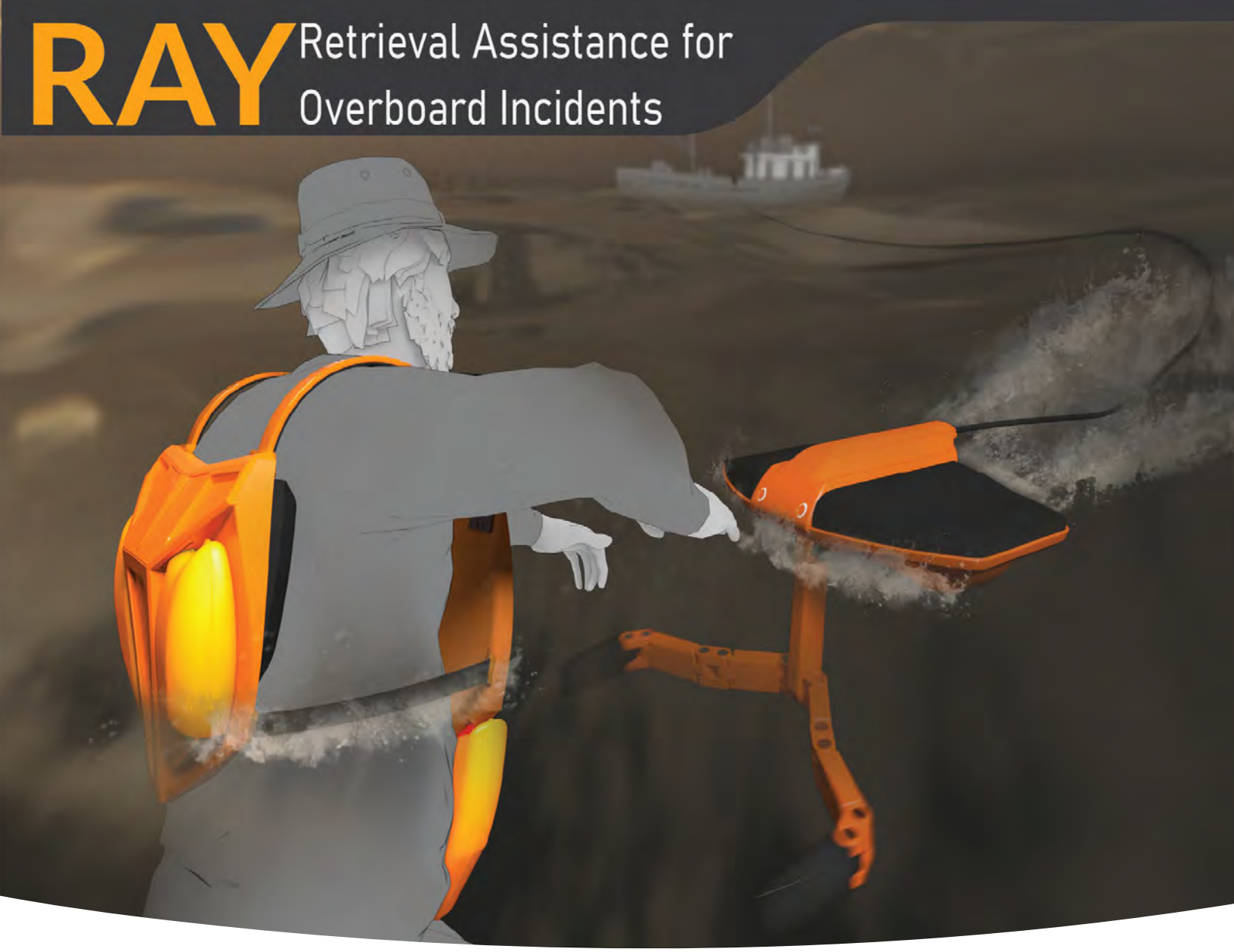
RAY Retrieval Assistance for Overboard Incidents



INDUSTRIAL DESIGN THESIS

NICHOLAS PRATICANTE

2020 | HUMBER COLLEGE

Marine Rescue System

By

Nicholas D. Praticante

Submitted in partial fulfilment of the requirements for the degree of

Bachelor of Industrial Design

School of Applied Technology Humber College of Technology and Advanced Learning

Supervised by: Catherine Chong & Dennis L. Kappen

© Copyright by Nicholas Praticante

2020

Consent for Publication in the Humber Digital Library (Open Access)

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 only	☐	☒

2020 Nicholas Praticante

The author grants Humber College of Technology and Advanced Learning the nonexclusive right to make this work available for noncommercial, educational purposes, provided that this copyright statement appears on the reproduced materials and notice is given that the copying is by permission of the author. To disseminate otherwise or to republish requires written permission from the author.

I warrant that the posting of the work does not infringe any copyright, nor violate ant proprietary rights, nor contain any libelous matter nor invade the privacy of any person or third party, nor otherwise violate the Humber Library Digital Repository Terms of Use.

Signature : 

Student Name : Nicholas Praticante

Abstract

The goal of this thesis project is to achieve a design system that enables commercial fisherman the ability to perform their jobs safer and more efficiently. Through the standpoint of user interaction, convenience of use and functionality. Commercial fishermen have one of the most dangerous jobs in the world. Injuries and fatalities caused in the workplace are a result of many factors like; lack of experience, visibility, inclement weather and most proficiently, drowning. Current lack and neglection of personal protection equipment have exhibited challenges with comfortability, accessibility, sustainability, and ergonomic factors related to the line of work. The design process will incorporate the use of research methods like surveys, video observation, interviews and conversations with the target user base. Detailed analysis of evaluation process is aimed to minimize the negative experiences and maximize the positive experiences of ingress and egress related to personal protection equipment. Focusing on ergonomics and comfortability to allow user the ability to perform the tasks required from a commercial fisherman while wearing the required personal flotation equipment to keep them safe. A one-to-one scale ergonomic buck is planned to be built to evaluate the ergonomics and human factors in context of the personal protection equipment to establish a full-bodied human interaction design solution. Results from the specific studies will be used to design the next generation of personal protection equipment to be used by commercial fisherman. The product could eventually be installed on small fishing vessels all around the world; allowing the product the chance to revolutionize the way we think about water safety.

Acknowledgments

I am whole heartedly thankful to the two most important people in my life, my supporting and loving parents Gilberto and Nelly. If it weren't for them my journey at Humber would not have been possible.

Another huge thank you to Reece Bennett and Ryan Ford who aided me through the design as my advisors. Without them this thesis project would not have been possible, he has taught me so much on the subject and has given me phenomenal feedback on ways that I can better my design.

Additionally, I would like to thank my academic advisors, Catherine Chong, Dennis Kappen, and Sandro Zaccolo. They have taught me the design process and to always think critically.

Finally, a huge shout out to my closer group of friends and the rest of the graduating Industrial Design class of 2019/2020. Without them, the past four years would not have been as enjoyable as they were. After many sleepless nights, and enough bubble tea and sushi to feed a city I am grateful to have shared this experience with them.

Table of Contents

1 Problem Definition

Image 1.1 Commercial fishing vessel sits aground near Cape Blanco, Ore.

1.1 Problem Definition

This thesis proposal investigates the safety, comfort and ergonomic requirements of personal flotation equipment used by the commercial fishing industry from the standpoint of user interaction, convenience of use and functionality. Current lack and neglect of personal protection equipment in this industry have exhibited challenges with comfort, accessibility, sustainability, and ergonomic factors related to the line of work. Additionally, many incidents have resulted in minor and fatal injuries for commercial fisherman. Focusing on ergonomics and comfortability to allow user the ability to perform the tasks required from commercial fisherman while wearing the required personal protection equipment to keep them safe while

working. This thesis project will propose a design meant to revolutionize the way we think of safety of users in open water.

1.2 Investigative Approach Taken

Key Information required:

- Current solutions
- Ergonomics with personal flotation devices
- Coast guard regulation
- Personal flotation device regulation and requirements
- Man-overboard procedures and protocols
- User demographics

This thesis project will be constructed based on the solutions of the following questions:

- How could we decrease the skill needed from crew to rescue a victim of an overboard situation?
- How could we retrieve victims that are unconscious or incapacitated?
- How can individuals who have fallen overboard when alone get back onto the vessel themselves?
- What are the needs of commercial fishermen?
- How could a device be manufactured to fit the experience of the mass majority of commercial fishermen?
- The commercial fishing industry is reluctant to change, how could a product influence the industry to convert current practice to a safer, modern solution?

Research Methods Exercised:

- Activity breakdown analysis
- Analysis of existing solutions
- Ergonomic studies
- Immersive research methods
- Literature reviews

- Regulations and Classifications of PFD's
- Research articles
- Statistical reports
- User interviews
- User observation

1.3 Background, History & Social Context

Commercial fishing has been around almost as long as humans have. Today fishing vessels are regulated and ordered to follow restrictions and specifications set by governments to make it safer for the workers. One of these specifications require that there be at least one personal flotation device on-board for each person.(Blackstone, 2019) While most commercial fishing crews follow this regulation, not every fisherman chooses to wear a personal flotation device (PFD). Results from a survey conducted with the help of "Fish Safe Canada" show that 40% of commercial fisherman still do not wear their life vests, or do not wear it as much as they would like. (see Appendix III) A search of published literature by Case, Lincoln and Lucas has informed that not wearing a life jacket severely increases the risk of drowning. Between 2000-2016, 204 commercial fishermen died after falling overboard. 59% of these falls were not witnessed, and 89.3% of the victims were never found. Out of all these falls 56 rescue attempts were made, 22 victims were recovered but were failed to be resuscitated.(Case, Lincoln, & Lucas, 2018).

Deckhands are the individuals who work on the main workstation of a fishing vessel. Some work for a few hours at a time while others stay on the boat for a couple months. Their tasks tend to be based around managing the equipment used to catch, they throw the

equipment over-board and retrieve the catch. They then sort by size and proceed to organize and store the fresh catch.

Image 1.2 Small sized commercial fishing boat specialized for shellfish

Depending on the location of fisheries, some individuals prefer to work alone and will sail off solo in small vessels and sometimes medium sized “yawls”. These individuals fish inland on the Great Lakes. If they were to fall overboard it will take a lot of energy to make it back onto the boat. Energy that some fisherman may not have after a long day of work.

Society views commercial fishing negatively, overfishing and bycatch cause tremendous amounts of damage to the ecosystem. (Wasted Catch, 2014) The best solution that we have right now is government enforcement of regulation on fisheries. This thesis project will not focus on this side of commercial fishing, but focus more on keeping deckhands that work on these vessels safe.

Essentially the goal is to create a product that could be used by the vast majority of commercial fisherman from all over the world, non-discriminant of their style or way of fishing.

2 Research

Introduction

This chapter focuses on the research methodologies carried out to obtain data on Deckhands and the current flotation devices available today. User profiling, activity mapping and ergonomic research was carried out to study the empathetic solution to the problem. Product functionality, aesthetics and material sustainability were gathered to understand what is currently out there in the world, and how it could be improved to better suit the user.

2.1 User Research

2.1.1 User Profile

Primary User	**Deckhand** The personnel working on the top deck of a fishing vessel. This is usually larger men in their 20's-40's. These are the crew members that are most susceptible to injuries while on-board the ship whether it be on a full-scale vessel or a smaller crew. The primary user works long shifts, occasionally put under circumstances risking their safety. A wide variety of fishing exists, with different sized boats and different catching strategies.
Secondary User	**Personnel in charge of rescue** These are usually other deckhands on the boat present with the primary user, once a man-overboard alarm is raised they spring into action to try and recover the victim from the water.

Demographics

According to the most recent numbers from the Alaska Department of Labor and Workforce Development, women account for only 14 percent of commercial fishermen. (Glamour.2017) With this information we know that a majority of commercial fisherman are male. Analysis reports age distribution reveals the aging population of active anglers in Canada. 55% of which are Canadian anglers aged 45-64." (Fisheries.2016) This means that the population of fishermen is aging, and there will be a higher amount of older aged fisherman than ever before. The older we get the harder it is for us to perform tasks, and our immune system weakens. The average deckhand makes around $60,000 annually. (Refer to appendix II)

Primary User: Deckhands

Deckhands are workers on the deck of these commercial fishing vessels. Using Humber resource library, the following keywords were applied to find out more about the primary user; "Fisherman, equipment, safety, outdated, fisherman gear, fisherman demographics 2019". The primary user works long shifts, occasionally put under circumstances risking their safety. A wide variety of fishing exists, in reaction to this, the thesis topic covers exclusively commercial fishing and the problems related to injuries associated aboard a commercial fishing vessel. The general knowledge obtained from this preliminary search pooled results that include demographics for commercial fishing matching young-middle aged males.

Secondary Users: First Responder / Coast Guard

The coast guard place a role in the rescue system either as a tertiary user or a secondary user. This is dependent on whether the victim (primary user) was out by themselves, or departed from the vessel long enough that the coast guard was the first to respond in a rescue

situation. Coast guards are highly trained in search and rescue missions and usually carry their own tools needed to rescue the individual from the water.

User Behaviour

Fishermen's working dress traditionally consists of inner and middle layers of cotton garments, a coverall (often with an insulating lining during the winter months) and an outer shell of heavy-duty rainwear (strap trousers and jacket). They also wear caps, boots (of various qualities) and gloves to keep their hand dry and ensure a good grip on the fish." (Special Report on Fishing (2017). This fisherman outfit is outdated, and shows no empathy for safety. While it may be comfortable, it won't stop you from drowning or getting dragged into the water by a snagged article of clothing.

User Persona

This fictional example provided is meant to demonstrate a summary of the demographic to visualize user behaviour.

Name: Connor Shepard
Age: 45
Occupation: Commercial Fisherman
Income: $60,000
Education: Highschool certificate
Relationship: Married with two children
Location: Winnipeg, Manitoba
Fishing Location: Lake Winnipeg
Injuries: Back pain through physical strain

Image 2.1 Visual of Connor Shepard

When Connor goes to work on his smaller fishing vessel, sometimes he likes to work alone. When he goes out to sail, he knows it is important to wear a life vest, but cannot properly reel in the line with the vest is inhibiting his ability to move his arms the way that is necessary. He then begins to pull more forcefully in an uncomfortable positioning potentially causing

damage to his back. All of his effort is exhausted into hauling this net into the boat and he decides that if he wants to haul in this catch, he needs to take off the jacket to gain a better grip angle on pulling in the net. He unbuckles the vest and attempts again. However, this time his gloves get caught in the line and he is unable to move his fingers. The boat rocks from his frustrated movements and begins to drift. Connor feels himself going over the lip of the boat. Frantically trying to untangle himself of the fishing net line. He is the pulled into the water as the boat slowly drifts away. He has no energy left to tread above the water and left his life vest on the boat. If only there was a personal flotation device that would feel like he wasn't wearing it until he needed it most.

2.1.2 Current User Practice

Current user practice would entail the use of safety drills that are practiced by the crew onboard the vessel. The safety drills require all personnel working on the deck to use personal

Image 2.2 Variety of Fishing Nets

flotation devices (PFD's). This is not always the case; a majority of users do not want to wear life jackets due to the fact that they could be over-cumbering. When deckhands need to complete tasks that require full motor ability, they opt to leave the PFD behind. Type IV PFD is a device that can be thrown to an individual who is in the water without a flotation device. These are used to pull victims out of the water. However, a significant majority of fishermen fish by themselves and no one is there to help them if they go overboard.

Lifestyle

The lifestyle requires crew that can quickly adapt to conditions of open water. The constant rocking motion of the boat will encourage new fisherman to “gain their sea-legs” this is known in the industry as the ability to walk around the fishing boat without crashing and stumbling into everything while the boat rocks from the waves.

Location

Fishing seasons take place at different times around the world depending on where the fishery is located, and what type of catch is being targeted. In-land lake fishing and coastal fishing will be the focus of this thesis topic.

Duration

The duration of a fishing trip can be between a few hours to a few months (with weekly arrivals to ports). For longer fishing trips the variables are always changing and the user needs to bring clothes to fit scorching hot weather one day, and then a shift full of frigid rain and heavy waves the next day.

Tasks

The deckhand is required to do most of the physical work on a fishing boat. They are responsible for casting out the fishing equipment, checking the nets for catch, reeling in the catch to then sort and place into a storage hold. Some miscellaneous tasks would include emptying the bilge drain and cleaning the deck to avoid slipping hazards.

Social

Depending on the type of commercial fisherman, some work through contracts with a bigger ship and crew and some work alone on their personal fishing boat with family members or fellow fisherman.

2.1.3 Activity Mapping

Safety among commercial fishing vessels rely on the knowledge of the crew and the necessary equipment onboard to handle situations. The pains and gains are focused on a “man-overboard” incident. Where the victim did not have a life jacket equipped, but the crew were well trained and able to rescue the casualty in time. The products used in this benchmark are a standard life-ring, and a life-sling. The life-ring has been designed to toss from a vessel to a victim in the water, the user then needs to grab onto it and is pulled back to the vessel. The life sling is then thrown down to the individual and is wrapped under arms, allowing the victim to be hoisted back onto the vessel.

To fully understand how a proper rescue procedure is carried out, a user observation study was assigned to gain further knowledge on the process. Due to crowding conditions, time constraints and requirements, first-person observation was not possible. Multiple videos of rescues from the ocean were analyzed along with safety drills. An existing safety advisor from fish safe Canada reviewed the clips and proceeded to give their insight on what was taking place in the clips stated.

User Observation

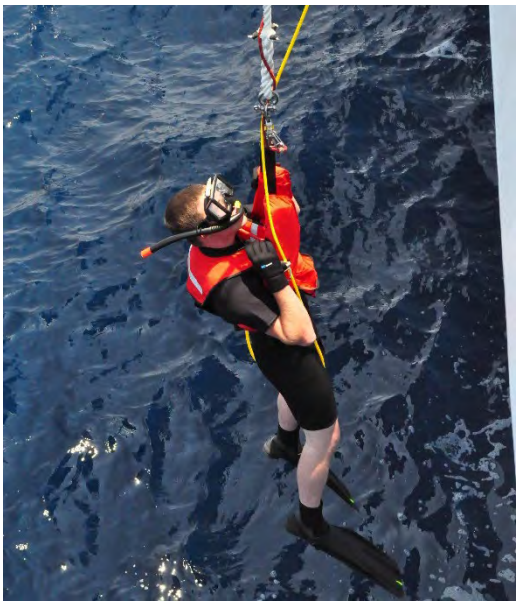


Image 2.6 Rescue drill part 1

Image 2.5 Rescue drill part 2

Image 2.3 Reeling in a trawl

Image 2.4 Handling lobster traps

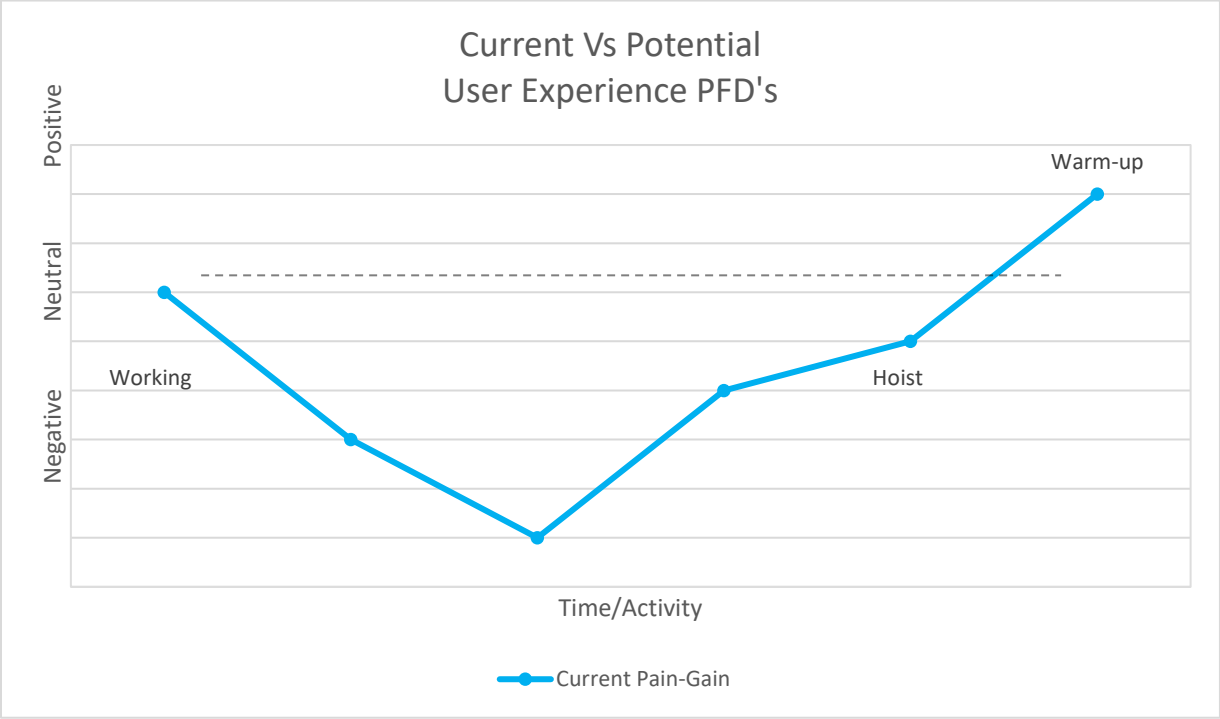


Table 2.1 Current Vs Potential User Experience PFD's

The current user experience is lowest when the victim is trying to tread water. Even if he was wearing a PFD there is still the threat of hypothermia setting in and having a fatal effect. A potential product will try to remedy this downward slope. A man-overboard situation is inevitable as best efforts to prevent a fall will still fail. The following include possible solutions that can help improve user experience. In the case of a net pulling an individual off the vessel, there is potential to design a pair of gloves that will eject the tips off if they are pulled hard enough by a tangled net. If the user has fallen off then the suit can detect a free fall or impact and release a pressure of air into the stitching allowing a bowl to encompass the head of the user protecting their head from the impact. In the water the suit can inflate keeping them above the water and an internal heater will keep their body warm. The retrieval of the user can

come from the boat as a retrieval device is launched from the boat tethered by a rope. The device can attach onto the individual and then pull them back to the boat. Lifting the individual onto the boat depends on the size of the vessel, for larger ships the device can attach to the side of the ship and then climb up the metal hull using a magnetic tread. Usually this will be the most the device could do for the individual but an additional heated vest could be given to the user to have them regain their body heat faster.

Image 2.7 Pulley device lifts user from the water comfortably

2.1.4 Ergonomic Research

The ergonomics for a modern flotation device requires the measurements of the upper body, arms, neck and head. To properly understand how to design the next generation of personal flotation devices, the product measurements need to cater towards a wide variety of body types. For this reason, the 97.5% male and the 2.5% female scale will be measured. It is important to include all body types for this device as failure to properly fit the user will lead to improper use of the device. The users seated position does not play a factor in the measurements, neither do the length of the arms. However, the location of the shoulder and the size of the arm in circumference are measured for the holes on the side of the vest. It is key to allow the maximum amount of movement for the user however while they have the device equipped.

Deckhands have breaks on the ship and can rest from the strenuous and repetitive motion their body endures through the shift. Some of these motions include carrying heavy crates of fresh catch, organizing the catch, reeling in lines and moving heavy pieces of equipment. Life jackets and heavier clothing make these movements more strenuous then normal and can potentially cause damage to the user's body. Figures from *The Measure of Man and Woman* by Henry Dreyfuss were obtained and re-created to fit the appropriate measurements needed to create a proportionally accurate design. Since a majority of fisherman are male, measurement bias will lean more toward the 97.5% tile male as it will be used predominantly by this body type. While the primary user is identified as the deckhand that has the device equipped, the secondary user is tasked with retrieving the individual back to safety. Contact points that are comfortably accessed by the secondary user will be incorporated into

the product system that will improve the user experience for the secondary user as well. This is to reduce the chance of injury from the secondary user while attempting to retrieve the victim.

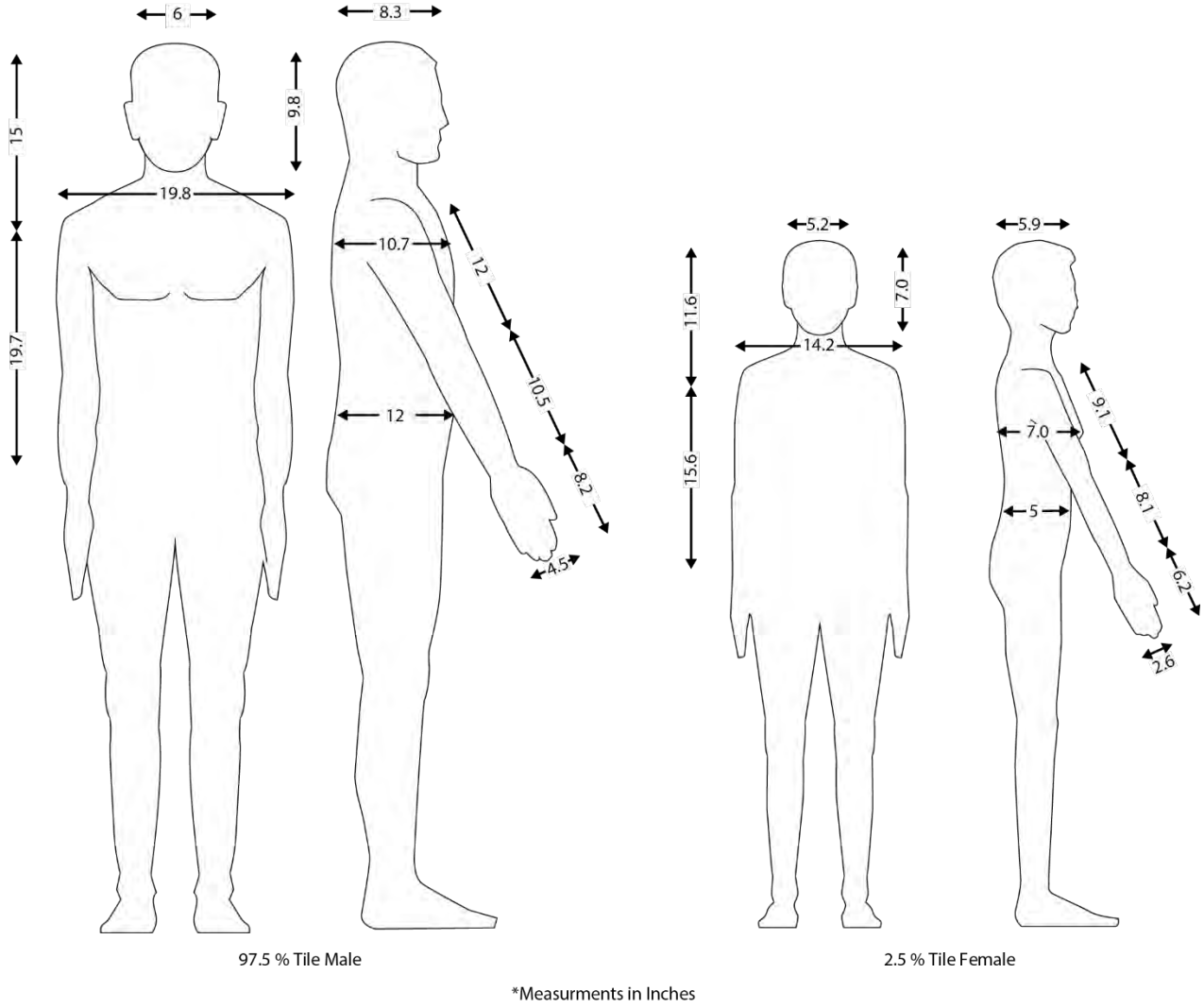


Image 2.8 97.5% Tile Male and 2.5% Tile Female size charts regarding vest measurements

2.1.5 Safety & Health Research

Health and Safety are first priority when it comes to commercial fishing. Rated as one of the most dangerous jobs in the world, regulations and safety drills are very prominent in the industry. There are many ways to obtain injuries while on a fishing boat. A short list of these injuries includes, but are not limited to the following:

- Drowning
- Piercing wounds from sharp objects (Knifes, Fishing hooks, sharp corners and machinery)
- Falling & Tripping
- Crushed by heavy equipment
- Strangulation/suffocation from fishing nets
- Dismemberment
- Hypothermia

There are protocols and procedures enforced by regulations in place to prevent these injuries from happening, but there is no full-proof way to eliminate the accidents from happening. This thesis topic will focus on man-overboard situations, which is the most common life-threatening incident to occur on a commercial fishing vessel. Current personal flotation devices help to mitigate drowning, and some help lower the risk of hypothermia setting in. However, most of these devices do not address other incidents that could affect the health and safety of the user.

2.2 Product Research

This thesis project involves the primary user -the deckhand of a commercial fishing vessel. According to information obtained from an ex-deckhand it is very popular for fisherman to work alone. There are two main reasons for this; primarily, the fisherman has a certain way of fishing that they like to do, as everyone has their own style of performing a task. Secondly, the boat will be too crowded with more individuals on it. On larger ships there will be more than one crew member and in the incident of a man-overboard accident then the crew remaining on the boat will become the secondary user as they attempt to retrieve their fallen crew member.

Product benchmarking for PFD's is extensive as there are plenty of different devices used to retrieve a victim out of water. Some of these products focus on different sequences in the rescue operation. For this topic, the focus will be placed on events taken place within table 2.1-Activity mapping. The following criteria was used to evaluate the compared products bellow.

- Training required to use (ease of use)
- Reliability
- Availability
- Repurpose (packability)
- Versatility (night/storm)

2.2.1 Benchmarking Features and Benefits

Before listing comparable products, it is important to note that there are different classifications to personal flotation devices that serve different purposes. Product benchmarking for PFD's has a wide source of existing products to sift through. These classifications are listed and briefly described below

Example	Type	Description
	I	Type I: Offshore life jackets- most buoyant, suited for all water conditions where rescue may be delayed. Bulky size allows for unconscious victims to be turned in face up position.
	II	Type II: Near shore buoyant vests – for calm inland water where rescue will occur quickly. Not designed for long periods in the water, will turn some unconscious victims face-up. Less bulky and more comfortable then Type 1. Least expensive.
	III	Type III: Flotation aids, for calm water where rescue will occur quickly. Designed to keep wearer in vertical position. Most comfortable to wear and popular in recreational boating and fishing. Can be used in coat, jacket vest form. Not meant for extended survival in rough water, high waves may cover users face
	IV	Type IV: Products designed to be thrown to a conscious person in the water, not designed to be worn. Examples include life ring, buoyant cushion or a horseshoe buoy
	V	Type V: Special use devices are to be worn for specific activities. Can also be listed as a Type I, II or III.

Table 2.2 Existing PFD classification table (Mobiles, 2019)

Each classification has a benefit and a disadvantage. Type 1 PFD's is for emergency, and is too heavy to work with on an active fishing boat. Since the primary user is the deckhand of a commercial fishing vessel, Type 2 is the least likely class to help a deckhand out at sea, but more useful for inland vessels. However, this type has the benefit needed by commercial fisherman, which is maneuverability. Offering the least bulky form and the most comfortable classification.

The most common cases for falls on commercial fishing vessels are working alone, drugs, alcohol abuse and inclement weather. (S. Case, Lincon, & Lucas, 2011) Type 4 PFD's needs to be thrown to the victim from a secondary user on the ship. On larger ships there is a crew that will aid with the rescue, but for most commercial fisheries located closer to land users work alone on smaller boats. Type IV PFD need to be tossed over-board which is not possible for 1-man crews. If the individual is unconscious injured or impaired then it is close to impossible to catch them with a type IV ring buoy. The most likely solution to this thesis topic will become a type V flotation device that is specialized for commercial fisherman.

Image 2.9 Smaller scaled fishing boats that allow for 1-manned operation

Personal flotation devices being compared (detailed list located in Appendix V):

- Kent Commercial Type I
- Stearns Adult Industrial Work Master Vest
- MUSTANG SURVIVAL classic bomber flotation jacket
- Fitz Wright Rogue vest buoyancy aid
- Mustang SAR Vest
- Eyson Inflatable Life Jacket
- Stearns The Challenger Anti-Exposure Work Suit
- Jim Buoy Life Ring Safety Station
- Lifesling2 Overboard Rescue
- Mustang Khimera Dual Flotation Men's PFD

Personal flotation devices can come in a wide variety of shapes and sizes as listed in the chart above. The biggest difference between these products are the ways the device stays afloat and the area of contact they have with the user's body. These factors were then compared in a scatter plot to find any niche in the collection that hasn't been filled.

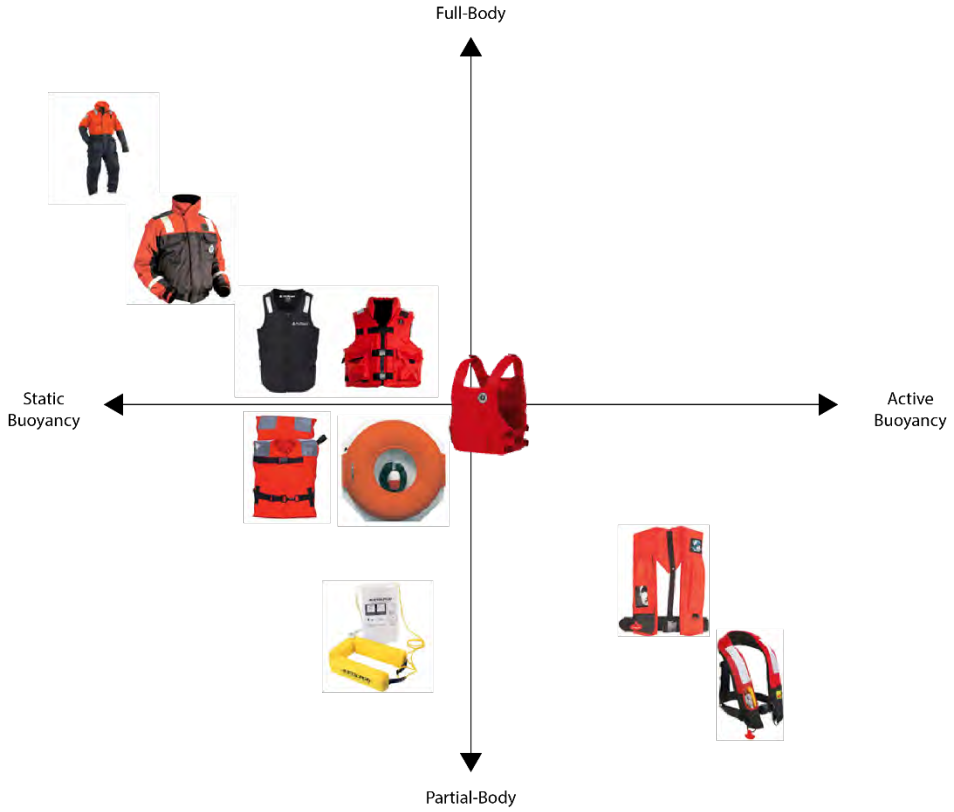


Table 2.3 Scatter-plot comparing buoyancy type with body coverage

Through the graph there is a noticeable gap in a personal flotation device that would contain an activated buoyancy device that will support the users' full body. The main benefit of an active flotation device is its size, it can be compact and usually take up less space on a user. Joining this with a full body system that could focus on enhancing other factors like alleviating strain on the users back.

2.2.2 Benchmarking Functionality

Introduction

Personal flotation devices are an essential piece of a fisherman's attire. Even though they could claim to be a decent swimmer, there are other factors to consider like being unconscious or injured and still having the ability to tread water. The objectives of this section will include the following:

- Determine how a user should interact with a personal flotation device?
- What functions are necessary from a personal flotation device?
- What classification of PFD is the best fit?

Method

Interviews were conducted with advisors specialized in keeping fisherman safe and individuals with experience fishing on commercial fishing vessels (see Appendix III).

Results

The functionality of each classification varies on the situation of the environment. Type I, IV and V relate the closest to commercial fishing vessels. Each category boils down in playing an important part to the survival of a victim who has fallen over-board. Each product has a different value to the following factors. Training required to use, Reliability, Availability, Repurpose (packability) and Versatility (night/storm). Type I is meant to be equipped by an individual who is located on a sinking vessel. The equipment is prepared to keep the victim afloat for a long time. Type I is not meant to be equipped while performing tasks on deck as it limits maneuverability and is relatively uncomfortable to wear. Type IV is great for securing a victim and retrieving them out of the water. The disadvantage however is that you need a

secondary user to throw the device out into the water. Type V is a PFD that is specialized for certain events. It is meant to only be used for those special events. An example would be kayaking or windsurfing. Some of these PFD's are designed to automatically inflate when entering the water and contain a small amount of buoyancy. Since this thesis topic will focus on full-bodied human interaction design (Incorporating hands, feet and lower body, unlike most PFD's) a special type V PFD classification best fits the description for a potential solution.

2.2.3 Benchmarking Aesthetics & Semantic Profile

Aesthetics

It is important for the aesthetics of the device to aid in the functionality of the product. The shape of the PFD needs to fit the user comfortably and promote an ergonomically satisfying solution to keep the user safe. Creating a Type IV device will need to focus on creating something that could float above the water and create a visually comprehensive description on how to use the product. It is important to know through the styling ques where to hold onto and how they could interact with the device allowing them the best chance of survival. This is present on both wearable and . The style of the device must help the user understand how to use the device, how to put on the device and how to interact with features like the pull cord that inflates the device. The highly reflective tape is used to show the location of a user. There is potential to place the tape in a certain way that will help demonstrate which way the victim is looking, generally stylize the tape differently than just its functional purpose.

Semantic Profile

The shape and form of a personal flotation device is relatively soft. It is soft because it needs to protect the user against potentially rough water. These devices also look very durable

as they look like they could be used over and over again through inclement weather situations that push the material to the limit. The comparable items noted in table 2.4 show the variety of shapes a personal flotation device can come in with most of them formed to fit over the mid-body of an individual as a vest. There are usually areas for additional storage and reflective tape lathered around the device. Choosing to go with an active inflatable system there would need to be a special housing for a C02 cannister.

This thesis project will aim to revolutionize the standard for personal flotation devices used around the world by commercial fisherman. Creating a family of products that will work together depending on the ever-changing needs of the user. This is only possible buy creating a product that reflect the semantics of a personal flotation device. For this current products were benchmarked for their colour selections, shape, size and texture.

Image 2.10 An automatic inflatable life jacket

Image 2.11 An inherent foam vest

Colour Selection

The Colour pallet used for safety devices usually consist of high levels of intensity. The reason for this is to allow the user to be seen easily when in dark conditions. However, there are

darker toned life vests like the “Fitz Wright Rogue Vest” seen in Table 2.4. This vest relies on the reflective tape to reveal its user.

Shape

Depending on the classification of the personal flotation device, the user requires different shapes to fit comfortably within. A majority of the classifications require the device to take the shape of a wearable to fit over the human form. This comes in the shape of jackets, vests, helmets and sleeves. Type IV PFD’s are products detached from the human body that take all sorts of shapes and forms. The device is meant to hold the users body like a raft. Some come in the shape of a doughnut that allow the user to fit through the holes and grab on to the edges of the tube. Other devices are in the shape of rafts that will hold the user on top of the water.

Size

Personal flotation devices need to be space efficient. Smaller PFD’s are mandatory and sometimes need to be stored on smaller vessels. Another way to gain buoyancy from a vest is through active inflation of the device. These devices use C02 cannisters to inflate sealed tubes that expand around the user keeping the afloat. The inflation of these devices needs to be faced away from the user to avoid harming them. This increases the volume that the device takes up in space (almost 3 times in some devices).

Texture

The texture used in PFD's come from neoprene and nylon giving it a gripped feeling in a wet environment. Since it is a wearable a majority of the material is going to be soft goods that could fit tightly on a user. The type IV PFD's usually are made of a harder material that is more durable.

Image 2.12 Variety of Personal Flotation Devices

2.2.4 Benchmarking Materials & Manufacturing

Reflective and water-resistant material is a necessity. The reflective material helps to identify the user in distress. The outer shell of a life-jacket is made of nylon or vinyl. The most commonly used material for PFD's in the modern day consists of plastic foams (polyvinyl chloride or polyethylene). There are three types of buoyancy substances used for PFDs. Inherently buoyant, inflatable and hybrid. Some models release CO2 into the jacket automatically when submerged in water and some when manually pulled by rip-cord.(Edmonds, 2019) Automatic submergence trigger is not ideal for inclement weather, heavy rain and hard waves will inflate PFD prematurely.

Problems

Poor sustainability and expiration of the devices lead to a linear life-cycle that collect in landfills. Some life jackets get caught on equipment and tear apart, rendering them useless. The foam insulated devices usually have a 10-year expiration date on them and are not fit for buoyancy after this date.

Potential Solutions

Creating a personal flotation device that can contain replaceable parts. This way the user can purchase replacement parts instead of a whole new device. There is even potential to find a material that could be consumed by marine-life.

The product will be made of materials available to the current industry because they are proven and comply with standards that classify the products as personal flotation devices. However, research with new conceptual materials will be completed and implemented if found useful for the project.

2.2.5 Benchmarking Sustainability

Safety & Health

Safety is an absolutely necessary aspect of a personal flotation device. Since the risk of going overboard while on a vessel safety will always be priority. The design of PFD's allows the user to equip the device and, in most cases, allow the device to work for them by turning their bodies in a proper position, keeping their head out of the water allowing them to breath. The device also needs to allow enough room around the neck to avoid constriction to the individual.

The accessibility of the device in the case of type IV devices need to be easily located, retrieved and thrown at the victim in a few seconds.

Environment

There has been little to no progress with developing PFD's made from sustainable materials. This is mainly because the availability(cost) and safety of the user outweigh the material choices. Some PFD prolong the life cycle by adding re-fillable CO2 cartridges that allow the life jacket to be used more than once. The life jacket itself does not have an expiration date, but the material used to keep it buoyant does. Losing the ability to keep the user afloat it is deemed unfit. Foam jackets can last a maximum of 10 years. Replaceable canisters have an expiration date of 1-3 years and need to be examined every few months for damage, debris or corrosion.(Goodwin, 2019)

Conclusion

Personal flotation devices are currently excellent at keeping the user safe in terrible conditions. There is still room for improvement on the materials used to create life vests as they will tend to rip and expire making them useless under regulations and safety standards. They then need to be thrown to the landfill as none of it is recyclable.

3 Analysis

3.1 Needs Analysis

A personal flotation device is a mandatory piece of equipment used by fisherman worldwide. The purpose of this device is to aid a victim in staying above the water while a rescuer attempts to recover the victim out of the water. Current models of flotation devices come in different specifications depending on where and when the commercial fishing aspect is

taking place. Since the product is targeted toward fisherman who work alone their needs specifically need to be addressed while designing this product.

3.1.1 Needs/Benefits Not Met by Current Products

Volume

According to Ryan Ford from Fish-safe Canada, the vast majority of over boards and fatalities come from small fishing vessels. Transport Canada defines small fishing vessels 12 meters and under. On the west coast of Canada 2,800 vessels out of 3,400 make up this amount. The same amount is true for the east coast.

Safety/Ergonomics

Some modern PFD's pose a great risk of snagging or getting caught on equipment posing a huge risk to the safety of the fisherman. This leads to injury of being pulled into heavy machinery or being thrown off the vessel into the water. Fisherman tend to purchase safety gear that fit snuggly to their body with belts and straps. Anything that can be tucked snuggly or out of the way. The goal of a PFD is to place the users head above the water as immediately as possible. Landing in cold water induces shock to the user's nervous system. Fish-safe Canada consults users about the 1-10-1 rule that states the following; 1 minute to get your breathing under control, 10 minutes of meaningful movement (loss of appendage movement) 1 hour before you become unconscious from hypothermia. Wearing a life jacket will help keep you afloat and stop you from breathing in cold water. The ideal scenario is to wear something that adds thermal protection and buoyancy. Carrying a radio or communication device is necessary to speed up the rescue process. Boaters who are alone adopt the H.E.L.P (Heat Escape Lessening Position). This means staying still in the water because movement will disturb the

water around you that has been heated by your body. Disturbing it will increase the rate of heat loss.

Cost

Commercial fishing is a boom or bust business, fisherman are very cost sensitive and hesitate to even buy mandatory PFD's that cost $200-300. Essentially any bells and whistles that are not absolutely needed will steer them away from purchasing that product. Designing a product that is re-usable for a long period of time without replacing parts is essential. Since all PFD's on the market have an expiration date within 5-10 years, creating a product that will at least double that could be a benefit that will win over the primary users interest in the product.

Space

Transport Canada classifies smaller fishing vessels as being 12 meters and under, this leads to a lack of room for placing an additional console onto the ship to launch a larger retrieval device. This lack of space is another reason why smaller vessels consist of a 1-manned crew. Current life jackets take up a lot of space on the user, through research it is found that users would purchase life jackets that are less bulky, to the point where you can hardly notice it

is on. However, there are drawbacks to wearing these devices as they do not properly protect the user from the elements.

In Table 3.1, the cost per unit is compared directly to the immediate comfort a user will

Table 3.1 Price per unit of product compared to the benefit of comfortability (with respect to environment)

feel while using the product. These two factors were compared because they are the most important factors to consider when designing for commercial fisherman who work by themselves. Since there is hesitation to purchase some life jackets that are worth more than $150, the price will need to have significant justification. Perhaps a life extending aspect? And functions not currently available with general flotation devices. The life jacket also needs to be as comfortable as possible otherwise they would simply neglect to wear it. Special consideration needs to be exercised when designing for these individuals because in the chance they do fall into the water or the ship begins to sink they will need to be wearing a personal flotation device that will connect them with the closest rescue team in the vicinity. All the while fitting into a compact package to fit efficiently on a small fishing vessel.

	Need	Improvement
1.	Comfort/Ergonomics	• Has to be comfortable and not impede work flow • Needs to provide thermal protection and buoyancy • Streamlined design with no snag-points or pieces that can get caught
2.	Affordability	• Needs to cost under $300, less than $500 if it's a full system • Needs to contain essential selling features • Lasts longer than regular PFD's
3.	Space	• System can fit on a smaller fishing vessel that is sub-12 meters • Life jacket needs to be less bulky

Table 3.2 User needs vs. improvements

Competitor Benefit Assessment

A comparison is shown bellow of two popular systems used by commercial fisherman. These systems are available on the market and compared to reveal a market niche that could reveal possible solutions for this thesis project.

Benefits	Life-sling	Jim-Buoy life ring	Potential Product
Comfort	Poor	Poor	X
Ergonomics	Fair	Fair	
Affordability	Poor	Poor	X
Space	Poor	Poor	X
Ease of Use	Fair	Good	
Solo use	Poor	Poor	x

Table 3.3 Benefits comparison

3.1.2 Latent Needs

User needs are very important to address when designing a product, especially if the product is focused on keeping the user safe. The needs discussed in this section are the fundamental human needs that take place whether the user is conscious of them or not while performing the tasks necessary on a commercial fishing vessel.

Image 3.1 Maslow's Hierarchy of Fundamental Human Needs

Product Need	Fundamental Human Need	Relationships with Benefits
User Experience	Physiological, Self-esteem, Self-actualization	Strong
Comfort/Ergonomics	Protection, Security, Safety, Clothing, Control	Strong
Affordability	Self-esteem, Status	Moderate
Safety/Health	Physiological, Safety, Security	Strong

Table 3.4 Current product relationship with fundamental needs

User Experience

The comfort of the user is extremely important if they are wearing a personal flotation device for the entire time they spend on a vessel. Inherent foam life vests just need to be put on, and they will keep the user's head above the water if fastened properly. Modern life jackets that are actively inflated by a CO2 cannister require knowledge on how to do so properly. Creating a device that can automatically inflate with a sensor or simple switch will improve the overall user experience. Having a life vest equipped mitigates the users fear of drowning and helps reinforces their sense of protection/security.

Comfort/Ergonomics

Decreasing the amount of bulk on an inherent foam vest is important. Additional bulk on the body hinders the users ability to perform tasks comfortably, leading to additional strain on the body. Inflatable vests improve the user experience because they are hardly noticeable while deflated. This allows the user to complete tasks that require a lot of movement. Deckhands perform repetitive tasks that will still put strain on their body and require additional support to ensure that their safety/protection has an additional benefit of comfort/ergonomics.

Affordability

As stated in the beginning of this chapter fisherman hesitate to purchase expensive gear for their line of work. Affordability is linked to self-esteem and status; the primary user wants to be able to purchase the product that has the best value for the money. Social groups and class are not a huge factor in the selling point of a personal flotation device.

Safety/Health

Since the device is classified as a product to protect the user from drowning, safety and health are a huge priority for users. Safety should come with simplicity, the second the product is too complicated to work with it can no longer be deemed safe in an emergency situation. The product needs to be catch-resistant and mitigate any chances of getting caught on equipment. The end result of the product should protect the user from as many factors they can face while out in open water on their vessel.

In this case, the latent needs that are fundamental for fisherman are for the most part being met by life-preservers. The pricing of these devices are relatively expensive for the users of the product, the users are not willing to pay $200-300 on a life preserver that is mandatory for them to use every day.

3.1.3 Categorization of Needs

After stating the needs of the product and how they can relate to the user, the next step is to categorize the needs. The resulting data was brought to professionals currently in the field of keeping commercial fisherman's safe. The results were categorized bellow, and will aid in carving a path for the final design direction.

Wishes/Wants

- Comfortable to use, doesn't brush up on neck or impede movement
- Ability to move freely while working
- Reduce the risk of snagging or getting caught on equipment
- Keep the body temperature normal, not too hot not too cold for the user
- Affordable

Immediate Needs

- Mitigate users fears of getting caught or drowning
- Enhancing overall user experience
- Reducing strain on back, hips, shoulders and elbows
- Modular design to allow user to customize depending on weather factors

Latent Needs

- Stylish (make the device desirable to use)
- Easy to replace or change
- Easy to use/minimal training required
- Affordable (cost vs. benefit)

- Easily accessible storage while wearing vest

3.1.4 Needs Analysis Diagram

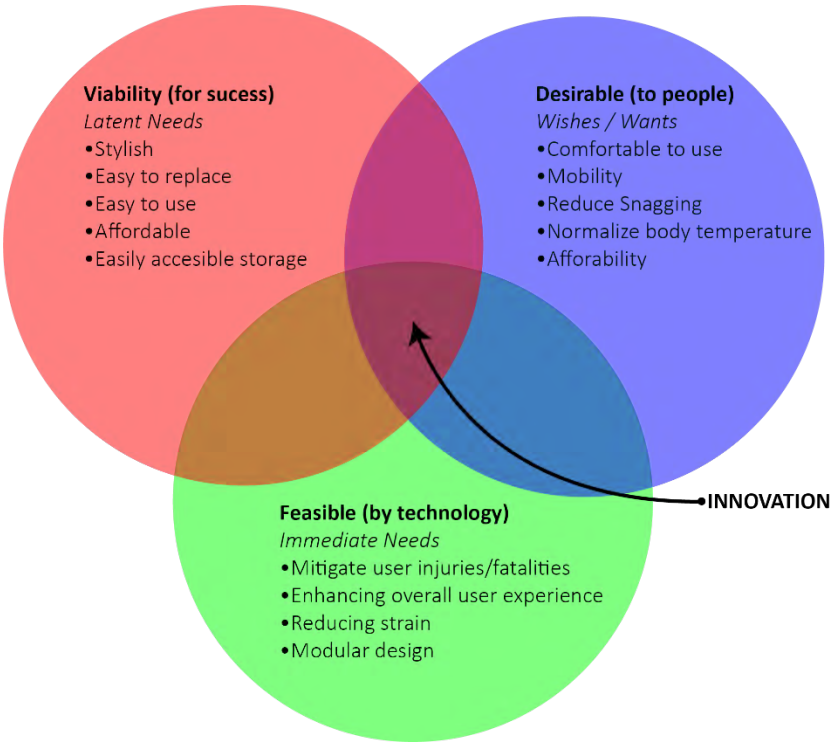


Figure 3.1 IDEO's Needs Analysis Diagram

Desirability

Users would have difficulty finding the desirability to equip a life vest if it were purely for the mandatory requirement to wear one aboard a vessel. Personal flotation devices should be seen as more than just a piece of equipment that keeps users safe in open water. They should have that desirable drive to want to put on a comfortable device that they could not imagine fishing without because it helps them.

Feasibility

Through history there have been a few improvements to the technology used to make personal flotation devices safer and easier to use. The technology for communication has

improved greatly alongside artificial intelligence. If the final product incorporated this technology, it would sense when the user has fallen overboard and has the potential to perform a rescue. This could be a game changer for fisherman who fish by themselves.

Viability

Because of the state of commercial fisherman and the constant pressure placed by rules and regulations from the government limit the amount fisherman can spend placing money back into their profession. Expenses paid for safety gear should be a priority for fisherman. When they are not willing to pay $200-$300 on a new life vest that shows that affordability is a huge factor to consider when designing the final product. Having a huge package of products that could only be purchased all in once will throw off potential customers, so it is beneficial to split that cost down and create a family of products. Creating a family of product that work together and allow the user to replace the products individually and fit into the system will become beneficial, and allow the user to consider purchasing certain accessories over time depending on what they require.

3.2 Functionality

The following section will focus on analyzing current user experience with PFD's pertaining to functionality. Insights can lead to designing a successful product solution.

3.2.1 Activity/Workflow Mapping

Observation

After concluding this observational research, three directed design directions were revealed. The methods used to observe user interaction will be research gathered from multiple mediums. Mostly surveys and interviews about personal flotation devices, followed by user

observation by watching incidents captured on video of deckhands being thrown overboard and accidents that occur on the deck of the boat. It is important to study these videos closely and identify the reasons for these problems. The solution to this problem will positively affect the user's ability to work safely and comfortably aboard a commercial fishing vessel.

The observational video takes place on a larger fishing boat dubbed "time bandit". The experience last around a few minutes and takes place in the frigid Alaska while crab fishing. It is important to note that the water here is a lot colder than in-land fishing water that solo fishermen are familiar with. Hypothermia sets in at 1 minute compared to 1 hour with coastal waters.

Steps		Image	Insights
1	Victim falls off side of boat		Man was trying to shimmy up cages to untangle them.
2	Captain tries to propel boat closer to victim		Piloting a boat takes a lot of skill too much time, that they don't have. Additionally, can't get too close to the victim, risk of collision.
3	Crew member equips submersion suit		Incase victim is unconscious and can't wrap arms into life sling.
4	Crew toss victim life ring		This is to reel the victim closer to the vessel.
5	Crew toss victim life sling		Life sling is used to attach individual to simple pulley system and hoist them out of water.
6	Victim is hoisted onboard		Two people are hoisting because they do not have a pulley system.

Steps		Image	Insights
7	Victim undressed and wrapped in blanket		This is to prevent hypothermia from setting in, he needs to regain his body heat.

Table 3.5 Observation Analysis of Deadliest Catch Man Overboard Rescue. (2019). YouTube. Retrieved 31 October 2019

Figure 3.2 Observational video captured on the "TIME BANDIT "

From this observational video, the user was not wearing a PFD when he decided to climb on the stacks of cages, he fell off after being crushed by waves and was being swept away. Through precise maneuvering the captain of the time bandit was able to pull as close as he could to the victim while the rest of the crew prepared for the rescue. In this extreme case they had only minutes to pull the victim out of the water, other cases with individuals who are sailing alone could last longer in the water if they tread conservatively. However, the important piece of data collected from this video is that the crew is very knowledgeable and has experience with man-overboard situations. This cannot be said for the thousands of individuals that go out on

their own. Nothing can prepare an individual suffering from shock after falling overboard alone. A product that is properly designed to prevent additional harm to the user. Precautionary features like a distress call to notify the nearest coast guard/ rescue operator to aid them is just one of the many features that could be implemented to improve the users experience.

3.2.2 Activity Experience Mapping

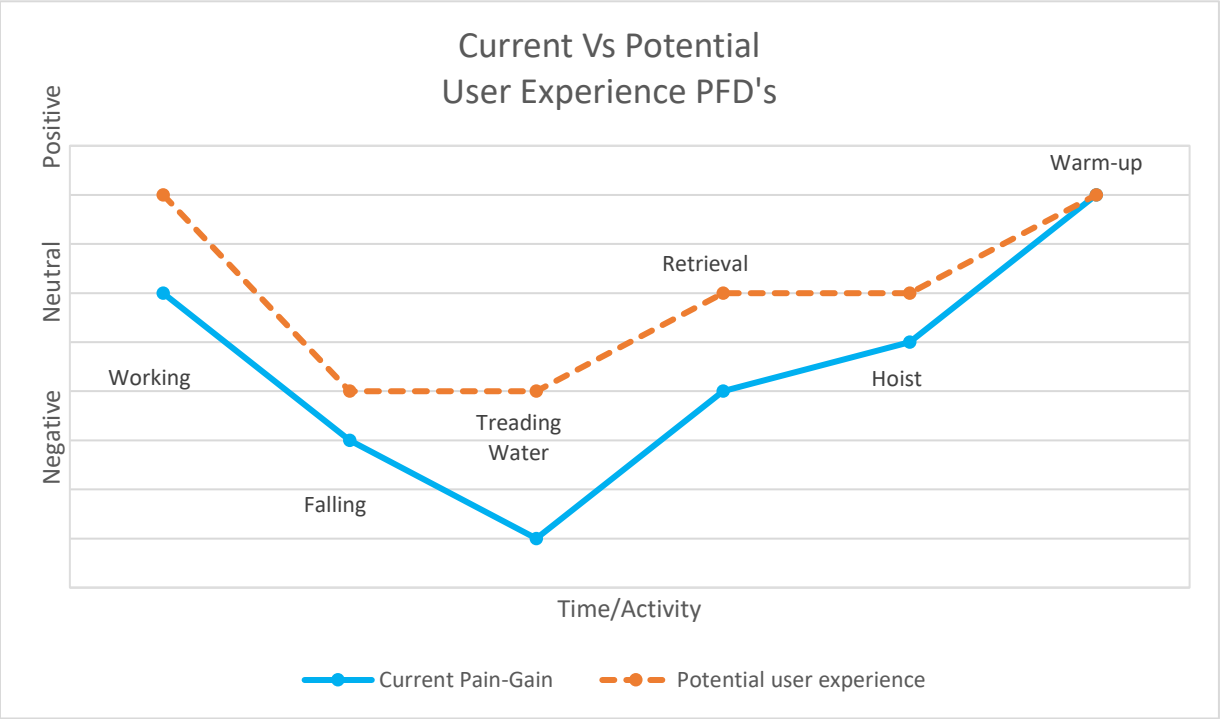


Table 3.6 Current Vs. Potential experience mapping for existing PFD's

Current PFD's do little to aid the user experience while wearing the device, rendering it useful only when the user is in an emergency. The user needs to feel like they want to wear the device because it will do more than just save their life. They purchase the product because they have to, but the objective is to make the user develop a connection with the product because they will need to use it for hours at a time while performing their tasks.

Activity	Steps/Action	Current Experience	Potential Improvements
Performing Tasks with PFD equipped	• Placing equipment into water • Reeling in lines • Placing lines into automated pulley systems • Organizing the fish • Traveling across the deck • Opening/closing bilge drain • Lowering/Raising anchor • Piloting the vessel	• Cumbersome • Annoying • Anxiety from life vest becoming caught in heavy equipment • Fear of hands getting tangled in fishing nets/ropes • Misplaced step could lead to slipping • Slipping leads to threat of falling overboard	• Hardly notice the PFD is equipped while tasking • PFD improves posture while performing tasks • Stress is relieved knowing they can contact rescue with a click of a button •Automated retrieval relieves stress of abandonment
Falling off of the boat	• Tripping on fishing lines • Rocky boat from heavy waves • Strong gust of wind • Loss of balance • Hit by heavy machinery •Alcohol/drug usage	• Fear of hitting head hard • Initial shock from cold water • Whiplash • Intake of cold water • Loss of bearing	• Inflatable helmet that protects head and neck from impact • Finger tips from gloves can eject when being pulled by rope to avoid falling in water • A way to locate where the ship has gone since falling off
Treading water	• Exhausting body movements • Loss of body temperature •Cumbersome life jacket makes it harder to move in different positions	• Exhausting body of energy needed to stay alive • Treading water lowers body temperature faster • Fear of dissertation set in • Engaged in panic mode	• Possibility of adding motors to the life jacket to propel victim • Active heating to keep user warm

Retrieval	• User will need to swim to the ship • Secondary user can throw a Type IV PFD to aid in tow	• Further exhaustion of energy by swimming • User may not be able to swim fast enough to catch drifting boat •(Potentially there is no boat to go back to {sunk})	•Automated retrieval relieves stress of abandonment • User can alert coast guard of falling off the boat
Hoisting	• Life-sling device is used with a pulley system • User climbs up the side of vessel or stern (rear)	• Danger of hitting propellers • Potential in damaging vessel	• Device latches onto vessel and helps individual get aboard • User can stand on device and make it onto boat • Temporary ladder

Table 3.7 Experience Breakdown with potential improvements

As seen in Table 3.5, the key room for improvement for users that are by themselves is the ability to get back onto the boat after falling off. Users who fish alone are at higher risk of perishing from falling overboard. A potential solution to this product is to have a device that can aid in notifying nearby ships or rescue officials and then attempt at retrieving the individual from the water. Getting back onto the boat is an awkward situation because grabbing on from the left (port) or right (starboard) side can tip the boat, potentially capsizing the vessel. Grabbing onto the back (stern) is the most balanced way to get back onto the boat, however there is the potential of coming into contact with the propeller.

3.3 Usability – Ergonomics

The following section goes into detail analyzing current models of PFD's and the ergonomic requirements met by these products. The ergonomic requirements needed by an

individual in the water being towed along and then hoisted will be recorded as well, for these are important measurements to take into designing the next possible personal flotation device product.

Introduction

Current personal flotation devices on the market are not designed to aid users who work alone while on board a boat. The devices come in different sizes to fit the users as best as possible. However, the recovery of a user is not taken into account in regular life vests. There are separate products used to hoist the user out of the water. For this project the primary user will focus on the individual who fishes alone. These users need special consideration when designing a system that will aid to keep them above the water, then retrieve the user from the water and place them back onto their vessel.

Literature Review

The anthropometric data that is referenced for this study was retrieved from The Measure of Man and Woman (Tilley & Dreyfuss, 2002). Measurements from the 97.5^{th} percentile male and 2.5^{th} percentile female were referenced for the overall dimensions of the jacket and retrieval device. Measurements for contact points include the head, neck, upper body, hips, thighs, arms and hands. These measurements were also accompanied by those for a fixed ladder.

Methodology

There were two separate full-scale bucks created to test the system of products. The ergonomic buck for the jacket used by the individual will provide maximum amount of mobility and comfort to work in, allowing easy reach to emergency equipment. Adding to this, providing

support for the retrieval device to attach itself to the user. The retrieval device will need to attach itself to the user through the waist and have the ability to tow the user back to the vessel. From here the user will travel up a retractable ladder that was deployed when the retrieval device entered the water.

Objectives

The goal of the task exhibited is to determine the human factors related to the proposed device aimed to be worn by a user and then attached to a retrieval device that will then begin to tow the user back to the vessel. From here they will then climb up the temporary ladder to safety. In relevance to this thesis project the product must ensure contact point with 3 major body part areas.

Decisions to be made

The following three user interactions were investigated according to the guidelines of this thesis project to be related to three separate major body parts.

1. Putting on and taking off the life jacket incorporating the mobility of the users arms.
2. Attaching the device to the user supporting the neck, spine and torso.
3. De-taching from the device and then proceeding to climb up the ladder. (legs and arms)

Description of Users Targeted by Product

The target demographic for this product would be commercial fisherman. Primarily fishermen that work alone. The age range for these individuals range from 20-60 years. These results were obtained through a survey put out by the designer to commercial fisherman located in Canada on the east and west coast.

Evaluation Process

The evaluation process consisted of designing a full-scale (1:1) ergonomic buck of the system including the life jacket, the contact points on the retrieval device and the retrieval ladder. The measurements taken from reference aided with the measurements applied to the system, this allowed for critical observation of the following:

1. Identify how the user interacts with the flotation device
2. Identifying the measurements, the user needs to comfortably grab for something located on the life jacket.
3. Identify the contact points the device will use to attach the user to the retrieval device.
4. Identify the dimensions necessary of the foldable ladder to allow a semi-submersed person to grab onto and climb out of the water.

Description of User Observation Environment Used in this Study

For this study, the ergonomic buck was created with paper-backed foam board and paper to allow the flexibility of the material to fit around the user easily. The location was the designer's basement in Vaughan, Canada. This is where potential users were invited to test out the ergonomic buck and measure how well the measurements on the product would fit the targeted percentile.

Location and Timeframe

Date of Observation: December 20, 2019 from 2-4 pm

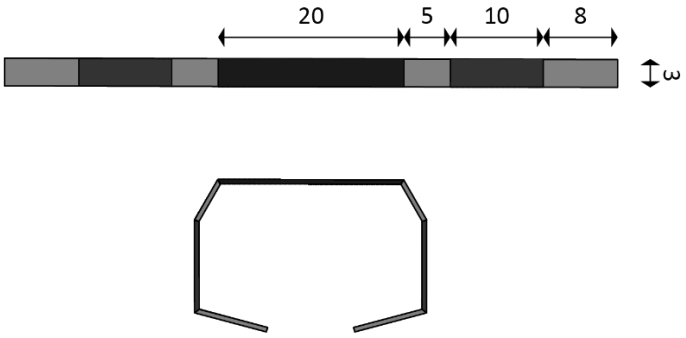
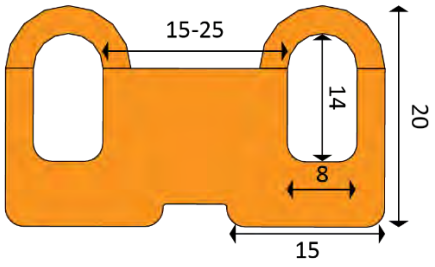
Location of Observation: Designer's home

Results

Results are demonstrated bellow with dimensions and measurements. Individuals that opted into being subjects for the following ergonomic anthropomorphic data.

Ergonomic Drawings:

The following chart shows the ergonomic drawings of three separate pieces of the overall system that will come into contact with the user the most. The drawings were made in reference to the 97.5th percentile male and 2.5th percentile female. The final measurements took the bias of the male percentile as a larger number of commercial fishermen are male.

Retrieval Device **The arm will be attached to the bottom of the retrieval device. It is deployed and will expand to its maximum dimension. Once the user makes contact with the arm it closes around them fitting to a comfortable size**	
Personal Flotation Device **The personal flotation device was sized using measurements related to jackets, accommodating extra room for heavier clothing. The jacket will be either adjustable or come in different sizes for the user.**	

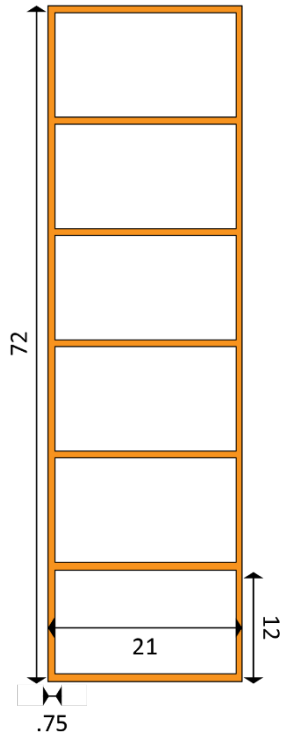
Temporary Ladder **Deployed by the retrieval device when launched the ladder hangs off the side of the vessel allowing the user to comfortably attach to the ladder while treading water and climb up the side of the vessel from the water.**	

Table 3.8 Ergonomic Buck System Drawings

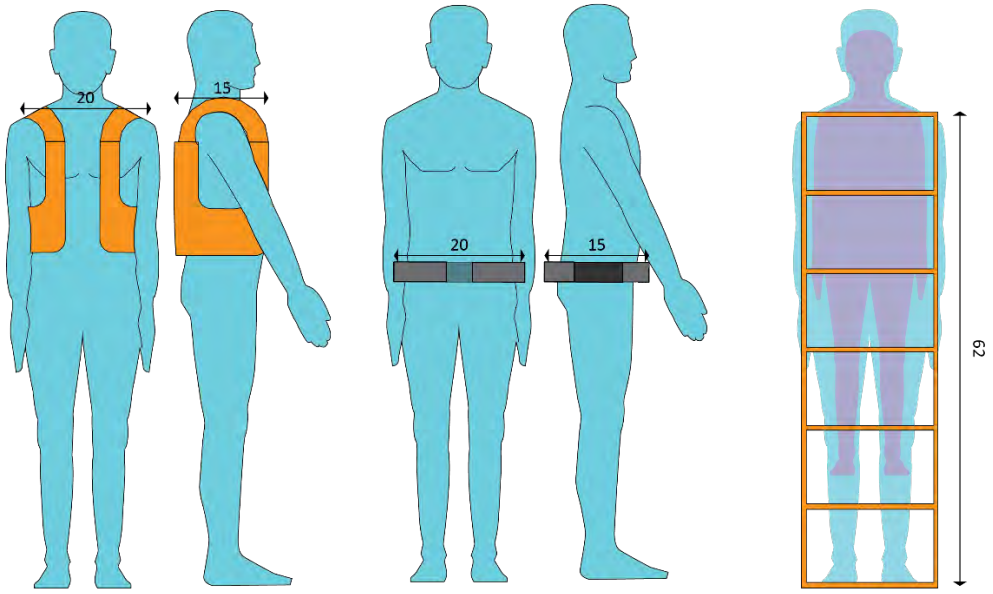


Figure 3.3 97.5th Percentile Male Interaction With System

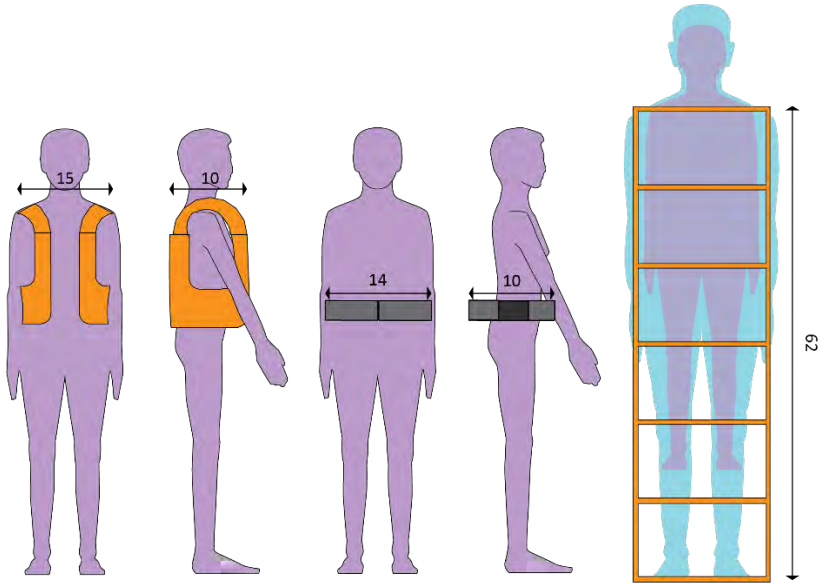


Figure 3.4 2.5th Percentile Female Interaction With System

The three pieces of the system will need to accommodate larger heavier males. The life vest is measured to fit comfortably around the user with adjustable straps at the front to allow a looser or tighter fit. The arm holes measure at 14”x8” allowing the user to have full range motion of their arms.

The retrieval device uses a rescue arm that grabs onto the user securing them to the drone and transporting them back to the ship. When the rescue arm initially deploys it will stretch out to its maximum size footprint (25”x20”) allowing any human within this footprint size to fit securely to the retrieval device.

Lastly, the ladder adopted its measurements directly from the measure of man and woman that relate to the optimal measurements of a fixed ladder. The temporary ladder available in the system will be deployed and submerged into the water allowing the user to grab onto the device. This means that for larger users the ladder will need to extend out past their

feet while submerged (62”). This will allow the user to easily find the rungs on the ladder and climb up and out of the water.

Ergonomic buck user observation

Using the measurements gathered from the figures above, a full-scale ergonomic buck was created to be tested on participants. The participants involved measured closely to the 95th percentile male and 5th percentile female. The tests are labeled with the corresponding images taken of the participants interacting with the buck.

Test 1: Life vest interaction

Figure 3.5 Test 1: 95th percentile Male Interaction

Figure 3.6 Test 1: 5th Percentile Female Interaction

The life vest needed to be cut and put back together for the 5th percentile woman to fit in the life jacket comfortably. The back panel of the device was reduced by 10” allowing for a better fit. The proportion of the suit fit well for both percentiles, this meant that the size of the arm holes and adjustable straps would not have to be changed to accommodate different percentiles. A longer hip piece will provide protection from the retrieval device and cutting out unnecessary material will create a more comfortable experience for the user.

Test 2: location of distress switch

Figure 3.7 Test 2: 95th & 5th Percentile Interaction

When the user falls into the water they would need a way to call for help, a way to launch the drone from the vessel would be a simple switch on the life jacket that once triggered will deploy the retrieval device from the vessel. Through this observation it was found that a comfortable and easy action will require the user to reach with one arm to the opposite side of their body, performing half of an X. This will allow them to effortlessly interact with the emergency switch on the life vest. Additional interactive buttons could be placed on the opposite side at the same height.

Test 3: Interaction with retrieval device

Figure 3.8 Test 3: 95th & 5th Percentile Interaction

The retrieval device will interact with the user with a claw that will grab around the waist of the individual because this is the safest place to tow a individual without causing discomfort. The device will reach out around the individual and then tightened until proper grip is achieved and the device can tow the user back towards the vessel while keeping their head above the surface.

Test 4: Interaction with rescue ladder

Figure 3.9 Test 4: 95th & 5th percentile interaction

Once the user arrives to the vessel they will need to climb back up to the deck. From where the retrieval device is deployed a temporary ladder will unfold allowing the user to climb up. The ladder needs to submerge deep enough to allow the tallest user the ability to mount on and climb up. For this the measurement of the 97.5% tile male was taken into account (specifically from the top of the shoulders down to the feet [62”]).

Analysis

The results of this evaluation alongside the proposed design solution are an example of how behind the fishing industry is in developing products that will aid users in falling overboard. The tests used in the evaluation came from the proposed design to enhance the users experience of using emergency equipment while fishing on a commercial vessel. However, the life of a fisherman in unpredictable and inclement weather along with rogue waves are constantly a factor which make a users experience extremely challenging. The user can also fall victim to injuries or disabilities that will challenge them further making it even harder to get back onto the boat.

A trend has begun that focuses on making the fishing industry safer for everyone. The goal of this thesis project is to create solutions that still to this day have not been realized or addressed by the commercial fishing industry. The design being proposed focuses on enhancing the user experience once they have fallen out of their vessel. Through this assessment three major steps in this design have been analyzed for user interaction, ergonomics and overall user experience.

The first test included the personal flotation device that will need to be worn by the individual. The device is comfortable and will allow the user to work freely allowing full range of motion from the arms, neck and hip area. Cutouts have increased dimensions compared to products available in the market right now. The life vest will need to fit all possible human sizes comfortably, this is why it will be available in different sizes and have adjustable straps that will allow the user to adjust the fitment of their device depending on how many clothes they are wearing. The weather is a constant variable since it changes constantly throughout the day with

freezing mornings, blistering hot mid-days and then chilling afternoons. The user will need to equip the vest the vest multiple times throughout the day to fit the fluctuating temperatures.

The second test included human interaction with the flotation device. How would the user interact with the device once they were in the water? Having a way to initiate a rescue procedure in an emergency is important this is why the placement of the control panel is located on the chest area of the vest. This allows the user to easily reach and activate the switch that is close to them at all times. Additional interactive switches such as the strobe light and GPS location are important to have in the event that weather conditions are poor and the ability to achieve extra visibility could save precious time in the rescue procedure. In the event that the users ship is capsized or sinking then the user would need to rely on floating alone in the water waiting for help to arrive.

The retrieval device is launched from the vessel and the user is tracked down using locating technology integrated within the retrieval device. Once contact is made with the user the device releases a latching mechanism that attaches to the user securing the user to the device and then transporting the user back to the vessel safely. The retrieval device will work similar to fishing nets in the sense that it will cast out a rescue arm that has a footprint of 25”x20” and then slowly retract closing the gap between the arms of the claw and the body of the user. This allows the device to fit securely no matter the size of the individual.

Until now there is no device that helps a user climb aboard their ship if they have fallen into the water. Currently they rely on two people being on the ship and the subject would need to be picked up by the individual still on the boat. It is still possible to climb onto a boat by themselves but the user would need to be in fit shape. Freezing cold water can impede the

users ability to climb up the side of a ship. This is where the flexible ladder comes into action. Once the retrieval device launches the ladder follows suit and deploys a ladder from the side of the vessel submerging itself 62” into the water. This will allow even a user that’s 7’ tall to locate a rung with their feet and climb up the ladder to safety.

Limitations and Conclusion

The evaluation encased a user observation with an ergonomic buck of the design system that sought out to locate critical touch points and dimensions. These findings would help finalize the final proportions and measurements. With these findings came limitations that are listed below:

- The user is still required (by law) to put on a life vest that will restrict them in some way because it adds mass and bulk to them.
- The size of the retrieval device needs to fit in a small commercial fishing vessel without getting in the way creating an additional hazard or limiting cargo space that the fisherman could use for catch purposes.
- Testing on land limited the accurate dimensions needed by a floating individual placed in the water to mount a ladder.
- The anxiety and rush received from panicking from going overboard were not available to the observed participants, this could change the way they interact with the life vest and retrieval device.
- The observants did not wear heavier clothes that some fisherman may use while working. This could affect/limit the mobility and interaction that the users had with the product.

- The length of the rescue arm detaching from the retrieval device is a discrepancy that needs to be resolved. This measurement is necessary to identify how far the claw is traveling away from the device to meet up with the users torso/waist.

In conclusion, the study of ergonomics and human interaction for the proposed design was a success. The tests help visualize the size and proportion of the devices, and how the user would interact with them. New opportunities and steps have been revealed to the product that will further enhance user experience. Future steps include focusing more on the interaction users will have with the device in the water and gain better knowledge on how the user will interact with the product in the water while attaching to the retrieval device and climbing out of the water on the ladder. The overall design aims to replace all personal flotation devices and is set to standardize the way the commercial fishing industry views personal flotation devices with one product family. Moving forward there is a clear design direction that is supported with the findings of this experiment.

3.4 Aesthetics

Introduction

Traditionally, PFD's are meant to stand out when a user I wearing them. They are meant to be seen easily so when the user is in a body of water the reflective tape and high intensity colour is easy to see. Depending on the function, the device can have a very light feeling to be used in the summer on a great lake, while some PFD's used by artic crab fisherman cover the entire body.

Image 3.4 Aesthetic comparison of (left to right) Airhead Keyhole ($12) Mustang SAR ($270) Mustang Integrity ($575)

Form Language

Designed to invoke a sense of safety when wearing the device, it looks very purposeful and functional. Intense spectrums are chosen like red, yellow and green for the major colour palette. Straps are easily identifiable along with pockets. The cost of the device also limits the aesthetic appearance, cheaper flotation aids will appear blocky with bland placements of reflective tape. Higher end PFD's have a form-fitting shape to them with foam cut-outs and stylized reflective tape.

Conclusion

The overall style of a life jacket is very functional, it should include an aesthetic style that appears purposeful. With high intensity and form fitting design that allow for easy mobility.

Implementations to a potential design would include a way to hide the straps from potentially getting snagged on a wire or hook. Incorporating the design to reassemble the human form and look more attractive instead of purely functional.

3.5 Sustainability-Safety, Health & Environment

User health and safety are priority when designing a personal flotation device. These aspects need to be critically analyzed and incorporated into the design. Through the history of personal flotation devices, the lifespan of the device has not taken into account the end of life placement for the device. Hopefully the result of this thesis project could help in finding a solution to properly deal with the end of life section of the product.

Safety

Personal flotation devices are designed to keep the user safe from drowning by keeping their head on top of the water. Since the risk of going overboard while on a vessel will always be a factor, the device must be easy to use and require little to no training. Once the user falls overboard, a potential solution would be to include an inflatable neck and head brace that will protect the user from hitting the waves with enough force to get a concussion. The design of PFD's allows the user to float face up so that if the user is unconscious or unable to move, they will not drown. The device also needs to allow enough room around the neck and arm/shoulder area to avoid constriction to the individual. The accessibility of type IV devices needs to be easily located, retrieved and thrown at the victim in a few seconds. These devices cause potential issues because of the material they are made of. The hard plastic could knock a victim unconscious when thrown at leaving them unable to grab onto the device. The same goes with

individuals under the influence or passed out, there is no way to throw this device to them and reel them in properly without them being attentive.

Health

The health of the users who use PFD's is very important as they will need to use the life jacket even when they do not need it. It is important that the ergonomic requirement of the user is met and that the device can limit uncomfortable positions. It is important that the user will be properly supported when hauling in a catch or lifting heavy containers to preserve their back, spine and joints.

Environment

Selection of material for safety products such as life vests should not be compromised in favour of a sustainable option that will lead to poor performance of said product. This is possibly why there were no improvements to the end of life cycle for life vests. The inherent foam used in the life vests are designed to resist decomposition, this can harm marine life. The proposed design selection should consider the environmental impact of the end-use cycle, and possibly incorporate a re-usable/replaceable system that will allow the user to replace parts without having to worry about buying a whole new system of products.

3.6 Commercial Viability

The following section will contain an investigation into material choice and the commercial viability status of the proposed solution.

3.6.1 Materials and Manufacturing Selection

The material selected for this proposed design will be based on the future and some current examples of material applications used by marine products. Sustainability for the

product is key and with the thought of marine life in mind any materials that cause harm to marine life such as PVC (Which is currently used for marine applications) will be turned down. Newer more sustainable material solutions like Polyurethane and recycled aluminum will be the main material choice for the mass production of this product. Concepts of utilizing recycled water bottles exist right now, this will not be applied for this design as one of the main selling features for this vest is to be thin allowing the primary user the space to complete tasks.

Figure 3.2 Life Jacket Graveyard in Lesvos, Greece

3.6.2 Cost

Since the design is an incorporated family of products, and the design does not yet exist a search online for products familiar with the proposed design were collected.

The online product search defined products like; modern day hybrid inflation life jackets, dual prop sea scooters, telescopic ladders and torque pulley motors. Searching on Alibaba the price of sea scooters varies massively but the average cost of a dual prop sea scooter is roughly $500 US. The cost of life jackets depends as well if the life jacket varies as well depending on the type of flotation included. The re-usable hybrid inflatable jackets cost around $350. Aluminum telescopic ladders can go for $30. While a powerful torque motor (for electric wheel chairs) sell for around $40 depending on quantity purchased.

With all these elements of the design accounted for the total cost to the consumer should cost less than $1000 to setup and install on their fishing vessel. This is a steep proportion of the price and can be reduced though further prototyping beyond the scope of this thesis project. A lot of fisherman won't be willing to pay this price but, what price would you put on a life, considering this product has the potential to save one?

3.7 Design Brief

The goal of this thesis design is to create a product/system that makes commercial fishing safer through full-bodied interaction. The following list are objectives which will need to be met to carve out a revolutionary final design direction.

1. Mitigate fatalities caused by going overboard for commercial fisherman who work alone.
2. Create a product that can fit comfortably on the person, allowing them to perform tasks.
3. Allow the user to customize their suit depending on weather factors.
4. Keep the cost of the final design low or flexible (depending on their needs)
5. Ensure that the system can fit comfortably on a small boat (12 Meters in length)
6. Allow users the ability to get back onto the boat by themselves easily.
7. Ensure compatibility with modern technology into a rescue system.
8. Incorporate a sustainable system that allow users to purchase replacement pieces instead of a whole new product.
9. Create an aesthetic that responds well to established product semantics.
10. Integrate a system into the life vest that helps to alleviate strain and pain to the user.

4 Design Development

This section will display the design development stage and the steps taken to propose the final design for the automated marine rescue system. Elements have been created through the use of different mediums that work through the design process from concept ideation all the way to final modeling refinement in accordance to the design brief.

4.1 Ideation

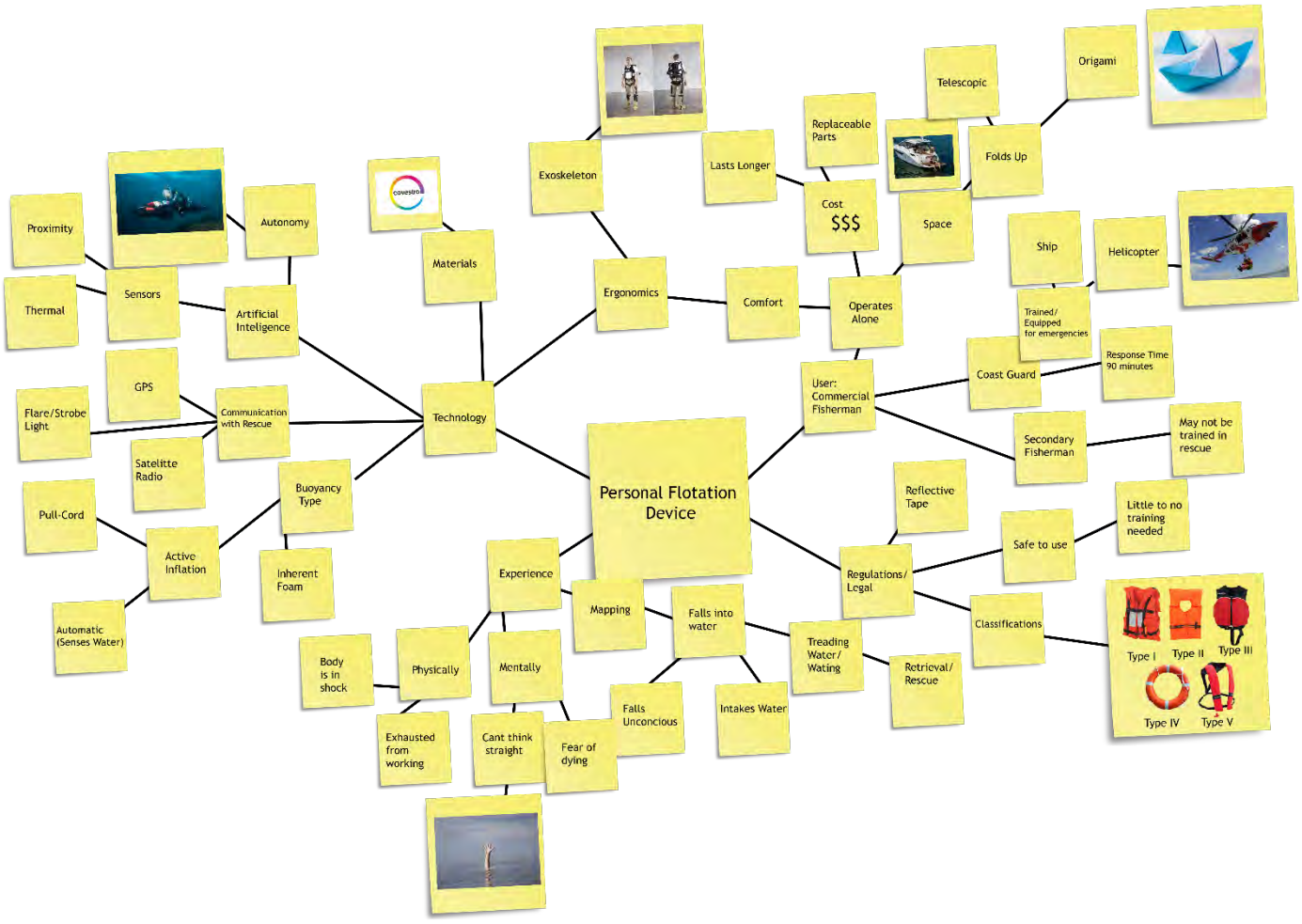


Figure 4.1 Personal Flotation Device Mind Map

Figure 4.2 Mood Board and Inspiration derived from marine products and working fishermen

A: https://inhabitat.com/self-inflating-hexa-raft-automatically-deploys-upon-contact-with-water/
B: https://tradiegroupwa.com.au/product/3-8-m-telescoping-aluminum-ladder/
C: https://www.outsideonline.com/2285566/go-fish
D: https://artsandgadgets.com/wp-content/uploads/2015/11/SOSBalloonLifeJacket800.jpg
E: https://skoda-wlc.s3.amazonaws.com/2/2017/03/232323_231313.jpg
F: https://cdn.yankodesign.com/images/design_news/2019/09/the-invisible-bike-helmet-that-can- take-a-blow/airbaghero.jpg
G: https://www.yankodesign.com/2013/09/17/collar-of-life/
H: https://www.pinterest.ca/pin/189080884330762573/
I: https://uncrate.com/aquajet-h2-water-scooter/
J: https://www.bhphotovideo.com/c/product/1421738-REG/sublue_us_mixab01_whiteshark_mix_aqua_blue.html
K: https://www.pinterest.ca/pin/373235887838708864/

Figure 4.1 & 4.2 represent mediums taken for the initial design exploration taken. Mapping the user experience and needs helped visualize important details that needed more attention. The mood board helped to understand the semantics of what the proposed design is supposed to look like. And inspire shapes for the elements in design.

4.2 Preliminary Concept Exploration

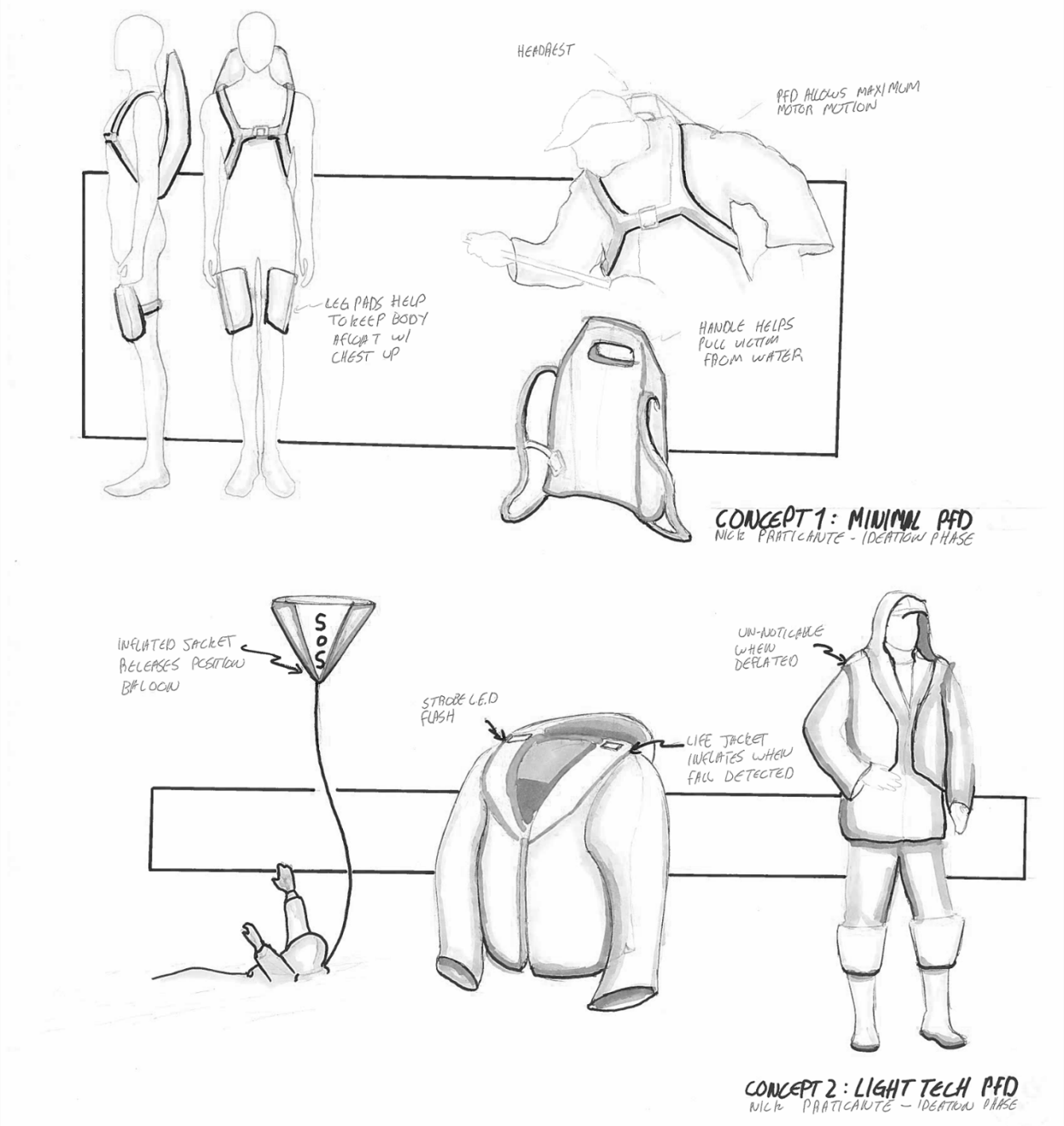


Figure 4.3 Concept 1 & 2 Personal Flotation Device

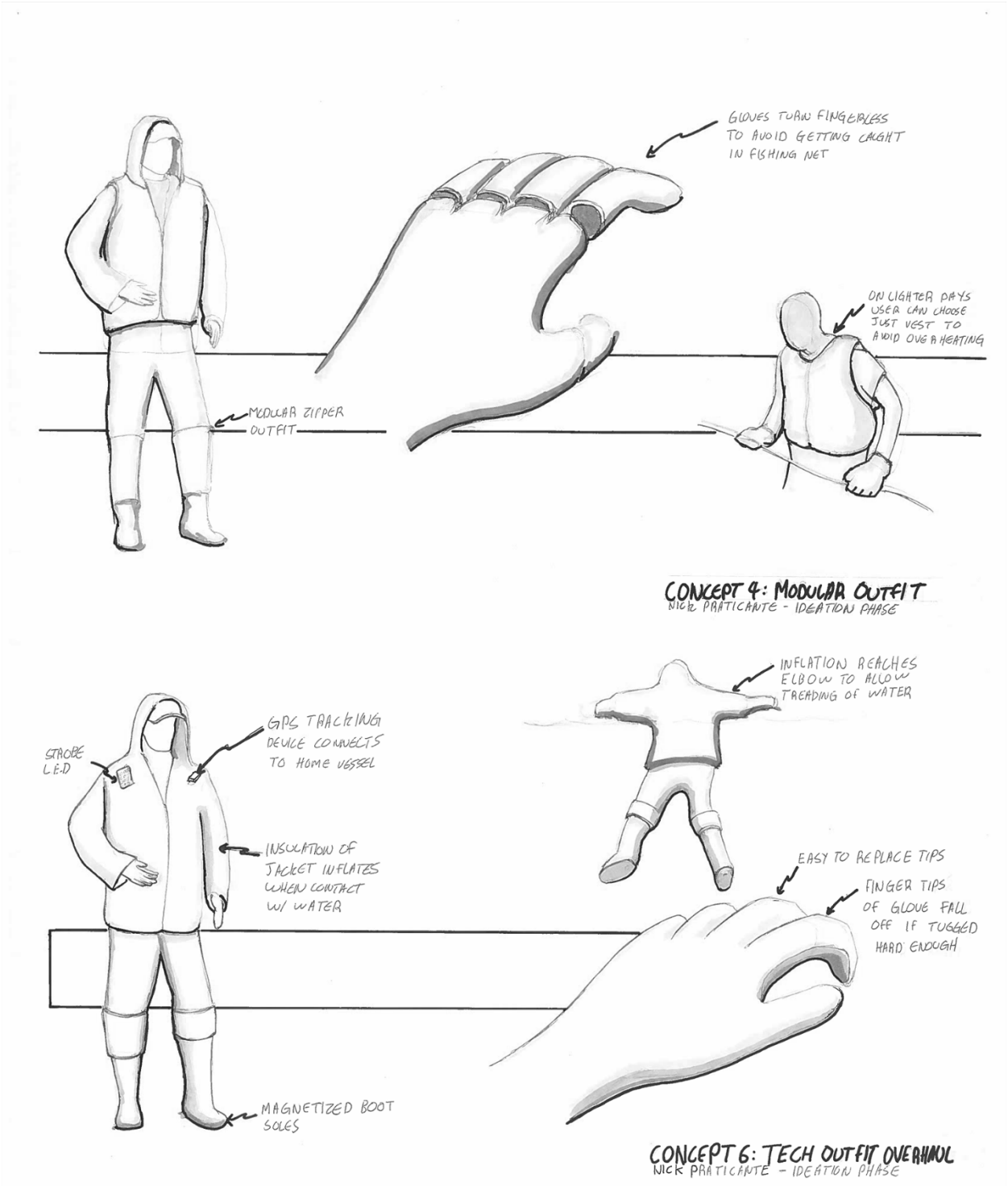


Figure 4.4 Concept 4 & 6 Tearing Glove Concept

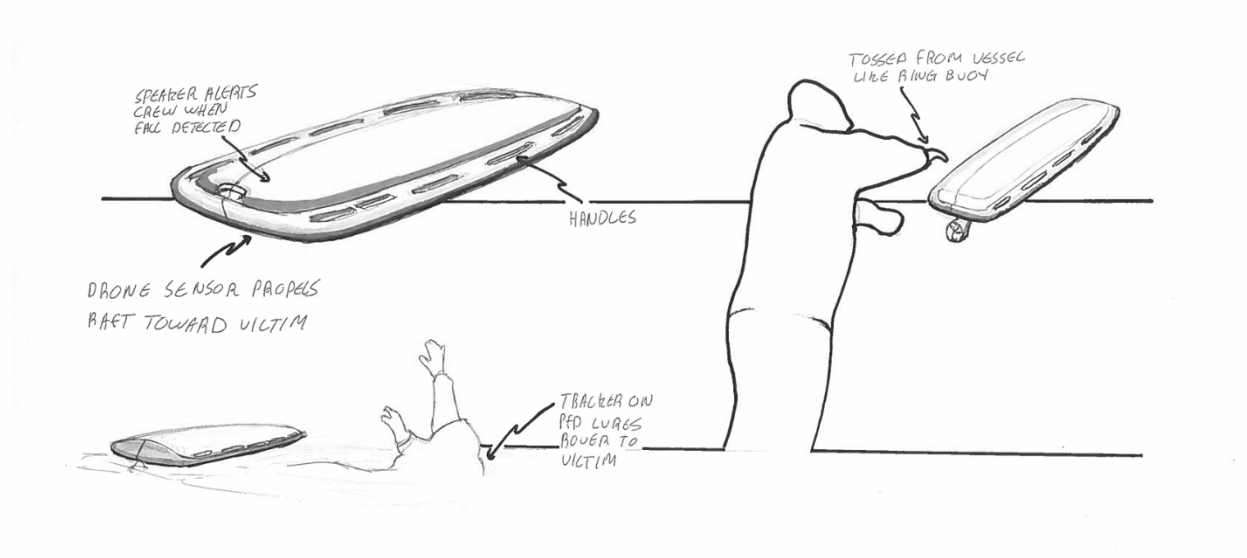


Figure 4.5 Concept 5 Retrieval Device

The ideation phase helped to understand initial problems that would be encountered with the design. In addition, an opportunity to merge the retrieval device concept with the vest has been achieved. Future concepts will use this integration of product family. Replacing the life ring with an automated retrieval device and a vest that was thin enough to complete exhausting tasks, and relay information to the retrieval device for automatic deployment.

4.3 Concept Refinement

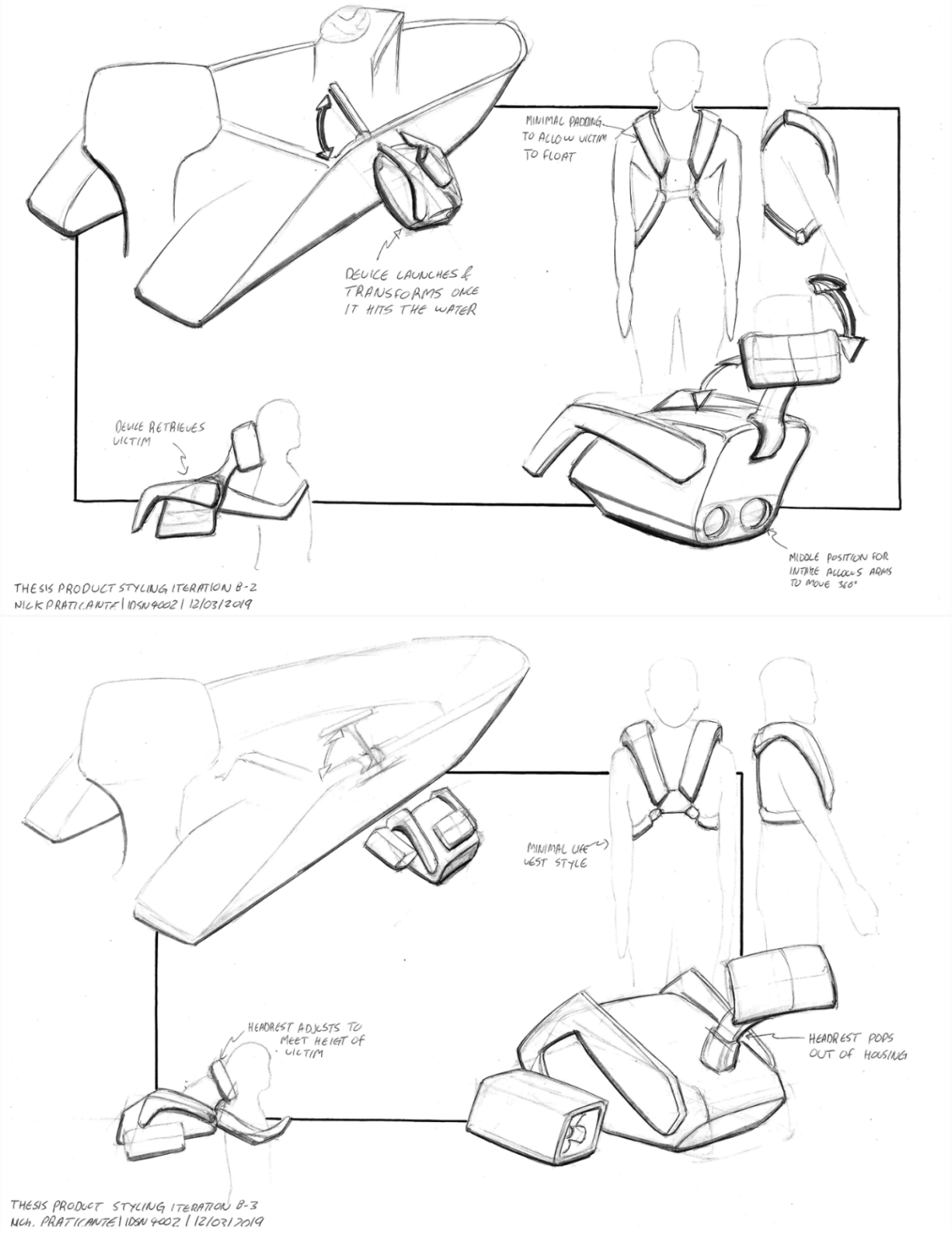


Figure 4.6 Concept Exploration 2&3 Retrieval Device Pivoting Arm

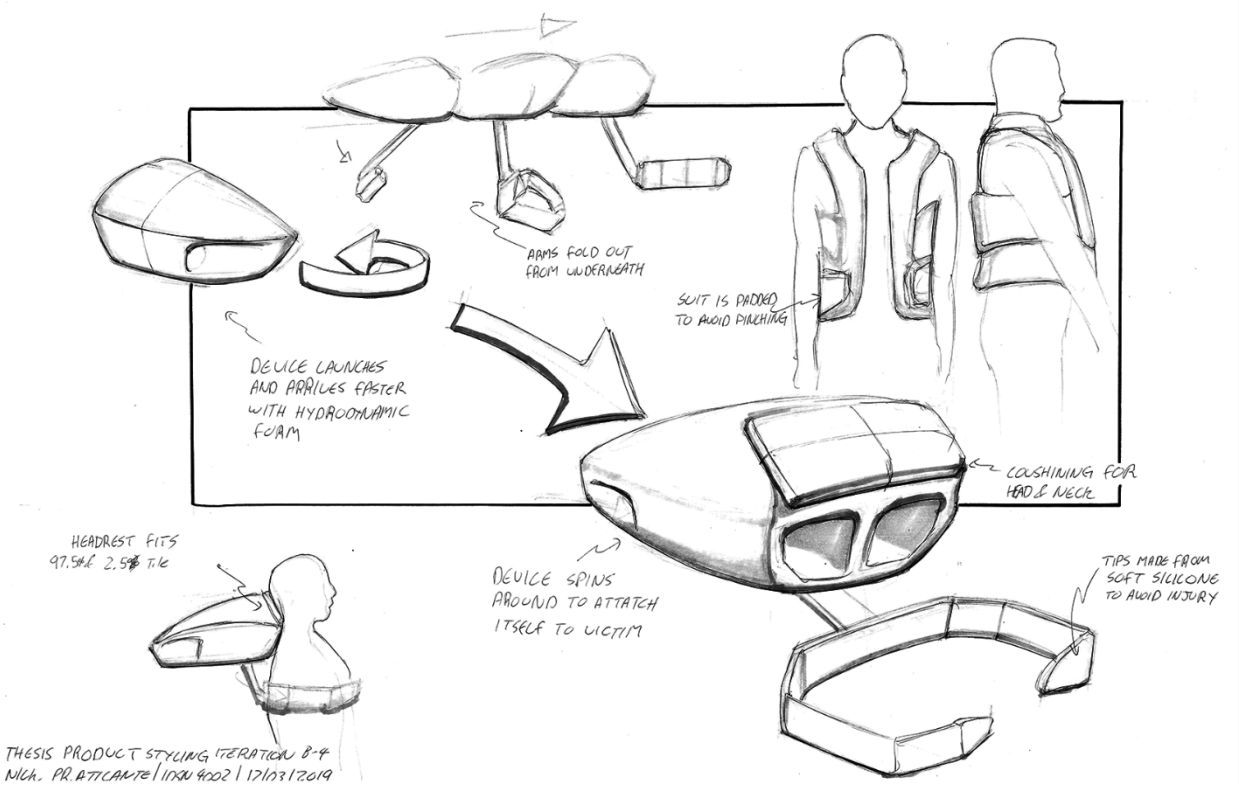


Figure 4.7 Concept 4 Collapsible Retrieval Arm

The arm for the retrieval device has been fine tuned in this stage of the design process to focus on how the device would attach itself to the individual and how they would be retrieved back to the ship. Two of the main concepts included an arm that would latch to the side of the ship and then launch off into the water but wouldn't be the most reliable way to deploy a device in an emergency because the arms would also fail to fit a universal group of individuals comfortably. The design chosen was a arm mounted to the bottom of the device that would fold out and latch onto the individual allowing them to be dragged back to the vessel safely.

4.4 Detail Resolution

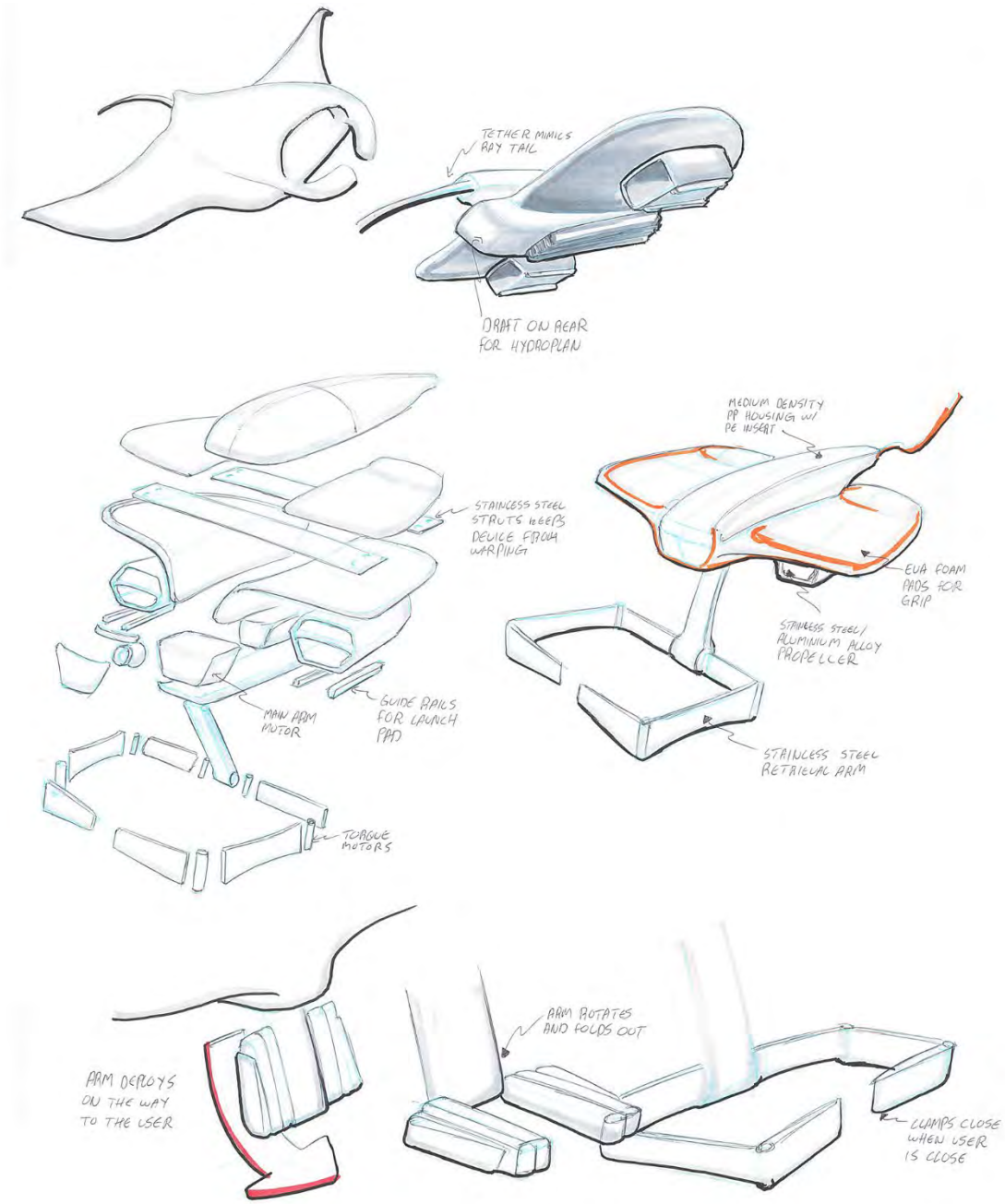


Figure 4.8 Retrieval Device Detail

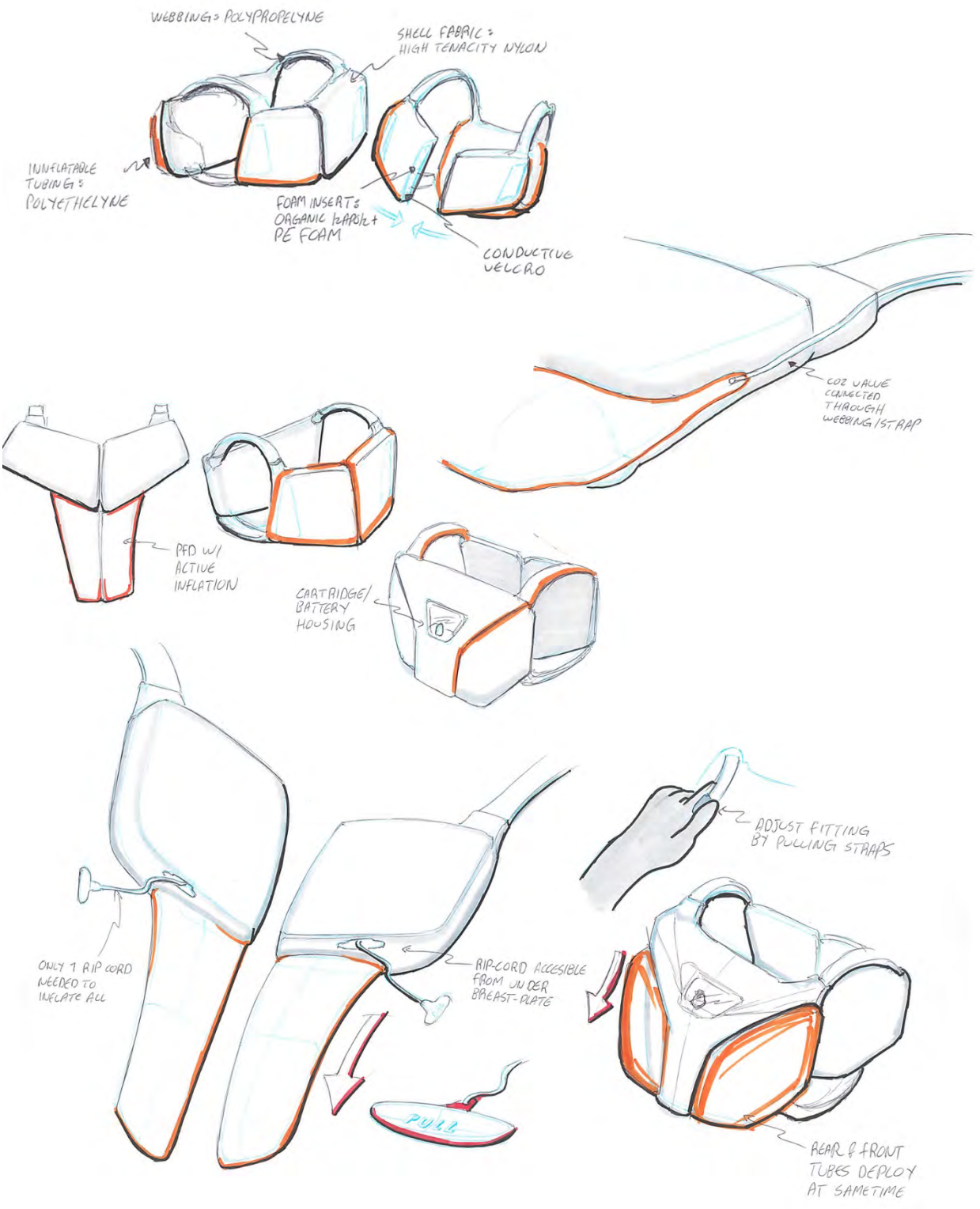


Figure 4.9 Vest Detail

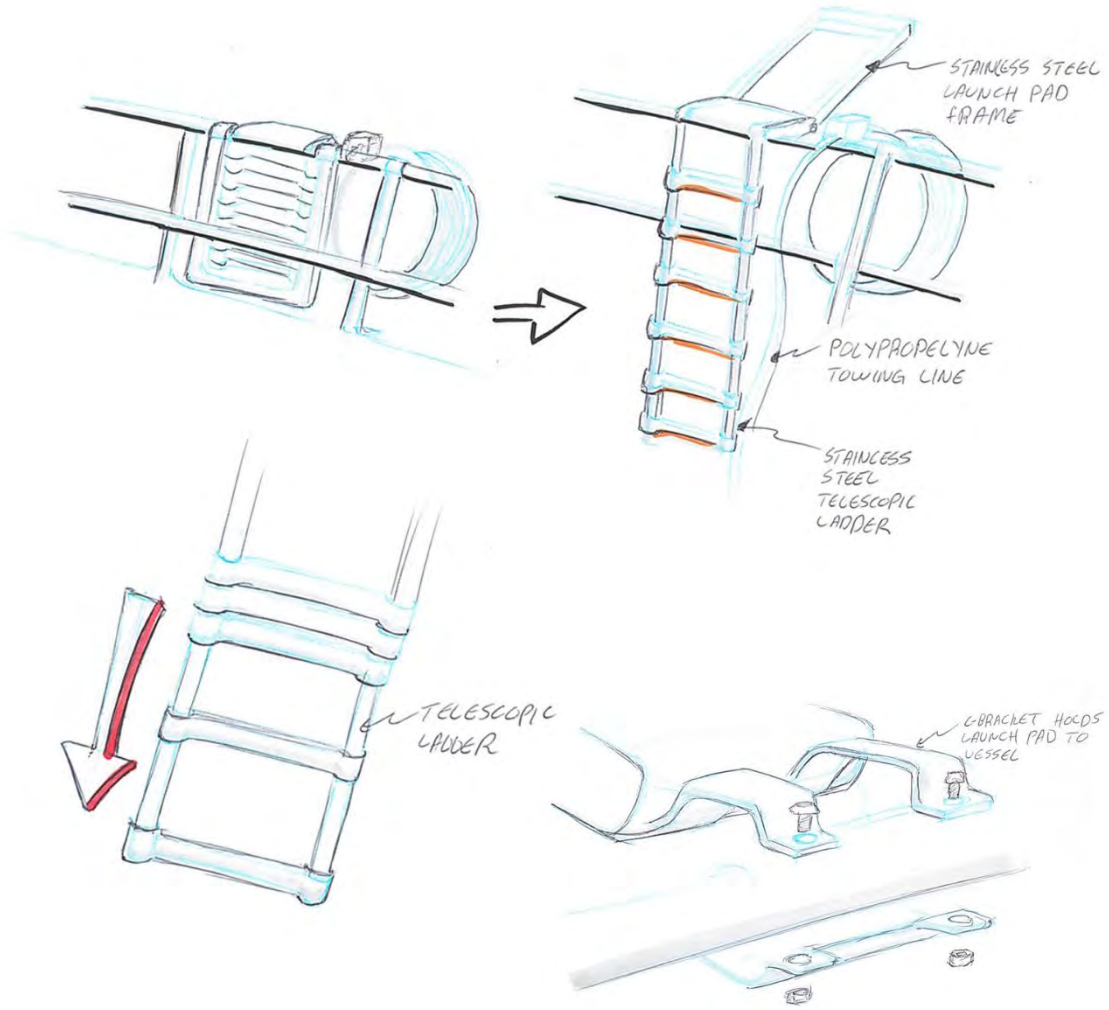


Figure 4.10 Deployment System Detail

The final stage of design detailing; development on how the proposed design would be manufactured, material selection and details on how features would interact with one another.

4.5 Sketch Models

Figure 4.12 Retrieval Device and Vest Front View Sketch Model

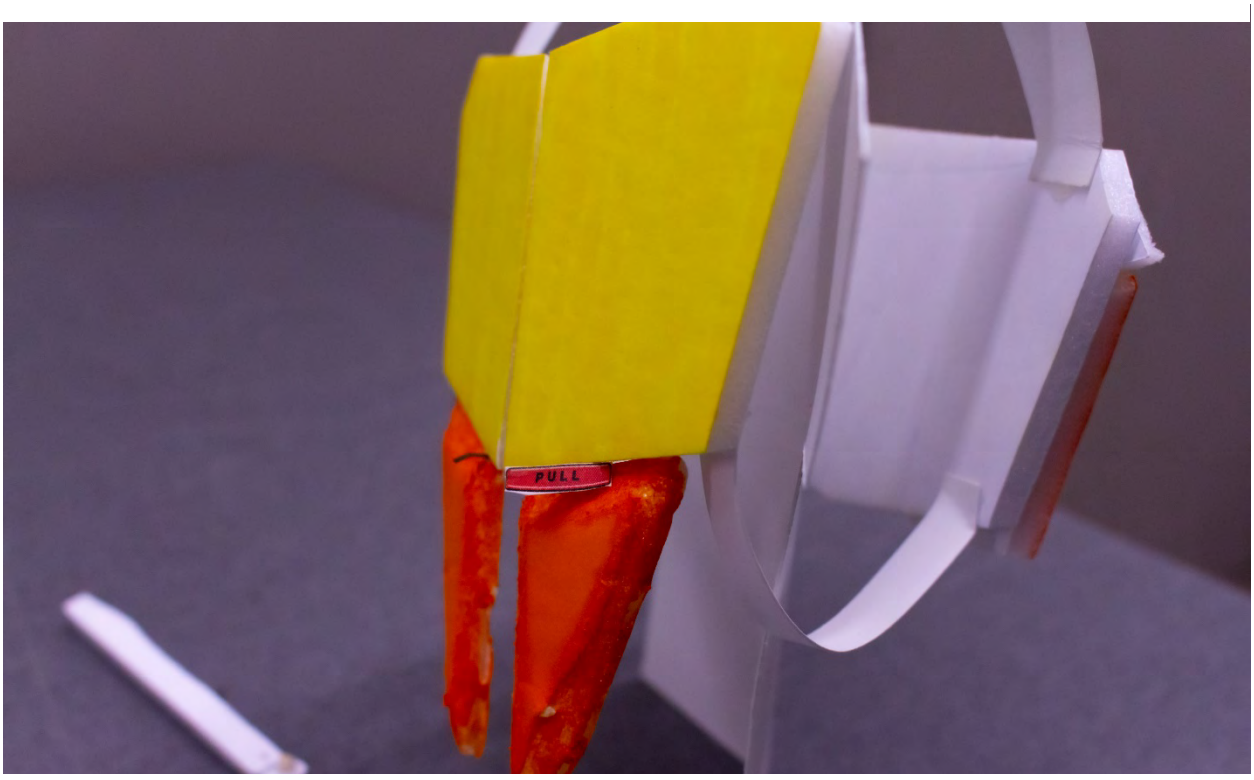


Figure 4.11 Detail View of Model

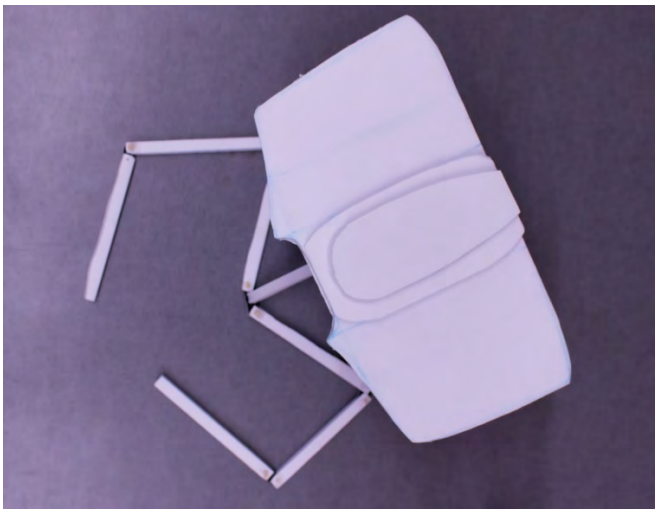


Figure 4.14 Top View of Retrieval Device

Figure 4.13 Rear View of Vest

The sketch model helped to determine proportions for human scaling for the vest and the retrieval device.

4.6 Final Design

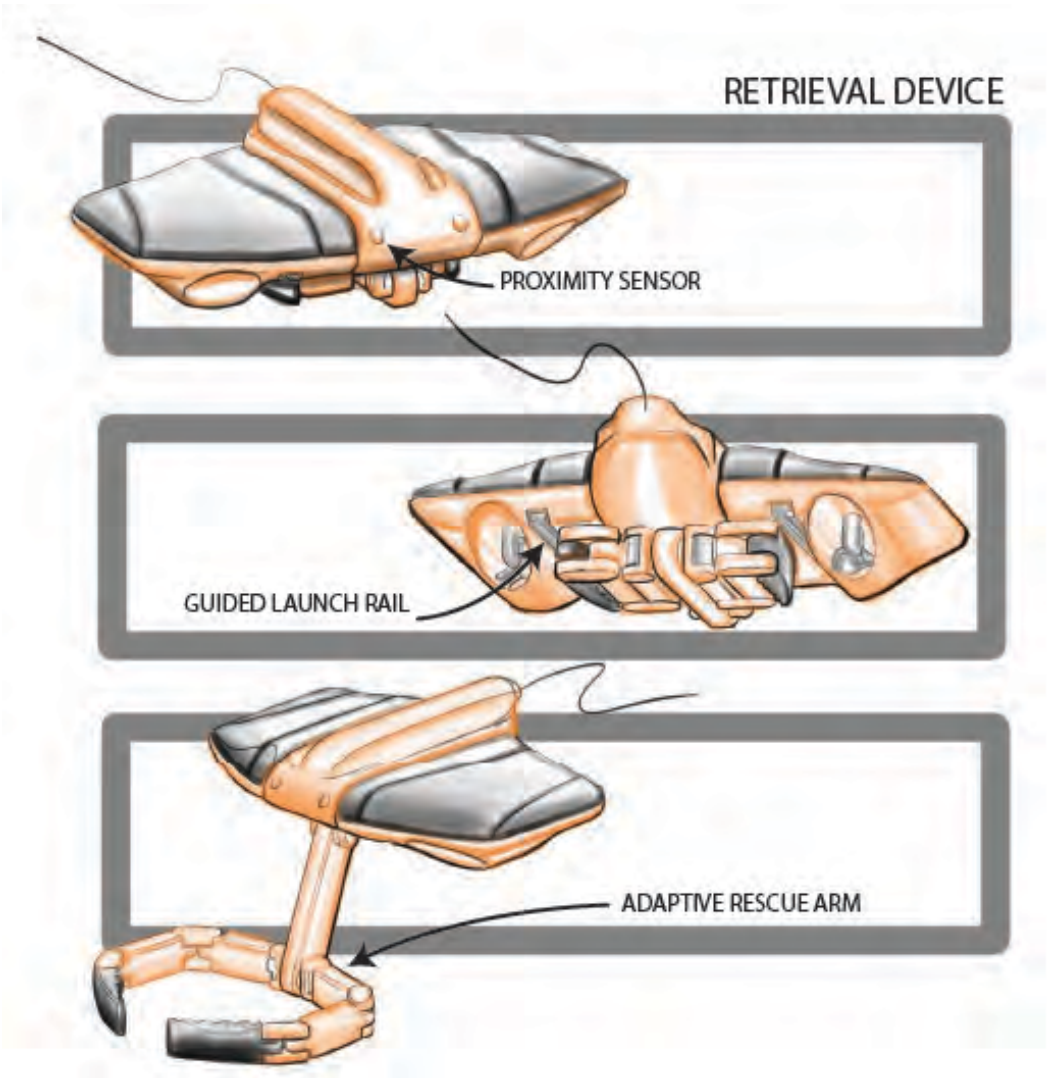


Figure 4.15 Retrieval Device Final Sketch

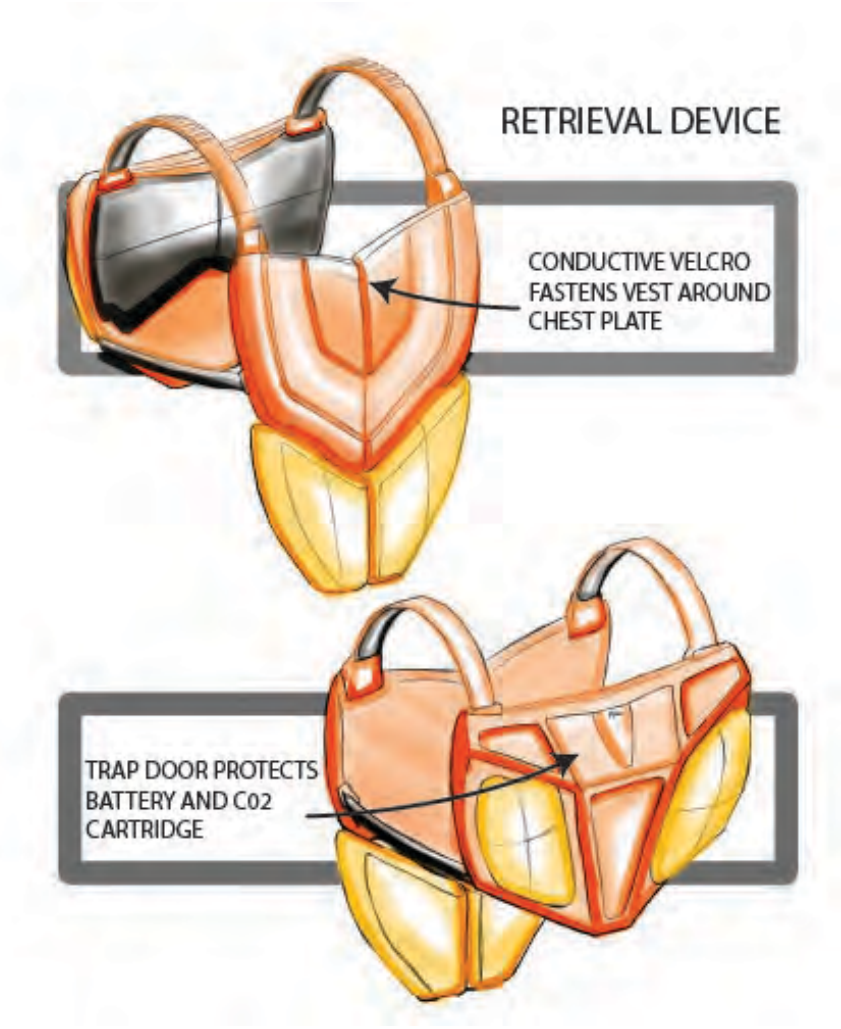


Figure 4.16 Vest Final Sketch

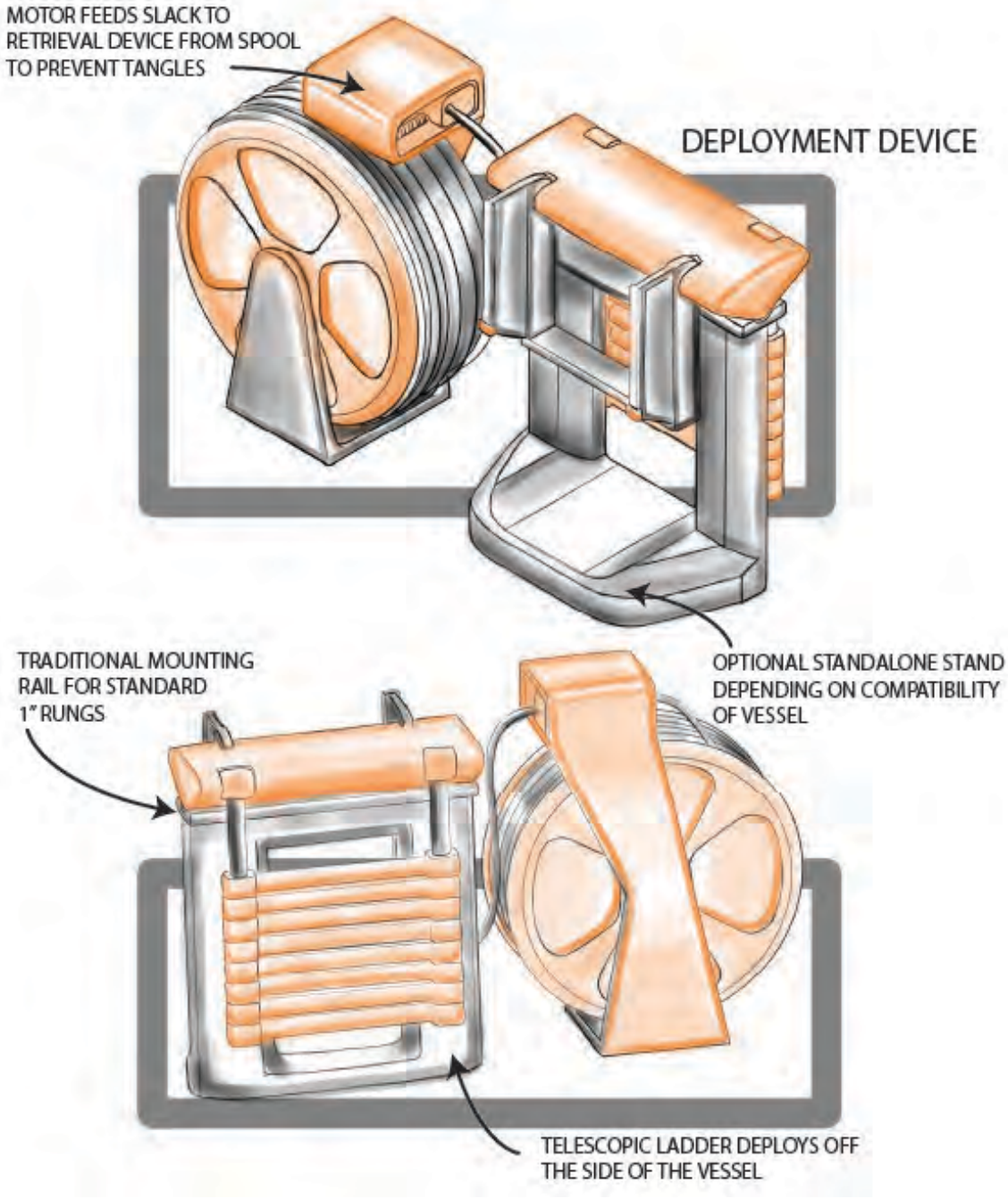


Figure 4.17 Deployment System Final Sketch

4.7 CAD Models

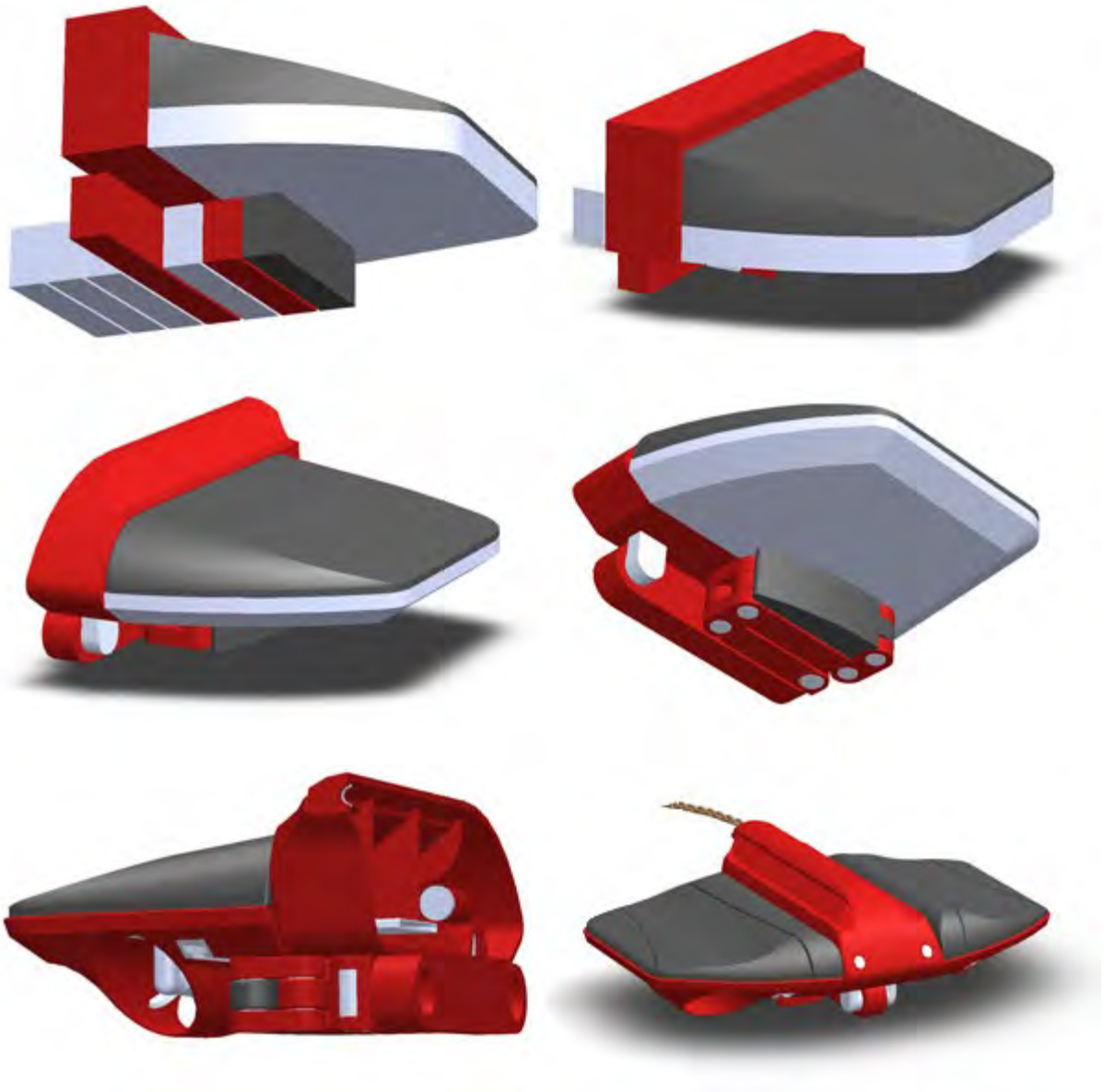


Figure 4.18 Retrieval Device CAD Model

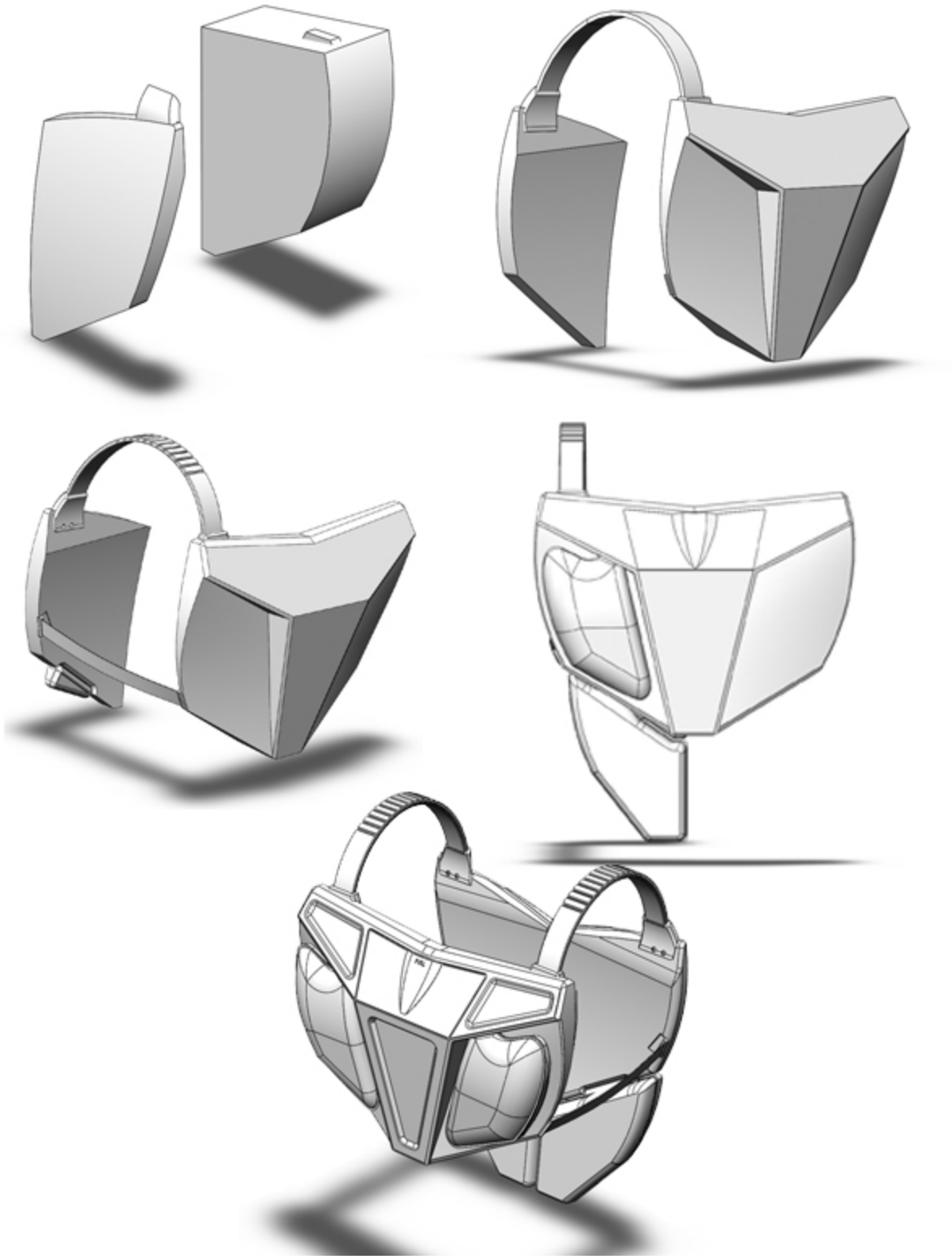


Figure 4.19 Vest CAD Model

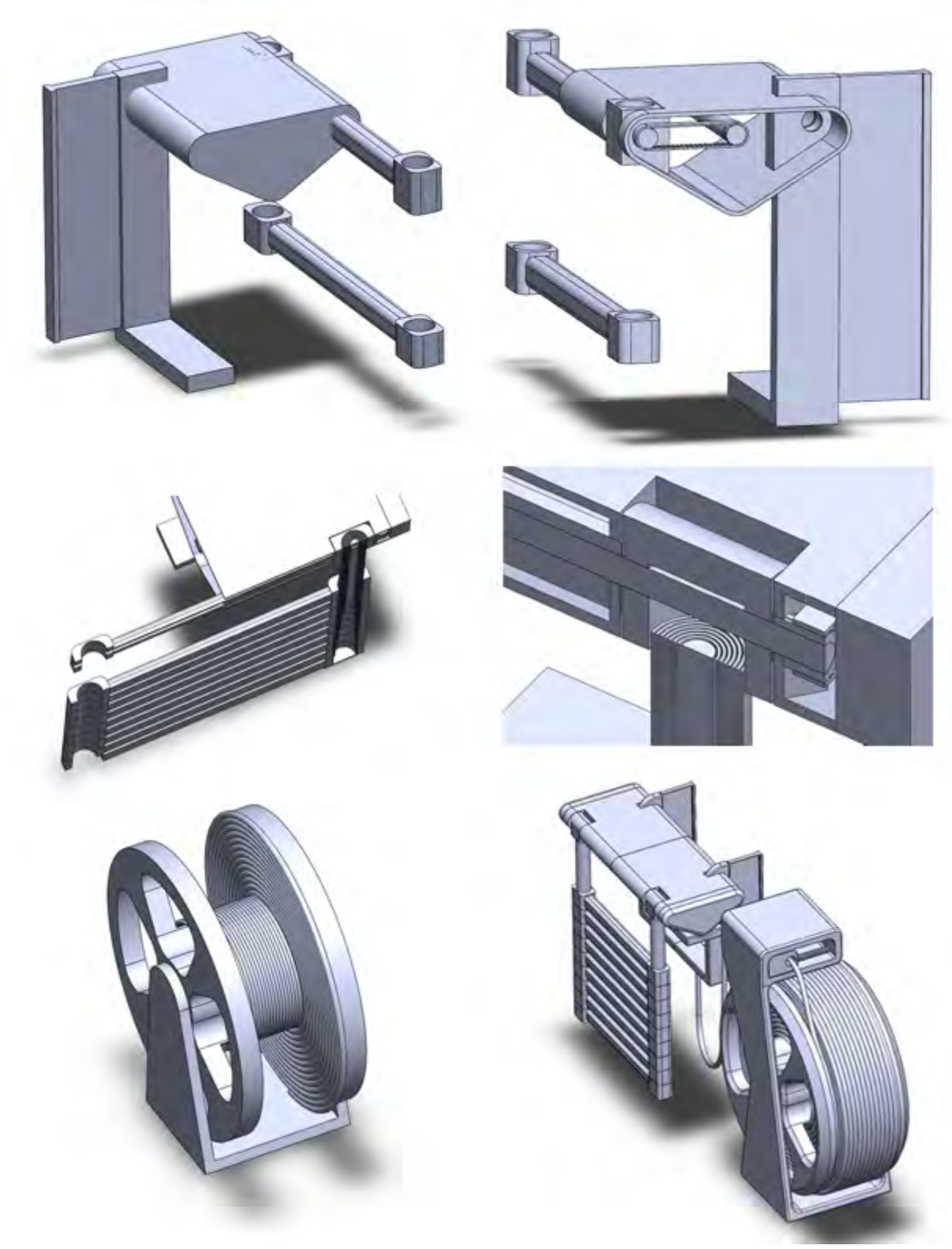


Figure 4.20 Deployment Device CAD Model

4.8 Hard Model Fabrication History

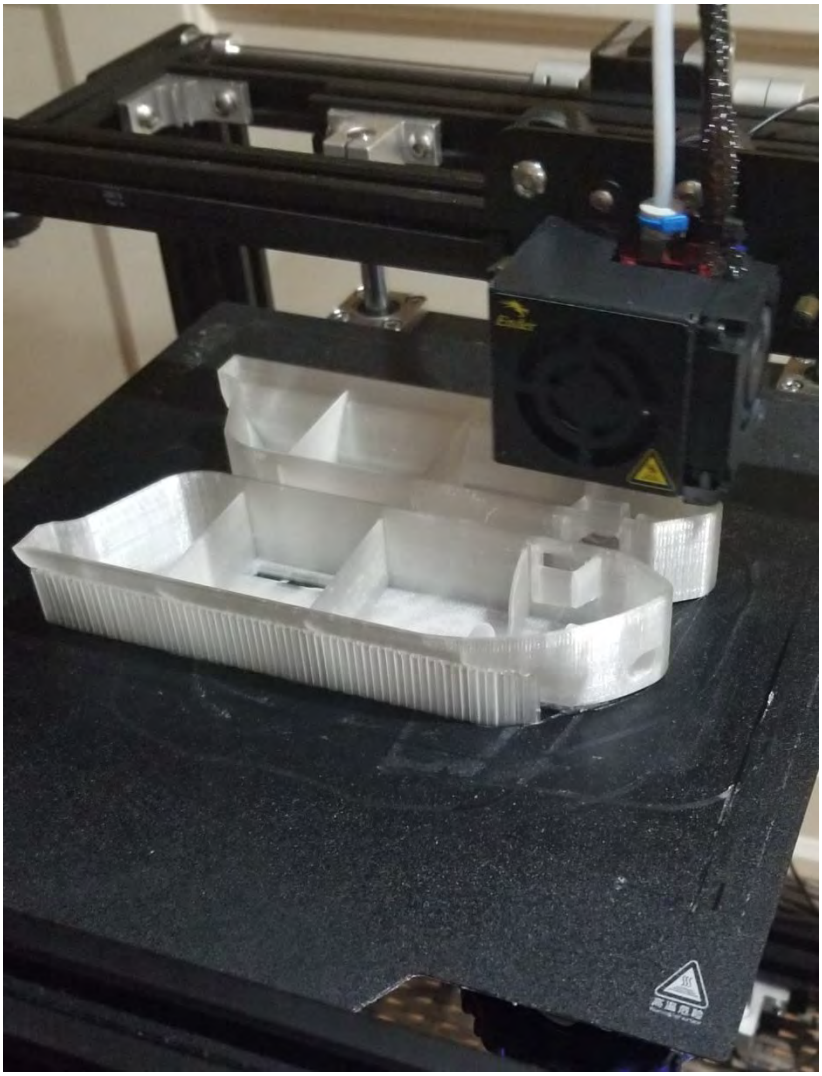


Figure 4.21 All parts were built on an Ender-5 FDM 3D printer

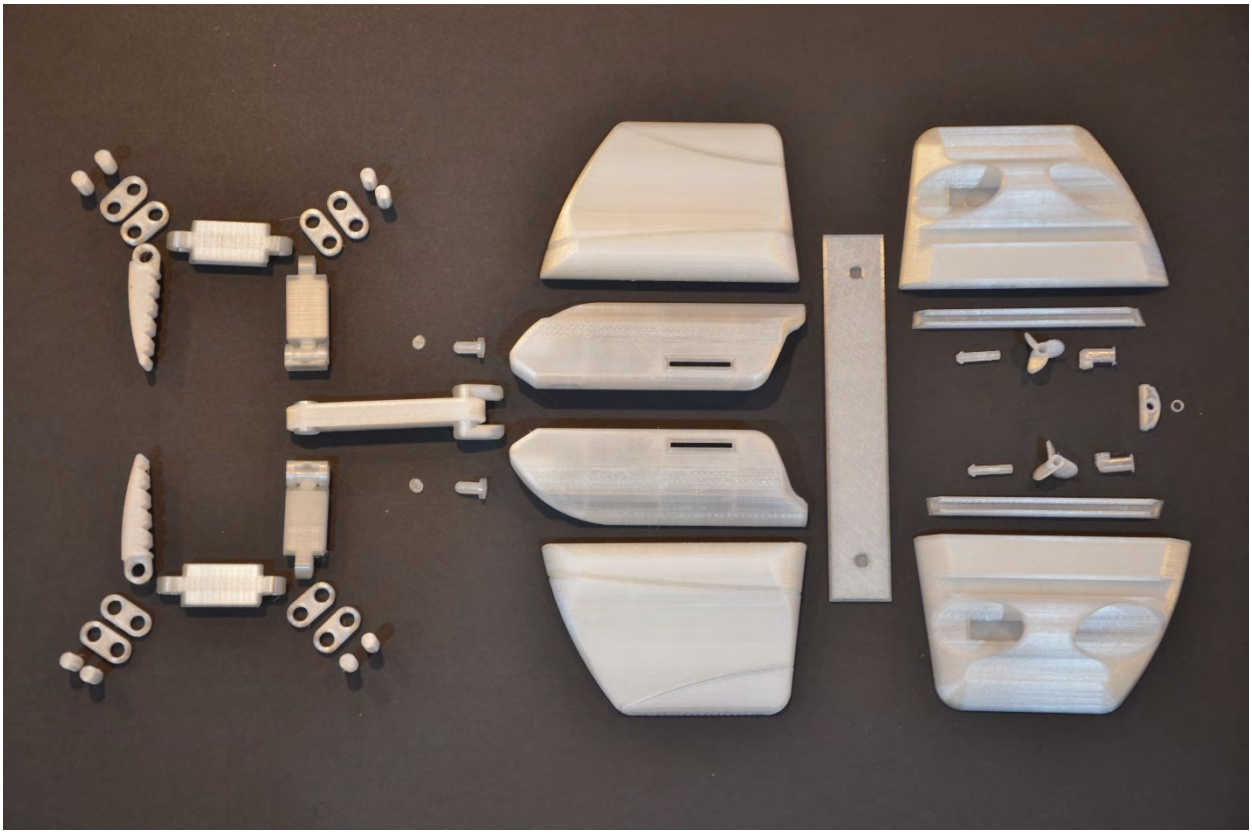


Figure 4.22Parts were organized, then sanded down with 220 grit

Figure 4.23 Parts were then epoxied together and patched with bondo, then sanded down again to 400 grit

Figure 4.24 after a few coats of filler primer the parts were sanded again to create a smooth surface for the top coat of paint

Figure 4.25 The final coat was painted outdoors, unfortunately exposed to debris and insects

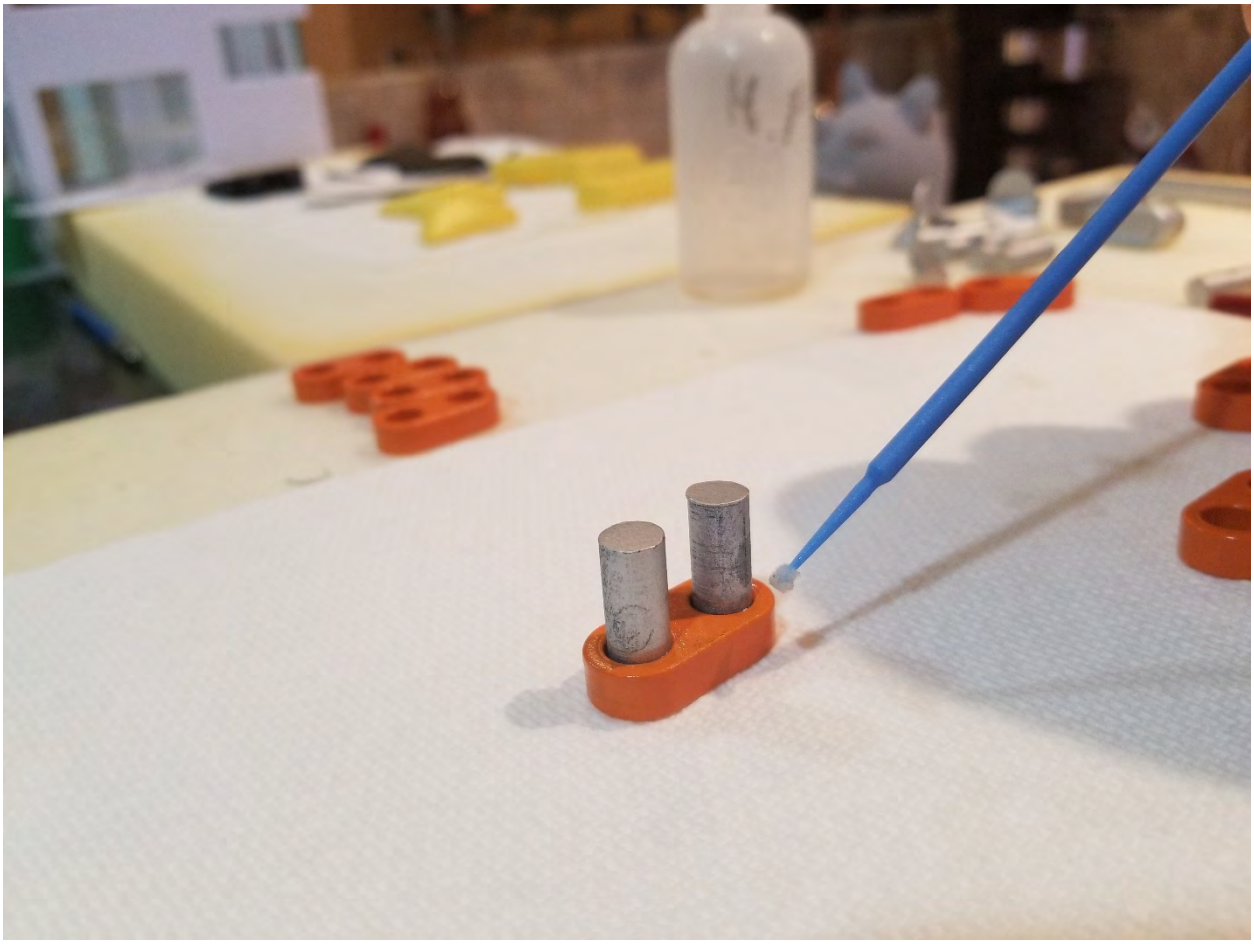


Figure 4.26 Parts were then assembled and gorilla glued together

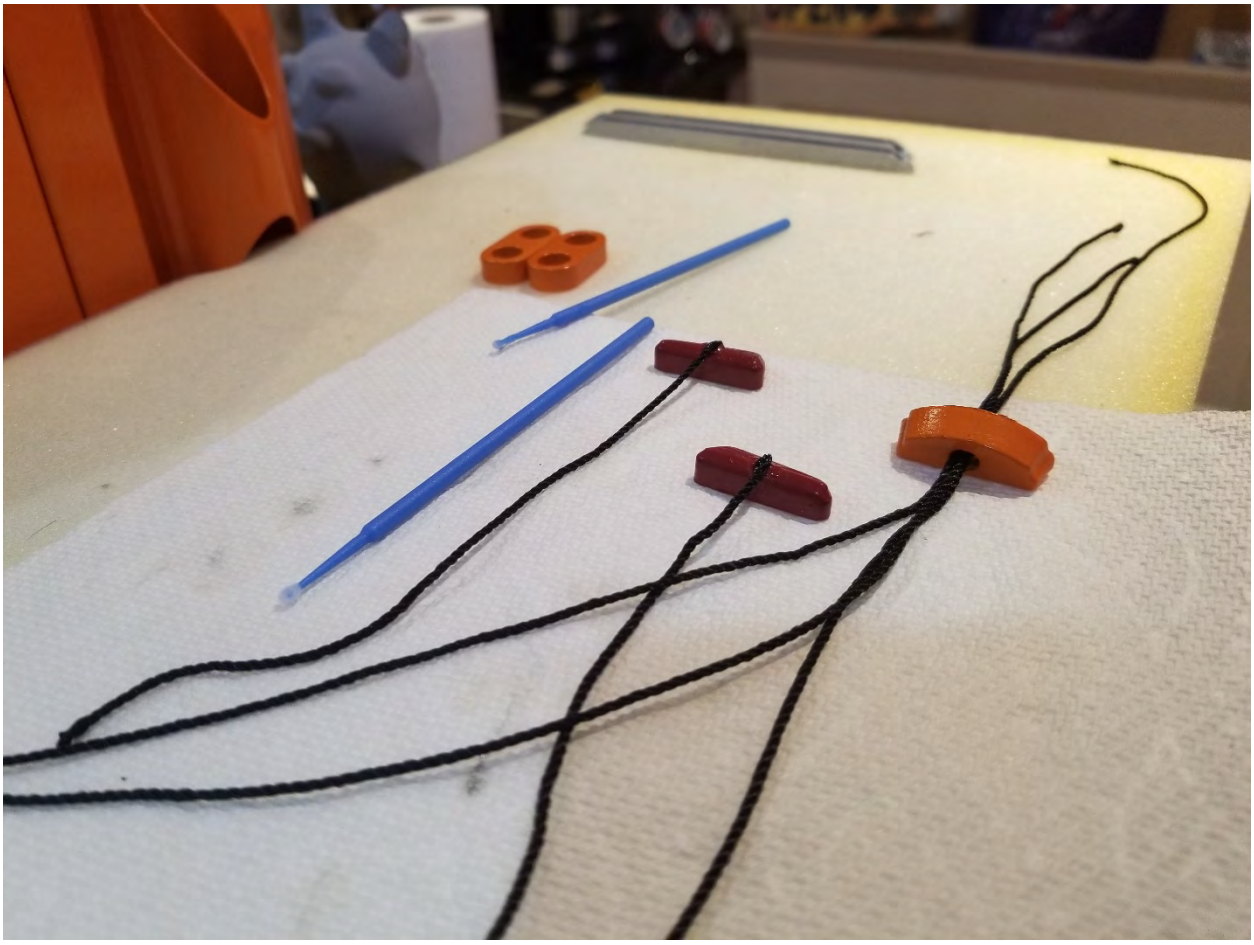


Figure 4.27Detail shot of nylon rope

Figure 4.28 Applying the finishing details to the retrieval device

5 Final Design

This chapter will be a culmination of previous chapters and display the final product of this design proposal. Design features, ergonomics and sustainability alongside final photorealistic renders, CAD and photographs of the final prototype model.

5.1 Summary

RAY is a revolutionary solution to open water rescue systems. The current design incorporates a personal flotation device that is lightweight and allows the user a full range of motion to complete tasks on a commercial fishing vessel. In the case of an overboard emergency victims who go overboard will be rescued by an autonomous retrieval device that will return the user safely to the vessel.

5.2 Design Criteria Met

The following segment includes elements of the open water rescue system concept and how it satisfies the design criteria.

5.2.1 Ergonomics

RAY's ergonomic interaction has been modeled out with a 1:1 scale ergonomic buck and the positioning of the emergency retrieval arm and the proportion of the vest have been scaled to fit the 95^{th} percentile male and 5^{th} percentile female comfortably. The arm is automatically adjustable to the users size. The vest will need to be purchased in a comfortable size to fit perfectly. The vest also has adjustable clips that will allow the user to adjust the straps to fit comfortably. The design criteria requires 3 major body parts to be interacting with the product, the design proposal fully incorporates full bodies ergonomics from the neck all the way to the legs.

Vest

The vest uses most ergonomic considerations since the product is a wearable and the user needs to fit comfortably in the vest to perform important tasks. Arm articulation in the vest, waste height and shoulder height with the width of a user including additional padding for heavy clothes. The adjustable straps allow for a more flexible and snug fit that the user could apply personally throughout the day as the weather changes rapidly in open water.

Retrieval device

Built off the measurements of the users arm span, height from waste up and width to accommodate a proper fit for the rescue arm. The retrieval device uses all these measurements to complete a universally comfortable fit for the 95th male and 5th female percentile.

Deployment system

The telescopic ladder measurements came straight from the measure of man and woman by henry Dreyfuss allowing for the most comfortable ladder design. The height of the device is meant to be mounted on the side of a commercial fishing vessel with universal mounts and a stand-alone piece that can mount into the floor board of the vessel to provide the user with adequate height when climbing out of the water.

5.2.2 Materials, Process & Technologies

Vest

The vest incorporates hybrid inflation technology and a local sonar system that pings back and forth with the deployment system on the vessel. When the user pulls on the rip cord located bellow the front plate the CO2 cartridge will release gas into the four air packets two on the rear of the vest and two in the front of the vest. The vest is made of high tenacity nylon with

organic kapok material and then filled with polyethene foam for flotation purposes. The rest of the vest is created with polypropylene to make it lightweight and durable. The vest also includes conductive Velcro technology that activates the locating beacon in the vest when the user equips the vest.

Retrieval Device

The retrieval device communicates to the deployment system and the vest to locate the user once they are in the water, using twin propulsion aluminum rotors the device is able to speed through the water at a faster rate than having the delay of a secondary user noticing the user has gone overboard and scrambling to equip a ring buoy and throw it to the victim. When the retrieval device locates and get near the victim it then transforms the rescue arm located on the bottom of the unit to unfold and rest in a catching position to grab onto the user. The retrieval device will then grab onto the user when the proximity sensors have sensed the users presence. The device is made from polypropylene and aluminum and the foam pads on the top are polyester fabric with EVA foam inserts.

Deployment System

When the user becomes out of range with the vessel the deployment system extends the telescopic ladder and launches the retrieval device with a mag rail that uses magnets to accelerate the retrieval device off of the design and into the water. Once the retrieval device has secured the user the deployment system quickly and effortlessly tows the couple back to the vessel. The universal mount located on the bottom of the device are designed to locate the device onto a number of different rail designs that could support the weight, if the rails are not suitable then the device has a standalone fixture that will allow it to be mounted onto the deck

of the vessel with a gasket insert to keep water out. The tether is made from a high durability nylon that keeps the retrieval device securely attached to the vessel.

5.2.3 Manufacturing Cost Report

In this section manufacturing costs were calculated through the aid of Solidworks2019 and the manufacturing cost of modern-day product examples. At the end the cost breakdown will reveal the total cost to produce one family of products.

Vest

QTY	Part	Estimated cost per unit	Item on market today	Produced cost of market item
A COST				
1	33g CO2 Cartridge	$3.00	Alibaba c02 cartridge 33g	$3.50
2	Nylon vest plate	$5.00	Nylon padded work vest	$5.50
1	Polypropylene housing	$3.00	Sprayer pump backpack	$3.00
4	Inflatable tubing	$2.00	Water sport inflatable tube	$2.25
B COST				
2	Polypropylene webbing	$1.00	Polypropylene belt	$0.75
6	Tubing	$0.20	PP Tubing per meter	$0.10
2	Pull Tabs	$0.50	Key fob housing	$0.50
2	Rip Cord	$0.05	Nylon cord per meter	$0.05
Total		$14.75		$15.65

Table 5.1 Vest Cost Analysis

Retrieval Device

QTY	Part	Estimated cost per unit	Item on market today	Produced cost of market item
A COST				
1	Electronics	$25.00	Raspberry Pi	$25.00

4	Polypropylene Housing	$20.00	Polypropylene board per square meter	$4.63
2	EVA Foam	$10.00	EVA Neoprene closed cell foam sheet square meter	$14.50
2	Propulsion Motor	$10.00	23mm Propulsion motor	$5.00
B COST				
2	Polyester	$2.00	Breathable polyester per square meter	$3.14
1	Aluminum Support	$0.50	0.8mm Aluminum Sheet per square meter	$0.50
2	Aluminum Props	$5.00	Aluminum cast propellers small boat	$2.50
Total		$72.50		$55.27

Table 5.2 Vest Cost Analysis

Deployment System

QTY	Part	Estimated cost per unit	Item on market today	Produced cost of market item
A COST				
1	Telescopic Ladder	$25.00	Telescopic aluminum ladder	$29.00
2	Torque motor	$25.00	High Torque High speed DC Motor	$23.50
6	Polypropylene housing	$30	Polypropylene board per square meter	4.63
1	Nylon tether rope (100M)	$21	Braided rope nylon	$0.21/M
1	Magnetic rail system	$50	Spring loaded launcher	$25.00
B COST				
1	Universal mount	$3.00	Mounting Brackets	$1.00
2	standalone stand	$10.00	Polypropylene board per square meter	$4.63
Total		$164.00		$108.97

Table 5.3 Deployment System Cost Analysis

5.3 Final CAD Renderings

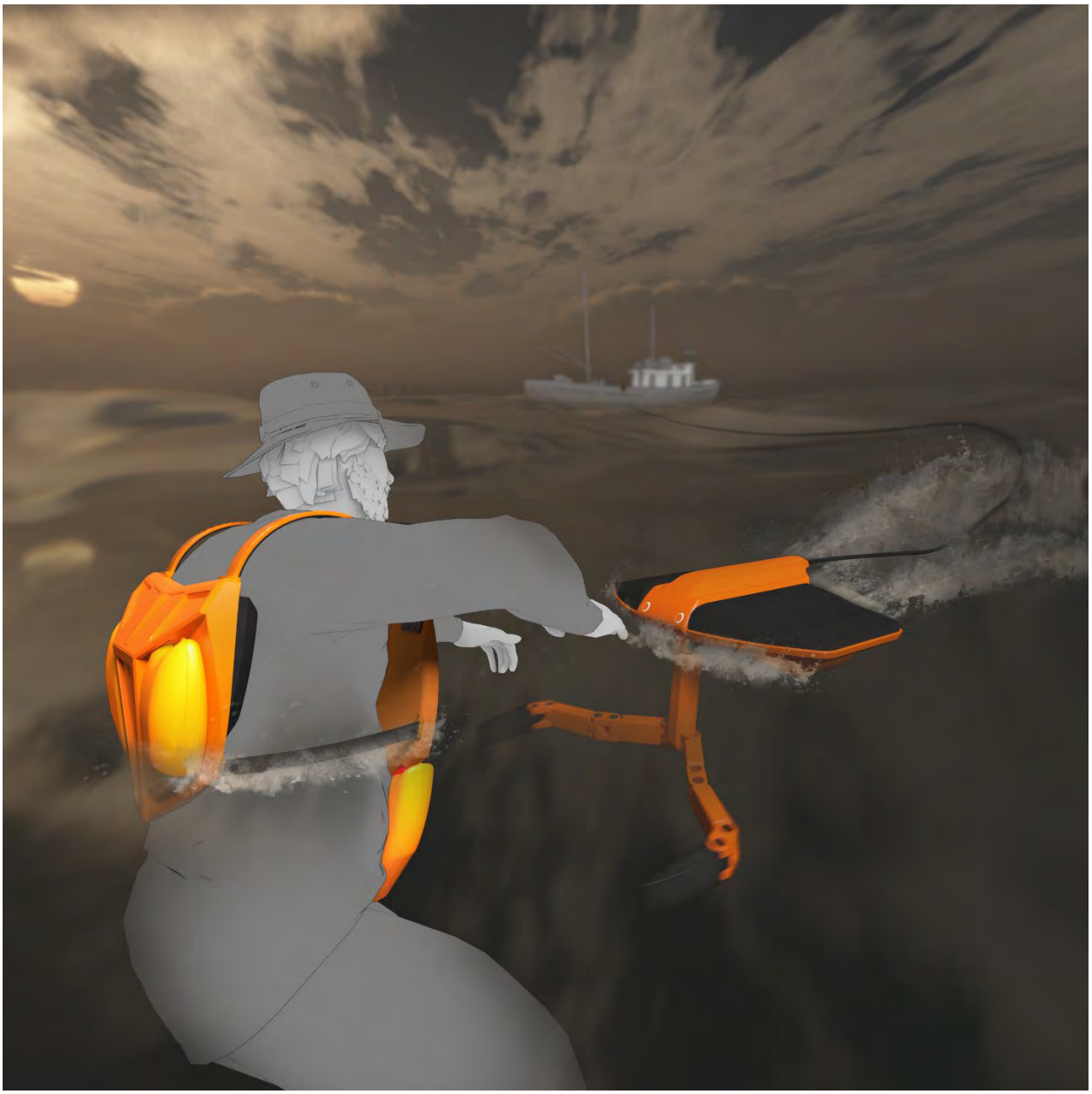


Figure 5.1 Hero Shot

Figure 5.3 Retrieval Device Overview

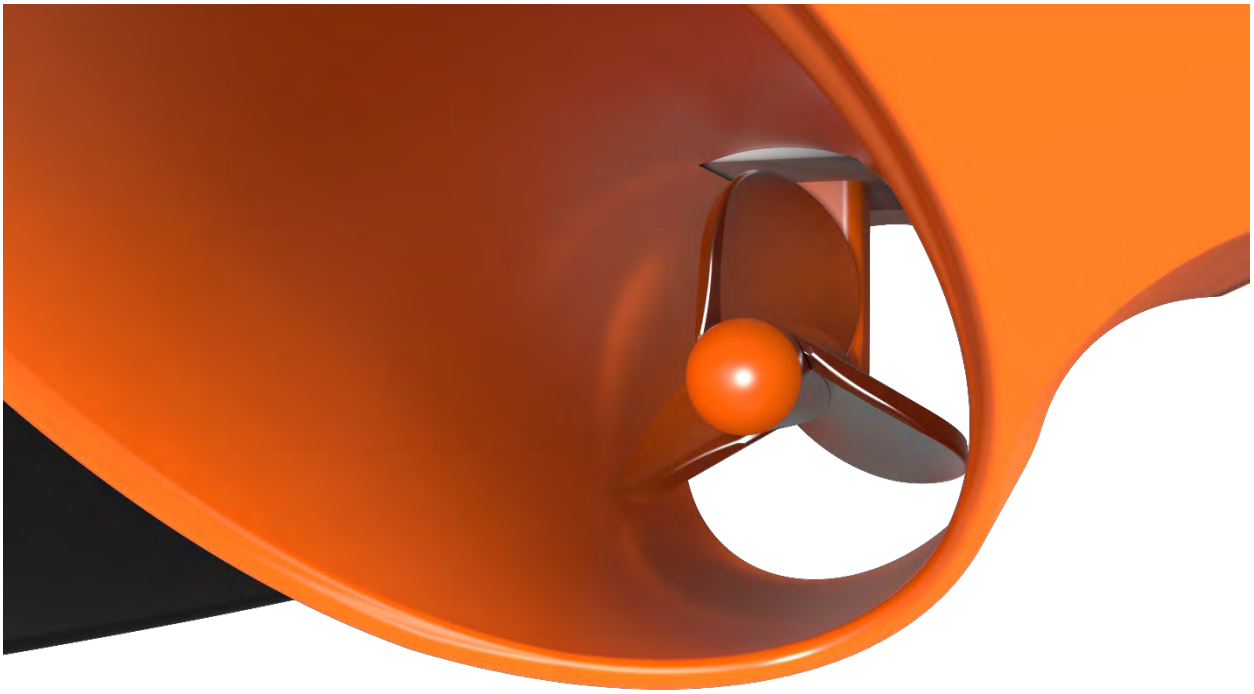


Figure 5.2Retrieval Device Aluminum Prop Detail

Figure 5.5Retrieval Device Launch from Vessel

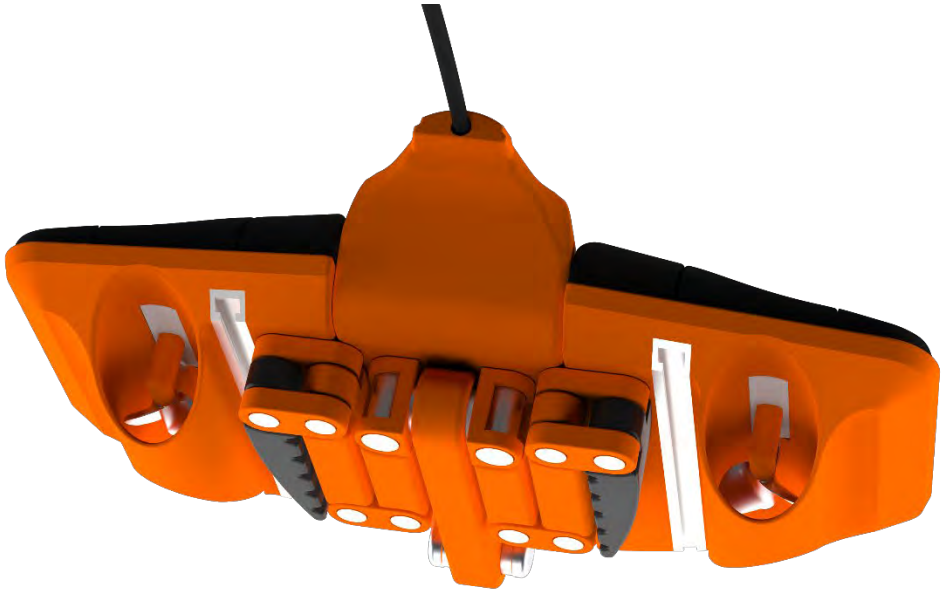


Figure 5.4 Retrieval Device Underside

Figure 5.6 Device Traveling to User

Figure 5.7User Mounts Retrieval Device

Figure 5.8 Deployment System Overhead

Figure 5.11Vest Equipped and Activated

Figure 5.10 Rear Left Air Packet

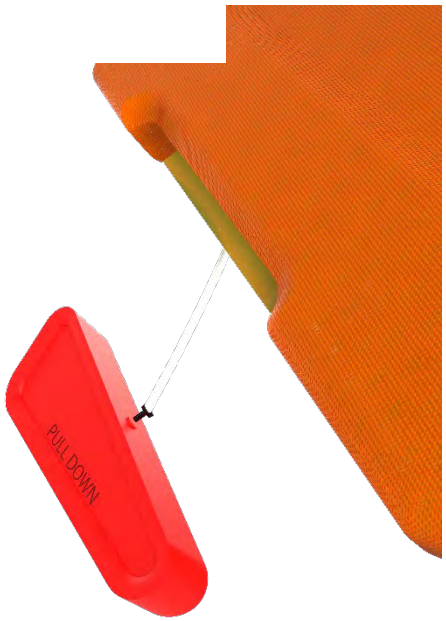


Figure 5.9 Rip Cord

5.4 Hard Model Photographs

Figure 5.12 Model Hero Shot

Figure 5.13 Model Hero Closeup

Figure 5.14 Vest Rear View

Figure 5.15 Vest Front View

Figure 5.16 Retrieval Device Posable Arm

Figure 5.17 Retrieval Device Detail

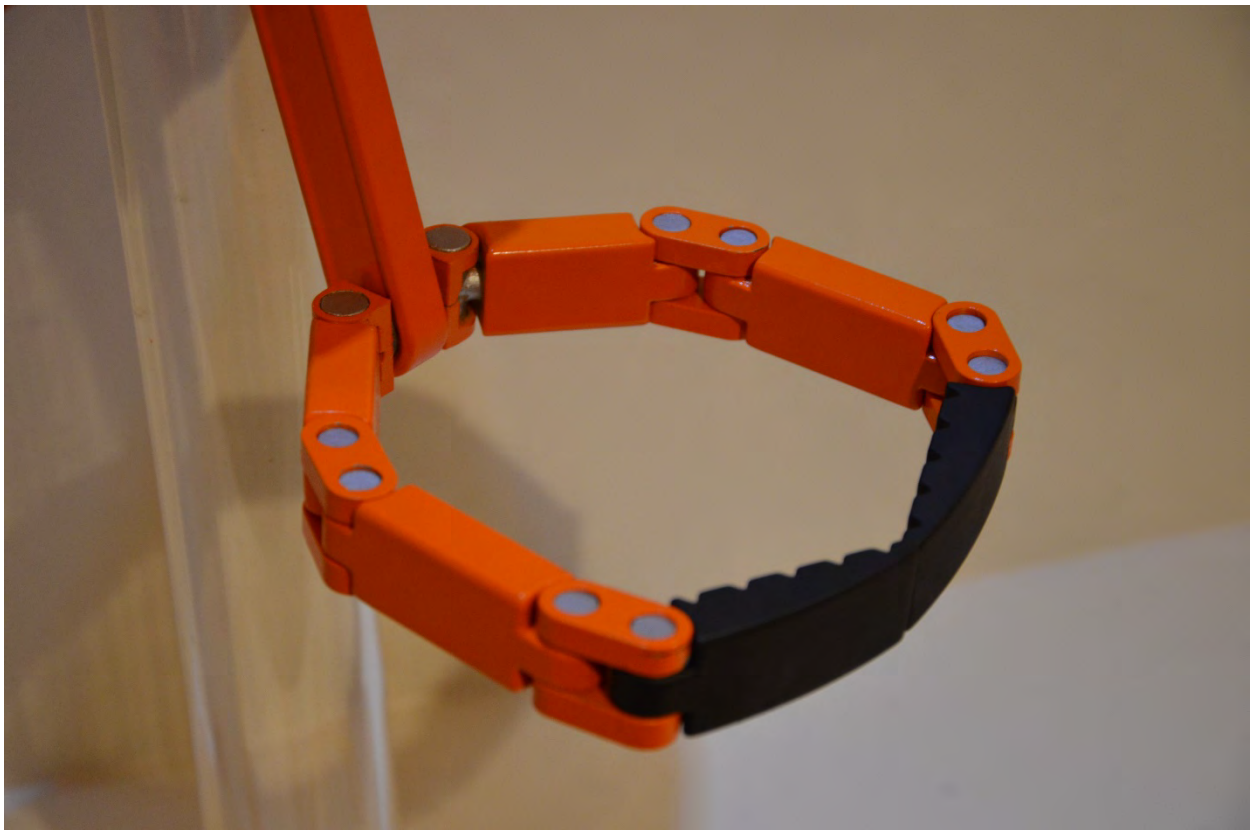


Figure 5.18 Retrieval Device Arm Closeup

5.5 Technical Drawings

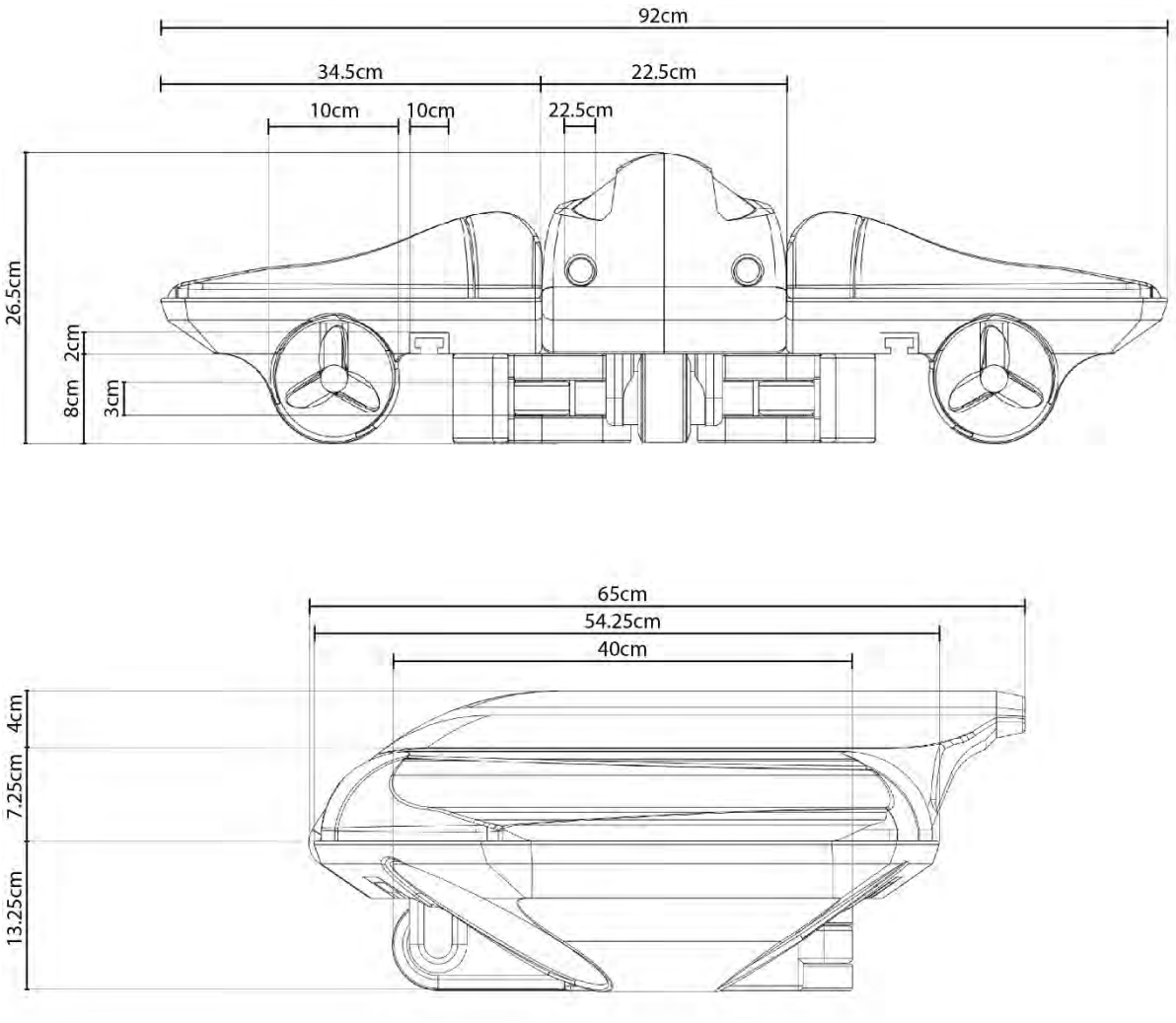


Figure 5.19 Retrieval Device Technical Drawing

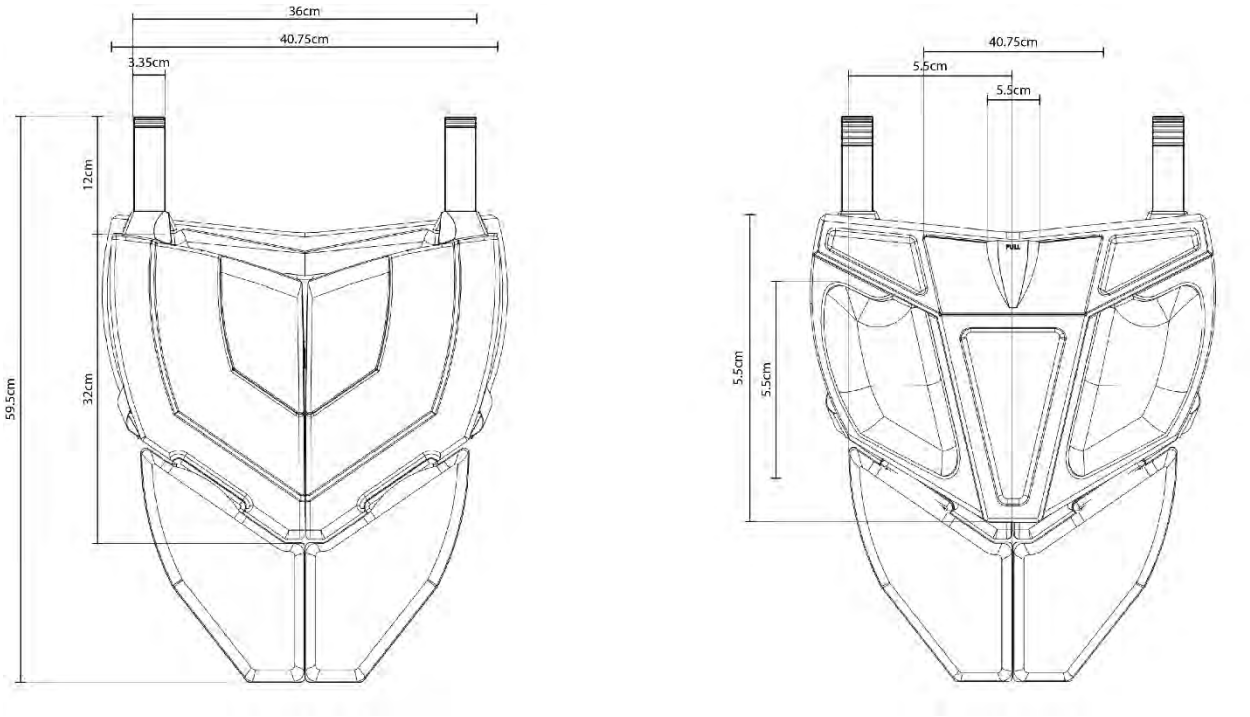


Figure 5.21 Vest Technical Drawing

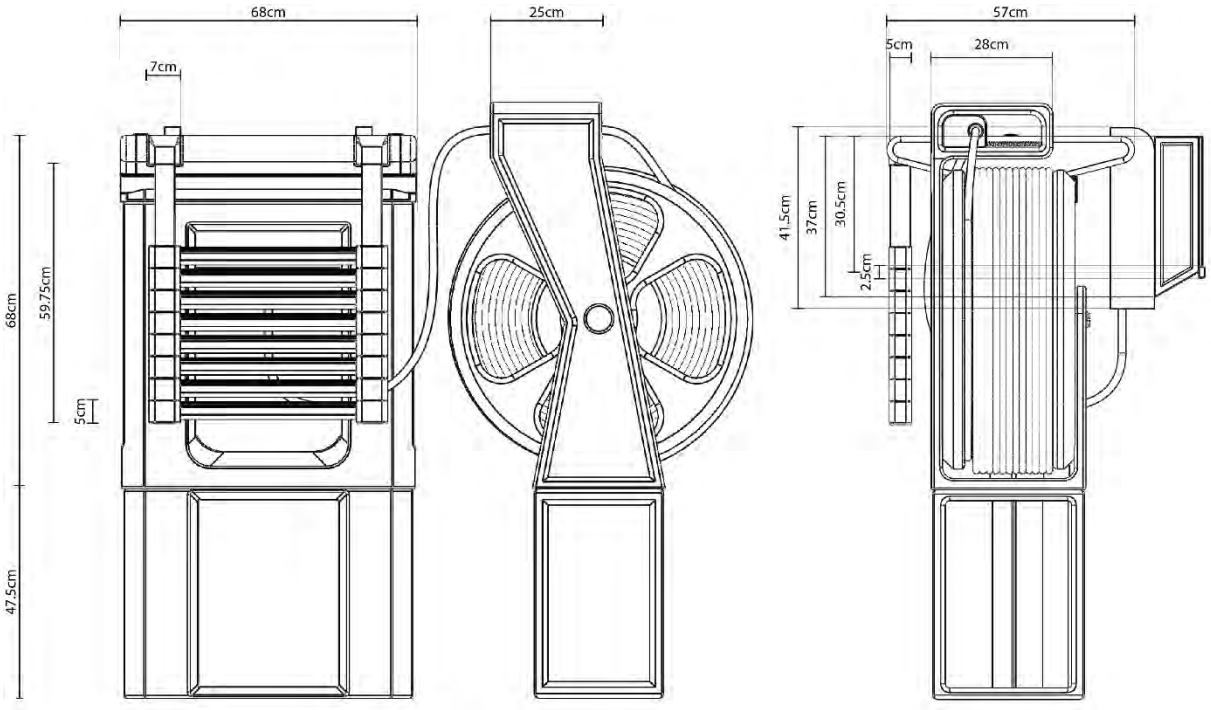


Figure 5.20 Deployment System Technical Drawing

5.6 Sustainability

Reflective and water-resistant material is a necessity. The reflective material helps to identify the user in distress. The outer shell of a life-jacket is made of nylon or vinyl. The most commonly used material for PFD's in the modern day consists of plastic foams (polyvinyl chloride or polyethylene). There are three types of buoyancy substances used for PFDs. Inherently buoyant, inflatable and hybrid. Some models release CO2 into the jacket automatically when submerged in water and some when manually pulled by rip-cord.(Edmonds, 2019) Automatic submergence trigger is not ideal for inclement weather, heavy rain and hard waves will inflate PFD prematurely.

Life Cycle Assessment

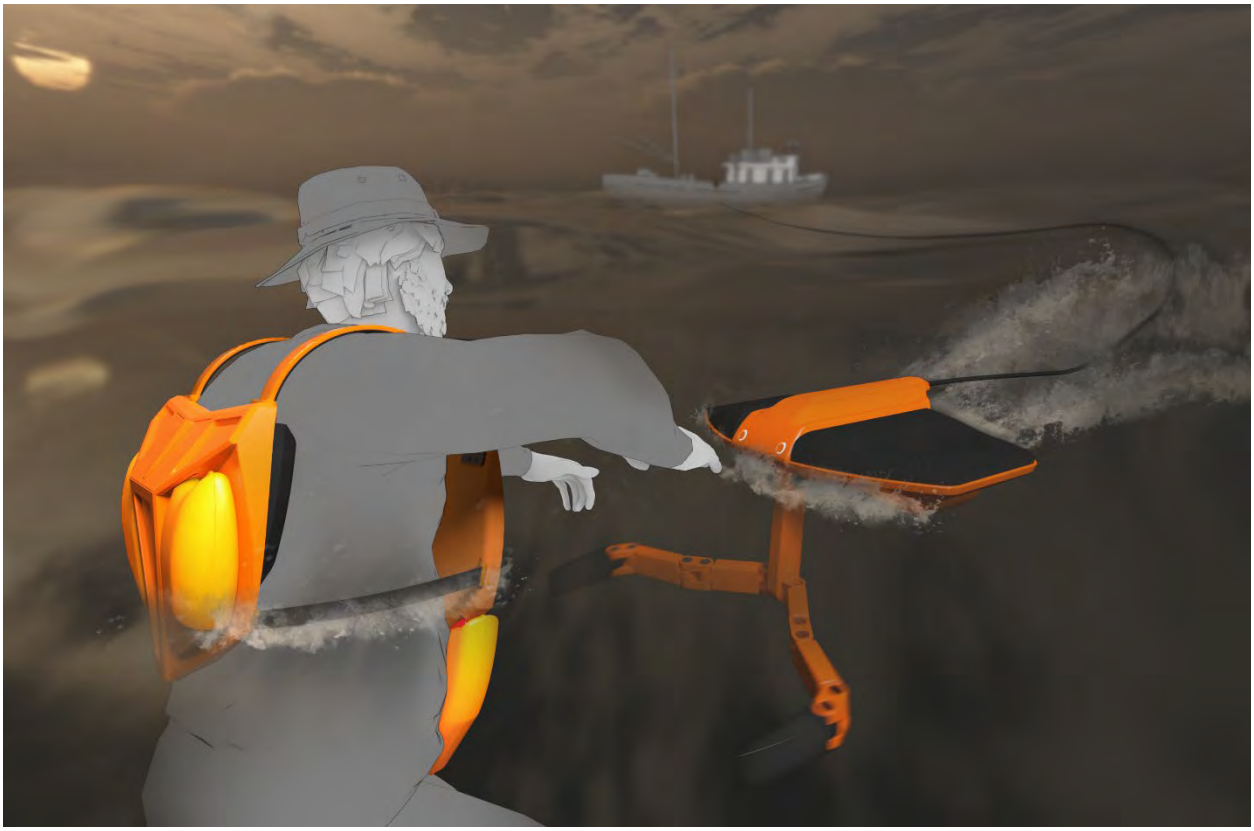
Through some online research, a publication was uncovered about the current life cycle assessment of modern material applications for marine environments. This publication states that "the marine industry has been investigating the use of thermoplastic matrix composites (TMC's) There has been an interest in the use of cheaper and lower performance polypropylene thermoplastics and glass reinforcements as a recyclable and durable structural material." (Shenoi,2011)

The system would achieve a sustainable title through the use of healthier material alternatives. The marine industry is under a shift currently of shifting from fiberglass to a carbon fiber structure. Completely eliminating environmentally harming materials like PVC that is commonly used in marine products. Incorporating flotation devices that use polypropylene instead of PVC. The design also incorporates a system that will allow the user to replace different parts of the entire system that will become obsolete or un-usable through regular

wear and tear. The aluminum and stainless steel used for the product is 100% recycled. The proposed design is estimated to last longer from the modularity feature within the family of products. Modern day life jacket and vests, depending on their buoyancy type expire after 5-10 years.

6 Conclusion

The vast majority of over-boarding and fatalities occur on small fishing vessels. On Canada's west coast the vast majority of our fishing fleet is made up of 2,800 small vessels. The same is true on the east coast. (Ryan Ford - Fish Safe) RAY aims to change the way we conduct open water rescue operations by replacing the ring buoy with an automated retrieval system that senses when a user has gone overboard. The main components of RAY are fully recyclable. Aluminum and polypropylene make up the majority of material used while the cushioning on the retrieval device, straps and webbing for the vest are made from polyester derived from recycled PET products.



7 References

Blackstone, K. (2019). *New regulations require commercial fishers to wear lifejackets on deck*. 1–4. Retrieved from https://hashilthsa.com/news/2019-07-03/new-regulations-require-commercial-fishers-wear-lifejackets-deck

Case, S. L., Lincoln, J. M., & Lucas, D. L. (2018). Fatal falls overboard in commercial fishing — United States, 2000-2016. *Morbidity and Mortality Weekly Report*, *67*(16), 465–469. https://doi.org/10.15585/mmwr.mm6716a2

Case, S., Lincon, J., & Lucas, D. (2011). Morbidity and mortality weekly report (mmwr). https://doi.org/10.1016/j.wem.2010.11.007

Edmonds, M. (2019). Inside a Life Jacket | HowStuffWorks. Retrieved February 11, 2019, from https://adventure.howstuffworks.com/outdoor-activities/water-sports/life-jacket2.htm

Fisheries. (2016, October 6). Survey Results. Retrieved from http://www.dfo-mpo.gc.ca/stats/rec/can/2010/section4-eng.htm

Glamour. (2017, December 7). The Small But Incredibly Strong Pocket Of Amazing Women Fisherman In Alaska. Retrieved from https://www.huffpost.com/entry/women-fishermen-in-alaska _b_8123800

Goodwin, D. (2019). Do Life Jackets Expire? Retrieved February 11, 2019, from https://aquamobileswim.com/life-jackets-safety-tips/#.Xb4LAOhKiUl

Keledjian, A., Brogan, G., Lowell, B., Warrenchuk, J., Enticknap, B., Shester, G., … Cano-stocco, D. (2014). Wasted Catch : Unsolved Problems in U.S. Fisheries. *Oceana*, 44. Retrieved from http://oceana.org/sites/default/files/reports/Bycatch_Report_FINAL.pdf

Mobiles, A. (2019). The 5 PFD Classifications. Retrieved February 11, 2019, from https://aquamobileswim.com/life-jackets-safety-tips/#.Xb4J8uhKiUl

Figures title:

Figure 1.1 commercial fishing vessel sits aground near Cape Blanco, Ore. From “Coast Guard Compass” by U.S Coast Guard, 2015 https://coastguard.dodlive.mil/files/2015/07/2080204.jpg

Image 1.2 Small sized commercial fishing boat specialized for shellfish from “New Jersey Scuba Diving” by Rich Galiano, 2006 https://njscuba.net/artifacts/ship_fishing.php

Image 2.1 User Persona retrieved from https://www.shoppcap.com/product_detail.php?c=bearded%20man%20wearing%20a%20hat%20beard%20pictures%20pictures%20of%20beards&p=9

Image 2.2 Variety of fishing nets from “Global Fishing Watch” by S. Carla, 2019 https://globalfishingwatch.org/fisheries/iuu-illegal-unreported-unregulated-fishing/

Image 2.3 Rescue drill part 1 from “Wikimedia commons” by Michael Anderson, 2013 https://commons.wikimedia.org/wiki/File:Man_overboard_drill_DVIDS1091896.jpg

Image 2.4 Rescue drill part 2 from “flickr” by Weston Jones, 2017 https://www.flickr.com/photos/cne-cna-c6f/33445981076/

Image 2.5 Reeling in trawl from “YouTube” by Vilhjálmur Hallgrímsson, 2017 https://www.youtube.com/watch?v=EuW_Xy_f6CA&list=PLYc9IqooYcYgLA3ZokLd65HbT0DAQZiAS&index=32

Image 2.6 Handling lobster traps from “Pixabay” by mroylbca, 2017 https://pixabay.com/no/photos/hummer-feller-hummer-fiske-b%C3%A5t-2759178/

Image 2.7: Pulley device lifts user from the water comfortably from “sail-world” by Sea Rsscue Sled, 2018 https://www.sail-world.com/news/202055/New-man-overboard-rescue-device-launched

Image 2.7 Ergonomic scale for PFD's 97.5% male vs 2.5% female

Image 2.8 Smaller 1-manned fishing boats on "Pxhere" by Enzol, 2019

https://pixabay.com/no/photos/fiske-fart%C3%B8y-havn-kommersielle-539592/

Image 2.6 An automatic inflatable life jacket from "eslr.me" by Alice May, 2019

https://eslr.me/

Image 2.7 An inherent foam vest from "MEC.ca" by Mustang Survival

https://www.mec.ca/en/product/6000-996/Rev-Young-Adult-Foam-Vest

Image 2.8 Variety of Personal Flotation Devices taken from "flickr" by Andy Blackledge, 2017

https://www.flickr.com/photos/hockeyholic/35774311604

Image 3.2 Life jacket Graveyard from "stateofformation.org" by Jenn Lindsay, 2017

https://www.stateofformation.org/2017/05/dispatch-from-the-lifejacket-graveyard-near-eftalou-beach-in-lesvos-greece/

Image 3.3 Aesthetic comparison Aesthetic comparison

Airhead Keyhole from https://www.amazon.com/AIRHEAD-Type-Youth-Keyhole-Orange/dp/B005ESLNUE

Mustang SAR from https://www.inlandliferafts.com/mustang-mv5601-sar-vest.html

Mustang Integrity https://www.sail.ca/mustang-integrity

8 Appendices

Appendix I Discovery

	Benefit	*Possible Corresponding Fundamental Human Needs (FHN)*	*Relationship between Benefits and FHN*
1	Comfort	Control, security, self-esteem (mastery)	strong
2	Style	Esteem, belonging, aesthetically pleasing	moderate
3	Efficiency	Accomplishment, autonomy, self-esteem	strong
4	Ease	Accomplishment, autonomy, protection, security, control, self-esteem (mastery)	strong
5	Fun	Leisure (excitement), Participation, Belonging (shared fun)	weak

Comfort (Basic Needs) in this context is increasing the sensory experience for the deckhand being protected, the fit of the product when working on the deck, the ability to have full motor motion of the arms and shoulders is important

Comfort also includes the harshness of the product in water (material rashes, and pinching pieces on the skin would cause discomfort when in water, increasing the possibility of injury (risk), both of which decrease one's sense of protection)

Security (Value) is the major fundamental human need met. The product needs to keep the product on top of the water, safe & sound.

Style is moderately important for this product. The style of reflective tape could look attractive while giving off the position of the user when in use.

Efficiency is defined as the effort required to perform at a particular level. This is related to control the user has during the situation. The user needs to be able to control themselves in the water. Most life jackets keep the users head above the water, with the user in an upright position to prevent unconscious victims from drowning.

Ease is in many ways related to efficiency in terms of fundamental human needs. The user needs to be able to equip the product appropriately and efficiently. If the product has a rip-cord activator then the user should be able to rip the cord easily.

Fun (Pleasure) related to leisure This product is strictly used for keeping individuals safe when in the water, fun is not a priority for this product. In a way the product allows the user to travel without the fear of drowning.

Needs Statement

Safety among commercial fishing vessels rely on the knowledge of the crew and the necessary equipment onboard to handle situations. The needs for a life jacket are based on the legal situation and sense of security that the user has when out on a water vessel. The user's safety and security are prioritized in the design of a life vest. The usability needs to meet the requirements of a "man-overboard" incident. Users need to be able to easily equip the life vest when on a boat. In the event where a user falls overboard, the life vest needs to efficiently keep the users head above the water, and in an upright position. The application of reflective tape on a life vest could be applied to look stylish while still performing a purpose. However, users typically avoid using a life vest because they are uncomfortable to wear and almost impossible to complete work on the deck of a ship. Smaller life vests are more comfortable. When all these factors come together than the user is able to work at leisure knowing that their security is in check.

Appendix II User Research

Introduction

Commercial fishing is one of the most dangerous professions in the world. The focus of this study is to improve safety for the deckhands onboard commercial fishing vessels. Proper research must be conducted to identify and reach an understanding from a demographic standpoint. Continuing to develop research for this topic, the next step is to identify the primary user and gain statistical data and research on them. This will be done by obtaining different factors including demographics, behaviour and profiles. The primary user for this thesis topic is the deckhands working the equipment on the main deck of the ship.

User Demographics

Primary User: Deckhands

Deckhands are workers on the deck of these commercial fishing vessels. Using Humber resource library, the following keywords were applied to find out more about the primary user; "Fisherman, equipment, safety, outdated, fisherman gear, fisherman demographics 2019". The primary user works long shifts, occasionally put under circumstances risking their safety. A wide variety of fishing exists, in reaction to this, the thesis topic covers exclusively commercial fishing and the problems related to injuries aboard a commercial fishing vessel. The general knowledge obtained from this preliminary search pooled results that include demographics for commercial fishing matching young-middle aged males.

Key Information Gathered

Age: 45-64
Gender: Mostly male
Income: $30,000 – $65,000
Major Injuries: Piercing wounds, drowning, trauma due to falling
Geographical location: North American

Secondary Users: Stevedore

The secondary user includes the stevedore located in ports. Their job is to help harbour the ship in to port and off-load the cargo. They come into similar contact that the deckhands are familiar with. The main difference is that they are on land and are relatively safe from drowning. There is still risk of injury with this role, but it is lower than that of deckhands.

Tertiary User: Vendor

Vendors are still involved in the commercial fishing system, and are the last ones to handle the cargo before it reaches the consumer. Vendors are fitting as a third user because they interact with equipment (such as fishing containers) that primary and secondary users work with.

Image Results:

Through searching the web for related images, the average deckhand on a fishing vessel is a middle-aged male. Equipped with orange rubber jackets and pants. All of them appear to be apart of the working class and in the middle of an interesting action. For example, in Figure 1, a Fisherman is handling lobster traps on his vessel, by the looks of it he is gathering the traps onto the vessel to take out into open water. The few dozen traps are handled into the back deck of the boat using nothing but his bare hands. In Figure 5, a fisherman is seen power washing his catch. This is to get rid of bycatch (fish species not targeted). The conclusion gathered from this data proves that a lot of work that happens on these vessels are rarely added by automation or heavy machinery. This creates a lot of manual, laborious tasks. Eventually leading to body strain, pain and sometimes injury.

Figure 1 – Fisherman handling lobster traps Retrieved from https://pixabay.com/photos/lobster-traps-lobster-fishing-boat-2759178/

Figure 2 – Deckhands reeling in trawl Retrieved from https://www.youtube.com/watch?v=EuW_Xy_f6CA&list=PLYc9IqooYcYgLA3ZokLd65HbT0DAQZiAS&index=32

Figure 3 - Oncoming boat. retrieved from https://d36tnp772eyphs.cloudfront.net/blogs/1/2014/05/005_Alaska-fishing-boat.jpg

Figure 4 - Power washing bycatch. Retrieved from https://www.joelsartore.com/assets/stock/FIS007/FIS007-00014-1920x1296.jpg

Figure 5 - Worker staring at scenic view. Retrieved from https://d36tnp772eyphs.cloudfront.net/blogs/1/2014/05/011_Alaska-fishing-boat.jpg

Literature search

Searches were conducted for articles pertaining to the primary user, records and statistics of user profile have returned with a significant finding. Statistics are outstanding, helping zeroing in on the primary user of the study. Below are pieces extracted from articles that help uncover the user demographics of commercial fishing.

Evidence

"According to the most recent numbers from the Alaska Department of Labor and Workforce Development, women account for only about 14 percent of commercial fishermen." (Glamour.2017) With this information we know that a majority of commercial fisherman are male.

"Analysis reports age distribution reveals the aging population of active anglers in Canada. 55% of which are Canadian anglers aged 45-64." (Fisheries.2016) This means that the population of fishermen are aging, and we will have more older aged fisherman then ever before in history. The older we get the harder it is for us to perform tasks, and our immune system weakens.

"Fishermen's working dress traditionally consists of inner and middle layers of cotton garments, a coverall (often with an insulating lining during the winter months) and an outer shell of heavy-duty rainwear (strap trousers and jacket). They also wear caps, boots (of various qualities) and gloves to keep their hand dry and ensure a good grip on the fish." (Special Report on Fishing (2017). This fisherman outfit is outdated, and shows no empathy for safety. While it may be comfortable, it won't stop you from drowning or getting dragged into the water by a snagged article of clothing.

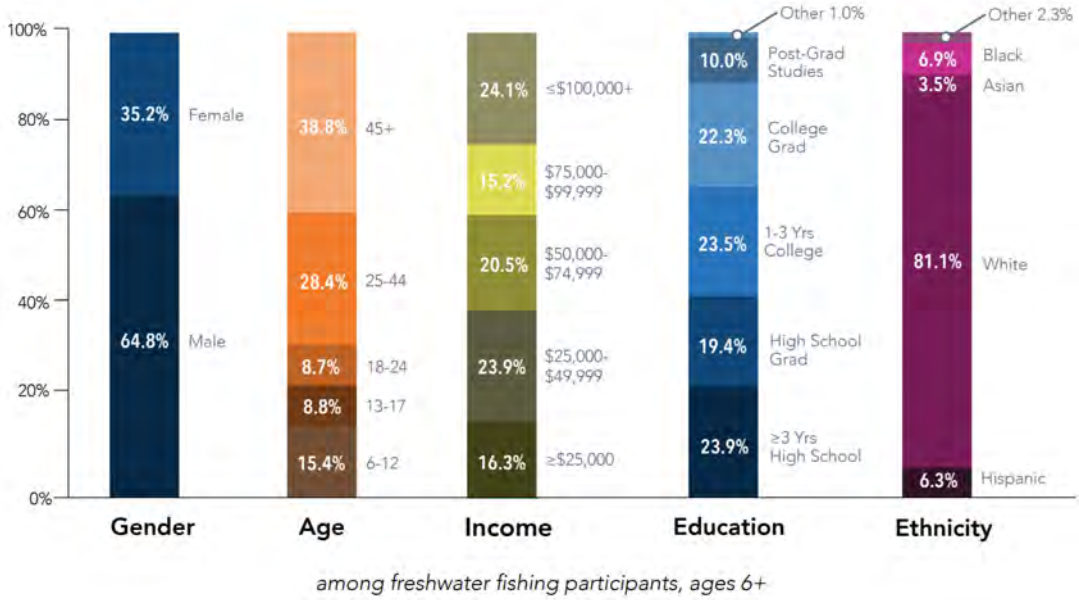


Table 1 (2017). Retrieved from https://outdoorindustry.org/wp-content/uploads/2017/05/2017-Special-Report-on-Fishing_final.pdf

From this bar chart, it is clear to see the majority of fisherman are white middle-aged males. While the variety of age may be significant, there is a larger percentage of middle-aged men working for commercial fishing.

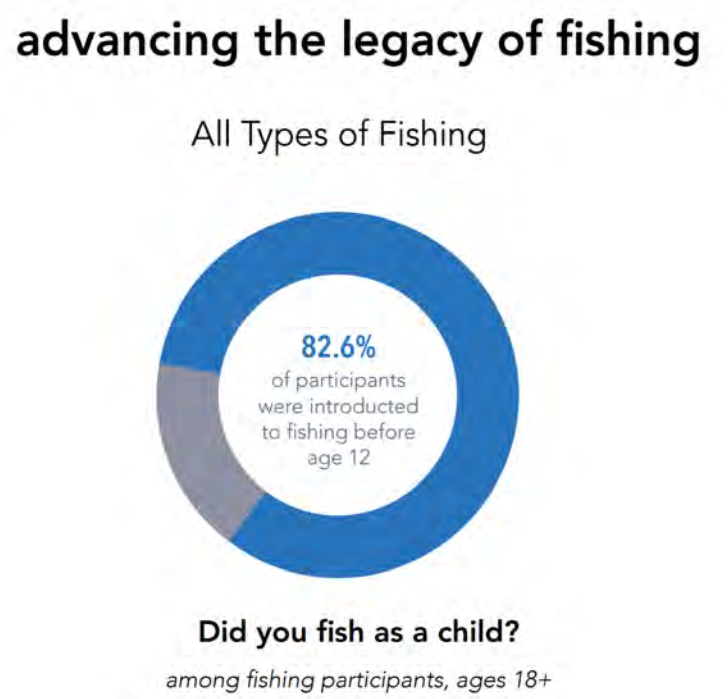


Table 2 (2017). Retrieved from https://outdoorindustry.org/wp-content/uploads/2017/05/2017-Special-Report-on-Fishing_final.pdf

A growing percentage of children are learning to fish, meaning that they would be more inclined to follow this hobby and turn it into a profession. This is important because it reinforces the family lineage of fishermen, and that fishing is here to stay for a while.

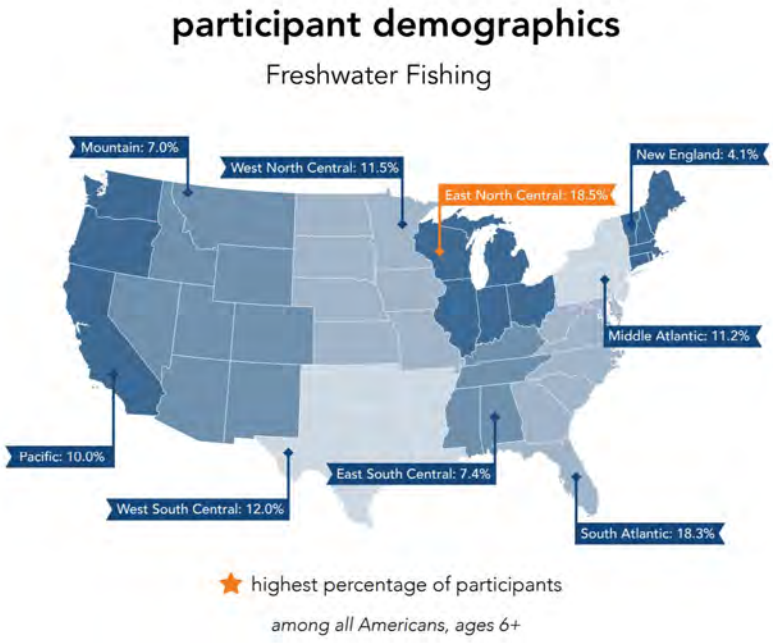


Table 3 (2017). Retrieved from https://outdoorindustry.org/wp-content/uploads/2017/05/2017-Special-Report-on-Fishing_final.pdf

Conclusions

Through the findings, the average target demographic is white middle-aged males. The average age group of active fishermen is growing in North America, the population will see a boom in older fisherman, this causes design opportunities to assist older fishermen. Design considerations would be affected as a whole by these findings. This factored with the priority of safety and comfort. Some considerations would include grip strength, and balancing devices.

User Persona

This fictional example of a user provides a demographic persona to familiarize and serve as an example of user behaviour.

Name: Connor Shepard
Age: 45
Occupation: Commercial Fisherman
Income: $60,000
Education: Highschool certificate
Relationship: Married with two children
Location: Winnipeg, Manitoba
Fishing Location: Lake Winnipeg
Injuries: Lost his right hand due to rope constriction

Article Resources

Fisheries. (2016, October 6). Survey Results. Retrieved from http://www.dfo-mpo.gc.ca/stats/rec/can/2010/section4-eng.htm

Geving, I., Sandsund, M., Reitan, J., Faerevik, H., Reinertsen, R. and Aasjord) (2019). Safer work clothing for fishermen. [online] Journals.viamedica.pl. Available at: https://journals.viamedica.pl/international_maritime_health/article/view/26321/21115

Glamour. (2017, December 7). The Small But Incredibly Strong Pocket Of Amazing Women Fisherman In Alaska. Retrieved from https://www.huffpost.com/entry/women-fishermen-in-alaska _b_8123800

Special Report on Fishing (2017). 2017 Report on Outdoor Fishing. [online] Outdoorindustry.org. Retrieved 25 September 2019, from https://outdoorindustry.org/wp-content/uploads/2017/05/2017-Special-Report-on-Fishing_final.pdf

Image Resources

Hallgrímsson, V. (2017). Electronic Logbooks & Trip Management. [online]. Retrieved from https://www.youtube.com/watch?v=EuW_Xy_f6CA&list=PLYc9IqooYcYgLA3ZokLd65HbT0DAQZiAS&index=32

Incoming boat. photograph. Retrieved from https://d36tnp772eyphs.cloudfront.net/blogs/1/2014/05/005_Alaska-fishing-boat.jpg

Lobster Traps, Lobster Fishing Boat. [online](2019). Available at: https://pixabay.com/photos/lobster-traps-lobster-fishing-boat-2759178/ [Accessed 25 Sep. 2019].

Power washing bycatch. photograph. Retrieved from https://www.joelsartore.com/assets/stock/FIS007/FIS007-00014-1920x1296.jpg

Worker staring at scenic view. photograph. Retrieved from https://d36tnp772eyphs.cloudfront.net/blogs/1/2014/05/011_Alaska-fishing-boat.jpg

Appendix II

Appendix III Product Research

Method 1 – Face-to-Face Interview

Face to face interview with Reece Bennett from Humber College. He has experience being a commercial fisherman in lake Winnipeg, Manitoba for 7 years. Experience aboard a small fishing boat called a yawl (20-24ft). An audio recording was taken by consent from Reece for research review and details. This mp3 file is available upon request and is saved on the computer in "research for thesis". Interview was taken on October 9, 2019 at Humber college in the CTI building around 2:30pm.

Findings/Evidence

Q: Do you enjoy fishing? Does anyone else in your family fish?

A: I do not enjoy fishing, (Laughing) which is why I'm here. I actually hated it; it was something I was forced to do because it was a family business sort of thing. So, both my parents are fishers, and both my grandparents were from both sides. In the community I grew up in about 90% of the people are fisherman there as well. It comes with the territory. You are either a fisherman or you leave, I was there until 19 then I left.

Q: How long were your fishing trips usually? What was like the shortest one what was the longest one?

A: Time out it completely depends on the nets you have set and the amount of fish you get. Depending on the number of fish in the area you can have a smaller amount of nets set. The time depends on how big the mesh is in the net. It takes a lot longer to take out 1000 little fish then it does to take out 100 smaller fish. It can be a few hours but it could be 18 hours with smaller fish and more nets. Nets are out there overnight; sometimes entire fishing seasons and you check on them once and sometimes twice a day. (Proceeds to draw out how they reel in nets to check on fish, image sourced in references)

Q: How does the weather affect your ability to work? What countermeasures do you use against sun, rain/water and wind?

A: Weather is a huge driving factor. Spoke to my dad and he's worried about the next 3-4 days, it's expected to blow really hard. If it blowing really hard then you can't lift your nets, if you can't lift your nets then the fish rot and go to waste. It's all waste, you would have to do the work still to lift the net and empty it with garbage and you kill all these fish for no reason. Rain can come with wind so its hand in hand. The sun isn't a huge issue because your fully covered but it could get very hot 25°c-27°c in June sometimes. Guys wear peak caps and sunglasses sometimes.

Q: What are the most prominent problems on a commercial fishing vessel today?

A: The main issue probably is over-cumbersome. The suits and the gear they have to wear is over-cumbersome by nature. It's this really stiff plasticky material and there usually quite large and thick. With all the gloves and boots and everything it can just be very over-cumbersome. Cumbersome equipment, rubber equipment, gloves and boots. Inherent danger, the boat is moving all the time. "Sea legs" the ability to get

good at walking around will take time to develop. Designing a boat will require too many factors, you would need to prototype it to even understand how to design it.

Q: Have you yourself, or any of your coworkers encounter accidents while fishing? If so, how many can you recall and which one stood out the most to you?

A: Ya so let's say we are in the middle here (Points to sketch) my glove got wrapped up because this mesh is a really fine mesh that is really strong. It just got wrapped, it got tangled and as this is going over because the boat is drifting along it started going over because it was blowing really hard and the wind was pushing the boat down. The boat was moving away from me and I was stationary. Just by luck I was able to slide my hand out and my glove was just shooting out into the water. None that I have witnessed but a lot of drownings, because men have fallen overboard. Another one is at the back of the boat, the valve to wash the boat out. Lots of guys have sunk their boat because they have forgotten to close this valve.

Q: How often do you use personal safety equipment or personal flotation devices when working on a commercial fishing vessel?

A: I can't think of a single time that I have used a piece of safety equipment. Other than like the gloves if that counts. Boots and gloves, sure every day but a floatation device, never. Most guys fish by themselves, who's throwing me this life jacket? No one else is in the boat how is that supposed to work? Between 30-50 of guys fish by themselves.

Q: Would you wear a life jacket more frequently if it helped keep you warm and dry while taking a less bulky form? How would you design the perfect personal protection/ flotation device?

A: I mean that's your job, but especially in the fall if you are cold you would wear a bunch of clothing and you would look like the Michelin man. Maybe something that would replace this.

Q: What current practices are conducted that improves safety for the workers?

A: More wild west, must have ring and safety vests, must have bilge pump and stuff like that. A radio, but that doesn't mean that they use it properly. There is inspectors, but I have never seen one in life, the government hires them but I haven't seen one. It's like we have this stuff so the government can say they due diligence. Most of the guys fishing in Manitoba is in a pretty remote area, it's pretty isolated. We have GPs, but it's not standard, it's for safe navigation in fog and such and we do not need to have that, as far as I know of.

Q: What do you believe is the largest room for improvement on a commercial fishing vessel?

A: Not tools but probably the gear, maybe the layout of the boat but that's so hard to prove, because you would need to test it, it's always changing a very dynamic environment.

Q: Concluding this interview, is there any additional information about commercial fishing/dangers of commercial fishing that is important to know? Anything that you think I missed?

A: Reluctance in general to adopt anything new or change anything. Whatever the solution it has to be a very obvious one to adopt it. The only advances in 30 years is

the design of nets have changed, in the sense that they use different materials for twines and ropes. Cork/top slimmed down to not catch on boat. (image in references)

Discussion/Conclusions

In conclusion from this survey, a lot of knowledge has been gained regarding the topic "how can we improve the safety of commercial fishing?"

The first one is the knowledge on how a fishing boat works, and how the workers on the ship would gather fish from the nets. (See attached image for reference)

Secondly, Reece mentioned the incident he had when reeling in the rope for a net. His glove got caught and he was lucky not to get thrown overboard, Fishing boats are always constantly moving and so it is important to note that if you are snagged on something in the water the boat can easily rip you apart if you don't untangle yourself.

Thirdly, weather can really hurt the performance of fisherman, so much so that enough bad weather for a few days can completely fill up a net of rotting fish that would need to be thrown out, wasting the time of the fisherman and a bunch of wasted fish.

Fourthly, he taught me that the industry is very reluctant to change, In the 30 years that he has been alive the one singular thing that he noticed being changed was the rope on fishing nets. They have been designed to not get snagged on the boat anymore from there predecessor boxy design.

Finally, the last major key point taken away from this was a subtle hint at what a solution could look like. What if there was a way to design a personal equipment that could easily be taken off so that if the fisherman were to go overboard, he could take it off easily and not be weighed down from all the equipment.

A bonus point learned was the bilge drain that is the main cause of flooding and sinking of a ship. It is important that this device is closed before sailing a ship otherwise the ship will be flooded quickly and there is no way to recover from this. That is how most fishing boats sink, is the neglect of this tool.

The first thing that would be done differently next time would be to ask questions specifically to how it is written in the script. The script was present, but there were multiple occasions in the interview when questions in the script were asked prematurely and this disrupted the planned flow of the interview.

Secondly, some of the answers to the interview questions were answered in earlier answers so it seemed unnecessary to ask some questions when the interviewee already answered similarly to what was just about to be asked. That way next time the questions will be a little more far apart from each other in terms of how they are related. This way if more depth is needed from the given answer, this could be asked to "explain more" or "could you go into more detail"

Method 2 – Survey results through the help of Fish Safe Canada

Q1
How long have you fished? Do any of your family members fish as well?

1. 35 years (onboard since I was 6 weeks old). My parents both commercially fished, as did my brother.
2. 24 years. my father and brother commercial fish (Dad 65 years fishing (he is 82 and still fishes), brother 30 years
3. Most of my life, generations of fishermen in our family.
4. Over 25 years and my brother
5. 55 yrs. 2 brothers still fishing
6. 43 years, my daughter and son fish as well
7. 20 years Yes, they do fish
8. 12 years no family fish yet but my children will
9. I've been fishing my whole life and started commercial fishing 5 years ago and my father, grandpa, and uncle fish
10. 20 years. Family fishermen. 1 to 20-day trips
11. 43 years. My son has fished but has moved on to other line of work
12. have fished with my own boat and license since 1975 My wife fishes with me My brother has his boat and license
13. 45 years, my family fishes as well
14. 6 years. No family
15. 40years
16. 40 years with no other family members
17. 43 years
18. 50 + years
19. 50 years. Yes, two children.
20. 30 years plus and whole family fishes
21. I've been fishing for 27 years and I am a 4 generation Fishermen
22. Yes, and yes
23. Yes, to both.
24. I love fishing, most of my family are fishermen
25. Yes

Q2
How long do fishing trips usually last? Shortest? Longest?

1. Seining can be 1-2 days, long lining 5-6 days, trolling 5-12 days, prawning ranges from day trips to 14 days, tuna 5 - 21 days, gill netting 1 - 2 days, herring can be 1 - 3 days (although guys can be on the grounds for 2 - 3 weeks some years).
2. define trip. gillnet fishing, we consider a trip when we depart home port for the season which could be 2-3 months, but actual fishing time varies from 1-3 days a week. when I fished in the seafood harvest fishery, trips ranged from 4-6 weeks, fishing daily except when weather was too severe.
3. 1 day up to 2 weeks
4. 1 day 10 days longest
5. 3 days - 2 months
6. 2 to 3 weeks between deliveries. 2 months between home port to home port
7. Around a week
8. 7-14
9. Tuna fishing from end of June - mid September
10. 4 hours to 21 days
11. Average 8 days, longest 11, shortest 4 days
12. we are day boats
13. Depends totally on the fishery, personally, I day prawn fish on a live boat
14. 50 days

15. 2days
16. 1 day to 45 days
17. 2 or 3 months
18. 1day to 1 week
19. One week. Two days. Two weeks.
20. 2 to 7 days
21. Usually 15 hours. Shortest is an hour. Longest is 3 days straight
22. Longest a month and a half shortest a day
23. Trips get cut short because of weather, but usually 8-10 hours.
24. From a day to 5 days for the fisheries I am involved in
25. 1hr- 2 weeks

Q3

How does the weather affect your ability to work? What countermeasures do you use against sun, rain/water and wind?

1. Wind is the biggest factor, as is the sea state (waves). We are limited in our ability to operate in large seas or high winds. Sun and rain do not affect any of the fisheries I have been involved in.
2. seafood harvest is dictated severely by wind, wave and swells. gillnet can be hampered by wind and sea conditions. typically protected by raingear from rain, wear ballcap to protect from sun.
3. My dad always said watch & listen to weather reports & don't take chances it's not worth it.
4. 3p knots we quit fishing We wear full slicker gear
5. usually don't fish in heavy winds over 30 knots. I\we dress appropriately in all weather including sunscreen, sun glasses, rain gear
6. wear rain gear pants and jacket when raining. The deck is partly covered so in some jobs it is possible to work with out a rain jacket.
7. It hampers production, severe stops it. Usually slicker gear
8. I fish year-round weather effects every day of my life.
9. Doesn't affect anything just shitty cause wet and cold
10. Weather over 30 knots wind makes it unsafe to gillnet salmon
11. Usually full rain gear and always at hat. We don't fish if more than 40kts of wind
12. good foul weather gear.
13. Raingear as needed, sunscreen when I remember
14. Work in any weather.
15. a day
16. Rain gear and overhead tarp
17. I use sunscreen, rain gear and if its too windy I go anchor.
18. Rain gear
19. 100%. Avoidance and preparedness.
20. You work
21. 60mph winds and rain
22. Weather affects everything and is only countered by skill experience and gear
23. Weather affects the safety and general comfort of my job. We don't necessarily use countermeasures against the conditions of rough weather but employ caution and common sense to stay safe in dangerous sea states.
24. Wind can stop work. Fuck the sun and rain.

Q4

What are the most prominent problems on a commercial fishing vessel today?

1. Politicians playing at populism, disregarding science and pandering to uninformed voters. Our fall salmon fishery was closed for political reasons, and there is talk of cancelling our spring herring fishery for political reasons. As fishermen we can address any of the environmental or scientific issues that arise, but we cannot work when adversarial politicians are uninterested in maintaining a historic industry.
2. lack of fishing opportunities, poor market conditions, difficult to find qualified crew due to the above noted factors
3. Equipment failure
4. Fishing in rough weather

5. Lack of fish resulting from governmental cuts to salmon enhancement, hatchery programs and loss of habitat in watershed and river estuaries. This results in the lack of funds to properly supply and keep in proper repair, the proper and adequate safety equipment on some vessels.
6. access to fish. But I think you are looking for something about safety. Safety drills
7. PFD fitting comfortably under slicker gear
8. Lack of knowledge, unsafe boats and people.
9. Running out of beer
10. The net going out is dangerous, lack of money in industry makes boat upkeep difficult
11. Always something different. Things break and need to be maintained. Keeping up with new regulation is challenging
12. our vessels today are much safer than what we had in earlier years
13. Trying to find qualified crew that want to work
14. Weather
15. not being alert all the time
16. On our vessels it's not awareness so maybe fatigue and equipment frailer
17. lack of fish
18. Dumb question.
19. Having to take chances with weather because of DFO management!
20. The bulky pdfs. they don’t suite or work for my fishery get in the way more then they help keep u safe
21. Floatation devices
22. Injuries assholes and bankruptcy
23. Not much really.
24. There is no place for drugs or alcohol on fishing boats. Old school beliefs of not using proper protection are also an issue.
25. Regulations, lack of skilled crews

Q5
Have you yourself, or any of your co workers encounter accidents while fishing? If so, how many can you recall and which one stood out the most to you?

1. Getting hooked while long lining happens on a semi-regular basis. This is the reason I personally do not wear a PFD while working with hook and line fisheries. The danger of being hauled overboard or into heavy equipment far outweighs the benefit of wearing a PFD.
2. I do wear PFD's while seining and gillnetting, and agree that they should be worn while trap fishing (crabs, prawns, black cod), trawling, trolling, and packing.
3. yes, many small bumps, bruises, cuts, etc. one fatal incident of a close friend on another vessel which impacted me so much I joined WorkSafeBC to try and assist in changing the safety culture in commercial fishing
4. 2 times I went overboard without a life jacket on , on an open set the sea anchor swung up as I was about to grab it and hit me square in the jaw , sent me flying overboard , I came to sinking slowly, I was under about 12 feet down when my senses came back , I'd better swim up & I'm lucky I did , now I wear a pfd fishing , got my MED 3
5. Setting crab gear in rough weather I guy just about got pulled over buy having a crab line wrapped around his leg and it pulled his boot right off his foot
6. years ago, there were a number of accidents involving in breakers in the salmon fleet when the seine fleet increased. One of my friends got wrapped on the drum. he broke a couple of ribs and suffered some severe bruising.
7. Mostly deck injuries, slipping, falling down,
8. My best friend died prawn fishing his name was ben, he was in the pfds save life's video.
9. I cut my finger 3 weeks ago working on a dive boat cutting cucumbers and got nerve damage and still recovering. That’s my worst injury from fishing. My bud tommy got hit in the head with a tuna jig offshore and cracked his head open n has brain damage
10. Fellow fishermen got tangled putting net out and drowned
11. I had a crewman who was also a family friend drown while working on a prawn vessel. No PFD
12. no
13. Had a Bachman while seining over 30 years ago get a broken wrist, wearing gloves, got hand caught in beach knot

14. Yes. Caught in the lines.
15. getting caught with the net on a button
16. Yes, many but the most prominent that comes to mind was man overboard
17. When I was young lack of training of beach men made the work more hazardous, I almost got killed 6 times the first year.
18. getting hit in head (not proper safety line on gear) putting hands where they should not be.
19. Of course. Cuts fractures. Lost the end of my thumb recently.
20. No
21. Over a dozen due to rough weather
22. Yes, in my harbor people get hurt every 2 weeks or so
23. I have witnessed 2 accidents this year. What stands out to me is that both were avoidable. With that being said they were incidents that experience was a factor
24. Yes, dozens of minor accidents. 3 serious. Guy losing an arm in winch stands out.

Q6

How often do you use personal safety equipment or personal flotation devices when working on a commercial fishing vessel?

1. Always when seining or gill netting. Never while long lining for ground fish. They represent a greater peril in the hook and line fisheries than the safety they afford.
2. always.
3. Salmon seining 100% while working
4. Once in awhile not enough actually
5. Very seldom unless there is poor weather and sea conditions
6. we use them at all times while on deck if actively fishing. But they are not comfortable and so it is not A NATURAL THING TO PUT THE pfd ON.
7. All the time
8. Everyday that I'm fishing
9. Not to often
10. Always wear pfd. Have survival suit on board
11. Majority of time at sea in the past 2 years. Rarely before that
12. we use the FitzWright pfds
13. Most of the time
14. All the time
15. very few
16. Always unless it impresses my safety
17. Always
18. Not enough as I found PFD a bit of a hazard. Vest much better. Maybe was model of pfd we had?
19. Not tied up in harbour. When I’m alone always.
20. Its mandatory
21. All the time
22. Never
23. As a captain I enforce all my crew to wear the necessary gear as recommended by coast guards
24. They are there on vessel, but not always worn

Q7

Would you wear a life jacket more frequently if it helped keep you warm and dry while taking a less bulky form? How would you design the perfect personal protection/ flotation device?

1. Often, I find PFD's to be too hot to work in, too bulky, and have far too many points that can be caught up on the equipment we use. Ideally a PFD would not add any insulation, be of minimal weight, and not impede the free movement of the individual wearing it. It MUST be made of a material that can easily be torn when hooked, as this is the greatest danger to wearing PFD's. There are several types of raingear that cannot be worn while longlining as they will not tear when hooked. We can only wear raingear that will allow a hook to tear out. I will only wear gear that allows a hook to easily tear through the material.
2. keeping warm and dry is important if its cold and wet outside. the bigger challenge is finding a PFD you can wear when its summer time and hot outside. also having a PFD that is designed for the fishery you are involved in, less things to catch on nets, etc.

3. Yes, I would but as long as I can work comfortably in it under my rain gear
4. Yes
5. I think I would wear a floatation device if it was something that was waterproof and could be used as a waterproof jacket\ vest. probably an inflatable type with a gas cartridge cartridge
6. Yes, if the pfd was more like a vest, did not rub on your neck and was low profile so it did not catch on gear. Not to warm so you can wear it in the summer
7. Yes. Maybe built into the slicker gear or incorporated somehow
8. I would want it to no effect my temperature at all, streamlined, I like the FitzWright pfds they are what me and my crew wear.
9. Yak probably it's just got to be nice n thin and warm
10. It needs to be without any hang ups that can catch a net. This is why o always wear mine under my rain jacket rain or shine
11. I like the FitzWright foam vest. My crew find the horseshoe inflatable type uncomfortable. As I get older, I find the cold affects me more so I like the vest
12. yes
13. I like vests that are warm and wearable with cloth around neck, like old red mustangs
14. Smaller less bulky
15. yes, if the PFD that is on the shelf today had a flap over top that was velcroid
16. Warm and dry no that's my rain gear job biggest problem with gillnetting is hanging up in net while setting pfd. That's was hang-up free and maybe that worked inside rain gear without being bulky
17. No, my Mustang inflatable is fine. It is comfortable and now that I have been wearing it a long time it isn't noticeable.
18. Yes, have seen them
19. I wear a vest type. And it is comfortable lined collar pockets good Velcro's over zipper. It would be bib or vest with nothing to catch fine web i.e. gillnet.
20. Thin so it's like a sweater
21. I do
22. Yes, maybe but probably not
23. I wont design this for you...
24. The purpose of a floatation device shouldn't be to keep someone warm and dry. It should fit over existing gear. The perfect floatation gear shouldn't rely a hydrostatic mechanism because I have witnessed many malfunctions from these types of pfds. It should be compact and durable but have a high floating element without the need for inflation.
25. It needs to be small and unnoticeable when worn. I don't want it to keep me warm.

Q8

What current practices are conducted that improves safety for the workers?

1. PFD's while net fishing, safety drills, familiarization with the vessel, decades of experience onboard fishing vessels.
2. mandatory wearing of PFDs on the deck of the vessel is a positive step
3. Work safe is very good
4. We took fish safe course We practice drills on the boat
5. Beachline safety courses for beginners. all courses associated with hands on practise
6. drills and the outreach by fish safe coming and training crew
7. Safety drills, wearing of PDF's on deck
8. I do many safety drills; I have worked on around 20 boats and did not a single real safety drill until I ran my own boat
9. Fire drills sinking ship drills
10. Pfds, better cell range keeps guys in contact with others
11. The fact it's law now has improved safety. Fish safe has helped a lot. It's hard breaking old habits
12. the pfds
13. Survival suits on all boats and emergency drills
14. Fish safe
15. to be alert all times
16. Drills

17. A lot of it has to do with common sense and not letting greed impair one's judgement.
18. Would say was safer in past as we spent more time on boat. From simple task of tie boat up to proper knots repetition is best teacher
19. Drills.
20. Drills
21. Staying on shore
22. Survival suits expires etc.
23. Proper training and enforcement of safety gear.
24. Risk assessments

Q9

What do you believe is the largest room for improvement on a commercial fishing vessel?

1. Educated politicians who are willing to work with the industry and the best science available, instead of pandering to the uninformed masses. We need statesmen in office, not populists. When political decisions are made that cost fishing operations money, we lose good crew to other marine sectors. The result is poorly trained crew available who could not find work elsewhere, as well as skimping on safety equipment and the upkeep of the vessels. The more unnecessary government legislation and the more limits there are on our fisheries means the less money available to retain good trained crew. Accidents are inevitable when boats cannot be maintained and good crew retained.
2. culture change so that it is the norm to wear PFDs not the norm to not wear them
3. When a crew change making sure survival, equipment fit the new crew member
4. More comfortable safety gear
5. some sort of guaranteed income so crews and fishers don't end up taking unnecessary risks when faced with poor catches or hole trips. I think it is important to make fishing financially viable with guaranteed share laws whose objectives should be to have lifetime work and not just a part time job. guaranteed viability to keep people employed and allow for a future in the fishing industry
6. Safety trading on the vessel
7. Safety, get the old guys that don't know anything about modern safety and make them go back to school, check all boats for safety compliance, in 12 years u have not had this happen a single time
8. Bigger beds
9. Non competitive fisheries and quota fisheries make it so fishermen don't need to fish thru bad weather, poor boat conditions etc. As for the vessel itself, proper loading procedures and stability knowledge
10. Education is the biggest thing. We rarely thought about it in the past
11. ranning
12. Proper crew training
13. Safety.
14. to be alert and tidy and do not panic think
15. Free schooling on any safety issues
16. There is little that I havnt already done to improve my vessel. Its mostly knowing and or spending money to keep the boat properly maintained.
17. More work
18. More money would help! Most commercial boats are safe now. The Small vessel compliance program is helping.
19. Nothing it's up to the captain to make sure his crew is safe
20. Extra floatation devices
21. Price of seafood per pound
22. Leadership. Lead by example and demonstrate the need for safety gear.
23. Safe practise, making use of safety equipment

Q10

Concluding this interview, Is there any additional information about commercial fishing/dangers of commercial fishing that is important to know? Anything that you think I missed?

1. I think I have made it clear that my issue is with political actors who have restricted our fisheries to the point of breaking. They are aiming for Canada to be the most politically correct country, with the highest regulations in every step of fishing chain. All of the cameras, dock-side validation, and monitoring, costs a lot of money. When great swaths of the coast are "protected" and the opportunities to fish are limited, there is less money to pay for all of these costs, as well as to pay for training and retaining good crew, let alone maintaining the vessels and keeping all of the equipment up to date. If we cannot balance the books, we cannot afford to keep fishing. All of this safety will be for naught if we cannot fish.
2. too much to list here. I think one major issue to consider is a lack of training for new/young workers coming into the industry, and getting the old guard on board with saying 'safety is a good thing' rather than 'this is how we have always done things, and change is bad'
3. Always let family & friends know where your going and stay in contact with other fishing vessels in your area
4. Guys not getting enough sleep
5. Maybe head protection
6. There are to many different situations to list anything here.
7. No it’s a pretty safe fishery just gotta know what you’re doing and pick the right captain
8. One of my biggest concerns is survival suits. The only design I would ever feel safe in is one Frank White designed. It has a neck and wrist seals like a dry suit for diving. I have 3 samples that were not Transport Canada approved. I’d love to see them available for our commercial fishery.
9. no
10. Alchohol and drugs have no place on a boat, especially when fishing
11. Nope.
12. no not offhand
13. Training training training but it must be free so fisherman are more apt to participate
14. The human factor and lack of common sense is the biggest danger. This is usually directly or indirectly the reason why a boat sinks or an injury occurs. Unfortunately common sense is something that can neither be taught nor learned.
15. Yes lots , this survey was slanted in respect that we are not safe . As I have fished ,salmon . Herring Prawn crab and packed . Just not enough time to train new people on the job . There is a few basic safety measures that you are not addressing .
16. Every time we sail there are dangers. People just need to be trained and prepared.
17. No
18. Listen to your captain
19. Nope you got most of it
20. It’s a dangerous job, accidents happen but most are avoidable. Check vessels regularly for wear and tear. Make sure your crew is prepared for bad situations and avoid poor weather conditions.
21. Getting caught in nets or a bight of rope whilst gear is being shot away is a risk. Many fishermen work alone- for these guys special thought is needed.

Appendix IV Needs Analysis

Objectives

7.1.1.1 Needs Statement

The vision is to create a product that will improve the safety of deckhands who work on a commercial fishing vessel. Deckhands face an abundance of problems when working. Drowning is a huge risk for commercial fishermen. Personal flotation devices are available but are rarely worn by the crew. The main reason for neglecting to wear a PFD has to do with the limitation it sets on the user. The user cannot perform the tasks they need to do with the over cumbering size and limitation put upon them by a bulky device. This device is counterintuitive for these workers as inability to complete certain tasks correctly could lead to endangerment of the individual. An example could be when reeling in a net, the inability to move the arm properly can cause the hand to get caught in between the nets trapping it and throwing the deckhand overboard. For this reason some users prefer to take their chances and refuse to wear a life jacket.

Now that the problem is identified, the method to observe user interaction will be research gathered from multiple mediums. Mostly surveys and interviews about personal flotation devices, followed by user observation by watching incidents captured on video of deckhands being thrown overboard and accidents that occur on the deck of the boat. It is important to study these videos closely and identify the reasons for these problems. The solution to this problem will positively affect the workers on a deck and revolutionize the way fishermen keep themselves safe.

Figure 1. Time Bandit off the coast of Alaska

7.1.1.2 Description

In this report a video documents an accident where a crew member of another boat goes overboard and the ship with the camera on it captures the event as it unfolds. The result is a successful operation with a recovered deckhand that was seconds away from dying in the frigid water temperatures in the Pacific Ocean. This report will analyze this video, cerate a user experience chart that will be ranking the pain-gain ratio of the events as they unfold. A conceptual experience map will then be constructed featuring a potential product for this thesis to see how the rankings could be reduced on the pain skill and improve the overall user experience.

7.1.1.3 Research Objectives

Research objectives include identifying what causes fisherman to go overboard and lowering the risks involved. Observing the user and their habits when onboard and trying to connect their actions to that of research gathered from articles on PFD neglection and statistics dealing with deaths from drowning after going overboard.

7.1.1.4 Key Activities

The key activities portrayed is a man going overboard in the pacific ocean where victims have only 1 minute until hypothermia sets in. The rescue needs to be swift with no room for error. The victim is successful saved and a quick interview with the victim is ensued by the camera operator once the casualty has regained sensitivity and is able to speak.

7.1.1.5 Target Users

The primary user for this thesis topic is the deckhands of commercial fishing vessels, the secondary users would be the rescuers that need to locate the individual who went overboard. A tertiary user would include personnel on land that work at shipping yards.

7.1.1.6 User Environment

The fishing vessel out on the open ocean. In cold weather where it is frequently raining and waves from the ocean splash on the deck. The scene is essentially always wet and sets a risk for slipping hazards.

Preliminary Video Observation

7.1.1.7 Preliminary Scoping

Starting for the search of documented videos, YouTube was the first platform to be paid a visit. In the search query, “Man overboard situation” was searched and the first dew videos were watched to see which one had the highest amount of information and the best graphics that illustrate the thesis problem at hand. The video chosen was located on YouTube under the “swcblackjack” channel. The video is titled “Deadliest catch man overboard”. Contents of the clip entails footage of a man who went overboard in a real case scenario while filming for a t.v show. The video is only 5:38 minutes long and was posted on January 2nd, 2009. At the time of writing this document the video has 1,376,359 views.

7.1.1.8 Video Observation

The video being analyzed contains footage from a T.V series called Deadliest Catch. The clip starts with a ship dubbed Time Bandit sailing near another ship (Ship remained un-named) . The deckhand on the secondary boat is clinging off the side of the boat. Holding onto empty crab cages, at first glance it appears the deckhand is trying to retrieve or un-hitch something that might be stuck. The man is vulnerable hanging off the boat stack, the boat is rocking intensively and the frigid sea is attacking the man. Eventually a wave hits hard enough to knock the victim into the water. The casualty has one minute in the water before hypothermia sets in, if he is not taken out before then he could die. Man overboard can be heard on the Time bandit and a fire-alarm sounding bell goes off. The captain orders a life ring to be thrown and a deckhand equips a immersion suit to battle the frigid water. The captain has a hard time piloting the boat closer to the victim. A life ring is tossed to the victim so he can grab onto it and be pulled closer to the haul of the Time Bandit. The life sling is being prepared by another deckhand and once the victim is close enough, he is hoisted up by the two men with a pulley system. Although he is out of the water the victim is still not safe. His body is still losing heat

and needs to be wrapped in a heavy blanket. The victim falls over as his limbs are numb and can't move. The victim is able to warm up and talks about how he was climbing the stack of empty crates to grab the next crate to place into the water. The captain comes down to see the victim and the victim thanks the captain. When the captain settles back to his chair, he states that he was scared and the last time he had to take someone out of the water like that they were dead. The deckhands talk about how the victim was scared, and in shock and was not expecting to live.

Figure 2. Victim climbing empty crab cages off of the un-named boat

Direct User Observation

7.1.1.9 Chronology

Order of Appearance	Description of observation
1	1. The time bandit and the un-named ship are sailing close to each other and the crew of the time bandit are watching the deckhand of the un-named ship who is climbing up a stack of empty crab crates.
2	2. The waves smash against the vulnerable man hanging off of the stack and is thrown into the frigid sea
3	3. Alarm bell is rung, captain yells man overboard and this is echoed throughout the boat from other crew members
4	4. Deckhand outfits himself in immersion suit to combat the frigid water temperatures incase he needs to get in the water.
5	5. Captain has trouble getting close to the victim, needs deckhands to throw him a life ring.
6	6. Life sling device and Life ring device are used to first catch and pull the victim closer to the boat and then hoist him up to the deck.
7	7. Victim is alive, but is still in danger, he strips down getting rid of soaking wet clothes
8	8. Victim is wrapped in a heavy blanket to help warm up body temperature
9	9. The captain of the boat descends from wheel to see victim and the victim thanks him; Victim is breathing heavily. Embraces like father and son.
10	10. Captain returns to his chair and states that the last time he brought someone aboard like that they pulled a dead guy out of the water.

7.1.1.10 Organizing the Data

Throughout the video notes were taken on key points. Questions for this video will be brought forward to a safety advisor

- Why was the victim climbing the empty cages?
- How do you avoid hitting someone with the life ring, but try and get it as close as possible to the victim?
- How much time does a regular rescue operation take?
- Were the actions performed in this video necessary? Were they trained well?
- What happens if the victim was unresponsive to the life ring?

- What if the deckhands had to jump into the water to rescue the individual, what steps would need to be taken?
- Would it be easier to have a motorized ring that could find its way to the victim?
- Is there a way to take the victim out of the water before coming aboard?

User Experience

7.1.1.11 User Experience Map

Timeline	Pain	Gain	Ranking (Pain-Gain)
Falls off the boat	Initial dunk into the water is shocking, Cold water will induce hypothermia in 1 minute	N.A	●●●○○
Equipment is drowning victim	Struggling to keep above the water, can't think straight when body is in panic mode	N.A	●●●●●
Crew toss victim life ring; grabs onto life ring	Danger of getting hit in the head, losing consciousness	Life ring pulls victim closer to safety and keeps him tethered to rescue ship	●●●●○
Crew toss victim life sling device; User wraps sling around body	Possibility of not being able to move to place life sling around arms	Secured to the hoist of the ship, can't get lost in open sea	●●●●○
Victim is hoisted on-board	Risk of breaking or spraining body parts with jerking movement of hoist	Finally, out of the water; reduced threat of drowning	●●●○○
Risk of hypothermia, needs to strip down and proceeds to have blanket wrapped over him	Even though victim was rescued from water, he could still die from hypothermia	Once aboard the coast guard is able to extract victim if they need extensive care	●●●○○
Victim rests to allow body temperature to heat up again	N.A	Finally safe, rest is needed but is able to speak to crew	●○○○○

7.1.1.12 Potential User Experience Improvement Chart

Timeline	Pain	Gain	Ranking (Pain-Gain)

Falls off the boat, life jacket inflates once victim hits water	Initial dunk into the water is shocking, Cold water will induce hypothermia in 1 minute	Life jacket inflates and user is safe from drowning	
life jacket keeps victim afloat but hypothermia is still setting in	can't think straight when body is in panic mode	Life jacket helps to keep him above water	
Crew toss victim device that moves closer to individual	N.A	Doesn't need to expend limited energy to swim over to device	
Device becomes attached to vessel and is hoisted up	N.A	Secured to the hoist of the ship, can't get lost in open sea	
Victim is hoisted on-board	N.A	Finally, out of the water; reduced threat of drowning	
Risk of hypothermia, needs to strip down and proceeds to have blanket wrapped over him	Even though victim was rescued from water, he could still die from hypothermia	Once aboard the coast guard is able to extract victim if they need extensive care	
Victim rests to allow body temperature to heat up again	N.A	Finally safe, rest is needed but is able to speak to crew	

Overall Analysis

Based on the observation made in the footage, there comes a new understanding of how the emergency is dealt with by trained professionals. They need to have the knowledge on what there doing because 1 minute is not a lot of time. If it takes only 1 minute for the victim to freeze over and die then there is no room for error. By reviewing the footage and analyzing the actions of the crew as a team to rescue the individual its curious to see what would happen if no one was there to witness the overboard, because members on the other ship would not be able to see this individual fall off due to obstruction of view from the crab cages. This was a best-case scenario for this operation. Some man overboard operations occur in the pitch darkness of night, with minimal crew. How do they assure no additional damage to the victim when they throw the life ring? Many of these factors could be improved as there is no time to waste. This encourages finding a modern solution to this problem with conceptual technology that could help to save lives. The ability to track and locate the victim with a rescue device that is readily available and is simple to operate, requires minimal training.

The potential equipment designed to improve this type of user experience will come in a package. Primarily the life vest used by the victim will be embedded in the jacket to allow for regular mobility, but to activate when the user needs it. This will focus on the upper body ergonomics for the induvial and stop the victim from drowning with all the over-weight equipment they are used to wearing. Secondly, a safety device used to track and locate the victim that will become useful in the night time situations. This would focus on the technology and will probably have a location on the individual like the life jacket. Thirdly a recovery device that could seek out the casualty, collect them and retrieve them to the ship efficiently. This will focus on the ergonomics of grip and holding onto the device as it retrieves the victim from the frigid water.

In conclusion the research findings for this report were successful in putting a perspective on an extremely life-threatening event. Man overboard situations happen, and when they do everyone needs to be prepared. The chances of being present to a real-life event like this is very slim, attending a drill is more likely. For this, contact will be made with the safety advisor on available information sessions near Toronto.

7.1.1.13 References

7.1.1.14 Deadliest Catch Man Overboard Rescue*. (2019).* YouTube*. Retrieved 31 October 2019, from*

https://www.youtube.com/watch?v=w1z-

hdqEewI&list=PLh9f9fxJf0ta_nvartVA6XFsQsC_es_d0&index=2&t=0s

Appendix V Product Benchmarking Pool

	Product Image	Description (Product name and specifications)
1		**KENT Commercial Type I** Material: Vinyl Buoyancy Type: Foam filling Classification: Type 1 Price: $44.24 Features: • Can turn an unconscious person to a vertical or slightly backward position. • USCG reflective material URL:https://www.amazon.com/KENT-Commercial-Jacket-Style-Orange/dp/B001UDYRQO
2		**Stearns Adult Industrial Work Master Vest** Material: Nylon shell, Closed cell foam Buoyancy Type: Foam Classification: Type III Price: $133.07 Features: • Soft, comfortable • encircling body belt • Belt tunnels to reduce snagging URL https://www.amazon.ca/Stearns-2000025692-Industrial-Master-Oversized/dp/B07C232JFQ/ref=olp_product_details?_encoding=UTF8&me=
3		**MUSTANG SURVIVAL classic bomber flotation jacket** Material: Nylon Buoyancy Type: Inherent Buoyant Foam Classification: Type III Price: $339.99 Features: • In-water insulation • Neoprene wrist seals • Storm collar • Relaxed fit for comfort and freedom of movement • 62square inches of reflective tape • Internal waist belt to reduce ride-up URL:https://www.westmarine.com/buy/mustang-survival--classic-bomber-flotation-jackets--P010802114?recordNum=1
4		**Fitz Wright Rogue Vest Buoyancy Aid** Material: Black neoprene Buoyancy Type: Inherent Foam Classification: Type III Price: $138.00 Features: • Loop for safety light attachment • Reflective tape • Allows maximum flexibility URL:https://www.pocomarine.com/shop/fitzwright-rogue-vest-buoyancy-aid/

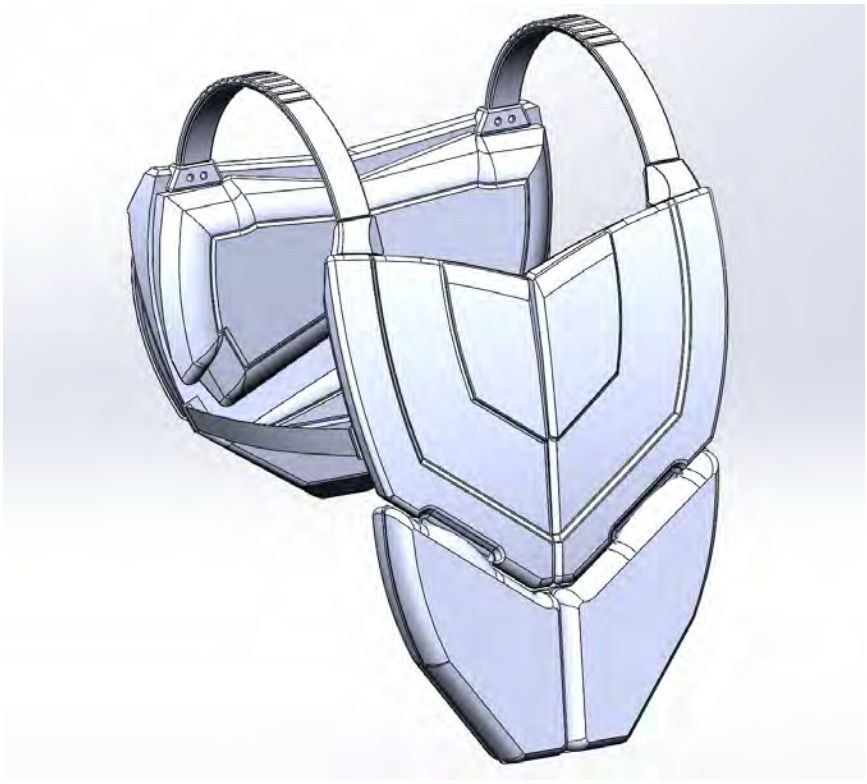
5		**Mustang SAR Vest** Material: Neoprene line, Buoyancy Type: Inherent Foam Classification: Type III Price: $325.00 Features: • Large cutaway holes for max range of motion • Fast-tab radio clip • SOLAS reflective tape URL: https://www.mustangsurvival.com/en_CA/products/government-and-industry/foam-pfds-clothing/sar-vest-MV5601.html
6		**Eyson Inflatable Life Jacket** Material: neoprene and nylon Buoyancy Type: CO2 inflated tube Classification: Type III Price: $104.99 Features: • Refillable CO2 compartment • Rip-cord inflation • Lightweight and minimal design URL: https://www.amazon.ca/Eyson-Lightweight-Inflatable-Preserver-Lifesaving/dp/B06Y5TDG29/ref=asc_df_B06Y5TDG29/?tag=googleshopc0c-20&linkCode=df0&hvadid=293019546650&hvpos=1o2&hvnetw=g&hvrand=2613455267418290546&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9000992&hvtargid=pla-493118104965&psc=1
7		**Stearns The Challenger Anti-Exposure Work Suit** Material: Nylon Buoyancy Type: Inherently Buoyant Foam Classification: Type V Price: $439.99 Features: • defense against frigid water • Easy to take on and off with waist belt and zippers • Adjustable straps • 3M Scotchlite reflective material URL:https://www.westmarine.com/buy/stearns--challenger-anti-exposure-work-suit-orange-black-s-34-to-38--P008_240_008_559?pCode=9446980&cm_sp=Onsite-Recs-_-DY-_-PDP
8		**Jim Buoy Life Ring Safety Station** Material: Closed-cell foam/Polycarbonate/Polyethylene/Stainless steel Buoyancy Type: Inherent Foam Classification: Type IV Price: $354.99 Features: • Stainless steel hinges and fittings • 100’ throw line • Ring Buoy hanger URL:https://www.westmarine.com/buy/jim-buoy--life-ring-safety-station-with-100-throw-line--P017155318?recordNum=1

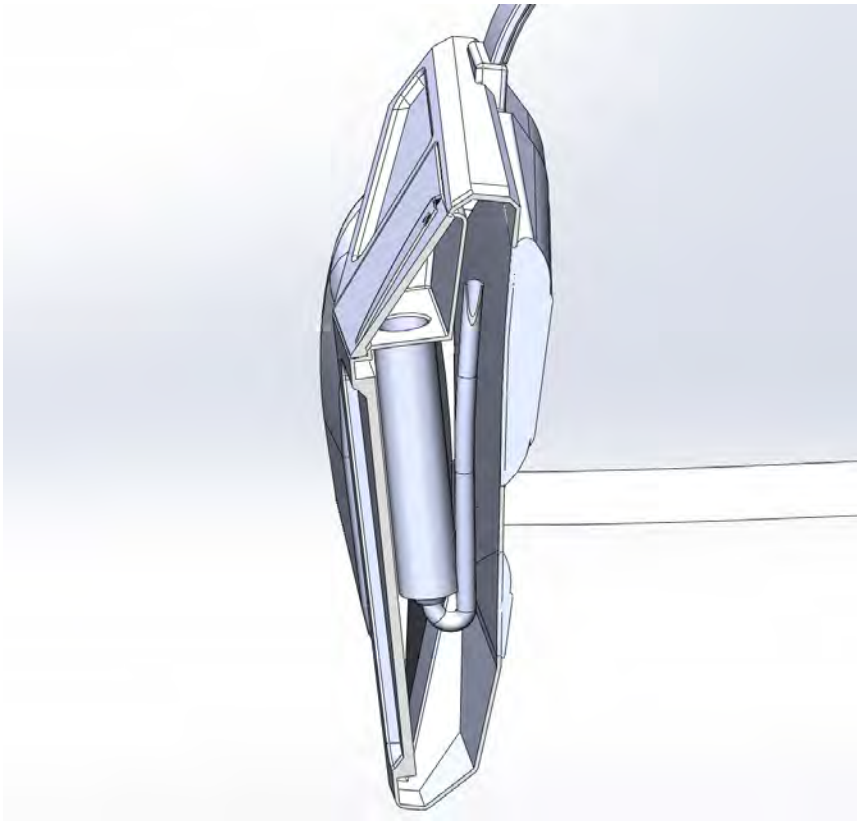
9		**Lifesling2 Overboard Rescue** Material: Multi-filament polypropylene Buoyancy Type: Inherent Foam Classification: Type IV Price: $189.99 Features: • Attractive vinyl storage bag • Graphics illustrate instructions • Mountable case URL: https://www.westmarine.com/buy/lifesling--lifesling2-overboard-rescue-system--357634?recordNum=1
10		**Mustang Khimera Dual Flotation Men's PFD** Material: slim foam chassis/ Nylon Buoyancy Type: Hybrid Foam and inflatable technology Classification: Type III Price: $249.99 Features: • Slim foam chassis keeps you afloat without creating bulk URL: https://www.atmosphere.ca/product/mustang-khimera-dual-flotation-mens-pfd-332938401.html?gclid=Cj0KCQiA2ITuBRDkARIsAMK9Q7N-JKOgVkrZ2tz8MRfdeSyemXFCnoSgDGQDU89fpYucnNDQaZhGMm0aAoXPEALw_wcB#332938401=332938415

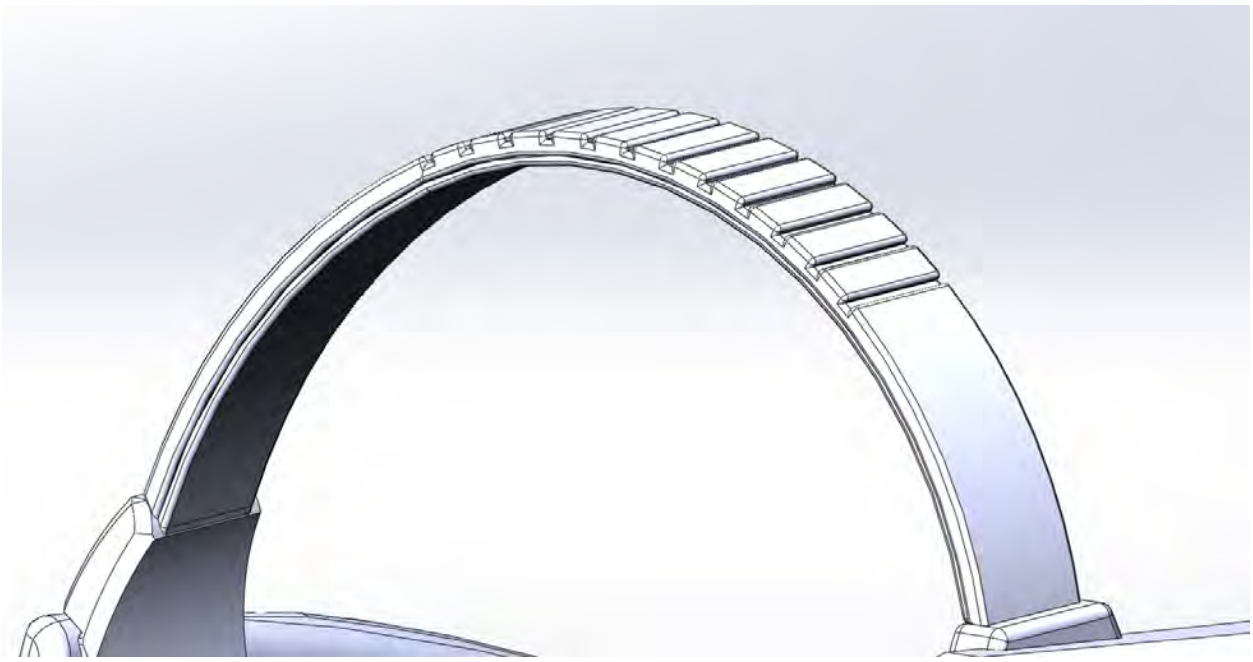
Appendix VI Other

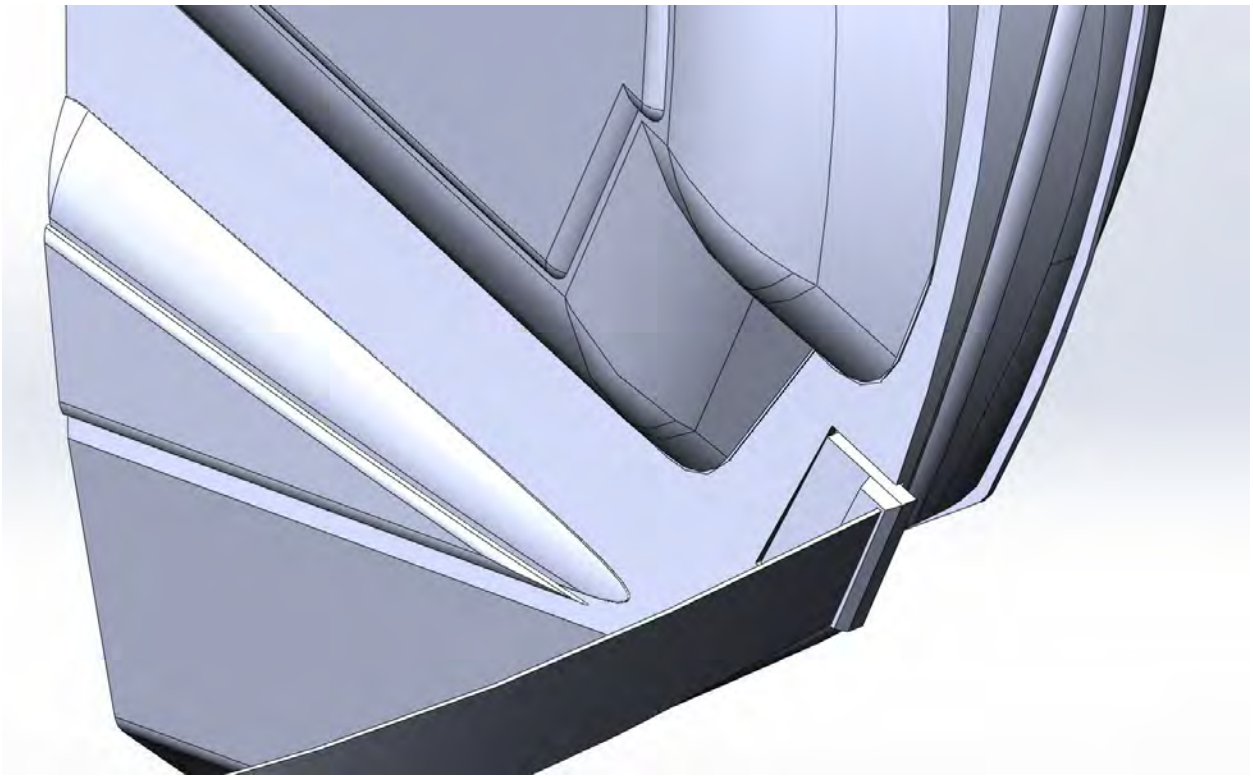
(To be filled out in the following semester)

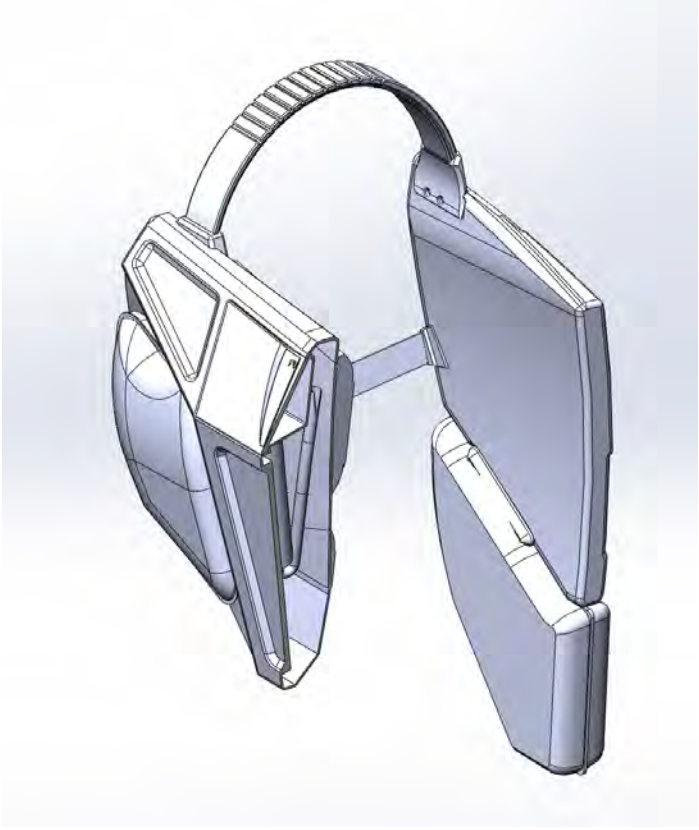
Appendix V CAD Models

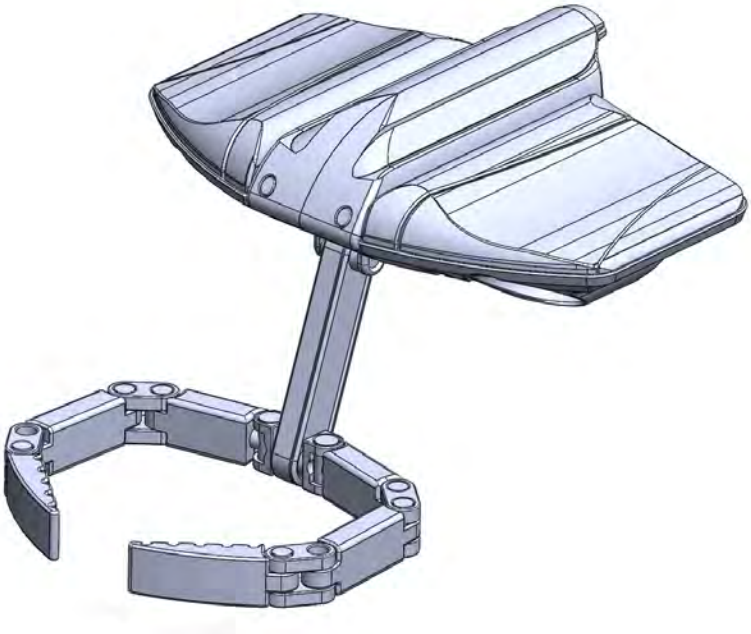


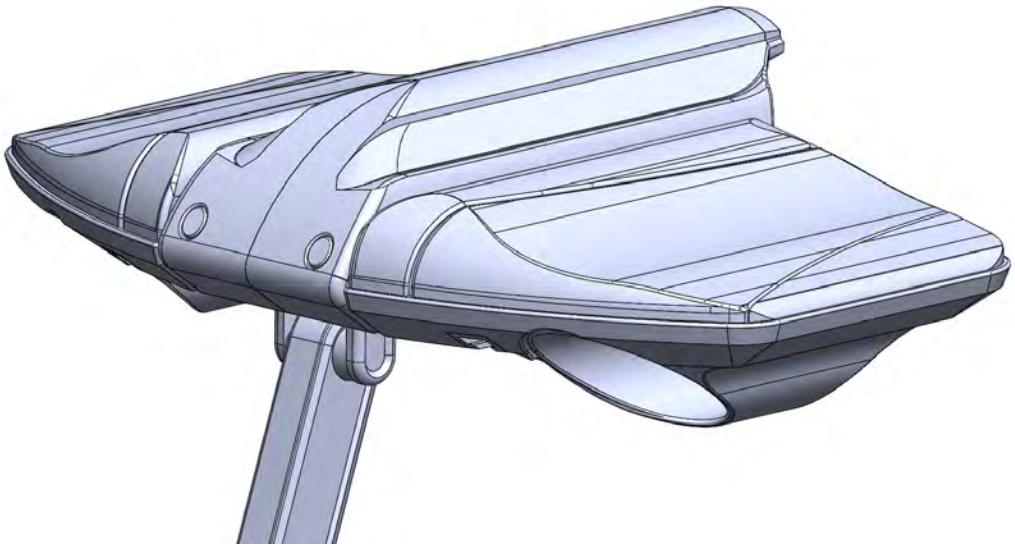


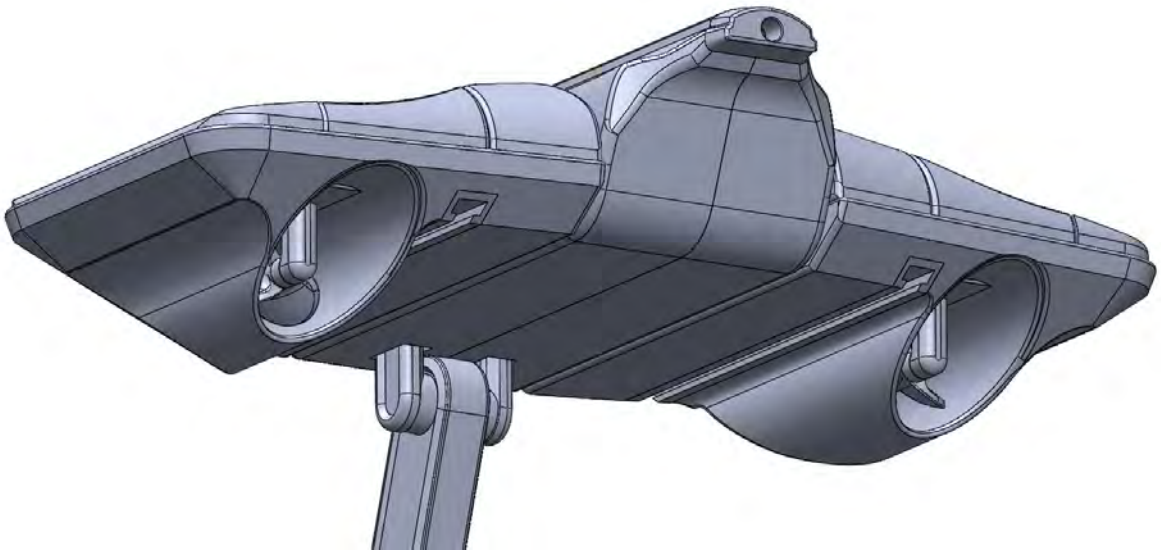


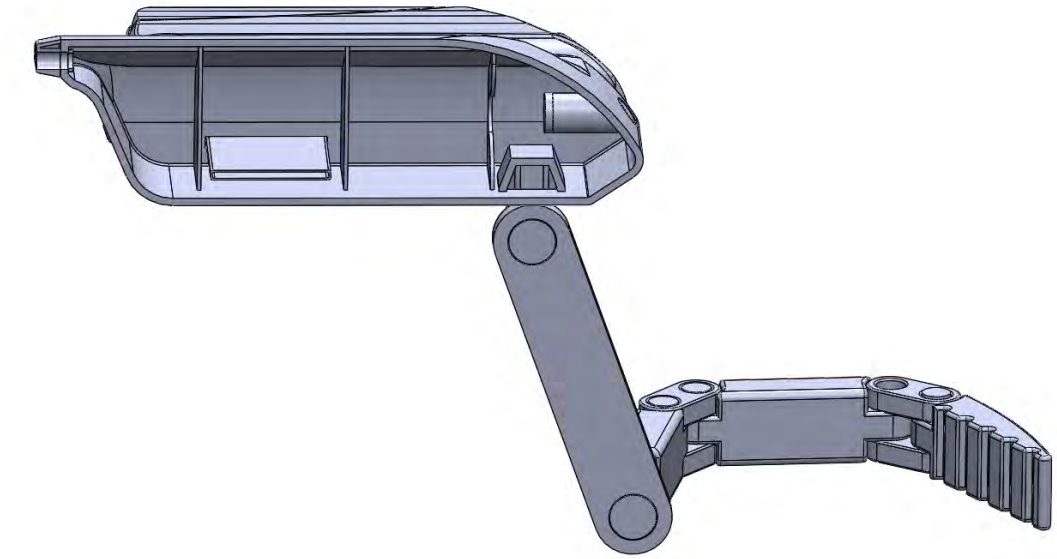


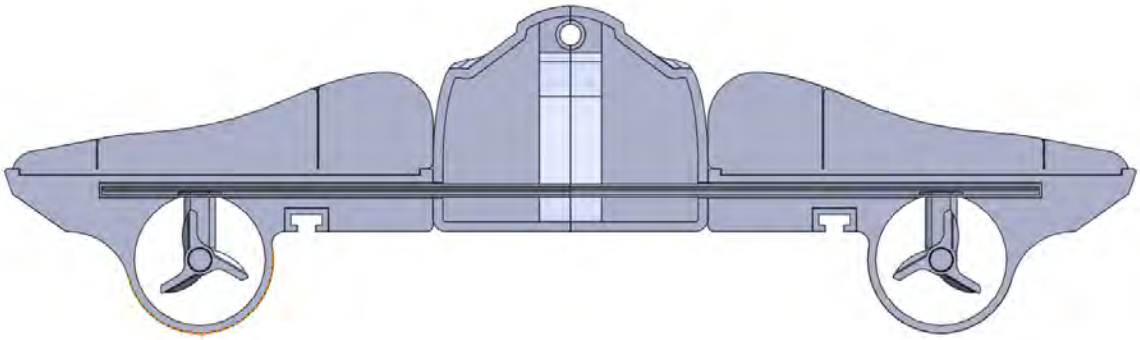


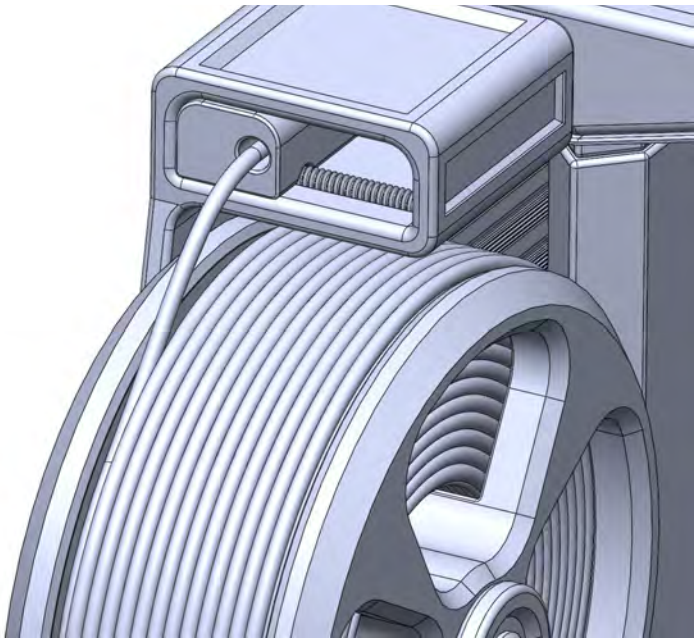


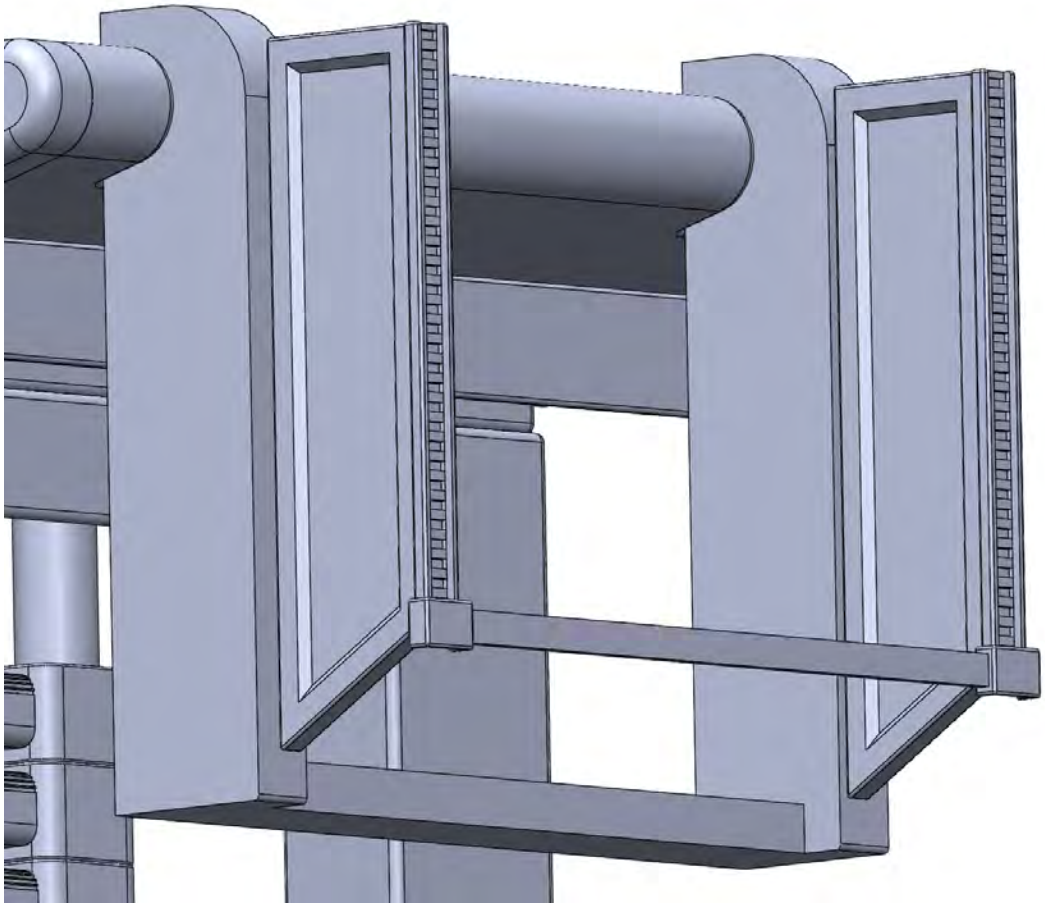


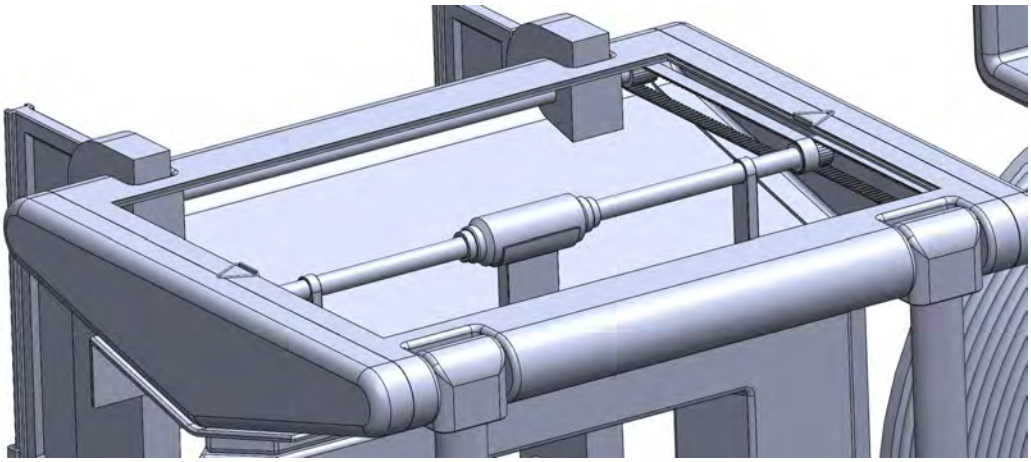


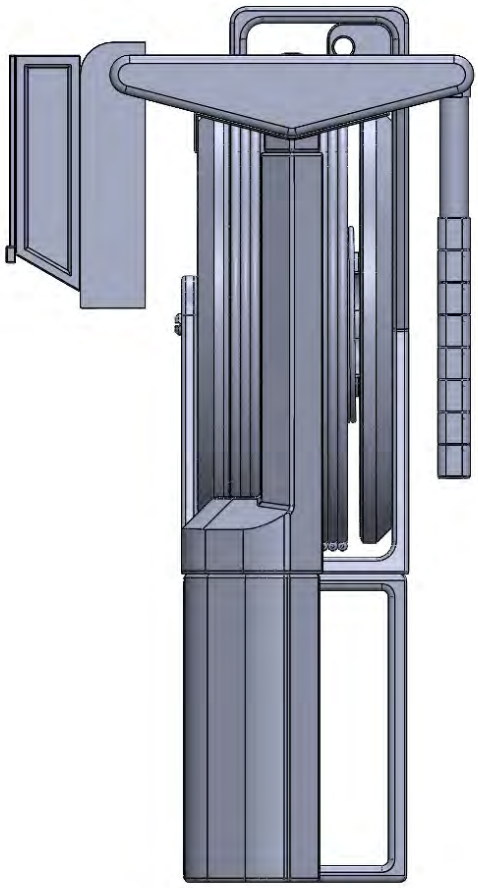




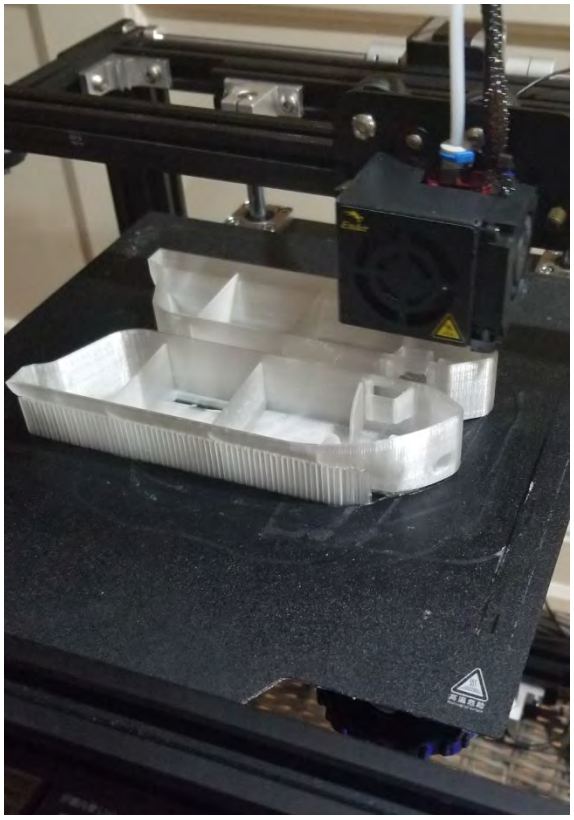


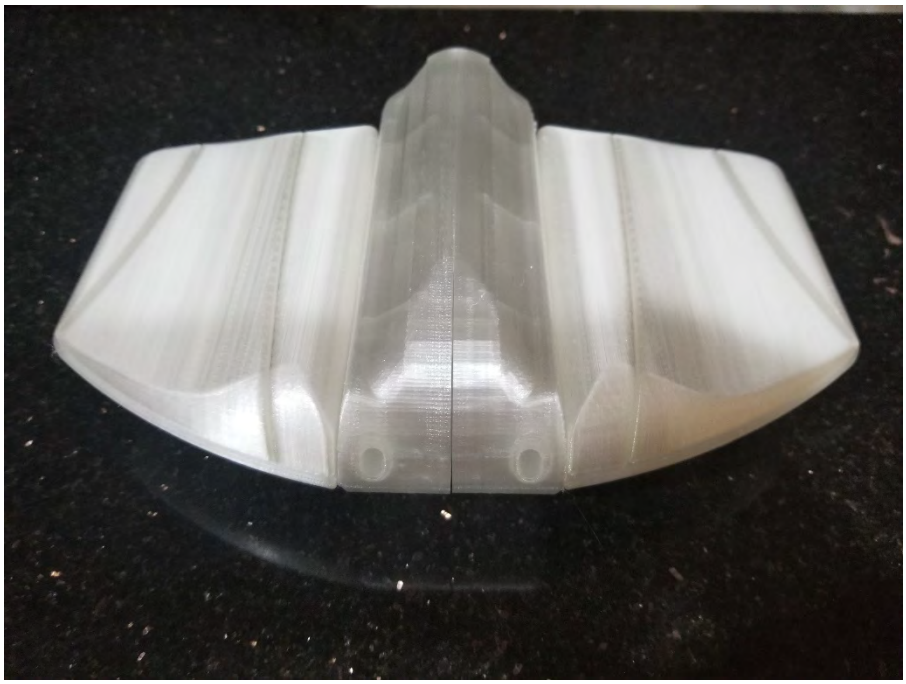


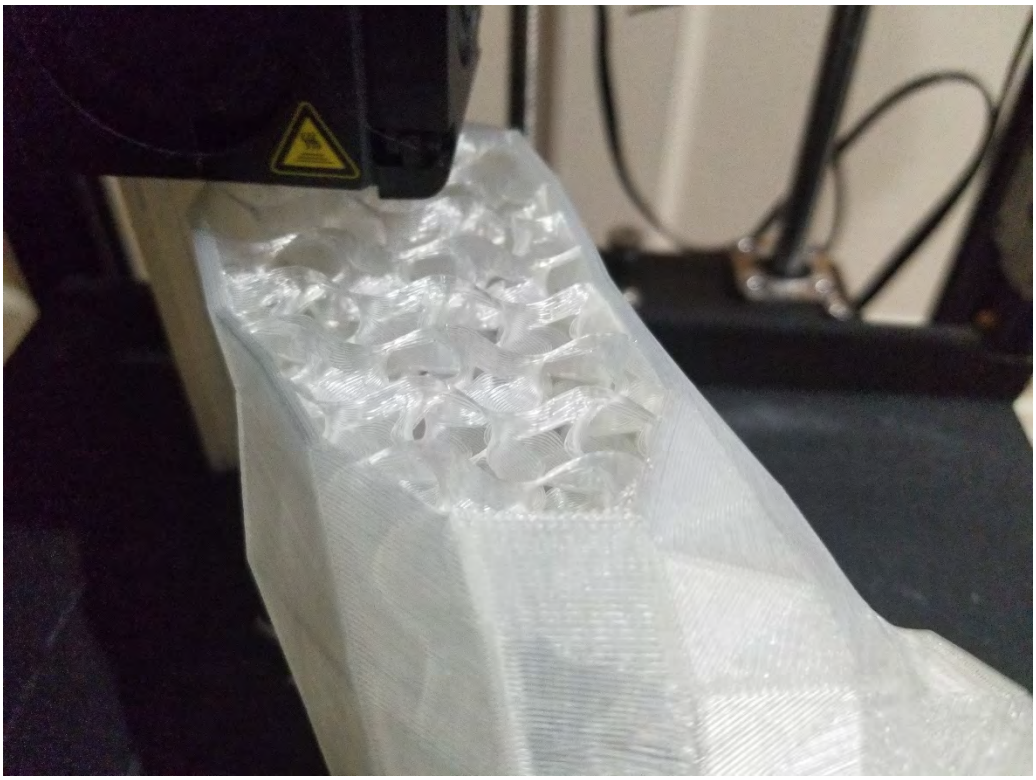


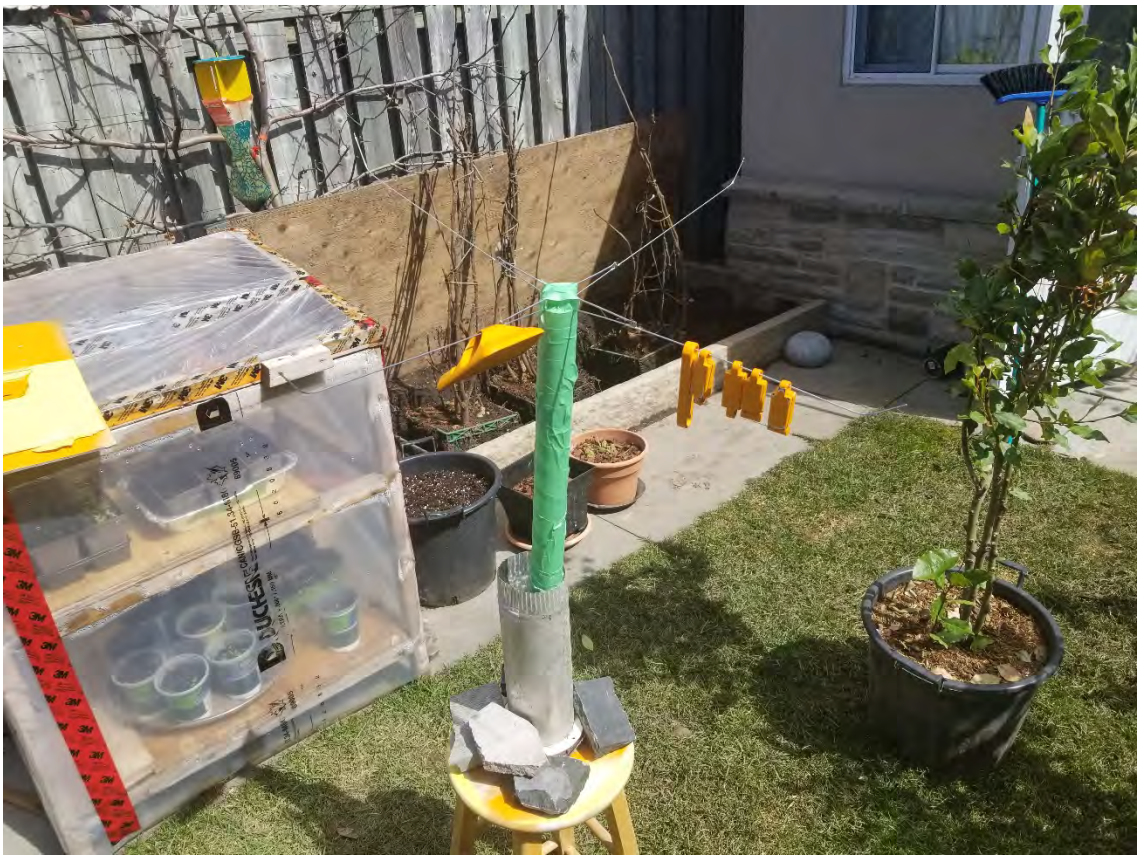


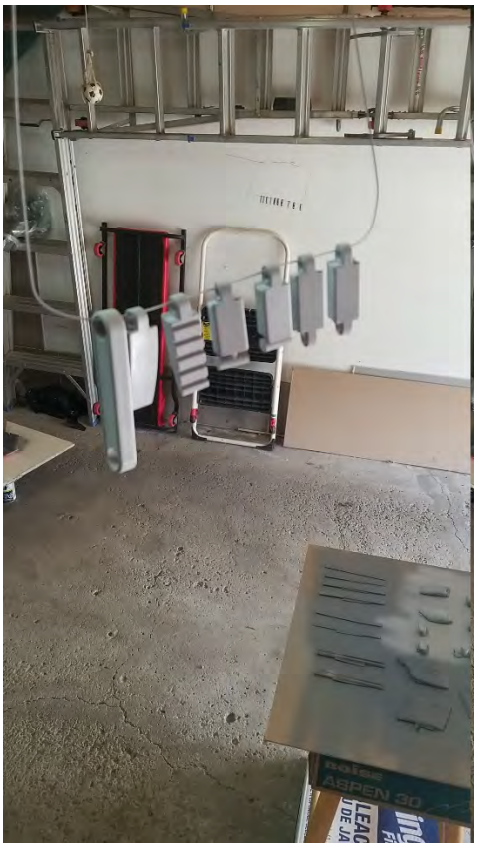
Appendix VI Hard Model Photographs

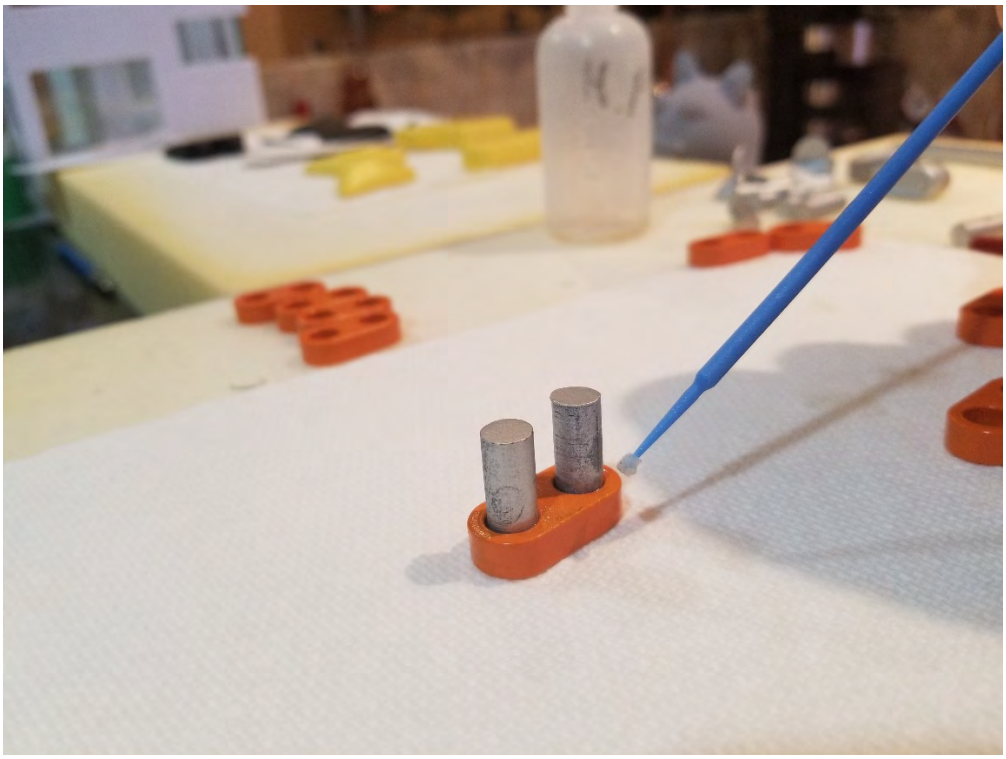


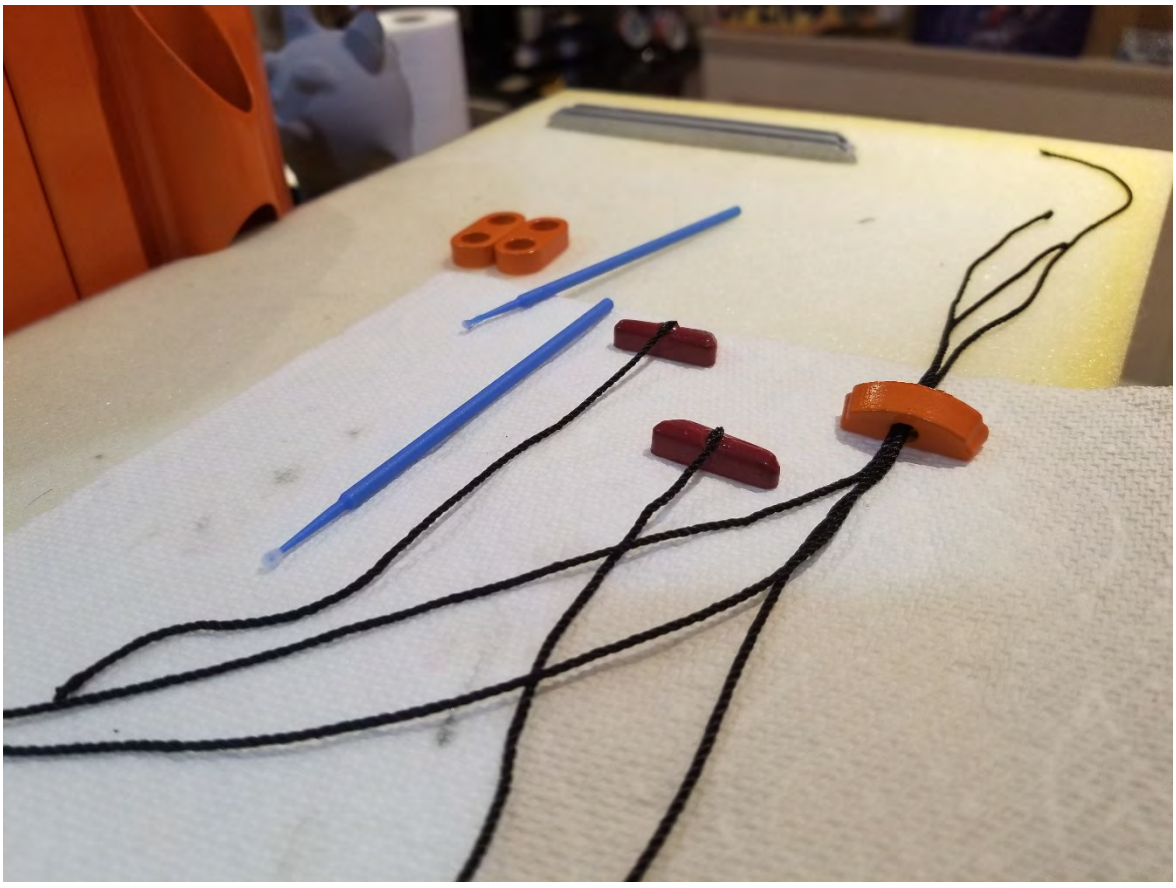







ASPEN 30





Appendix VII Sustainability Report

Abstract

The following report dives into analyzing the sustainability aspects of the proposed design for the universal marine rescue system. This is established through scope of materials, manufacturing, health, safety and environment. The proposed design aims to revolutionize the way users in distress are rescued after falling overboard from a vessel. The old ways of using PVC and materials that harmfully effect the environment is the way of the past. Since commercial boating and fishing have a realistic future, it is of interest to improve the safety of commercial boaters and fisherman by using new and upcoming polymers that have a safer environmental impact. The emerging technology we have today to navigate and track targets of

interest is on a track to become more accurate and reliable therefore safer than relying on human interaction in rescuing environments. These are all factors that the system of products aims to fully integrate into the concept to improve the way of future marine rescue systems.

2.2.4 Benchmarking Materials & Manufacturing

Reflective and water-resistant material is a necessity. The reflective material helps to identify the user in distress. The outer shell of a life-jacket is made of nylon or vinyl. The most commonly used material for PFD's in the modern day consists of plastic foams (polyvinyl chloride or polyethylene). There are three types of buoyancy substances used for PFDs. Inherently buoyant, inflatable and hybrid. Some models release CO2 into the jacket automatically when submerged in water and some when manually pulled by rip-cord.(Edmonds, 2019) Automatic submergence trigger is not ideal for inclement weather, heavy rain and hard waves will inflate PFD prematurely.

Life Cycle Assessment

Through some online research, a publication was uncovered about the current life cycle assessment of modern material applications for marine environments. This publication states that "the marine industry has been investigating the use of thermoplastic matrix composites (TMC's) There has been an interest in the use of cheaper and lower performance polypropylene thermoplastics and glass reinforcements as a recyclable and durable structural material." (Shenoi,2011)

Problems

Poor sustainability and expiration of the devices lead to a linear life-cycle that collect in landfills. Some life jackets get caught on equipment and tear apart, rendering them useless. The foam insulated devices usually have a 10-year expiration date on them and are not fit for buoyancy after this date.

Potential Solutions

Creating a personal flotation device that can contain replaceable parts. This way the user can purchase replacement parts instead of a whole new device. There is even potential to find a material that could be consumed by marine-life.

The product will be made of materials available to the current industry because they are proven and comply with standards that classify the products as personal flotation devices. However, research with new conceptual materials will be completed and implemented if found useful for the project.

2.2.5 Benchmarking Sustainability

Safety & Health

Safety is an absolutely necessary aspect of a personal flotation device. Since the risk of going overboard while on a vessel safety will always be priority. The design of PFD's allows the user to equip the device and, in most cases, allow the device to work for them by turning their bodies in a proper position, keeping their head out of the water allowing them to breath. The device also needs to allow enough room around the neck to avoid constriction to the individual. The accessibility of the device in the case of type IV devices need to be easily located, retrieved and thrown at the victim in a few seconds.

Environment

There has been little to no progress with developing PFD's made from sustainable materials. This is mainly because the availability(cost) and safety of the user outweigh the material choices. Some PFD prolong the life cycle by adding re-fillable CO2 cartridges that allow the life jacket to be used more than once. The life jacket itself does not have an expiration date, but the material used to keep it buoyant does. Losing the ability to keep the user afloat it is deemed unfit. Foam jackets can last a maximum of 10 years. Replaceable canisters have an expiration date of 1-3 years and need to be examined every few months for damage, debris or corrosion.(Goodwin, 2019)

Conclusion

Personal flotation devices are currently excellent at keeping the user safe in terrible conditions. There is still room for improvement on the materials used to create life vests as they will tend to rip and expire making them useless under regulations and safety standards. They then need to be thrown to the landfill as none of it is recyclable.

3.5 Sustainability-Safety, Health & Environment

User health and safety are priority when designing a personal flotation device. These aspects need to be critically analyzed and incorporated into the design. Through the history of personal flotation devices, the lifespan of the device has not taken into account the end of life placement for the device. Hopefully the result of this thesis project could help in finding a solution to properly deal with the end of life section of the product.

Safety

Personal flotation devices are designed to keep the user safe from drowning by keeping their head on top of the water. Since the risk of going overboard while on a vessel will always

be a factor, the device must be easy to use and require little to no training. Once the user falls overboard, a potential solution would be to include an inflatable neck and head brace that will protect the user from hitting the waves with enough force to get a concussion. The design of PFD's allows the user to float face up so that if the user is unconscious or unable to move, they will not drown. The device also needs to allow enough room around the neck and arm/shoulder area to avoid constriction to the individual. The accessibility of type IV devices needs to be easily located, retrieved and thrown at the victim in a few seconds. These devices cause potential issues because of the material they are made of. The hard plastic could knock a victim unconscious when thrown at leaving them unable to grab onto the device. The same goes with individuals under the influence or passed out, there is no way to throw this device to them and reel them in properly without them being attentive.

Health

The health of the users who use PFD's is very important as they will need to use the life jacket even when they do not need it. It is important that the ergonomic requirement of the user is met and that the device can limit uncomfortable positions. It is important that the user will be properly supported when hauling in a catch or lifting heavy containers to preserve their back, spine and joints.

Environment

Selection of material for safety products such as life vests should not be compromised in favour of a sustainable option that will lead to poor performance of said product. This is possibly why there were no improvements to the end of life cycle for life vests. The inherent foam used in the life vests are designed to resist decomposition, this can harm marine life. The

proposed design selection should consider the environmental impact of the end-use cycle, and possibly incorporate a re-usable/replaceable system that will allow the user to replace parts without having to worry about buying a whole new system of products.

5.6 Sustainability

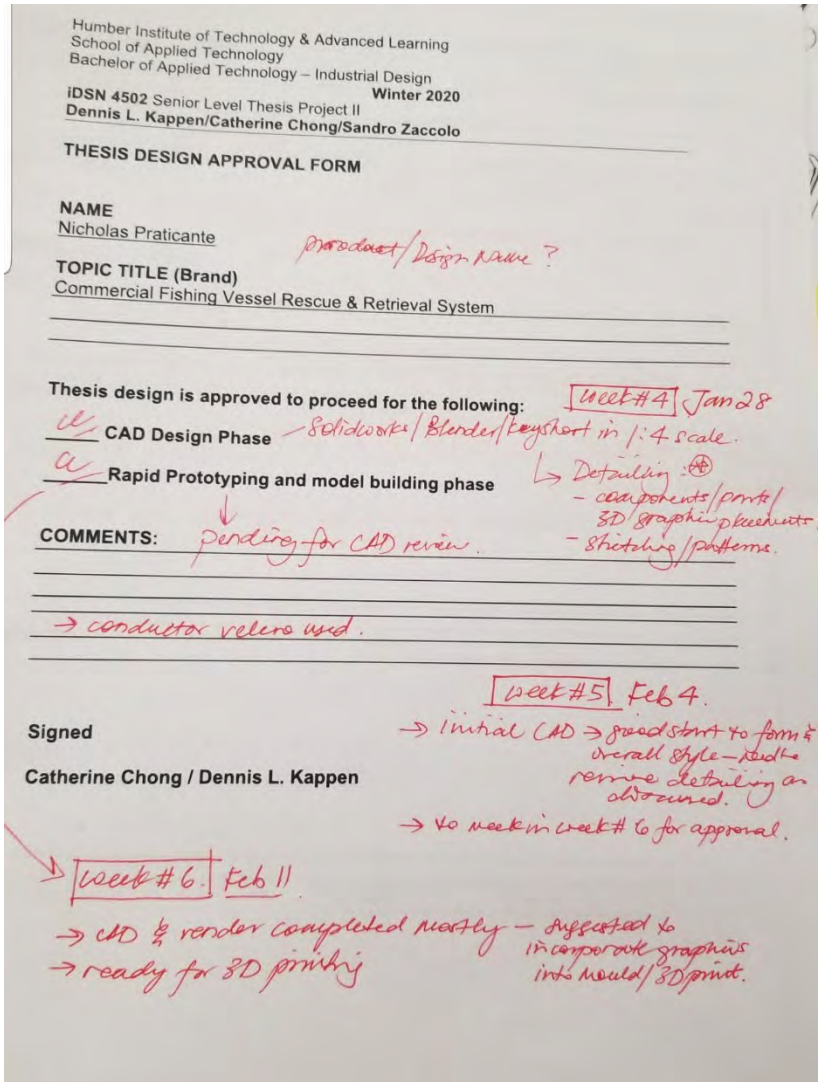
The system would achieve a sustainable title through the use of healthier material alternatives. The marine industry is under a shift currently of shifting from fiberglass to a carbon fiber structure. Completely eliminating environmentally harming materials like PVC that is commonly used in marine products. Incorporating flotation devices that use polypropylene instead of PVC. The design also incorporates a system that will allow the user to replace different parts of the entire system that will become obsolete or un-usable through regular wear and tear. The aluminum and stainless steel used for the product is 100% recycled. The proposed design is estimated to last longer from the modularity feature within the family of products. Modern day life jacket and vests, depending on their buoyancy type expire after 5-10 years.

Edmonds, M. (2019). Inside a Life Jacket | HowStuffWorks. Retrieved February 11, 2019, from https://adventure.howstuffworks.com/outdoor-activities/water-sports/life-jacket2.htm

Goodwin, D. (2019). Do Life Jackets Expire? Retrieved February 11, 2019, from https://aquamobileswim.com/life-jackets-safety-tips/#.Xb4LAOhKiUl

Shenoi, R. & Dulieu-Barton, Janice & Quinn, S. & Blake, James & Boyd, Stephen. (2011). Composite Materials for Marine Applications: Key Challenges for the Future. 10.1007/978-0-85729-166-0_3.

Appendix VIII Topic Approval Form



Humber Institute of Technology & Advanced Learning
School of Applied Technology
Bachelor of Applied Technology – Industrial Design
iDSN 4502 Senior Level Thesis Project II — Winter 2020
Dennis L. Kappen/Catherine Chong/Sandro Zaccolo

THESIS DESIGN APPROVAL FORM

NAME
Nicholas Praticante

product / Design Name ?

TOPIC TITLE (Brand)
Commercial Fishing Vessel Rescue & Retrieval System

Thesis design is approved to proceed for the following: week #4 Jan 28

w CAD Design Phase — Solidworks / Blender / keyshot in 1:4 scale.
→ Detailing: (A)
- components / parts / 3D graphic placements
- stitching / patterns.

a Rapid Prototyping and model building phase

COMMENTS: pending for CAD review.

→ conductor velcro used.

week #5 Feb 4.
→ initial CAD → good start to form & overall style — need to refine detailing as discussed.
→ to meet in week # 6 for approval.

Signed

Catherine Chong / Dennis L. Kappen

week #6 Feb 11
→ CAD & render completed nearly — suggested to incorporate graphics into mould / 3D print.
→ ready for 3D printing

Appendix IX Advisor Meetings & Agreement Forms

2019-20 Industrial Design Thesis Project HUMBER

INFORMATION LETTER

Title: User Centered Interaction Study (commercial fishing equipment)

Investigator: Mr. Nicholas Praticante

Sponsor: Humber College

Introduction

My name is Nicholas Praticante, I am an industrial design student at Humber College, and I am inviting your participation in a research study on various problems that commercial fishing workers deal with. These problems include visibility, whole-body strain and access to safety equipment. The results will be contributed to my senior project/thesis.

Purpose of the study

This study is being conducted as an aid in designing a Personal device/equipment that is capable of performing many tasks while on open waters keeping the user safe. The product to be designed is inspired by current floatation methods and fisherman gear and the many problems that revolve around them. With your help, I plan to address problems that workers of these vessels face on a regular basis. This study is primarily based 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 activities in interacting with device/equipment will be observed and documented. Your activities will be documented by the means of a digital camera/video camera/written notes while operating. You will also be asked questions pertaining to the device/equipment and how you use it.

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 want to end your participation, please let the moderator know and they will end your participation the immediately.

Conditions of Participation

- I understand that I am free to withdraw from the study at anytime 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)

2019-20 Industrial Design Thesis Project

HUMBER

- 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.

Ryan Ford - FishSafeBC

Name of Participant (please print)

Signature of Participant

Feb 26 '20

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, please contact me at Ph: 647 389 1619, email: nickpraticante@gmail.com.

My supervisors are:

Prof. Catherine Chong, catherine.chong@humber.ca, 416 675 6622 xt. 4672

or Prof. Dennis L. Kappen, dennis.kappen@humber.ca, 416 675 6622 xt 4832,

2019-20 Industrial Design Thesis Project

HUMBER

Verification of having read the informed consent form:

☒ I have read the informed consent letter

I, Ryan Ford *(First Name, Last Name, Signature)*, have read this document and give consent to the use of the data from questionnaires and interviews in research reports, publications (if any) and presentations with the proviso that my identity will not be disclosed.

Signature : _____

Participants Name : Ryan Ford

Humber Research Ethics Board

This 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. Darren Lawless, REB Chair, 416-675-6622 ext. 3226, darren.lawless@humber.ca.

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, please contact me at Ph: 647-389-1619, email: nickpraticante@gmail.com.

My supervisors are:

Prof. Catherine Chong, catherine.chong@humber.ca, 416 675 6622 xt. 4672

or Prof. Dennis L. Kappen, dennis.kappen@humber.ca, 416 675 6622 xt 4832,

Good afternoon Ryan,

So I am still working on some concepts but I do have some quick sketches that I can send you now. In a few weeks I will be coming up with a presentation between two main ideas

Bear with me because these ideas are very, very early in the concept stage and there is a lot of quirks that needs to be worked out. I would love to take any feedback that you can give about the design concepts and let me know what you think!

These ideas include:
1. A PFD that is very lightweight, it has a hoop attachment that allows a retrieval drone from the vessel to reach out, latch onto the victim and tow them back to the vessel.
features a heating apparatus, heated gloves and a respirator that modifies air temperature for a comfortable working condition.
GPS Location and sensor to aid the retrieval device.

2. This device is more useful for individuals who go overboard without a PFD, essentially the retrieval device will launch from the ship. the user attaches themselves or the device will attach itself to the user and make there way back to the boat. For unconscious, under the influence and injured individuals this device can be piloted by a secondary user (Or by an A.I with sensors) that will manage to locate the user and tow them back to the boat.
[Quoted text hidden]

3 attachments

20191126_131345.jpg
6994K

20191126_131324.jpg
6510K

Thesis Sketches 11-20-2019.pdf
6417K

Ryan Ford <ryan@fishsafebc.com> 28 November 2019 at 13:11
To: Nick Praticante <nickpraticante@gmail.com>

Hi Nick – thanks for sending along your sketches and comments – it's really great to see your out-of-the-box thinking on this subject.

Some things to think about as your work progresses:

- Who is your audience for your product? Fishermen working on small fishing vessels or large fishing vessels?

2019-20 Industrial Design Thesis Project

HUMBER

Informed Consent Form

Research Study Topic : *Commercial Fishing*
Investigator : Nicholas Praticante
Course : iDSN 4002/iDSN 4502

I, Ryan Ford, have carefully read the Information Letter for the thesis project. A member of the research team has explained the project to me and has answered all of my questions about it.

I understand that if I have additional questions about the project, I can contact Nick Praticante via email nickpraticante@gmail.com at any time during the project. I understand that this course has been approved by the Humber Research Ethics Board.

- ☐ I hereby give consent to have my voice recorded
- ☐ I hereby give consent to have photographs taken with the proviso that my identity will be blurred in reports and publications
- ☐ I hereby give consent to have videos taken 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 of data with privacy and confidentiality maintained in the Humber Digital Library which is an Open Access platform	☑	☐
Review	I give consent for review by the Professor	☑	☐

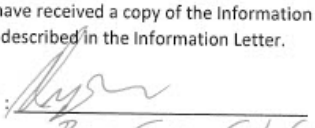
Withdrawal:

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

Privacy:
All data gathered is stored anonymously and kept confidential. Only the researcher

Mr. N. Praticante and Prof. Catherine Chong and Prof. Dennis L. Kappen 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.

My signature below verifies that 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.

Signature : 

Participants Name : Ryan Ford - FishSafeBC

Gmail Nick Praticante <nickpraticante@gmail.com>

Fish-safe Survey results as of 2019-11-05

8 messages

Nick Praticante <nickpraticante@gmail.com> 5 November 2019 at 09:46
To: Ryan Ford <ryan@fishsafebc.com>

Hey Ryan,

Here are the results compiled from the survey. I wanted to wait a while to allow enough users to answer. I have gained a significant amount of insight from this survey and will be using it for my thesis project.

If you are interested I can keep you up to date with the concepts I come up with within the coming months.

Nick Praticante

Survey Results Commercial Fishermen.pdf
99K

Ryan Ford <ryan@fishsafebc.com> 6 November 2019 at 08:40
To: Nick Praticante <nickpraticante@gmail.com>

Thank you Nick – I'm on the road this week but will review more thoroughly shortly – I appreciate you providing me with the update.

Ryan

[Quoted text hidden]

Nick Praticante <nickpraticante@gmail.com> 6 November 2019 at 15:45
To: Ryan Ford <ryan@fishsafebc.com>

Sounds good, take your time

I would also like to send you a few concepts I have sketched out, once I refine them for class next week

Best,

Nick
[Quoted text hidden]

Ryan Ford <ryan@fishsafebc.com> 26 November 2019 at 12:56
To: Nick Praticante <nickpraticante@gmail.com>

Hi Nick – just wanted to touch base – how are you progressing?

Best.

[Quoted text hidden]

Nick Praticante <nickpraticante@gmail.com> 26 November 2019 at 20:32
To: Ryan Ford <ryan@fishsafebc.com>

- The vast majority of man overboards and fatalities occur on small fishing vessels – Transport Canada defines a 'small' fishing vessel as being 12 M and under. On our west coast the vast majority of our fishing fleet is made up of these small vessels – about 2,800 vessels out of 3,400 vessels. The same is true on the east coast.

- Generally speaking, there won't be room on small fishing vessels for stand-up consoles to operate a drone.

- What is the cost of purchasing and installing and possibly modifying a vessel to accommodate a drone and operating station?

- Many fishermen are single operators. How does the solution you design protect a single operator that falls overboard without anyone on board to help him/her?

- The vast majority of fishermen are very, very cost-sensitive. Fishing is very much a boom and bust kind of business. Most fishermen currently resist the thought of having to spend more than $200-300 for a PFD.

- Fishermen will not wear a PFD that has an obvious catching or snagging risk. They will tolerate some belts and straps as long as they fit snuggly to the body or out of the way, but anything beyond that poses a real risk of being pulled overboard by nets, hooks and gear or being pulled into machinery.

- A PFD must get a user's head above water immediately. I've attached information about cold-shock and it's very important to understand what happens the moment a person is immersed in cold-water.

Just some things to consider as you move along Nick.

[Quoted text hidden]

Coldwater 1-10-1 Poster double sided.pdf
2390K

Nick Praticante <nickpraticante@gmail.com> 2 December 2019 at 13:33
To: Ryan Ford <ryan@fishsafebc.com>

Hey Ryan,

Thank you so much for this additional information, I'm in a hard spot right now with the design process.

Cost is definitely a consideration since I will be shifting the focus to single fisherman in smaller boats.

I believe my final design will focus on a type of drone that will go together with a vest.

However, my thesis guidelines put me in a hard spot as it requires me to design a product that has full-bodied interaction. So unfortunately i cant just make a new life jacket because it only
has two possible contact points which are the chest and the back.

The device I will end up designing will need to consider more points of contact like the hands and neck/head.

So what i was thinking was creating a family of products that go together that create this whole package to full fill my thesis requirements. This way if a commercial fisherman has a budget to only spend $150 on a life jacket it wont be a problem.

I will definitely keep you updated once I have chosen a single design direction

P.S I saw the video you sent me on the students project, yeah I believe you sent it before I think its a great idea and i want to see if i could incorporate some of that technology into the final design.

Best,

Nick
[Quoted text hidden]

Ryan Ford <ryan@fishsafebc.com> 2 December 2019 at 19:20
To: Nick Praticante <nickpraticante@gmail.com>

Yes, you have some challenging thesis requirements, but it's good because it's forcing you to consider the unconventional.

I'm not sure if you've seen the floatation pants and bib pant concepts – but they're a popular choice for many fishermen in the US and internationally. Fishermen here in Canada like the concept too but because none of these pant-style pants are Transport Canada approved they are forced to consider choices that are approved, whether they find them comfortable to wear or not. Many fishermen like the pant-style option with built in floatation as they involve clothing they normally wear anyways – they normally wear rain pants to keep the fish guts off them and to keep water from soaking them – so it's not a big adjustment. Just thought I would mention these as you are having to consider more than 2 points of contact.

https://www.regatta.no/en/leisure/floatation-suits/regatta-fisherman-dress/#

https://www.stormlinegear.com/product/662-heavy-duty-oilskin-fishing-flotation-pants/

[Quoted text hidden]

Appendix X Topic Specific Data, Papers, Publications

Commercial fishing vessels docked at Fishermen's Harbour, Port Alberni, B.C. (Kelda Blackstone photos)

Port Alberni, BC —

WorkSafeBC has introduced new regulations aimed at improving safety conditions for workers on board commercial fishing vessels. Every person on board is now required to wear a life jacket or PFD (personal floatation device) while on deck. The regulation went into effect last month, on June 3, and applies to all commercial vessels, regardless of size.

The change was not unexpected by commercial fishers, said Patrick Olsen, manager of Prevention Field Services at WorkSafeBC, in a phone interview on June 25. But overall, he says, the regulations have been well-received. Crewmembers have been pulled into the water while managing lines, setting gear, and in other situations. The use of a life jacket reduces the risk of drowning, stated Olsen.

WorkSafeBC's regulations are informed by new recommendations for safety onboard commercial fishing vessels that were made following the September 2015 capsizing of the Caledonian near Tofino. Three crewmembers drowned in the incident; only the crewmember wearing a PFD survived the tragedy.

George Chester John Sr., a seasoned Ahousaht commercial fisherman known to friends and family as Chester, supports the new regulations. He is the skipper of the Flora Queen, a 36-foot wooden troller based in Tofino, and has been fishing for 64 years.

"I've done longlining, seining, gill netting, trolling," John said in an interview at his Port Alberni home. "When I started, I was only about 10 or 11."

When John heard about the regulation, he phoned around to five or six fellow fishermen, to see what they thought about it.

"Everyone agreed," John said, "They want to have their life jackets. Keep them safe. Because they're responsible for their crew."

"They might blame me, eh," John continued, speaking of his responsibility as skipper on the Flora Queen. "If [the deckhand] falls overboard or like if I'm napping, tell him to take the wheel for a while, he might go outside . . . accidently [fall overboard]."

John is waiting for the next opening, when he will go out for spring salmon. Part of his willingness to comply with the new regulations is motivated by a desire to avoid penalties.

"One guy was saying 'I don't have to wear it,' to me yesterday," he said. "But I said no, I think we gotta have it, otherwise we'll be in trouble. They might tie us up [restrain the vessel at the dock, preventing them from

fishing]."

But he does understand and support the safety reasons behind the regulation. He has been in situations himself that led him to put on a life jacket, at a time when regulations were not as prescribed.

"I've seen a lot of storms," said John. "Once going to Ahousaht, I sort of got scared...There was another boat behind me not too far, used to disappear by the big groundswell, some of it was breaking. So I put a life jacket on. I was by myself. Just in case something happened. I think you gotta have it, anyways."

Dale Miller, executive director at the BC and Yukon branch of the National Lifesaving Society, says the introduction of the new regulations is good news. Anything resulting in more people wearing life jackets is supported by the Lifesaving Society, said Miller in a phone interview.

Any flotation device approved by Transport Canada is acceptable and will follow regulation. Miller describes a new hybrid type of PFD, which is inflatable but also inherently buoyant. It's not nearly as bulky, and could be a good solution for those working on fishing vessels, as it won't inhibit movement. Similar to the enforcement of seatbelt use in vehicles, Miller hopes that everyone gets used to the idea, and that it becomes commonplace.

"The new regulation will help [improve safety] a lot," stated Miller. "There may be some resistance initially, but if you look at the number of tragedies, it's well worth it having everyone wear a life jacket."

Photo Gallery:

George Chester John Sr., Ahousaht fisherman and skipper of the Flora Queen, outside his Port Alberni home.

Nuu-chah-nulth Council of Ha'wiih endorses Gord Johns

Background

Commercial fishing is a complex industrial process that varies greatly among fisheries. The work is often conducted under adverse weather conditions on unstable work platforms. Fall protection systems such as safety lines and guard rails are often absent because they might interfere with the work or introduce new hazards.

Most fatalities of commercial fishermen are related to vessel casualties such as capsizing, sinking, foundering, grounding, and collision. However, a large number of fatalities result from falls overboard and are not related to vessel casualties. PFDs are known to increase the chances of survival for all fishermen who enter the water for any reason. But many commercial

known to increase the chances of survival for all fishermen who enter the water for any reason. But many commercial

fishermen say that they are unwilling to wear a PFD during routine work on deck because it might interfere with their performance. USCG regulations [46 CFR 28.110] require commercial fishing vessels to be equipped with at least one USCG-approved PFD or immersion suit of the proper size for each person on board. However, the PFD is not required to be worn.

The effectiveness of PFDs in saving the lives of fishermen who fall overboard or abandon sinking or capsized vessels is supported by available informationabout those who survived such incidents during the period 1991-93 [NIOSH 1994B]. Fishermen who drowned or were presumed to have drowned were compared with those who survived incidents in which at least one fisherman drowned: 63% of those wearing PFDs survived (10 of 16), but only 12% of those without PFDs survived (6 of 50) . Seventeen fishermen fell overboard and drowned during the period 1991-93; none of them were wearing PFDs.

Fishermen who fall overboard in cold water are at risk of hypothermia (the cooling of the core body temperature). This condition causes shivering, loss of muscle coordination, unconsciousness, and possibly death. A well-trained crew and captain have a greater chance of rescuing and reviving a fisherman who has fallen overboard wearing a PFD than one who is not wearing a PFD. Near-drowning victims have been successfully resuscitated after relatively long immersions in cold water (up to 1 hour) [Modell 1993].

Fatality Rates in the Commercial Fishing Industry

Fatality rates for commercial fishermen in the United States are collected by both the NIOSH National Traumatic Occupational Fatality (NTOF) Surveillance System and by the USCG.

The NTOF Surveillance System recorded the deaths of 637 commercial fishermen in the United States during the 10-year period 1980-89 [NIOSH 1994a]. Drownings accounted for 69% of these deaths. The actual number of commercial fishermen who died is higher than reported by NTOF because methods for collecting and reporting data tend to underestimate the total number of deaths [NIOSH 1993].

The USCG recorded 648 deaths of commercial fishermen in the United States during the 5-year Period 1982-87—an annual fatality rate of 47 deaths per 100,000 commercial fishermen [NRC 1991]. The fatalities were distributed nearly evenly among the Atlantic coast, the gulf coast, the west coast, and Alaska.

Fatality Rates in the Commercial Fishing Industry

Fatality rates for commercial fishermen in the United States are collected by both the NIOSH National Traumatic Occupational Fatality (NTOF) Surveillance System and by the USCG.

The NTOF Surveillance System recorded the deaths of 637 commercial fishermen in the United States during the 10-year period 1980-89 [NIOSH 1994a]. Drownings accounted for 69% of these deaths. The actual number of commercial fishermen who died is higher than reported by NTOF because methods for collecting and reporting data tend to underestimate the total number of deaths [NIOSH 1993].

The USCG recorded 648 deaths of commercial fishermen in the United States during the 5-year Period 1982-87—an annual fatality rate of 47 deaths per 100,000 commercial fishermen [NRC 1991]. The fatalities were distributed nearly evenly among the Atlantic coast, the gulf coast, the west coast, and Alaska.

In Alaska alone, the fatality rate among commercial fishermen was 195 deaths per 100,000 fishermen during 1991-93 [NIOSH 1994b]. During the same period in Alaska, 233 workers died of occupational injuries; 91 (39%) of these workers were commercial fishermen, and 83 of the 91 fishermen (91%) drowned [NIOSH 1994B].

Federal Regulations

PFDs

All commercial fishing vessels must be equipped with at least one USCG-approved immersion (survival/exposure) suit or wearable PFD (Type I, II, III, or V) of the proper size for each person on board [46 CFR 28.110]. Immersion suit and PFD requirements are based on vessel location, temperature of the water, type of operation, and length of the vessel. In addition, requirements for Type IV PFDs (throwable devices) depend on the length of the vessel. Each wearable PFD or immersion suit must be stowed so that it is readily accessible to the person for whom it is intended from both the normal work station and berthing area. If no location is accessible to both the normal work station and the berthing area, an appropriate PFD or immersion suit must be stowed in both locations [46 CFR 28.110].

Cardiopulmonary Resuscitation

All commercial fishing vessels must have a minimum number of persons on board who are certified in first aid and cardiopulmonary resuscitation (CPR) [46 CFR 28.210]. The requirements are as follows:

- 3 to 16 persons on board–1 certified person
- 17 to 49 persons on board–2 certified persons
- 50 or more persons on board–4 certified persons

Commercial fishing is one of the most dangerous jobs in the United States, with a 2016 work-related fatality rate (86.0 deaths per 100,000 full-time equivalent workers) 23 times higher than that for all U.S. workers (3.6) (*1*). Sinking vessels cause the most fatalities in the industry; however, falling from a fishing vessel is a serious hazard responsible for the second highest number of commercial fishing–associated fatalities (*2*,*3*). CDC's National Institute for Occupational Safety and Health (NIOSH) analyzed data on unintentional fatal falls overboard in the U.S. commercial fishing industry to identify gaps in the use of primary, secondary, and tertiary prevention strategies. During 2000–2016, a total of 204 commercial fishermen died after unintentionally falling overboard. The majority of falls (121; 59.3%) were not witnessed, and 108 (89.3%) of these victims were not found. Among 83 witnessed falls overboard, 56 rescue attempts were made; 22 victims were recovered but were not successfully resuscitated. The circumstances, rescue attempts, and limited use of lifesaving and recovery equipment indicate that efforts to reduce these preventable fatalities are needed during pre-event, event, and post-event sequences of falls overboard. Vessel owners could consider strategies to prevent future fatalities, including lifeline tethers, line management, personal flotation devices (PFDs), man-overboard alarms, recovery devices, and rescue training.

Figure 2

Table

References

Related Materials

[PDF]

A case of commercial fishing–associated overboard fall fatality was defined as a fatal traumatic injury resulting from an unintentional fall from a commercial fishing vessel in United States waters during 2000–2016. Fishermen often live on their vessels when working and are exposed to hazards while off duty; therefore, victims were considered to be at work for the entire time they were at sea. Cases were identified from NIOSH's Commercial Fishing Incident Database, a national surveillance system that collects detailed information on all work-related fatalities in the fishing industry; data sources include U.S. Coast Guard investigative reports, local law enforcement reports, medical examiner documents, and news media. Records for each fall overboard were reviewed to determine the circumstances of the fall, including time in water, any use of survival or rescue equipment, recovery attempts, and administration of medical treatment. A descriptive analysis of event and

Life jackets with foam are classified as inherently buoyant because a person does not need to do anything to activate the flotation. These foams use closed cells that trap air in pockets when the jacket is submerged.

Life jackets can also be classified as **inflatable**. These life jackets have cartridges of carbon dioxide gas sewn into them. When activated, the gas will release and fill the chambers of the jacket.

Some models will activate the release of gas automatically when the jacket is submerged, thanks to a small dissolvable stopper, like a bobbin or a pill. These devices are made of a water-soluble material, and when they dissolve, the gas is released and inflates the jacket. Other inflatable models require the wearer to pull a tab to activate inflation. When the user pulls the tab, it pierces the carbon dioxide canisters to release the gas. Both of these inflatable devices include tubes that a person can blow into, providing a backup way to inflate the jacket.

Inflatable life jackets have been in use since World War II, but the Coast Guard did not approve them for recreational use until the 1990s because of the extra steps involved. However, inflatables have become more reliable, and many people prefer inflatable life jackets because they aren't at full size until inflated. They're less bulky and more comfortable for all-day use. Inflatable life jackets are recommended only for adults who are strong swimmers.

Hybrid life jackets are a mix of natural buoyancy and manual inflation. Inherently buoyant, inflatable and hybrid life jackets all work the same way, though. No matter how the trapped air gets in there, it weighs much less than the weight of the displaced water, and holds the person in the life jacket afloat.

https://adventure.howstuffworks.com/outdoor-activities/water-sports/life-jacket2.htm