or instructions for medication or procedures before providing them the treatment to ensure that they understand benefits and risks. Maria takes pride in her successes in improving the well beings of her patients and has a

strong determination to continue to improve her own knowledge and skills in medicine to help others.

Maria's Relationship with the Urgent Care Clinic

Maria has worked in the Urgent Care Department at her local hospital since the start of her career. She has since gotten very familiar with the environment and learned the systems of operation within her department. As patients arrive at the clinic, they wait in a designated seating area and fill out necessary forms if they are able, until they are directed into a treatment room. Maria is assigned patients that need help within her area of expertise and frequently checks all forms and logs posted by other healthcare workers in the department to determine which patients she needs to help.

Questions for Empathy Mapping

Interview with the user.

Specific questions that can be asked to give a more complete picture (for each of the main 7 questions).

Who are we empathizing with?

1. Can you tell me about yourself?
2. Can you tell me about your background?
3. Do you live with other family members?
4. Can you tell me about your career?
5. Tell me about how you started working in the healthcare industry.
6. How do you feel about working in the healthcare industry?

What do they need to do?

1. What are your job duties at work?
2. What equipment and tools do you use to perform your tasks?
3. Who do you interact with at work?
4. What is important to you in a completed task?

What do they see?

1. Ask for a tour of their facility. (optional)
2. Where do you get information for your daily tasks?
3. Where do you mainly work?
4. Do you have to travel between areas often to complete tasks?
5. What kind of people do you see in your workplace?

What do they say?

1. What are you thinking as you are working?
2. Do you need to communicate with others at work? What is being communicated?

What do they do?

1. How do you prepare for a workday?
2. What form of commute do you use to travel to work?
3. Can you tell me about how you will complete your daily job duties?
4. How do you interact with other people in your workplace?
5. What is usually going on when you are completing your tasks?

What do they hear?

1. What responses or comments do you hear from others in your workplace regarding your job duties?
2. What do others often think about your work? How do you know?

What do they think and feel?

A: Pains

1. Is there anything you find challenging in your job duties? Why?
2. What are some challenges you face daily?
3. If you could change anything regarding your workplace, what would it be?
4. Can you remember the last time you were completing your duties, and something surprised you? Tell me about that.
5. Is there anything you would do differently to improve your work experience?

B: Gains

1. What are your goals at work?
2. What do you enjoy about your work?
3. How do you often feel about the outcome of your work? why?
4. Is there anything that you think would ease your work process in the future?
5. Tell me about a work experience that was very enjoyable for you.
6. Is there anything about completing your job duties that would make the experience for you or for others even better?

"What other thoughts and feelings might motivate their behavior?"

1. Anything that would make this easier if doing this again?
2. Is there anything that would make it more productive?
3. Is there anything that would make the experience more enjoyable for you?
4. Is there anywhere you go to get ideas for doing this?

Empathy Map

Thesis Topic: *How may we improve healthcare facilities in regions that experience flood disasters?*

***Objective of the user observation**:*
To determine the main pain points of the user working in a healthcare facility system.

User (individual or group):
Individual, working in the hospital emergency department.

User Background:
Patient registration doctor. The first step in an emergency room systems of operation.

Method:

Interview

Driven by the analysis method- the Empathy Map.
Questions

Recording Techniques Used

- *transcription app*

Results:

Transcript of the Interview with the user

Analysis:

The Empathy Map
The Empathy Map insights into generates insights into Pains,
and possible solutions which make the task easier, more productive, or more enjoyable?

Result

Transcript

Shown below is a sample of the transcript taken from the interview with the user.
The transcription was generated from a transcription app.

Who are we empathizing with?

Can you tell me about yourself?

I am a mother of 2 who immigrated to Canada when I was 10. I worked at a dental office for about 10 years before the owner sold the practice and I got a job at the hospital. I've been working at Markham Stouffville for roughly 3 years now as a patient registration clerk.

Can you tell me about your background?

I am from Goa, India which was a Portuguese colony. I have lived most of my life in Canada and consider my main background as Canadian.

Do you live with other family members?

Yes, I am married and have 2 sons.

Can you tell me about your career?

I work as a patient registration clerk at Markham Stouffville hospital as a patient registration clerk. Basically, I book people in after they go through the initial triage with the nurses.

Tell me about how you started working in the healthcare industry.

As I said in a previous point, I worked previously in a dental office so the experience helped me get a job in the hospital. The transition was quite smooth since I understood a lot of the systems and terminology.

How do you feel about working in the healthcare industry?

I enjoy it but I do feel that there needs to be more transparency along the administrative side of the hospital.

What do they need to do?

What are your job duties at work?

I book people in after they go through triage. I take their health card and any other necessary info before they are booked in.

What equipment and tools do you use to perform your tasks?

I generally only use a computer and a notepad.

Who do you interact with at work?
I interact with everyone, from administrators to doctors to nurses to patients. If you are coming to the hospital, chances are I have interacted with you at some point.

What is important to you in a completed task?
Making sure the job is done correctly and efficiently.

What do they see?
Where do you get information for your daily tasks?
Based on the patients who I register coming in.

Where do you mainly work?
Patient registration.

Do you have to travel between areas often to complete tasks?
Sometimes I will work as a bed allocated but 90% of the time it is in patient registration.

What kind of people do you see in your workplace?
Usually sick patients.

What do they say?
What are you thinking as you are working?
I am just focused on getting the information from patients and entering it correctly.

Do you need to communicate with others at work? What is being communicated?
Yes, I usually communicate patient's names, areas, ailments, insurance, next of kins and more.

What do they do?
How do you prepare for a workday?
I wake up at quarter to 5am, get lunches ready and arrive for 7am. I work till 3. I come dressed in a business casual attire generally.

What form of commute do you use to travel to work?
I drive every day.

Can you tell me about how you will complete your daily job duties?
I arrive at my station, log in and wait for people to go through triage before registering them.

How do you interact with other people in your workplace?
I communicate any information they may need as well as have general conversations when waiting between patients.

What is usually going on when you are completing your tasks?
Patients are giving me info and I am inputting it.

What do they hear?
What responses or comments do you hear from others in your workplace regarding your job duties?
I do not really hear much; we work as a great team, so everyone knows that they are necessary for everything to flow well.

What do others often think about your work? How do you know?
I have no idea; I do not usually discuss work with friends.

What do they think and feel?
A: Pains
Is there anything you find challenging in your job duties? Why?
I think that better seating as well as a more efficient layout would help my job.

What are some challenges you face daily?
Unruly and disruptive patients who refuse to give necessary information.

Is there anything you would do differently to improve your work experience?
As I said before, changing the layout would aid in efficiency.

B: Gains
What are your goals at work?
I strive to be efficient and accurate in the information I input.

What do you enjoy about your work?
I enjoy the team aspect as well as knowing that I play a small part in helping a patient make the experience at the hospital a little better.

Tell me about a work experience that was very enjoyable for you.
When patients have information ready and read it out clearly, it makes my job very easy.

Is there anything about completing your job duties that would make the experience for you or for others even better?
Hopefully as I do my job, patients feel comforted and welcomed as they get the required work done.

Analysis

Empathy Map Canvas

1 WHO are we empathizing with?

- Married and mother of 2
- From Goa, India, immigrated to Canada at the age of 10
- Worked at a dental office for 10 years before getting a job at the hospital
- Worked at hospital for 3 years
- Enjoy working in the hospital

2 What do they need to DO?

- Patient registration clerk
- Book people into the hospital after undergoing triage process, taking any necessary info
- Use a computer and notepad

3 What do they SEE?

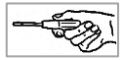
- Tasks are repetitive, taking information from patients Mainly works in the patient registration office
- Sometimes works as a bed allocator, 90% in patient registration
- Usually deals with sick patients

PERSONA

5 What do they SAY?

- Usually focused on getting information from patients and entering it correctly into the system
- Communicates patients' names, areas, ailments, insurance, next of kin, etc. with other healthcare professionals

4 What do they DO?



- Wake up 4:45am, arrive at work for 7am, work until 3pm
- Drive to work every day
- Arrive at station, log in, prepare for the day
- Communicate any necessary information to patients and other healthcare professionals
- Input important patient information into the system

PAINS

Fears, frustrations, anxieties

- Uncomfortable long hours seated in front of a screen
- Unruly and disruptive patients who refuse to give necessary information
- The layout of the facility can be improved for efficiency

GAINS

Goals achieved; experiences enjoyed

- Strive to provide efficient and accurate information of patients
- Patients feel comforted and welcomed
- Patients who are prepared to provide necessary information

6 What do they HEAR?

- Facility is often quiet
- Emergency team works well together, everyone knows their duties for everything to flow well
- Appreciation from patients after having registered them
- Sometimes complaints from patients about wait times

What might make this easier, more productive, more enjoyable?

- Patients having their necessary information prepared
- Having an efficient system of workers that flows
- Improved layout for efficiency for patients and workers moving throughout the facility

Summary

Major Take-aways from the Empathy Map

Discussion and Summary

Hospitals have many different departments and sectors that are operated by healthcare workers of different specialties and job duties. Within an emergency department, there are different sectors containing healthcare workers who contribute to the workflow of the department to aid and treat their patients efficiently. Patients in the emergency department undergo a process throughout their visit to receive treatment, entering different sectors of the emergency department along the way of their hospital experience. The process of an emergency room visit consists of mainly 3 steps including triage, registration, and treatment which keep the hospital organized and operating smoothly.

As the interviewee for this empathy map works in the patient registration sector, she would interact with the patient near the middle of their emergency room experience. Patients in the triage sector are organized into specific categories depending on their condition and the urgency of care needed. Once categorized, patients are sent to the registration sector where they give all necessary information to be inputted into the system to prepare for their next step in the process, which is treatment.

My interviewee typically works an 8-hour day shift, driving to work daily. She works in the patient registration sector, where she interacts with nearly everyone who enters the hospital. This includes patients, doctors, nurses, administrators, etc. As her job duties is to collect important information from all patients, she is situated at a desk with a computer. 10% of the time she may also work as a bed allocator, a healthcare worker who oversees moving patients around.

She feels that in her main duties, improvements can be made to maximize efficiency including the layout of the department, more comfortable seating, and the cooperation of patients. As she plays a role in the hospital's systems of operation, she strives to provide efficient and accurate information to her fellow workers regarding patients, and make patients feel comfortable and welcomed into the facility.

The emergency department has different sectors with many healthcare workers of different job duties that work together to create an operating system. Each duty is important in the workflow of the hospital and must be considered in the design process of this thesis project.

User Observation

Thesis Topic: *How may we improve healthcare facilities in regions that experience flood disasters?*

***Objective of the user observation**:*

To determine the main pain points of the user while undergoing the process of an urgent care treatment system.

User (individual or group):

***Secondary User:** Injured/ill individual seeking immediate help from an urgent care healthcare facility.*

User Background:

Individual with experience going to the emergency room.

Method:

Type of User Observation

1. *A contextual inquiry* of a user* ***OR***
2. *Video observation with an expert*

Recording Techniques Used

- *transcription app*

Results

Transcript of the User Observation

Analysis:

User Journey Map

User Experience Map

Method

Brief description of set-up with the expert
(see 'Remote User Observation with an Expert' on p. 3)

Video URL's

Video

URL: https://youtu.be/rZwUW5yIVtk

Title: What to Expect When you Visit the Emergency Department at Osler

Brief Description: A walkthrough of a patient's experience through an emergency department. This video shows what you should expect from an emergency department throughout the process and steps that the patients will take to treat any illness or injury.

Relevance to Thesis Topic: This video will help the secondary user remember or relive their emergency room experience and determine any possible pain points that they might have had during that time. This remote user observation will also aid in the design and ergonomic considerations in the design process of this thesis project.

Results

Transcript

"Shown below is a sample of the transcript taken from the user observation.

The transcription was generated from a *transcription app."*

*Transcription should be in 5 pt. font and have **headings** for the major tasks/ events undertaken, on 1 page.*

Have you ever been to the emergency room before?

Yes, on multiple occasions.

Do you remember the last time you went to the ER? What was it for?

I went to the ER not too long ago for my son, who claimed he could not see through one of his eyes. I have been to the emergency room several times for both of my sons, I remember all the visits.

Were most of your visits to the emergency room for serious health concerns?

Some of the visits were for serious concerns, a few of them were for more minor concerns that just needed to be looked at in case they were serious.

When you entered the ER how did your experience begin?

We went into the ER and met this greeter at the entrance who directed us to triage where my son and I stood in line waiting to be seen by the triage nurse.

What happened when you saw the triage nurse?

You essentially know what you are coming to the ER for, and triage determines the severity of your condition. Depending on the severity of your condition they determine the priority of who gets seen or treated first. For example, if you come in with sniffles, you'd be close to last to be seen, if you come in with a heart attack, you'd be bumped up to first. When we saw the triage nurse, they take your blood pressure, temperature, oxygen level, stuff like that.

After seeing the triage nurse, were you able to be treated right away?

Well, after seeing the triage nurse, you go sit down and wait for registration to call you, then you go to registration and they take your information and give you an armband. Then you sit back down again and wait for them to call you in. Depending on the severity of your condition, you may have to wait for a long time, even for a couple hours, which could get uncomfortable and you feel like you just want to leave. But we went on a Monday, there was nobody there, so we got in pretty quickly, mostly because he couldn't see through one eye, so it was quite serious. Other times that we went to the ER for like appendicitis, was about 35-45 minutes wait before we were seen.

Once they call you into the ER, what happened?

Once we went in, they did a bunch of tests to determine the cause and what is needed to be done. For his eye, they suspected a pre-stroke but could not find the specific cause of the condition. They treated his eye, and he got his sight back and after a few hours we were able to go home. Although, when we went into the ER for his appendicitis, they ran tests and found that it was septic, so they had to take him into the operating room.

How long did the operation for his appendicitis take?

The operation for the appendicitis took about 1.5-2 hours. But the whole visit from start to finish was about 27 hours.

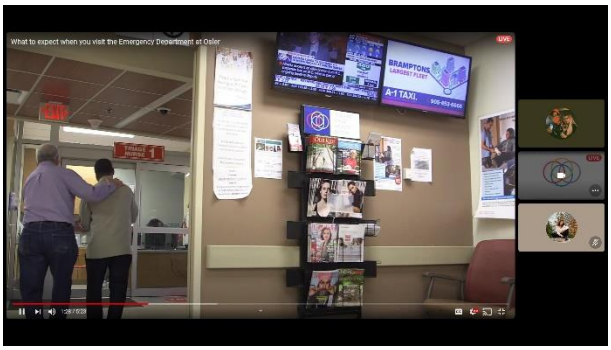
What did you find challenging about this experience?

You never know what's going on and they don't tell you what's happening next. You don't know what test you're waiting for and sometimes they come in and tell you what they know. The doctor sometimes tells you what's next, but you never know when they are going to come get you or how long you will be waiting.

Images

"Shown below are samples of the photographs taken from the user observation.

The photographs were generated from *screenshot images* "



Analysis

User Journey Map

	Stage 1 Concerns	Stage 2 Entering the ER	Stage 3 Triage	Stage 4 Registration	Stage 5 Treatment	Stage 6 Completion
User Goals	Going to the ER to determine cause	Easy navigation through the ER	Determine severity of the condition	Provide necessary information	Run tests, provide medicine, etc.	Leaving the ER with effective treatment
User Actions	- Driving to ER	- Welcomed into ER by a greeter - Directed to the triage lineup and wait to see a triage nurse	- Enter a triage nurses office - Blood pressure taken - Temperature is taken - Oxygen level is taken - Goes back to waiting room	- Called to registration from the waiting room - Provide necessary information (health card, etc.) - Sent back to waiting room to wait to be called on again	- Called into the ER from the waiting room - Tests are run (blood test, urine analysis, EKG, X-rays, CT scans, etc.) - Tests may determine conditions that need operation for treatment	- Once treated and discharged, patient can leave the ER - Sometimes, patients leave without knowing what the cause of their health concern was
Storyboard/Photos						
User Experience (Rate 1 – 5 1-Good, 5-Bad)	5	5	4	4	2	1
Problems	- Having a health concern that may or may not be serious - Needing to travel to the hospital in a bad condition	- Waiting for long periods to be seen by a nurse - Not knowing where to go when initially entering the facility	- Feeling uncomfortable or pain - Uncomfortable seating or bedding - Further waiting for instruction	- Getting up from seating and travelling to a separate office for registration - Further having to wait before treatment	- Travelling to another area in the facility - Tests can take long - Uncomfortable seating or bedding - Further waiting for test results and treatment	- Leaving without being treated - Leaving without knowing the cause of your condition
Ideas/Takeaways	- Non-serious injuries can be treated outside of the hospital - Eliminate the need for ill or injured patients to commute to the hospital	- A more efficient facility layout that is easy to follow	- Wait times can be long and uncomfortable seating would worsen a patient's ER experience - More ergonomic seating and bedding for comfort	- Minimize the need to travel to other offices and departments	- Minimize the need to travel to other offices and departments - More ergonomic seating and bedding for comfort - Non-serious illnesses and injuries can be treated faster - More serious illnesses and injuries may need further treatment such as operations or long-term treatment	- Non-serious illnesses and injuries can be treated more effectively

Summary

Major Take-aways from the User Journey Map and User Experience Map

Discussion and Summary

After taking multiple trips to the emergency room for different health concerns, the user was able to determine certain details and challenges that they had often experienced during their time at the ER.

The process of their entire emergency room experiences consists of the same or similar steps for every visit. These steps included being seen by the triage nurse, registering into the hospital, and getting the necessary treatment needed for their condition.

Wait times depend on the severity of a patient's condition as serious life-threatening illnesses or injuries will be treated immediately while non-serious injuries will be treated after. The observed user sometimes experienced wait times that were relatively long (between 30minutes to 2-hours) as other patients visiting the emergency room had more serious conditions that have a higher priority to be treated. These long waits spent sitting in the waiting room can be quite uncomfortable and frustrating.

When called upon to register into the hospital system, the user then must leave the waiting room to register in the patient registration office. Then after registering, return to the waiting room in hopes of obtaining a seat again if the waiting room is busy that day. A busy emergency room or triage sector can be crowded on a busy day which can worsen a patient's hospital experience.

After waiting for a period, patients are called into the emergency room where tests are performed, and possible treatment is given to patients. As there are so many different departments at the hospital, a lot of travelling occurs between different departments by both healthcare workers and patients, which may not be ideal for patients who are ill or injured. Test results help doctors to determine what steps to take next in treating the patient. These could lead to minor treatments or more serious ones such as surgeries.

Minor treatments and medicine would be able to be given to the patient faster than major surgeries which would keep the patient at the hospital for an extended period. The user has experienced an emergency room visit that had lasted about 1.5-2 hours including wait times and treatment. This was believed to be a condition that seemed to have been a pre-stroke, but causes were unknown, and the patient left without much treatment done. Although, another one of their emergency room experiences had lasted approximately 27 hours, which was for appendicitis and required a surgery to be performed.

C Product Research

PART 1 – Competitor Product Analysis

Table 1 – Selection of Comparable Products with Product Image and Description

	Product Image	Description (Product name and specifications)
1		Revere Survival Coastal Commander 2.0 Life Raft • Size: 10 1/2"W x 27"L x 17 1/2"H packaged • Weight: 65lbs • Capacity: 6 people • Material: Synthetic Rubber Coated Polyester
2		Corral Shelter • Size: 12’W x 12’L x 5.5’H • Storage Space: 605 Cu. Ft. (147 Sq. Ft.) • Canopy: Polyethylene fabric, water resistant • Frame: All-steel powder coated
3		Portable Ice Fishing 8-Person Tent • Size: 141.75" L x 70.75" W x 70.75" H • Weight: 36.3lbs • Capacity: 5-8 people • Material: Composite fabric, fiber tube
4		Flexotent • Size: 240cm x 240cm x 280cm • Storage Space: 6 m² • Capacity: 3-4 people
5		ShelterLogic Round Shelter • Size: 97.3”W x 239.1”L, 286.5”L, 334”L x 98.2”H • Material: standard 9oz Polyethylene • Frame: heavy duty 1-5/8 in. diameter steel • 100% waterproof

6		Kampa Croyde 6 Classic Air Canopy • Size: 65 x 18 x 20cm Packaged • Weight: 6.6kg • Material: Weathershield® Airflow Polycotton/Airframe Beams
7		Shoal Tent • Size: 8'W x 8'L x 6'3"H • Weight: 75lbs • Inflatable • Waterproof PVC coated fabric
8		POD Tent Maxi Elite • Size: 2.72' x 1.41' x 1.41' packaged • Weight: 52.9lbs • Material: Polyester/Nylon PU coated • Modular

Figure 1 - Comparable Products Grouped Using an X-Y graph with Comparator Dimensions relating to Form and Scale: Short-Long and Compact-Large

Design Take-Aways

1. Most products fall within the Short-Compact sector
2. Some products fall within the Long-Compact sector
3. Some products fall within the Long-Large sector

Other Criteria that can be used:

- Price
- Ease of setup and takedown
- Land vs water situation
- Framework type (metal vs inflatable)
- Modularity/Collapsibility

PART 2 – Features and Benefits of Comparable Products

Product 1 – Shoal Tent (https://www.smithfly.com/products/shoal-tent)

Promotional Piece: Highlighted benefits and features

Introducing the Shoal Tent. A first of its kind inflatable, floating raft with a tent topper that allows you to sleep out on the water. Camp on your favorite farm pond, saltwater flat, spring creek or an eddy on your favorite river. *The world is your waterbed. Sleep under the stars, on the water, feel the flow and let it lull you to sleep.*

Features

1. No tent poles, tent structure is completely inflatable, and stands up to high winds without a problem.
2. Three air chambers in the raft body, two in the lower tube, one in the structure; inflate to 2.5 PSI.
3. Floor is a 6" thick drop stitched high-pressure floor (similar to a paddleboard), doubles as your air mattress.
4. D-Rings on the tent body sides allow for easy anchor attachment.
5. The waterproof tent topper sides attach and detach using a heavy-duty hook and loop to use just the top and get in and out easily through the sides if the need arises.

Product 2 – Viking RescYou ISO 9650-1/ISAF Life Raft
(https://www.westmarine.com/WestAdvisor/Selecting-a-Life-Raft)

Promotional Piece: Highlighted benefits and features

This Viking RescYou™ ISO 9650-1/ISAF **Life Raft** is a good choice for coastal or offshore cruising or fishing. It is available with a choice of three equipment packs, for greater or less than 24-hour survival gear.

Features

1. Most appropriate for boats encountering real offshore conditions including high seas and heavy winds
2. Two independent stacked tubes provide redundant flotation should one chamber become damaged.
3. Inflatable boarding ladder to easily get you aboard from the water.
4. Self-erecting canopies.
5. Most will have deep triangular or rectangular ballast bags and a large drogue for stability.

Product 3 – Universe 5-Person Three-Element Tent (https://www.tentsile.com/products/universe-5-person-three-element-tent#js_product_accordion)

Promotional Piece: Highlighted benefits and features

Just as it sounds, The Tentsile Universe can be pitched in the air, on the ground and even on water! The Universe comes with a Trillium 3-Person Hammock which supports the Universe when set up in Air Mode and is suspended between 3 trees. The rigid inflatable SUP base provides insulation in both ground and air modes but also allows the tent to float on water. This provides an amazing sunbathing deck and play structure, great for summer days at the lake or even for some casual fishing. The Universe is spacious, easy to use, durable and everything you need comes included & packs into one neat, trolley bag. No matter where you go, Tentsile Universe will have you well-prepared when you're face-to-face with the elements.

Features

1. Webbing reinforced floor, adds strength to the tent, creates a separate sleeping bay for each person.
2. Inflatable SUP board base allows tent to be pitched on the ground, in the air, or floating on water.
3. Comes with a built-in no-see-um insect mesh to protect you from insects and other creepy crawlies.
4. Polyester Rainfly extends outwards from the tent, gives you a large, dry area underneath the tent to store gear or act as covered living space.

5. The central hatch makes climbing into the tent simple when in air mode.

Product 4 – Portable Ice Fishing 8-Person Tent (https://www.wayfair.ca/outdoor/pdp/outsunny-portable-ice-fishing-8-person-tent-with-ventilation-windows-and-carry-bag-otsu2236.html?piid=)

Promotional Piece: Highlighted benefits and features

Waiting all season long for an ice fishing adventure? Let us help to make this adventure more convenient and fun! Made of premium waterproof fabric, this tent can keep the cold out even in - 30°C condition. The 4 roll-up windows located on the side of the tent allows for great ventilation inside the tent to ensure you remain comfortable and avoid overheating. 2 zippered doors (front and back) allow for easy access to the tent. Comes with stakes and cord loops to secure this tent to the ground. And a carry bag offered for easy transportation.

Features

Stakes and cord loops are used to add stability on windy days.

1. Comes with a carry bag to store the ice fishing tent for easy transportation.
2. 2 zippered doors for you to enter the tent easily and freely.
3. 4 built-in holes for great ventilation and roll-up windows in transparent PVC material for a nice and clear view.
4. Pop up ice tent, spacious enough for 5-8 persons and easy to set up and take down.

Using Excel to Sort Your Data

Benefits	Sort #1	Sort #2
From Promotional Material	Data on Menu Bar	Groups Like Catergories
on the water	adventure	comfortable
favourite	amazing	spacious
favourite	appropriate	spacious
under the stars	at the lake	stability
on the water	available	stability
sleep	casual fishing	large, dry area
no tent poles	coastal or offshore cruising or fishing	no tent poles
stands up	comes with	appropriate
without a problem	comes with	available
doubles as	comfortable	comes with
easy	convenient and fun	comes with
easily	doubles as	doubles as
good	durable	durable
coastal or offshore cruising or fishing	easily	encounter real conditions
available	easily	good
encounter real conditions	easily and freely	great
appropriate	easy	great
provide	easy	great
easily	easy access	included
stability	easy to use	protect
in the air	easy transportation	provide
on the ground	encounter real conditions	provides
on the water	favourite	provides
support	favourite	stands up
provides	float on water	strength
float on water	good	support
provides	great	easily
amazing	great	easily
great	great	easily and freely
at the lake	ice fishing adventure	easy
casual fishing	in the air	easy
spacious	in the air	easy access
easy to use	included	easy to use
durable	large, dry area	easy transportation
included	nice and clear	simple
strength	no tent poles	without a problem
on the ground	on the ground	adventure
in the air	on the ground	amazing
on water	on the water	at the lake
comes with	on the water	casual fishing
protect	on the water	coastal or offshore cruising or fishing
large, dry area	on water	convenient and fun
simple	protect	favourite
ice fishing adventure	provide	favourite
adventure	provides	float on water
convenient and fun	provides	ice fishing adventure
great	simple	in the air
comfortable	sleep	in the air
easy access	spacious	nice and clear
easy transportation	spacious	on the ground
stability	stability	on the ground
comes with	stability	on the water
easily and freely	stands up	on the water
great	strength	on the water
nice and clear	support	on water
spacious	under the stars	sleep
easy	without a problem	under the stars

Comfort **5**

Style **2**

Efficiency **19**

Ease **10**

Experience **21**

Figure 2 - Word Frequency Table for Comparable Product Benefits

Features	Sort #1	Sort #2
From Promotional Material	Data on Menu Bar	Groups Like Categories
inflatable	2 zippered doors	attach and detach
floating	3-person hammock	D-rings
tent topper	4 roll-up windows	heavy-duty hook and loop
inflatable	air chambers	stakes and cord loops
air chambers	anchor attachment	carry bag
inflate	attach and detach	three equipment packs
high-pressure floor	built-in insect mesh	trolley bag
D-rings	carry bag	2 zippered doors
anchor attachment	central hatch	4 roll-up windows
waterproof tent topper	chamber	built-in insect mesh
attach and detach	D-rings	rainfly
heavy-duty hook and loop	floating	self-erecting canopy
three equipment packs	heavy-duty hook and loop	tent topper
two stacked tubes	high-pressure floor	transparent PVC material
chamber	inflatable	waterproof fabric
inflatable boarding ladder	inflatable	waterproof tent topper
self-erecting canopy	inflatable boarding ladder	air chambers
triangular or rectangular ballast bags	inflatable SUP base	anchor attachment
large drogue	inflate	central hatch
3-person hammock	large drogue	chamber
inflatable SUP base	play structure	high-pressure floor
sunbathing deck	popup	inflatable boarding ladder
play structure	rainfly	inflatable SUP base
trolley bag	self-erecting canopy	large drogue
webbing reinforced floor	sleeping bay	sleeping bay
sleeping bay	stakes and cord loops	sunbathing deck
built-in insect mesh	sunbathing deck	triangular or rectangular ballast bags
rainfly	tent topper	two stacked tubes
central hatch	three equipment packs	webbing reinforced floor
waterproof fabric	transparent PVC material	3-person hammock
4 roll-up windows	triangular or rectangular ballast bags	floating
2 zippered doors	trolley bag	inflatable
stakes and cord loops	two stacked tubes	inflatable
carry bag	waterproof fabric	inflate
transparent PVC material	waterproof tent topper	play structure
popup	webbing reinforced floor	popup

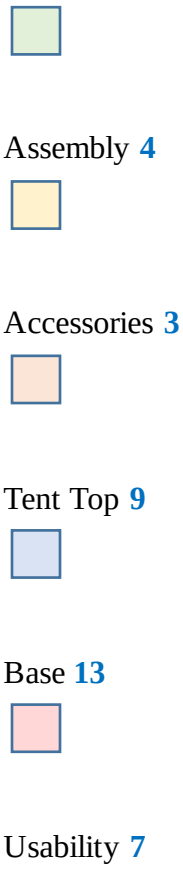


Figure 3 - Word Frequency Table for Comparable Product Features

Results and Analysis

Benefits Table

Key Benefits of Comparable Products	
Keyword	***Frequency***
Comfort	5
Style	2
Efficiency	19
Ease	10
Experience	21

Features Table

Key Features of Comparable Products	
Keyword	***Frequency***
Assembly	4
Accessories	3
Tent Top	9
Base	13
Usability	7

PART 3 – Benchmarking

Table 2 – EXAMPLE of Ten Benchmarked Products (Product Literature collected in Appendix 2)

Comparable Products	
Revere Survival Coastal Commander Life Raft	Kampa Croyde 6 Classic Air Canopy
Corral Shelter	Shoal Tent
Portable Ice Fishing 8-Person Tent	POD Tent Maxi Elite
Flexotent	Viking RescYou ISO 9650-1/ISAF Life Raft
ShelterLogic Round Shelter	Universe 5-Person Three-Element Tent

A table comparing the main features for all 10 comparable products was then constructed. The main features chosen for comparison were:

9. Fabric Material
10. Frame Material
11. Base type
12. Accessories
13. Size and Capacity
14. Cost
15. Packaging
16. Stability

Table 3 - Comparing Main Product Features

#	Item Name	Ft. 1	Ft. 2	Ft. 3	Ft. 4	Ft. 5	Ft. 6	Ft. 7	Ft. 8
1	Revere	Polyester	Synthetic rubber	Inflatable	Yes	Compact, 6 people	$1799.99	Valise	Anchorable
2	Corral	Polyethylene	Powder-coated steel	Open	Yes	Large	$449.00	Box	Not anchored to ground
3	Portable	Composite	Fibre tube	Open	Yes	Compact, 8 people	$395.99	Folded, carry bag	Anchored
4	Flexotent	N/A	N/A	Platform	Yes	Medium, 3-4 people	Customize	Collapsed	Not anchored to ground
5	ShelterLogic	Polyethylene	Steel tubing	Open	N/A	Large	$897.49	Box	Anchored
6	Kampa	Polycotton	Airframe beams	Open	Yes	Medium	$479.64	Folded, carry bag	Anchored
7	Shoal	PVC coated fabric	N/A	Inflatable	Yes	Compact, 2-3 people	$1999.00	Rolled, carry bag	Anchorable
8	POD	Polyester/nylon	Aluminum / steel	Fabric	Yes	Compact, modular	$899.00	Disassembled, carry bag	Anchored
9	Viking	Silicone-coated Nylon	Natural Rubber	Inflatable	Yes	Compact, 4 people	$3199.99	Valise	Anchorable
10	Universe	Polyester	Aluminum	SUP board	Yes	Medium, 5 people	$1999.0	Packed, trolley bag	Anchorable

Determining Main Benefits and Features of Comparable Products Method

The technique used was to select promotional material for 3-5 products which are related to the thesis topic. From this promotional material, the words describing **features** were color coded one color, the words describing **benefits** were color coded another color. The frequency of these words was determined, and the most common identified.

Results

Results are shown in Appendix 3

Conclusions: Key Benefits

The top 5 words associated with benefits and features, as determined from promotional literature, are listed in the following table.

Key Benefits of Comparable Products	
1	Comfort
2	Style

3	Efficiency
4	Ease
5	Experience

Conclusions: Key Features

The top 5 words associated with features, as determined from promotional literature, are listed in the following table.

Key Features of Comparable Products	
1	Assembly
2	Accessories
3	Tent Top
4	Base
5	Usability

Competitor Benefit Assessment Method

Two products close to the 'Design Opportunity' (graph on p.4) were assessed on how they met customer needs.

The two products selected were

Shoal Tent

POD Tent Maxi Elite

Results

Results are seen in the Table below. Benefits are the ones identified for this product. Possible Niche Markets are deficits in current product offerings.

Benefits / Customer Needs	Benefit Comparison		
	Shoal Tent	POD Tent Maxi Elite	Possible Niche Market
Comfort	Good	Fair	X
Style	Fair	Good	X
Efficiency	Fair	Fair	X
Ease	Good	Fair	
Experience	Good	Good	

Conclusions

As seen above, the Shoal Tent and the POD Tent Maxi Elite were taken from the previous Features X-Y Graph. As similarities in the frame structure and base type were found for these two products, they have been chosen to create a comparison to determine the possible niche market regarding their features. Although the environment of use for these products differs from one another, the benefits and customer needs can be compared between these two products. Features including comfort, style, efficiency, ease of use, and experience were analyzed for these products. The shoal tent resulted in good comfort, fair style, fair efficiency, good ease of use, and a good overall product experience. The POD Tent Maxi Elite resulted in fair comfort, good style, fair efficiency, fair ease of use, and a good overall experience. The products were evaluated based on their comfort, complexity, and appearances. A possible niche market was determined for the comfort, style, and efficiency of the products.

Product Research Which Informs Design

Benchmarking

Portable shelters are growing in popularity in the outdoor lifestyle market and have a high degree of differentiation. Major key features for product selection includes cost, materials, portability, ease of use and comfort. Many of these portable shelters are specific towards certain user needs and vary in price depending on the materials used, included accessories, and complexity. Although cost is not a focus within this product comparison analysis, it is a major factor in the product selection and decision-making aspect of the market.

Key Benefits and Features

Key Benefits of Comparable Products
1. Comfort
2. Style
3. Efficiency
4. Ease
5. Experience

Key Features of Comparable Products
1. Assembly
2. Accessories
3. Tent Top
4. Base
5. Usability

Competitor Benefit Assessment

A comparison of benefits for two products close to the potential market niche determined from the X-Y graph.

Benefits / Customer Needs	Benefit Comparison		
	Shoal Tent	POD Tent Maxi Elite	Possible Niche Market
Comfort	Good	Fair	X
Style	Fair	Good	
Efficiency	Fair	Fair	X
Ease	Good	Fair	
Experience	Good	Good	X

Needs Statement

The availability of health care needs to be improved to help treat ill or injured people in regions that experience flood disasters. If health care can expand beyond existing hospital facilities and can accommodate for the people who need medical care in distant areas, the death rate that occurs due to flood disasters each year can be greatly reduced. Easily portable units that have available supplies to aid ill or injured flood victims and can be situated upon the water's surface would be beneficial to flooded communities. Collapsible and modular product features can maximize the purpose and use for product innovation regarding this thesis project.

Comparing Pairs of Features on an X-Y Graph (scatter graph)

When key features are identified, pairs of these features can be plotted on an x-y graph (also known as a scatter graph). The intent was to see if a pattern emerged which could indicate a particular neglected market niche.

Method

Two features are assigned to either the x or y axis, and images of each of the comparable products can be placed on the graph.

Figure 4 - Comparable Products Grouped Using an X-Y graph with Comparator Dimensions relating to Features: No Base-Base and Inflatable/Flexible Frame-Hard/Stationary Frame

Results

Most of the comparable products have similarities in the base and frame types as they have bases but are constructed with inflatable or flexible frame structures. Other comparable products have either no base but have an inflatable or flexible frame structure, or have no base and are constructed with hard, stationary frames. The least number of products fall within the sector containing a base and a hard, stationary frame.

Summary and Conclusions

Portable shelters are growing in popularity in the outdoor lifestyle market and have a high degree of differentiation. Major key features for product selection includes cost, materials, portability, ease of use and comfort. Many of these portable shelters are specific towards certain user needs and vary in price depending on the materials used, included accessories, and complexity of the product. Although cost is not a focus within this product comparison analysis, it is a major factor in the product selection and decision-making aspect of the market.

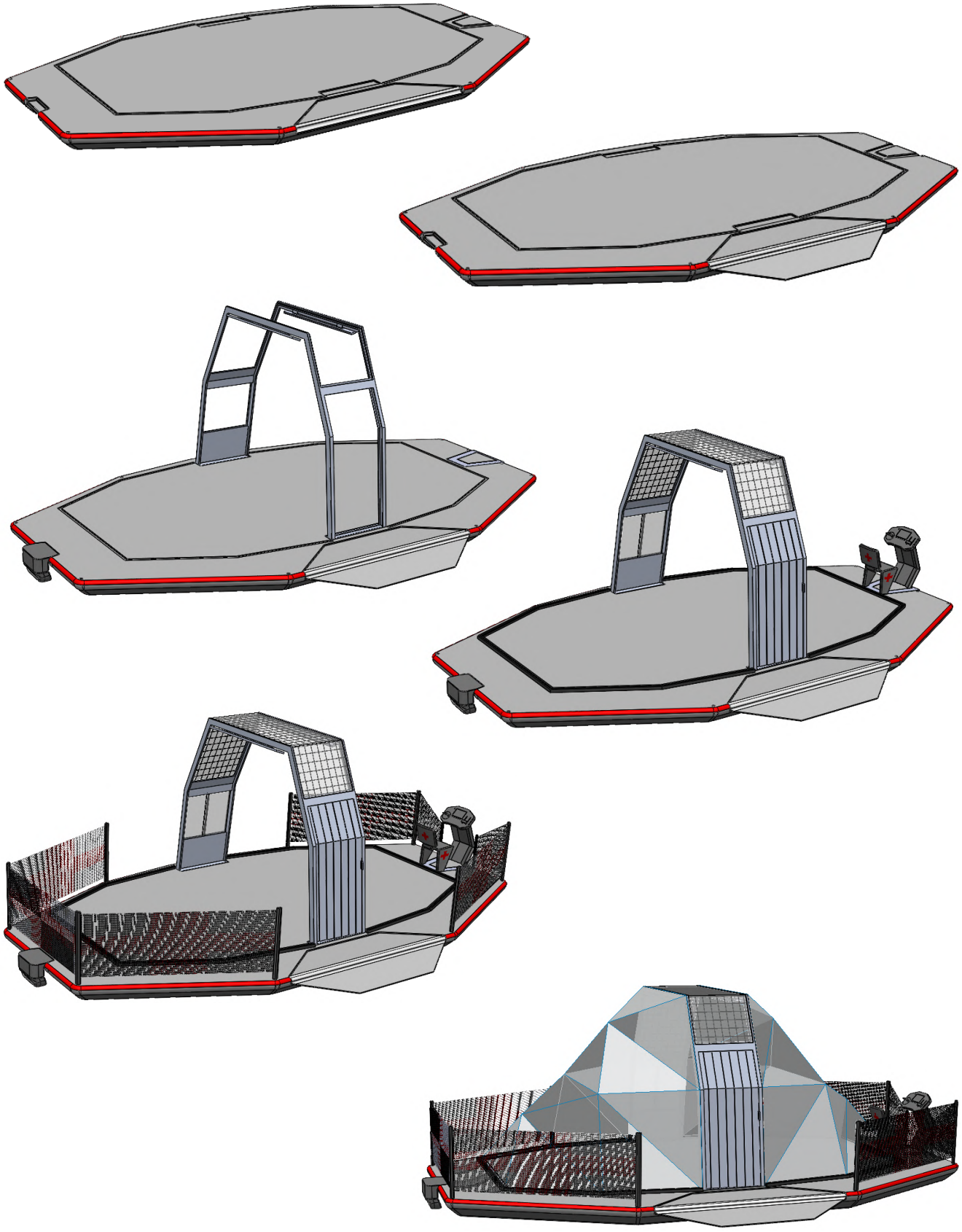
D Analysis

Why Should We?

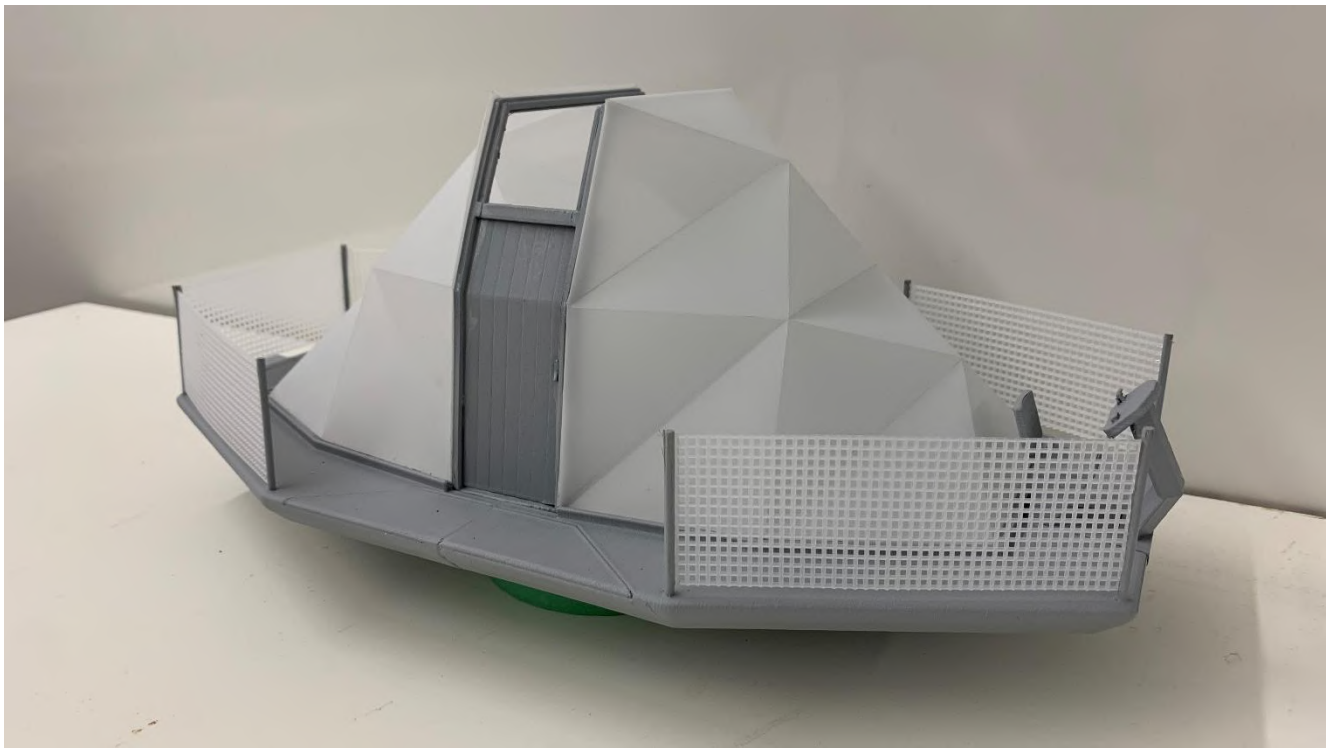
NEEDS		DESCRIPTION	COMMENTS BASED ON EVIDENCE & EMPATHY	
Category of Fundamental Human Needs **(Max-Neff)**	Category of Psychological Needs **(Maslow)**	Interpretation of possible relevance to design problem space	Comments about Needs discovered in topic/problem space (include source from discovery search, if possible)	Level of Relative Importance to design of new product **(Slight, Moderate, High)**
Basic Needs				
Subsistence			- surviving from effects of flood disasters	High
Protection			- protection from harm including illness and injury	High
Physical (Need for food, water, shelter)			- sustenance for ill and injured patients, medical care workers, etc.	High
Security				
Safety			- safety for patients, medical care workers, etc. from effects of flood disasters, external dangers including people - safety equipment	High
Securing resources		- value, in terms of fulfilling a need at lower price and enhancing access, reliability	- medical equipment and tools - sustenance; food, water - medical supplies - price	High
Control over environment (tasks)			- facility operations and organization	High
Long term security/stability			- ability for facility to operate efficiently to withstand the effects of future flood disasters	High
Social Belonging				
Participation		- convenience, in terms of speed (fast, uses less time) - optimization of limited resources	- medical facility convenience (speed, efficiency, effectiveness of care) - optimization of limited resources	High High
Social (need for belonging, being loved, inclusion)		- fear of abandonment - fear of the enemy - Tribal identity (belonging to the winning team)	- effective communication system between medical staff	High High

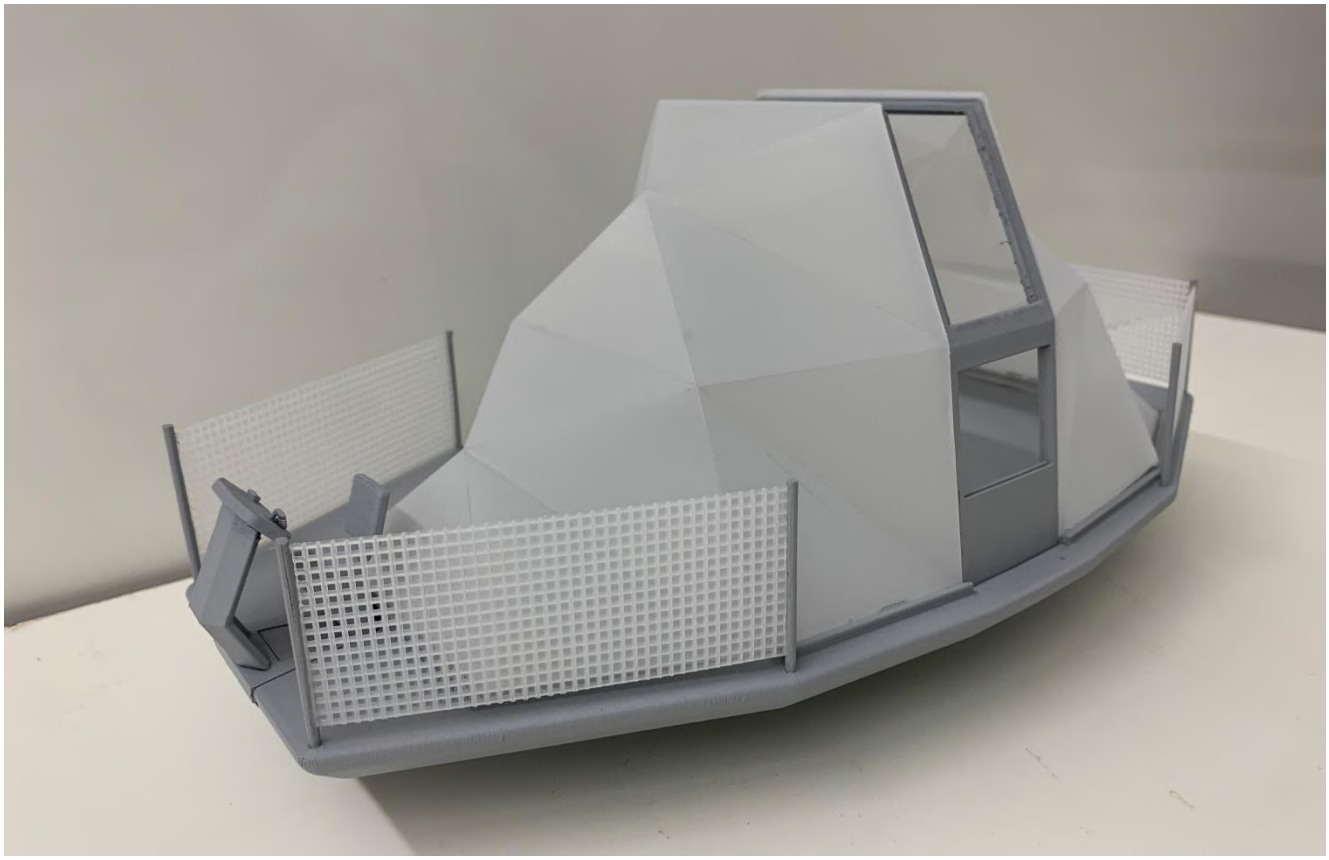
	- Peer Pressure (direct and indirect 'Everybody else has it') - could also consider ease of use that permits participation where participation had been limited	- effective communication system between medical staff and patients	
Esteem			
Ego (Need for self-esteem, power, recognition, prestige)	- social expectation - social status (the elite has it. I want to be like them) - social recognition - convenience and ease of use that enhances social recognition - gift giving, reciprocal social covenant	- respect for patients - respect for medical staff - social recognition - convenience and ease of use that enhances social recognition	High High High High
'Higher Order' Functions/Needs			
Creation	- could consider the convenience aspect of a product (tool) that amplifies human abilities - ease of use	- amplifies human abilities - increases efficiency - accommodates for many - modularity/portability	High
Identity	- could relate to the next generation and be longer term / less immediate. Examples: sexual attractiveness; the health/care/education of children - environmental sustainability	- ability to function with introduction of advancing and evolving technology for future use - environmental sustainability - availability to regions experiencing flood disasters	High Moderate High
Self-Actualization (Need for development, creativity)	- includes sensual pleasure, such as: visual, acoustic, tactile, haptic, taste, olfactory - emotional response: empathy, excitement, fun, nostalgia, memory, etc. - compulsive behaviours: buying, gaming, smoking, drinking, sex, adrenaline rush, etc. - aesthetically pleasing - intrinsic pleasure - the ability to prepare for the future in terms of insurance (house, car, medical), pension, investments	- ergonomics - aesthetically pleasing - ability for long term usage - emotional response: empathy, comfort, care, rehabilitation, improvement, healing, etc.	High Moderate High Moderate

E CAD Development



F Physical Model Photographs





G Approval Forms

IDSN 4002 /4502
SENIOR LEVEL THESIS ONE & THESIS TWO

HUMBER
Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / FALL 2020 & WINTER 2021

INFORMATION LETTER

Research Study Topic:	How may we improve health care accessibility in regions that experience flood disasters?
Investigator:	Emilie Fung, (647) 460-2085, emilie.fung12@gmail.com
Sponsor:	Humber ITAL, Faculty of Applied Sciences & Technology (IDSN 4002 & IDSN 4502)

Introduction
My name is Emilie Fung, I am a student in the Industrial Design program at Humber College ITAL, and I am inviting your participation in a research study on various problems that healthcare workers/patients experience. These problems include daily challenges, overcrowding, visits for common illnesses and injuries. The results will be contributed to my Senior Level Thesis project.

Purpose of the Study
This study is being conducted as an aid in designing a deployable medical unit that can provide medical aid for patients living in regions that often experience flood disasters and do not have access to medical facilities. This study focuses on on understanding ergonomics, human interaction design activities, and user experience aspects of the research area.

Procedures
If you volunteer to participate in this study, your hospital experience will be observed and documented. You will be asked questions based on your experiences within the hospital environment after doing a walkthrough of your experience.

Confidentiality
Every effort will be made to ensure confidentiality of any identifying information that is obtained during the study. In the case of being recorded visually, your face will be masked /blurred or hidden. The information and documentations (photographs) gathered are all subject to being used in the final presentation of the study.

Participation and Withdrawal
Your participation in this study is completely voluntary and you may interrupt or end the study and the session at any time without giving a reason or fear of being penalized.

If at any point during the session, you feel uncomfortable and wish to end your participation, please let the moderator know and they will end your participation immediately.

Humber Research Ethics Board
This research project /course has been approved by the Humber Research Ethics Board. If you have any questions about your rights as a research participant, please contact Dr. Lydia Boyko, REB Chair, 416-675-6622 ext. 79322, **Lydia.Boyko@humber.ca**

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IDSN 4002 / 4502
SENIOR LEVEL THESIS ONE & THESIS TWO

HUMBER
Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / FALL 2020 & WINTER 2021

INFORMATION LETTER

Conditions of Participation

- ✓ I understand that I am free to withdraw from the study at any time without any consequences.
- ✓ I understand that my participation in this study is confidential. (i.e. the researcher will know but will not disclose my identity)
- ✓ My identity will be masked.
- ✓ I understand that the data from this study may be published.

☒ **I have read the information presented above and I understand this agreement. I voluntarily agree to take part in this study.**

Thomas Chang		**11/08/2020**
Participant's Name	Participant's Signature	Date

Project Information

Thank you very much for your time and help in making this study possible. If you have any queries or wish to know more about this Senior Level Thesis project, please contact me at the followings:

Phone: (647) 460-2085
Email: emilie.fung12@gmail.com

My supervisors are:

Prof. Catherine Chong, **catherine.chong@humber.ca**
Prof. Sandro Zaccolo, **sandro.zaccolo@humber.ca**

PARTICIPANT INFORMED CONSENT FORM

Research Study Topic: How may we improve health care accessibility in regions that experience flood disasters?

Investigator: Emilie Fung, (647) 460-2085, emilie.fung12@gmail.com

Courses: IDSN 4002 & IDSN 4502

I, Thomas Chang have carefully read the Information Letter for the project Health Care Facilities for Post Flood Disasters, led by Emilie Fung. A member of the research team has explained the project to me and has answered all my questions about it. I understand that if I have additional questions about the project, I can contact Emilie Fung at any time during the project.

I understand that my participation is voluntary and give my consent freely in voice recording, photography and/or videotaping; with the proviso that my identity will be blurred in reports and publications.

Consent for Publication: Add a (X) mark in one of the columns for each activity

ACTIVITY		YES	NO
Publication	I give consent for publication in the Humber Library Digital Repository which is an open access portal available to the public	☒	☐
Review	I give consent for review by the Professor	☒	☐

Privacy

All data gathered is stored anonymously and kept confidential. Only the principle investigator /researcher Emilie Fung and Prof. Catherine Chong or Prof. Sandro Zaccolo may access and analyze the data. All published data will be coded, so that visual data is not identifiable. Pseudonyms will be used to quote a participant (subject) and data would be aggregated.

I also understand that I may decline or withdraw from participation at any time, without negative consequences.

I understand that I can verify the ethical approval of this study, or raise any concerns I may have by contacting the Humber Research Ethics Board, Dr. Lydia Boyko, REB Chair, 416-675-6822 ext. 79322, **Lydia.Boyko@humber.ca** or Emilie Fung, (647) 460-2085, emilie.fung12@gmail.com

Verification of having read the Informed Consent Form:

☒ I have read the Informed Consent Form.

My signature below verifies that I have read this document and give consent to the use of the data from questionnaires and interviews in research report, publications (if any) and presentations with the proviso that my identity will not be disclosed. I have received a copy of the Information Letter, and that I agree to participate in the research project as it has been described in the Information Letter.

Thomas Chang		11/08/2020
Participant's Name	Participant's Signature	Date

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IDSN 4002
SENIOR LEVEL THESIS ONE

Humber ITAL / Faculty of Applied Sciences & Applied Technology
Bachelor of Industrial Design / FALL 2020
Catherine Chong / Sandro Zaccolo

FTA-4 THESIS TOPIC APPROVAL
This project/assignment constitutes 5% of total mark for the course

Start: Week #4 / Sep-28
Due: Week #5 / Oct-05

THESIS TOPIC APPROVAL:

Student Name:	Emilie Fung
Topic Title:	How May We Improve Health Care Facilities in Regions that Experience Flood Disasters?

Abstract

Flooding is the most frequently occurring natural disaster in the world and has resulted in loss of lives, serious injuries, and spread of disease within many regions worldwide. Between 1995 and 2015, 2.3 billion people have been affected by flood disasters, which have only become more frequent as a result of climate change.

Masses of people endure illnesses and injuries after experiencing the effects of flood disasters, requiring immediate medical attention to survive. Resources during flood disasters also become limited due to damages to hospital infrastructure and medical equipment. An increased influx of patients often causes overcrowding in hospitals which can lead to loss of control over communication and organization systems, inefficient treatment and care for patients, and spread of disease within the hospital. These factors can further negatively affect health care staff and patients, reducing efficiency within the hospital and chances of patient recovery.

Research investigations will be conducted for this report through surveys, interviews, and articles, to determine supporting documents and information regarding health care facility improvements and solutions to overcrowding hospitals. Professional views and advice will be considered in designing a solution for problems and challenges faced in a health care facility environment.

Improving health care facilities in certain regions to withstand or adapt to the effects of flood disasters would benefit and enhance the human lifestyle through the increased availability of medical treatment for many ill or injured disaster victims. This report will address the issues faced by hospitals in regions that experience flood disasters and provides the opportunity to apply full-bodied human interaction, ergonomics, and social responsibility regarding the primary, secondary, and tertiary users.

Student Signature(s):	
Date:	08 / 10 / 2020

Instructor Signature(s):	
Date:	18 / 10 / 2020

Chong, Kappen, Thomson, Zaccolo

IDSN 4502
SENIOR LEVEL THESIS TWO

Humber ITAL / Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / WINTER 2021
Catherine Chong / Sandro Zaccolo

CRITICAL MILESTONES: APPROVAL FOR CAD DEVELOPMENT & MODEL FABRICATION

Student Name:	**Emilie Fung**
Topic / Thesis Title:	**Mobile Health Care Facilities for Post Flood Disasters**

THESIS DESIGN APPROVAL FORM

Thesis design is approved to proceed for the following:	**X**	**CAD Design and Development Phase**
Comment: Initial CAD progress well as of week #7/March 1st, continue with detailing and refinement.		

Thesis design is approved to proceed for the following:	**X**	**Model Fabrication Including Rapid Prototyping and Model Building Phase**
Comment: Design development progress well as of week #7/March 1st, once CAD is completed, can move forward to model fabrication from week #9 onward.		

Instructor Signature(s):

Catherine Chong Sandro Zaccolo

Date:	10th March 2021

PANEL ON RESEARCH ETHICS
Navigating the ethics of human research

TCPS 2: CORE

Certificate of Completion

This document certifies that

Emilie Fung

has completed the Tri-Council Policy Statement:
Ethical Conduct for Research Involving Humans
Course on Research Ethics (TCPS 2: CORE)

Date of Issue: **1 October, 2020**