Progress Swim Equipment For Young Swimmers

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By Lewis Hui

Progressive Swim Equipment For Young Swimmers

by

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Abstract

Learning to swim is an important life skill that allows users to save themselves in unforeseen water-related accidents. Whether it's falling off a boat or into a pool, being able to swim is the difference between life or death for the user. As swimming is an essential life skill, parents sign up their children to learn how to swim at a young age. Children are at an initial disadvantage due to limited attention spans, cognitive/physical limitations and/or potentially experiencing past traumatic water-related experiences. Common hindrances children experience include being unable to kick with flexed feet, accomplish physical actions or being unable to multitask at the same time. Due to the problems, learning to swim can become a lengthy process depending on how quickly the child can overcome the problems and learn how to swim. Depending on how long it takes the child to progress through the swimmer levels and pick up the skill, swimming lessons can become costly/expensive for parents. Standards set by the Lifesaving Society are used to teach children the necessary steps on learning how to swim efficiently enough to save themselves in water-related incidents. Many types of equipment do possess problems that hinder children's learning experiences. By finding unique problems and solving them, the process of learning to swim and the cost associated with swimming could be reduced. To further data collection, observations & interviews will be conducted to analyze the problems in depth. Interviews will be done by going to community centres during swimming lessons and conducting interviews with past/current swim instructors/lifeguards within this field of expertise. Through interviews, the interviewee could relay experts with extensive swimming knowledge within this field for further investigations. Through these findings, groups of experiences can be themed & potential problems can later be identified & solved.

Acknowledgements

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Adding on, I would like to thank my interviewees and my advisor for their in-person experience in teaching young children and identifying key problems that young swimmers have had. From their past experiences instructing young swimmers, unique problems were brought forward allowing for an opening of this thesis capstone project.

Lastly, I would like to thank Nathan and Dominik from Agile Manufacturing for helping me 3D print the flipper portion of my thesis.

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Chapter 1 - Introduction to Problem Definition

1.1 Problem Definition

Learning to swim at a young age is essential to allow children to stay safe when near bodies of water. Although children are motivated to learn how to swim, various factors hinder their learning experience. These factors can include physical body build hindering what children of small size can do, cognitive problems that either reduce overall control they have over certain actions as well as limited attention spans. If the young swimmer were to have a post-traumatic experience in a water-related incident, this will hinder their learning journey when learning to swim. The current teaching methods rely solely on how well the swim instructor can utilize the equipment to teach the class and if the swim instructor is within the range of the young swimmer to provide essential feedback. The objective of this thesis project is to find a solution to allow for young swimmers to have an easier time learning to swim and an easier way for the swim instructors to teach young swimmers how to swim by reducing existing problems both parties face.

1.2 Rationale & Significance

There are many different approaches taken to teaching a young swimmer how to swim. However, throughout the learning process problems do arise which hinder a child's learning experience. The investigation approach is taken to identify these key problems. The following methods will be used to collect and analyze data on problems young swimmers have:

- Literature reviews
- Online sources
- User interviews
- Advisor interviews
- Observations
- Benchmarking of existing products
- Empathy & journey mapping
- Ergonomic & anthropometrics study
- Sustainability study

1.3 Background / History / Social Context

Learning to swim is a very important life skill to have. In 2021 alone, there were a recorded 152 fatal drownings in Ontario (Lifesaving Society). According to the Lifesaving Society, even if the user survives a non-fatal drowning, it can result in a serious lifelong disability. Through the total of non-fatal drownings, children and youth have the highest count compared to older people (Lifesaving Society). To reduce potential water-related accidents, many different organizations offer swimming lessons to teach users of all ages how to swim. Lifesaving Society (Lifesaving Society) is just one of these organizations that offer different swimmer levels to teach the basic strokes to the users.

In a social context, learning how to swim is essential. In just Ontario alone, Ontario touches four of the great lakes (Wikimedia Foundation, 2021). During all seasons, users can be found participating in water-related activities including swimming, fishing, boating, and kayaking which can take place around large bodies of water. To keep users safe, it is of utmost importance to teach them how to swim. However, due to young children being physically smaller than adults and still developing, they have a tougher time learning how to swim.

Chapter 2 - Research

2.1 User Research

This chapter gives an in-depth overview of the research. The details including user persona, activity mapping and ergonomic studies will be shown. The research conducted brings forward the users' problems and limitations. Through the research, a potential solution could be achieved.

2.1.1 User Profile

User Profiles:

Category	User	Description
Primary	Young Swimmer	The primary user is the children who use swimming equipment during swimming lessons. Can be eager or nervous depending on how comfortable they are in the water.
Secondary	Swim Instructor	The secondary user assists the primary user by distributing swim equipment/and providing demonstrations on how to use the said equipment.
Tertiary	Pool Supervisors	The tertiary user is the pool supervisor who overwatches the primary/secondary users. Tertiary user also makes sure the swim equipment is adequately supplied and stocked.

Table 1 - User Profiles

Demographic:

User Data	Primary User: Young Swimmer	Secondary User: Swim Instructor	Tertiary Use: Pool Supervisor
Equipment use frequency	Often	Often	Minimal
Equipment use Duration	Varies depending on class & competency level (Est: 15 - 20 minutes total)	Handing out swim equipment or demonstrating with it (Est: 5 - 10 minutes total)	Varies depending on how often they have to hand out equipment (Estimated: 0 minutes)
Age	5-12	16 - 22	28 - 40
Education	Kindergarten- Elementary	Highschool - College	College/University
Physical/Mental/ Cognitive Aspects	Physical limitation due to size Developing brain Limited attention span Limited motor skills Limited understanding on swimming skills/strokes	Almost developed brain Good motor skills Clear understanding on swimming skills/strokes	Fully developed brain Good motor skills Very clear understanding on swimming skills/strokes
Behavior	Has a hard to focusing & becomes easily side tracked Activities has to be engaging Can be anxious & shy	Professional through personal relations Demonstrates	Professional through personal relations

Table 2 - Demographics

2.1.2 Current User Practices

Interview Method: Overview of a shift of a swim instructor

Working as a swim instructor, the tasks and timeline during a shift is linear. Swim instructors arrive 15 minutes early to their shift to prepare for the lessons they need to teach. Preparation includes getting the necessary swim equipment, wet worksheets and lesson plans. Once the shift officially starts, the swim instructor would gather the students for the class and begin going through the lesson plan. Depending on the lesson and the number of students in the class, the swim instructor will try to divide an even amount of time for each student. The amount of time allocated to the skill being taught/student can vary depending on how capable/attentive the individual is. Once the lesson ends, the swim instructors would gather the class and bring the swimmers back to their parents to be picked up. The swim instructor would then proceed to get ready to start the next class. This repeats until the shift is over. Depending on how well the individual classes are progressing and the individual instructors'

attitudes, teaching these young individuals to swim can be either very rewarding (fun) or very tiring/mentally draining.

More often than not, swim instructors would have to dedicate time to help assist the weaker swimmers. This would be through both verbal feedback and physical manipulation in hopes of the swimmer grasping the taught concept. However, it will often take a considerable amount of time before the user understands how to master the proper technique. By having to instruct large classes of up to 12 students, swim instructors can only give so much feedback per student at a given time. Practice time is limited per skill due to having to go through the different lesson items planned before the start of class.

Interview Method: Special Tasks for the swim instructor:

There are four different sessions in a year. These are Spring, Summer, Fall and Winter sessions. The total amount of weekly lessons depends on the number of weeks in a session. The total amount of weeks can vary from ten to twelve weeks in total.

The two single-time (per class) events take place at the midway point of the session (parents' day) and the last week of the session. Swim instructors for both events have to end lessons early depending on the number of students in the class. Constructive feedback on their child's learning progress and next steps will be provided to the parents by the swim instructor.

2.1.3 User Observation - Activity Mapping

Activity Map For Front Crawl:

Table 3 - Activity Map

Observation:

The young swimmer has trouble continuing the moment she loses her momentum from kicking off the wall. The young swimmer had trouble breathing to the side and moving her arms when attempting to do front crawl with the aid.

2.1.4 User Observation - Human Factors of Existing Products

(Figure 1 - Flutterboard Grooves)

(Figure 2 - Minimalist Life Jacket)

(Figure 3 - Two-Tone Fins)

There have been attempts in the industry to progress swimming equipment. These included solving pain points users had from the previous generations of swim equipment. For instance, the flutterboard (Reference figure 1) (Cite board), has added gripping holes to allow users to hold it with ease and eliminate the chances of slipping off. The grip holes only accommodate if the users are focusing specifically on head-up flutter kicking. The minimalist life jacket (PFD) has reduced in size/bulkiness from the previous generation of life jackets. The lifejacket is adjustable for the user's width, however, the additional strap to stop the lifejacket from flipping over the user is nonexistent. Flippers for the competition swimming/swimming lessons change the fin sizes, however, users will have to continue to cram their feet into it to fit on. Some considerations for the products have been made by the swim industry, however, there is room for improvement. There hasn't been any aid or equipment that gives users feedback on how well they swim.

2.1.5 User Observation - Safety & Health of Existing Products

The health and safety of the swim equipment purchased by community centers to be used for lessons are of great importance. Specific types of equipment like lifejackets and fins come in different sizes to accommodate users of varying sizes and weights. Pools do not authorize the use of inflatables (water wings) as a piece of safety/swim equipment due to the dangers they possess. U.S Coast Guards have also disapproved of water inflatables due to safety concerns (Philpott, 2021). The main concerns surrounding inflatables are that they can easily puncture causing them to deflate and the chance of them easily slipping off the user. Because of these safety concerns, pools do not purchase inflatables to be used as swim equipment

2.2 Product Research

The following section compares existing swimming equipment available on the market. The section will showcase the benefits and drawbacks of each item followed by first-hand experiences from interviewees.

2.2.1 Benchmarking - Benefits & Features of Existing Products

Benchmarking Product Benefits							
1	2	3	4	5	6	7	8
							
Flutterboard	Noodles	Pull Buoy	PFD	Water Dumbells	Swim Belt	Fins	Googles
Benefits							
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 4 - Product Benchmarking

2.2.2 Benchmarking - Functionality of Existing Products

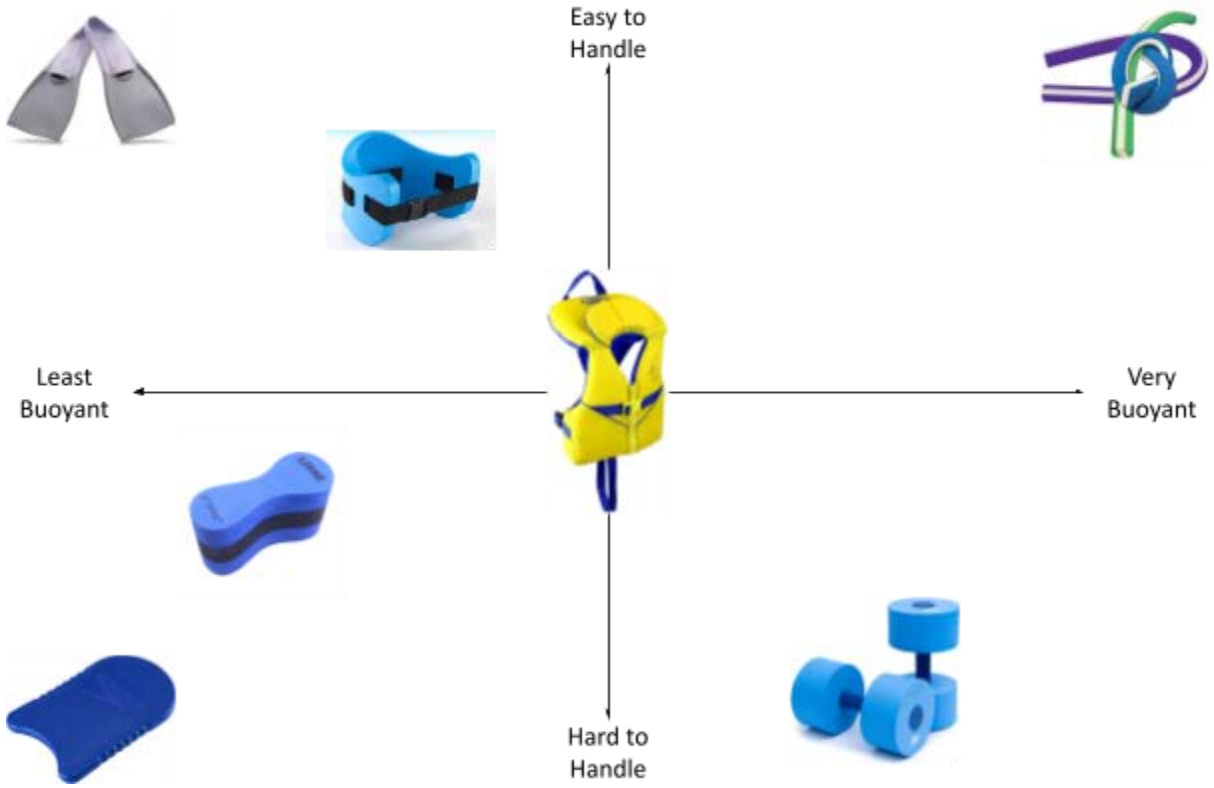


Table 5 - Product X-Y Graph

As shown in the chart above the top right quadrant is the most ideal for young swimmers who are just grasping how to swim. The items in the lower left quadrant tend to be for slightly more experienced swimmers who have a grasp of the basics of individual skills/strokes. However, all equipment shown does not provide feedback. Feedback is given solely by the swim instructor.

2.2.3 Benchmarking - Aesthetics & Semantic Profile of Existing Products

Aesthetics:

From the current benchmarked products, the overall design language is very utilitarian. The overall colours used for the final products are usually solid colours. On occasion depending on the number of parts, they can be two-toned. Most of these colours consist of different grays with the addition of bright accent colours to highlight it like blues and reds.

Semantic Profile:

In the current market of swim equipment, there are some semantic profiles built into the final product. The flutter boards currently on the market have built-in holes or built-in side grooves. These semantic profiles indicate to the user that the flutterboard should be held in a certain way. Fins/flippers have an opening where users would put their feet in. The opening is similar to footwear so intuitively, users would know how to wear them without having prior experience. Lifejackets are utilized in the same manner as if the user is putting on a jacket and zipping up. Overall the design language as mentioned is very utilitarian and due.

2.2.4 Benchmarking - Materials & Manufacturing of Existing Products

The material usually chosen for swimming equipment is foam due to the material being buoyant. The main characteristics of the final produced product are foam density, stiffness and durability. The lower the density of the foam, the more buoyant it is.

Material	Description & Benefits	Manufacturing Method
EVA Foam	Final item can only be flat and featureless for the moulding process. Injection moulding is more costly than thermoforming.	Cold/Hot Press Injection Moulded Thermoforming
EPP Foam	Good characteristics for buoyancy, weight ratio impact/chemical resistance. 100% recyclable	Cold/Hot Press Injection Moulded
EPE Foam	Can be soft & flexible and inexpensive compared to the other foams.	Cold/Hot Press Injection Moulded
Nylon Webbing	Used for the straps of PFDs and swim belts.	Not Applicable
PP Buckle	Used to secure the user/nylon webbing	Injection Moulding
Neoprene	Has insulating properties and is completely waterproof. Used in wetsuits, scuba gear	
Silicone	Water-resistant and used in swim caps and fins	

Table 6 - Material & Manufacturing Graph

2.2.5 Benchmarking - Sustainability of Existing Products

Sustainability is an important factor when designing for future swim equipment. Through sustainable initiatives can “meeting the needs of the present without compromising the ability of future generations to meet their needs” (Quote) be achieved. The manufacturing of foams can be reused and recycled throughout the manufacturing process. If there is an error for the final product, the item itself can be remelted and reused for the same production.

Chapter 2.3

Although the young swimmers do their best in learning to swim, cognitive/physical limitations hold them back. Swim equipment does enhance the swimmers' learning experience according to interviewees. However, findings suggest that the equipment can be most effective depending on how competent the individual is and depending on what level the swimmer is on.

Chapter 3 - Analysis

3.1 Analysis - Needs

This chapter gives an in-depth overview analysis of the findings from chapter 2. Explanations will be given on what current swim equipment on the market worked, what needs to be improved and potentially an opportunity to help alleviate user needs which current swim equipment cannot do.

3.1.1 Needs/Benefit Not Met by Current Products

Current swim equipment is designed to solve the users' problems. This has led to a Utilitarian aesthetic. Due to the utilitarian design, ergonomics wasn't a primary consideration when the product was being designed. Most of the feedback to improve the swimmers' stroke/skill comes directly from the swim instructor. There are currently no products that provide feedback to the user on how to improve their technique. Often various equipment will be used during different learning stages when a young swimmer learns to swim. However, there is a gap between the different swim equipment used at certain levels. Some equipment may be very buoyant and easy to handle but when moving to less buoyant equipment, the user will have a harder time doing the same thing as before due to switching equipment types.

3.1.2 Latent Needs

Needs	Needs Statement
Control & Mastery	The swimmer needs a way to get live feedback without having to wait on the instructor. Equipment that isn't difficult to handle at a lower level
Ease of use	Equipment that is easy to put on/handle and secure to the user or by hand
Ergonomics	To allow for better comfort when the user uses it
Safety	The user needs a piece of equipment that doesn't slip away when used

Table 7 - Latent Needs

3.1.3 Categorization of Needs

Immediate Needs	**Benefit**	**Relationship to Benefit Rating**
Physical/Vocal Feedback	User needs physical feedback to see if they're on the right track to success	High
Control & Mastery of strokes/skills	Through swim lessons and in-class practice, users will want improvement on their strokes/skills they've attained	High
Latent Needs	**Benefit**	**Relationship to Benefit Rating**
Ergonomics	User needs equipment that is comfortable to improve the learning experience	Medium
Wants	**Benefit**	**Relationship to Benefit Rating**
Comfortability	Rest and reassurance knowing the lesson will go well	Medium

Table 8 - Categorization of Needs

3.2 Analysis - Usability

This section will explore the journey map on the young swimmer learning to do front crawl with equipment in the previous chapter.

3.2.1 Journey Mapping

Observation: Young Swimmer Attempting Front Crawl with flutterboard

For the young swimmer, her troubles began when she lost her initial momentum from kicking off the wall. The swimmer attempted to kick but to no avail and due to this, capsized for a few seconds.

After recovering she manages to continue kicking and eventually adds in her arms for the front crawl. The problem the user had included not having an effective flutter kick to propel herself through the water.

The swim instructor throughout the observation was trying to get the young swimmers' attention to provide feedback. However, the swim instructor was unable to reach the swimmer as the swimmer was underwater and unable to hear. The Instructor did provide physical manipulations.

3.2.2 User Experience

Table 9 - Activity Mapping User Experience

After listing down the challenges and examining the users' feelings and actions, what the user needs most is an item that provides effective feedback to the user. Learning to swim requires some level of physical manipulation for the user to grasp, but the rest of the learning relies heavily on the user. If there is a way to give the user some feedback but without fully assisting them, there can be an opportunity for the learning enhancement of the young swimmer.

3.3 Analysis - Human Factors

The following section goes over the configuration diagram for the selected demographic and the ergonomic study of the user interacting with the product.

3.3.1 Product Schematic - Configuration Diagram

The product schematic configuration diagram gives the general size of the concept product. The percentiles are listed for size reference.

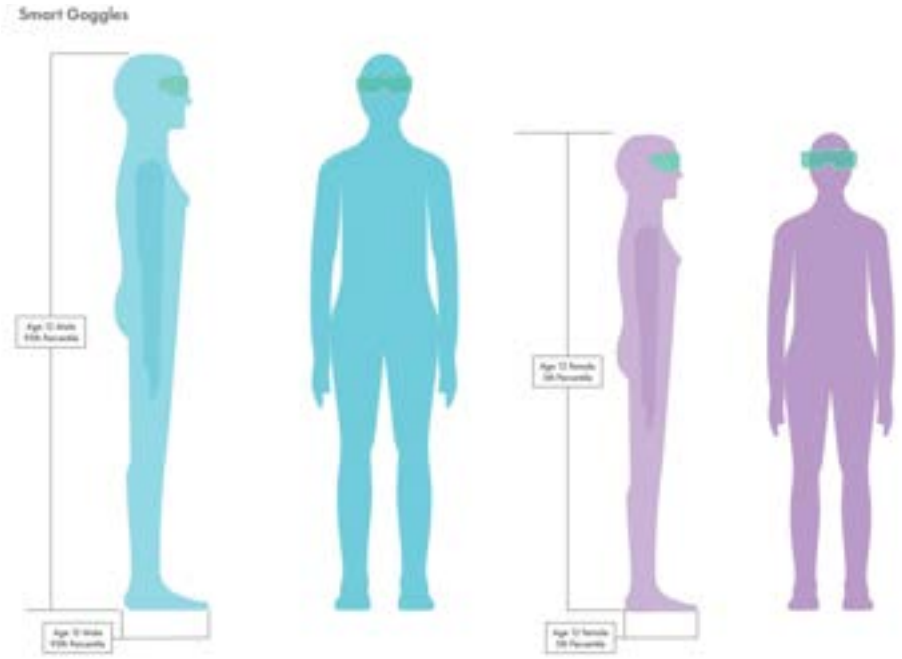


Figure 5 - Smart Goggles Configuration Diagram

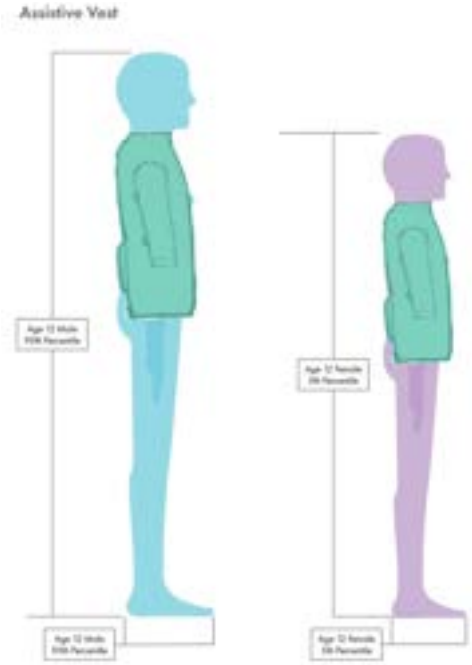


Figure 6 - Assistive Vest Configuration Diagram

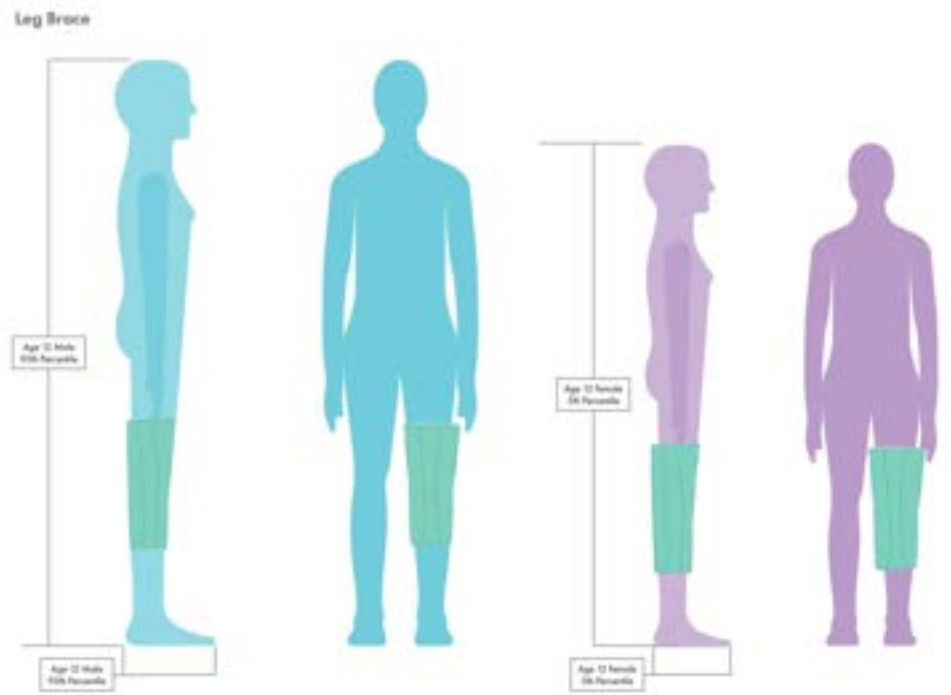


Figure 7 - Leg Brace Configuration Diagram

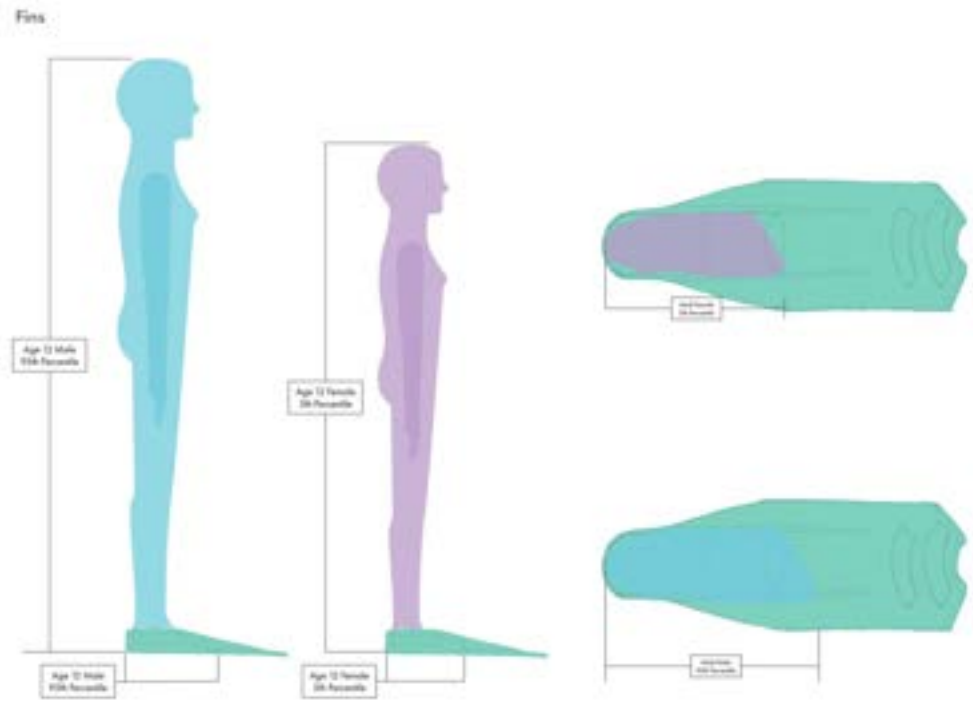


Figure 8 - Fins Configuration Diagram

3.3.2 Ergonomic - 1:1 Human Scale Study

The participant was chosen as a model to fit the role of the 50th percentile 12-year-old female as her build/measurements closely resembled that of the 50th percentile 12-year-old female. Participants' height was only 20mm taller than the 95% percentile 12-year-old female who stands at 1563mm.

<table>
<tr><td colspan="2">Smart Goggles</td><td colspan="2">Assistive Vest</td></tr>
<tr><td> 
Figure 9 - SG Front View</td><td> 
Figure 10 - SG Side View</td><td> 
Figure 11 - AV Back View</td><td> 
Figure 12 - AV Side View</td></tr>
<tr><td colspan="2">Size: 16.5cm x 5.5cm x 5 cm</td><td colspan="2">Size: 28.5cm x 58.6cm x 20cm</td></tr>
<tr><td colspan="2">Study: The mock goggles were made to see how well it would fit the user, user visibility and feasibility of the integration of technology.</td><td colspan="2">Study: The mock vest was made to see how well the integration of technology was and how well it would fit the user</td></tr>
<tr><td colspan="2">Leg Brace</td><td colspan="2">Fins</td></tr>
<tr><td> 
Figure 13 - LB Front View</td><td> 
Figure 14 - LB Side View</td><td> 
Figure 15 - F Front View</td><td> 
Figure 16 - F Front View</td></tr>
<tr><td colspan="2">Study: The mock leg brace was made to see how well it would fit the user and how much it would reduce user leg movement</td><td colspan="2">Study: The mock fins were made to see how well it would fit the user and to check the physical restraints/feasibility of the build</td></tr>
<tr><td colspan="2">Size: 15cm x 38 cm x 14cm</td><td colspan="2">Size: 15.25cm x 7cm x 36.83cm</td></tr>
</table>

Analysis of ergonomic study:

Through the demonstration of the mock models, the measurements gained through this study supports that of the 50th percentile 12-year-old female ensuring it to be as accurate as possible to the target demographic. Testing the 1:1 scale mock models gave insightful results for the future development of the final models. Some areas that required adjusting were the electronic placements for the vest, the width of the fins and goggle height.

The goggles were kept similar to the ones in the market to allow users to put them on with ease. However through the demonstration of the mock model, placements of the electronics needed to be moved to the top due to physical restraints. On top of this, the goggle height needs to be adjusted so that users will have a better point of view.

The build of the vest was made similar to a lifejacket to allow users to intuitively put it on. However, reducing the overall size of the mock electronics will be needed. Although the vest had fit the user well, in practical use the vest needs to be tighter to keep the user warm in the water.

Through the demonstration of the fins, the fins need to be tighter overall as the current mock models offer too much tolerance. Reducing the tolerance will allow for more of an effective kick by the user.

3.4 Aesthetics & Semantic Profile

(Figure 17 - Small Fins)

(Figure 2 - Flutterboard Groove)

The general aesthetic of swim equipment usually tends to use a choice of solid colours for the entire product. If the product comes in potential multiple parts then a two-tone colour approach will be

taken. The overall styling is utilitarian due to the products solving the users' problems directly. The semantic profiling of objects tends to be straightforward. An example would be the flutterboards where the product has built-in grooved edges or holes to show the users where to hold/grip the product.

3.5 Sustainability - Safety Health & Environment

Electronics swim equipment has yet to expand into the aquatic environment. However, electronics in water have been done before and have been used by swimmers and coaches in competitive swimming. Most swim equipment utilizes different types of foams to give the product buoyancy to stay afloat. The different types of foam including EVA, EEP, and EPE foam can be recycled.

This current section is still being researched and developed. This will be revised and updated at a later date during the project duration.

3.6 Innovation Opportunity

Young swimmers need assistance when they cannot do a certain stroke or skill. Repeated verbal/physical feedback is needed to be given to the young swimmer until a full understanding can be achieved. In practicality, the swim instructor is not always there to assist due to having to help others or simply being too far away to provide any effective feedback. Through this problem, an innovative design solution can be made.

3.6.1 Needs Analysis Diagram

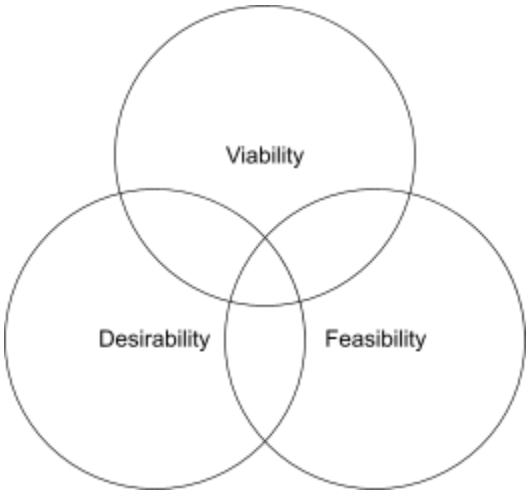


Table 10 - Needs Analysis Diagram

3.6.2 Desirability/Feasibility & Viability

This current section is still being researched and developed. This will be revised and updated at a later date during the project duration.

3.7 Summary of Chapter 3 - Defining Design Brief

The objective of this thesis project is to design swimming equipment that can enhance the users' learning experience when learning how to swim. The following list should be added to the final design direction.

Young Swimmer Additions:

- Tactile feedback to areas that require improvement for the user
- Visual feedback that relays back to the user so that they can improve
- An added component that reduces the over kicking for flutter kick
- Training component that allows for user adjustability

Chapter 4 - Design Development

4.1 Initial Idea Generation

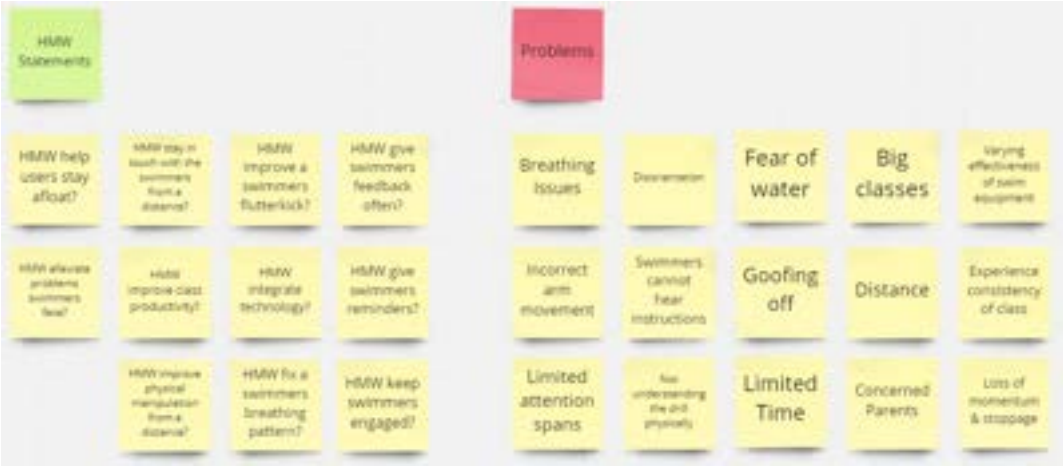
The initial idea generation phase consists of solving initial problems that young swimmers face. Ideas of potential ways that could help eliminate problems swimmers faced were quickly sketched. Once the general ideas were reviewed and finalized, revised concepts were created.

4.1.1 Aesthetic Approach & Semantic Profile

Due to having the opportunity to design swim equipment for young children, the aesthetic approach was to keep it bright, playful and fun to cater to the younger audience. Design and aesthetic inspirations were drawn from fun things which included adorable aquatic animals. Inspirations such as sharks, ducks, and geese were taken into account which influenced the aesthetics of the final product. These were chosen due to the fact that they live on land yet there adapted to aquatic environments like lakes and oceans. This inspiration was taken and used in the final design. The design intent was to stray away from the current trend of swim equipment aesthetics and to stand out.

4.1.2 Mind Mapping

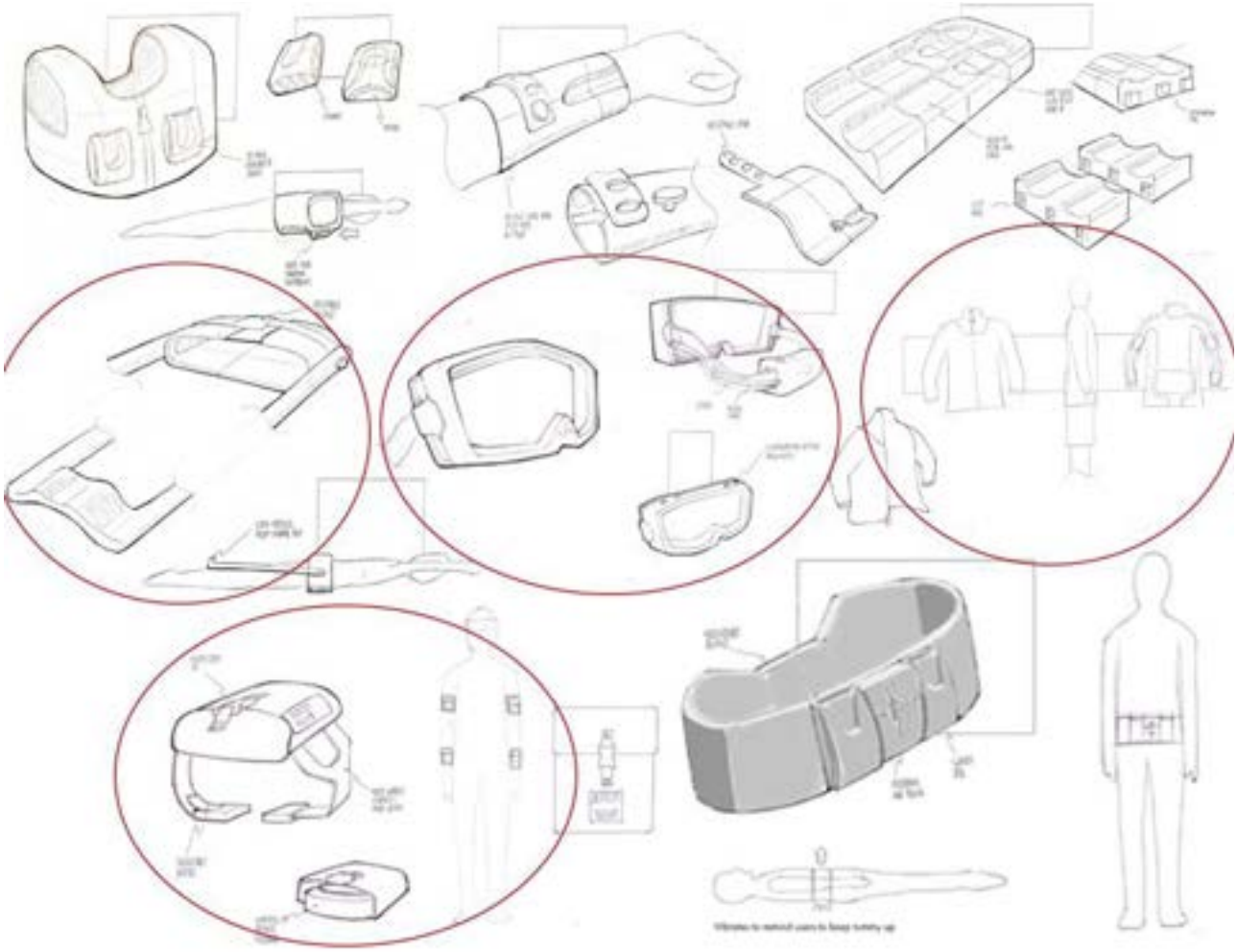
Mind mapping explored problems faced by both swim instructors and swimmers. Problem definitions and potential design directions were established to overcome these problems.



(Figure 17 - Mind Mapping)

4.1.3 Idea Sketches

Initial sketches explored a variety of different problems and solutions to help alleviate the swimmers' pain points. Later ideation sketches included the use of electronic technologies which opened up many different opportunities. The ideations that were circled in red were the concepts that proceeded forward. The concepts were either combined or refined further or modified heavily to serve the exacta similar purpose.



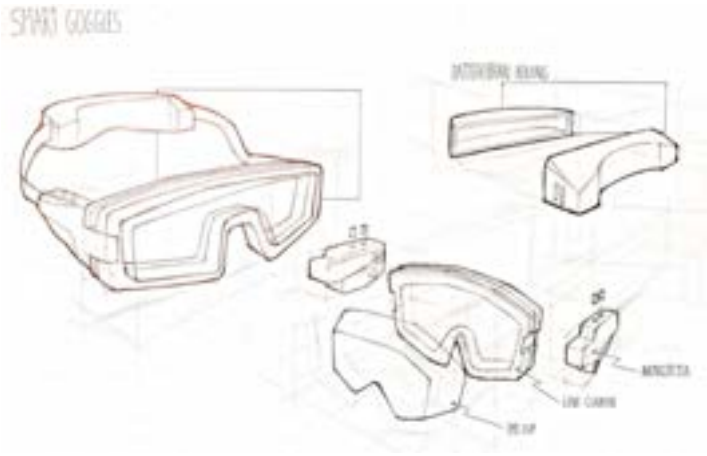
(Figure 19 - Ideations)

4.2 Concept Exploration

The concept directions lead toward the implementation of technology to help alleviate some of the pain points swimmers faced. Ideas for a pair of smart goggles and a smart vest were explored to see the potential of the use case of technology aiding the young swimmers. The enhancements/improvement of fins were also considered as fins are effective at improving a swimmer's flutter kick.

4.2.1 Concept One

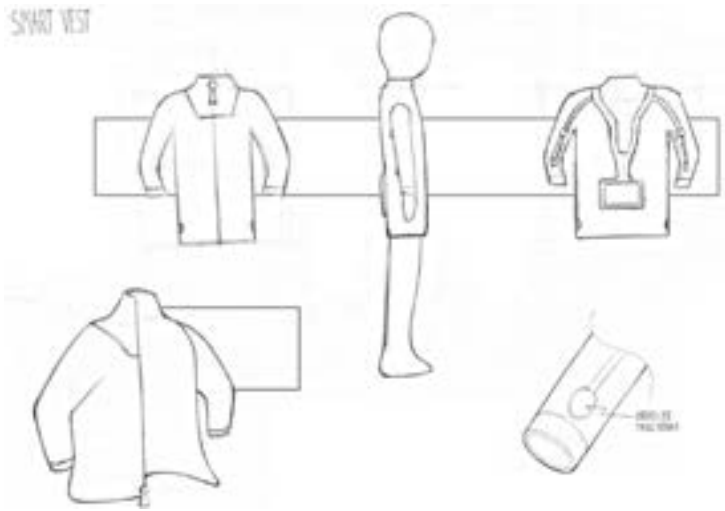
The first initial concept was a pair of smart goggles. The idea behind the smart goggles was to help alleviate minor problems swimmers faced on a common basis. Problems include forgetting the distance swam, and disorientation of the individual, colliding with other swimmers. Through the use of a pair of smart goggles that give visual feedback, some of the problems mentioned can be alleviated.



(Figure 20 - Concept One)

4.2.2 Concept Two

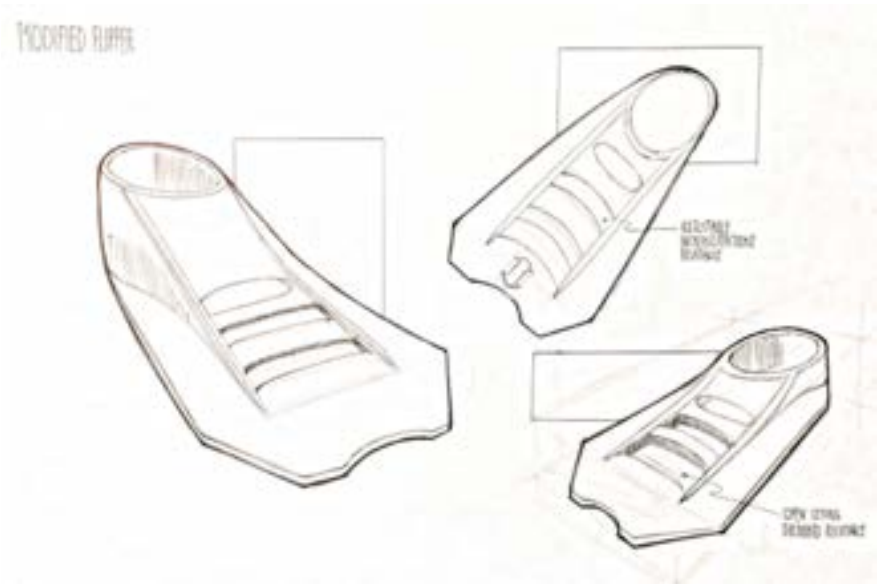
The second ideation was of a smart vest. The idea behind the smart vest was to help provide tactile feedback when there is an absence of a swim instructor. The best way for swimmers to improve is through feedback, however, due to limited class times and multiple swimmers, swim instructors can give so much feedback to an individual. The implementation of a smart vest will allow for tactile feedback to the swimmer in certain areas including the back & arms. The individual will be notified through vibrations in the mentioned key areas & through that can potentially remember to fix their stroke.



(Figure 21 - Concept Two)

4.2.3 Concept Three

The final concept is for an adjustable pair of flippers. Flippers have a background in helping to improve an individual's flutter kick. However, when users do take off the flippers, their flutter kick immediately goes back in quality. The concept of the adaptive will idealistically help bridge the gap from having flippers on to taking them off. Swimmers can practice their flutter kick by utilizing the full extent of the pair of flippers. Once they adjust the settings to reduce water resistance, the swimmers then can rely partially on themselves and partially on the flippers to bridge that gap. An enhancement of user life was added through the implementation of a quick release. Instead of having to fit the foot in with force, the quick release allows the swimmers to plop their foot in and quickly lock their foot in.



(Figure 22 - Concept Three)

4.3 Concept Strategy

The configuration diagram and product schematics were conducted. Making the diagrams assisted in obtaining a general size of the goggles, vests & flippers and listed any potential constraints the sketch may have not shown. The buttons and small interactions were also mapped and referenced to real-life examples to make sure they would work.

4.3.1 Concept Direction & Product Schematic One

The configuration of the goggles showed that more room was needed to potentially house larger components for the internal electronics and securing mechanisms.

4.3.2 Concept Direction & Product Schematic Two

The configuration diagram of the fins showed the general constraints faced. The items that were considered were how the general size of the flippers, how the back of the individual's foot was secured and the slide that decreases the fin resistance to water.

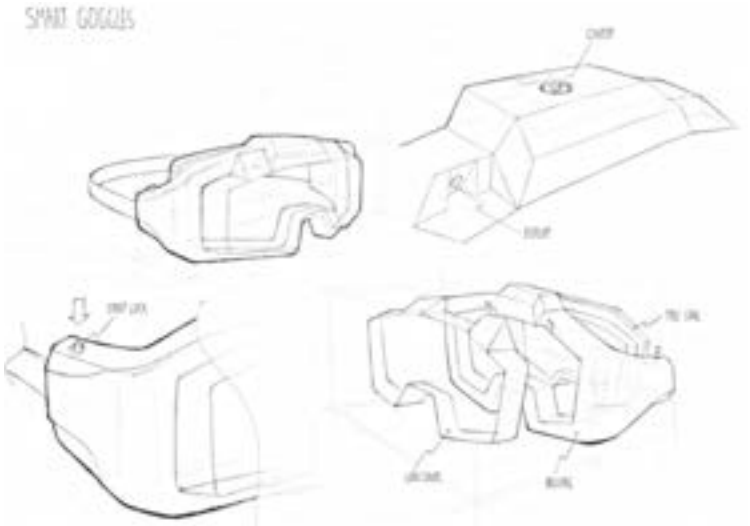
4.4 Concept Refinement & Validation

The concept refinement stage includes further detailing of the parts components choosing colours, finishes and materials were finalized.

4.4.1 Design Refinement

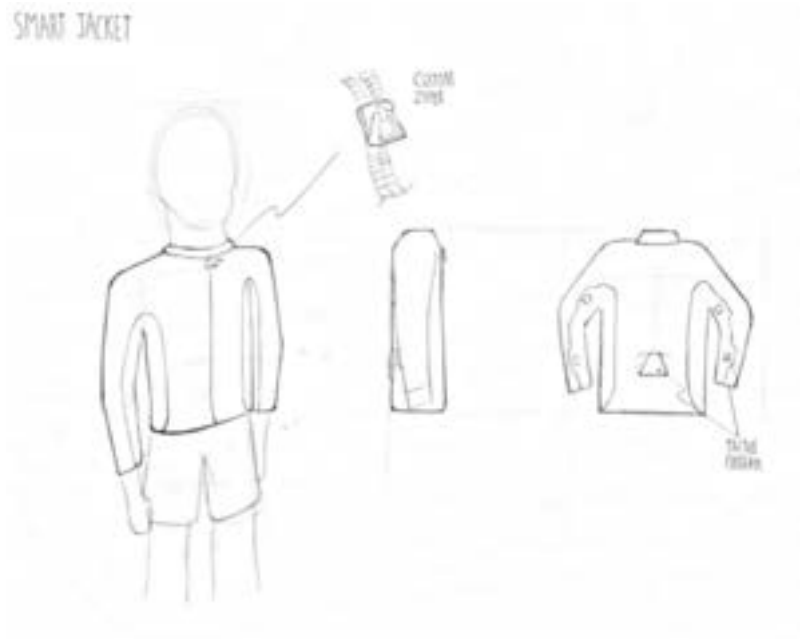
Further detailing of the goggles, vest and flippers were sketched out. The detailing included close-up views, iterations of the designs, and exploded views of how components would come together. General revisions of the smart vest aesthetic were changed but the general positioning of the vibrators was kept the same.

Goggles had an increase in size over the overall frame. Projectors were added to the top in this iteration.



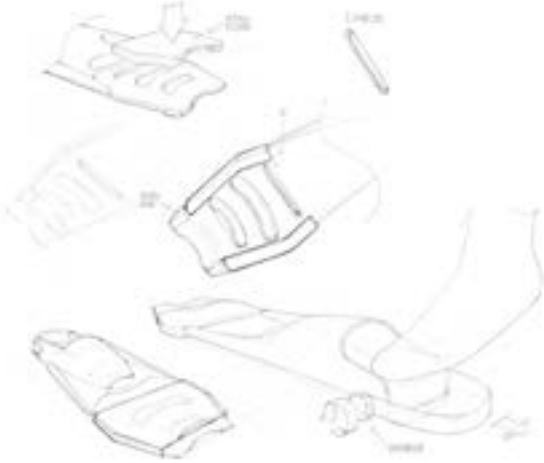
(Figure 23 - Concept One Refined)

Smart Jacket worked on the finer details. General iterations were created.



(Figure 24 - Concept Two Refined)

A removable pad was added to the fins to allow for adjustable water resistance. A quick-release mechanism that featured a rotating easy-to-use lock was implemented.



(Figure 25 - Concept Three Refined)

4.4.2 Detail Development

The colouring & finishing directions were done in Solidworks due to time constraints. A list of different colours was chosen from the inspiration of mammals that dwell in aquatic environments. The colours were added to the items & a list was compiled onto Miro for review.

Further detailed development was made to the flippers. Iterations of the top view were created for the best aesthetics possible to fit the intended theme.

(Figure 26 - Concept 3 Ideations)

Accent cuts were made into the side of the goggles to continue the same design language. Initially, cuts were also made to the bottom of the goggles, but it was rather intrusive. The cuts were later replaced with an orange overlay to connect both the front of the goggles to the side parts. Through the change, in an abstract way users can make out the shape of a duck's face.

Different adjustments to the highlights of the smart vest were made. Different colour iterations were conducted to best match the vest to the user.

4.4.3 Refined Product Schematic & Key Ergonomic

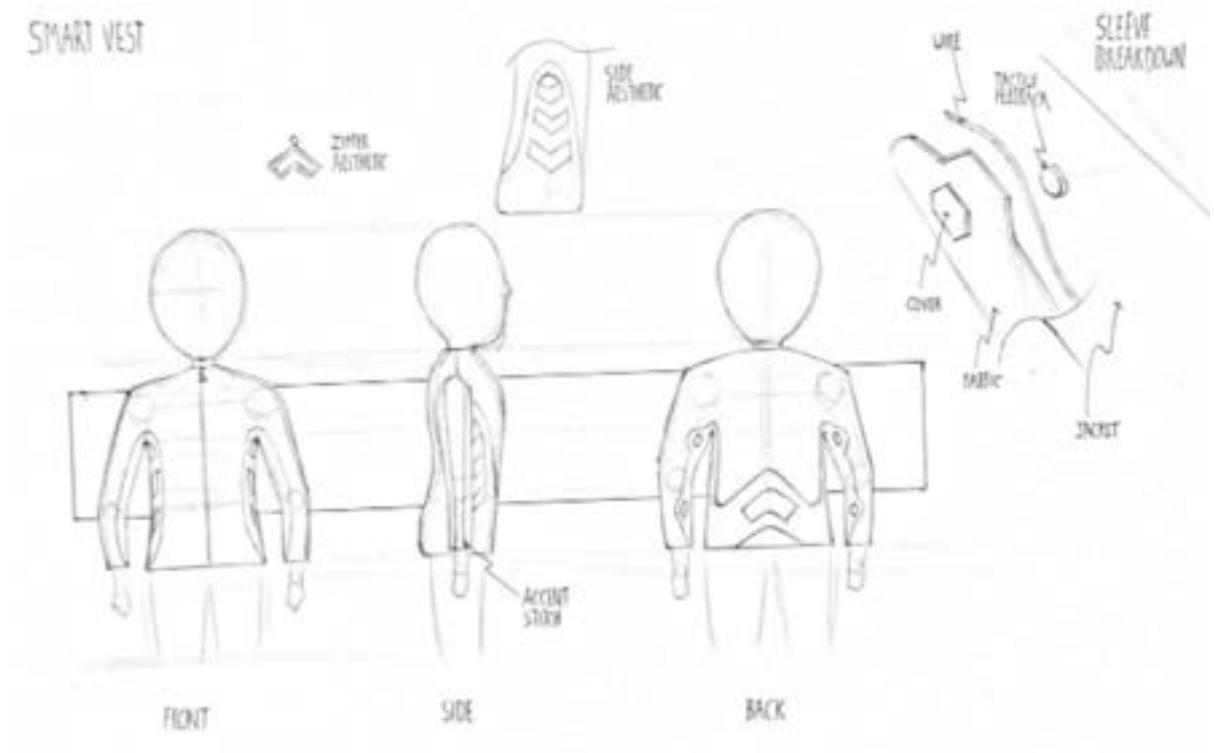
Only a 50th percentile mannequin was located for the CAD modelling. The 50th percentile mannequin was used for the modelling of the smart goggles, smart vest and goggles. The ergonomics of the buttons were made

4.5 Concept Realization

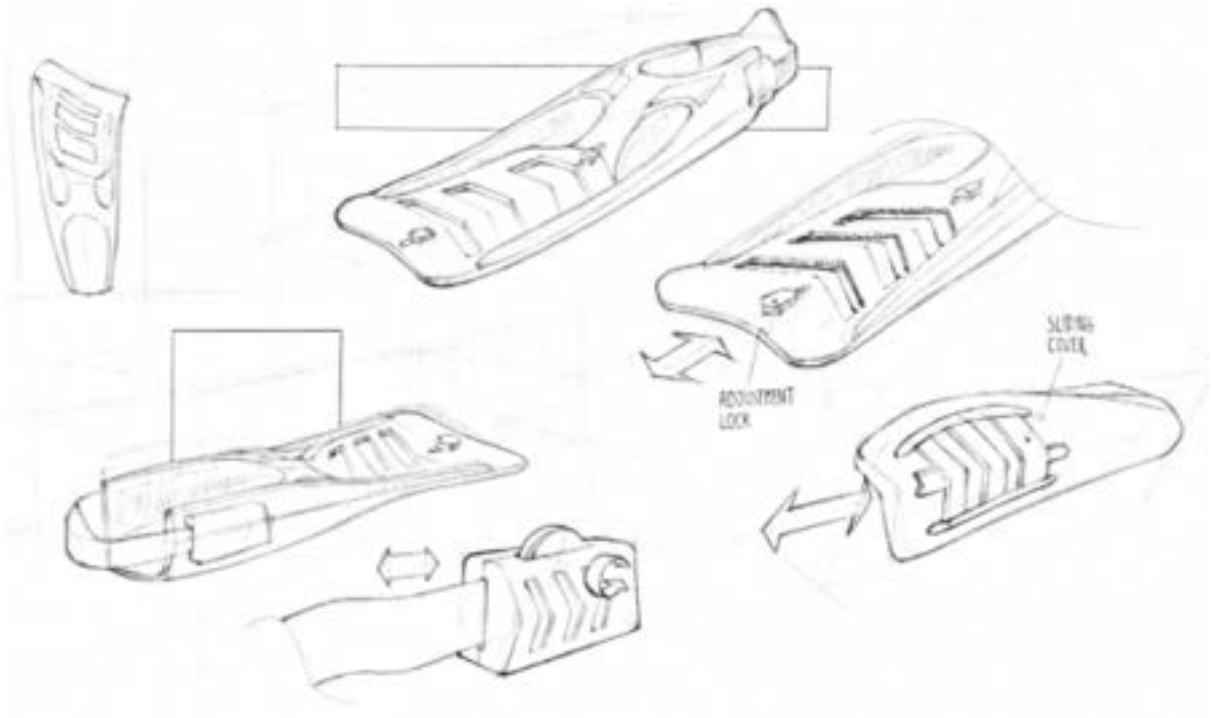
Upon concept finalization, the final dimensions of the smart goggles, smart vest and flippers were obtained through study models. Finalization of the colours, finishes, materials and manufacturing methods were made.

4.5.1 Design Finalization

The final aesthetics and colour choice was based on a duckling. Ducklings are small, cute, amphibious and provide a bright colour choice. The colours that were chosen from the duckling were the yellow from its fur and the orange from its beak. Overall semantics, buttons and small interactions were made by comparing them to preexisting life-size models from products that would fit the intended user group.



(Figure 27 - Smart Vest Refined)



(Figure 28 - Adjustable Flippers Refined)

4.5.2 Physical Study Models

The overall profile of the flipper was made into a physical model. The physical model demonstrates the general size of the flipper and helps define where the profile of the rail of the flippers will be. Due to the limitations of limited hand tools and no access to any power tools or workshops, the inside of the flipper wasn't hollowed out. A shoe last was used to help give constraint to the overall dimensions of the physical study model.

(Figure 29 - Front View of Mock-Up)

(Figure 30 - Top View of Mock-Up)

(Figure 31 - Side View of Mock-Up)

4.6 Design Resolution

The goggles consist of several different materials. Acrylonitrile butadiene styrene (ABS) for the main housing structure of the goggles, silicone eye seal & polycarbonate lens. The goggle housing comes in four parts. A front housing, back and the two side components that hold the strap. The projector that projects visual images onto the lens is indented into the goggles housing so that it will remove the intrusiveness to the individuals wearing them. The main colour of the front and back housing of the goggles is yellow. An over-moulded section at the front housing will be in the colour orange to connect the design to the side components and give it an overall more cohesive look. The side components holding the strap are orange with the white accents built-in. The housing component parts are with snap-fits to allow the parts to come together to secure without the use of adhesives. However, the securing of the polycarbonate lens and goggle seal utilizes glue to keep them together and provide a waterproof seal. Most swimming lessons happen indoors and due to varying lighting indoors, the polycarbonate lens for the goggles is translucent to allow swimmers to have an easier time viewing their surroundings. The battery & PCB board is placed between the front and back housing of the goggles' mainframe.

The smart vest utilizes neoprene, a material that has proven used in swimming and diving suits. The design relies on a tight fit to the individual which adds to the benefit of keeping them warm in the cold pool waters. The different colours chosen include yellow & orange for the main colours followed by white acting as an accent colour. The areas that provide tactile feedback are located on the back and both the lower and upper parts of the arm. The areas were chosen as most strokes required to be fixed are located in those areas. The battery is placed along with the back pad to keep the weight distribution balanced. The wires connecting these areas are covered up by the interior material.

Silicone was chosen due to the strength and flexibility needed for swimming flippers to work. A semi-matte yellow finish was chosen for the flippers. An over-moulded section in orange on the top of

the flippers was used to help give an accent to it. Through the decision, the look of the flippers will give a very abstract look of a duckling. A quick-release mechanism utilizing ABS was placed in the rear in black to allow for the component to stand out visually. A quick-release mechanism was used to allow for easier adjustment by the individual. The push knob was designed the way it is for three reasons. First to keep it streamlined so as to not resist the water and second to follow the side profile of the flippers. Lastly, the knob is slim to the profile to reduce the chances of users accidentally moving it to a different setting. There is added material to the main flipper in that region to allow a definite lock-in position for the knob. The knob is also used to secure the slide of the flipper through the implementation of a screw connecting both components.

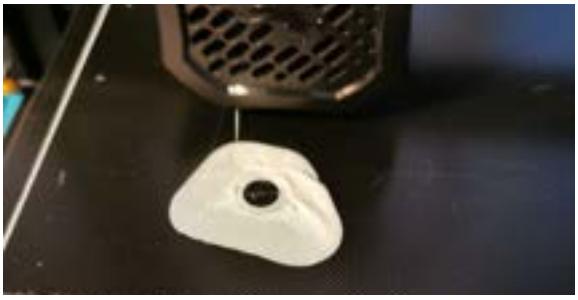
4.7 CAD Development

The initial CAD progress started with laying down isometric drawings of the product onto the front, right & top planes. Following this, the general shape of the products was formed using lofts built by many profiles and guide curves. Shelling of the material wasn't used due to the nature of the different part thicknesses. Due to the constraints, additional lofts were used to cut away interior material. Smaller items were built on top of the main products and when the general shape was finalized were sent to a separate file using the save bodies function. Additional features and detailing were done there on a separate part. Following the final details, Solidworks development would split into two separate directions. The first type was designed to be 3D printed where parts in Solidworks will need an additional 0.5 mm of tolerance to ensure the physical printed parts will come together. The second road of development included making the parts in Solidworks as close to real-life manufacturing potential as possible. Making the parts as realistic as possible allowed for the use of more detailed exploded views.

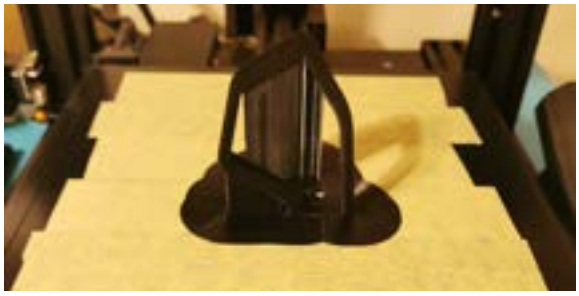
(Figure 32 - CAD Progress of Flippers)

4.8 Physical Model Fabrication

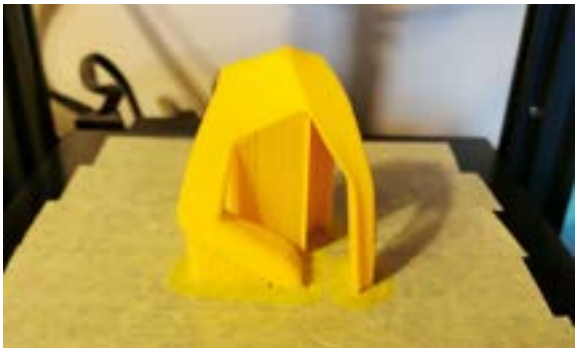
Fused deposition modelling (FDM) Ender 3 V2 3D printer was used to print most of the physical model parts in Polyethylene Terephthalate Glycol (PETG). These included the quick-release mechanism for the flipper/goggles, buttons, and fin slides. Due to the bed constraints on the printer, the goggles' mainframe and the seal were split in half. Issues were encountered along the way and the nozzle temperature was changed from 235C down to 225C. The printing speed was also reduced from 75mm per second down to 55mm per second. The size of the flippers was one to one scale and therefore was sent to Agile Manufacturing to be printed. The flippers were printed using stereolithography (SLA).



Levelling The Bed & Initial Prints

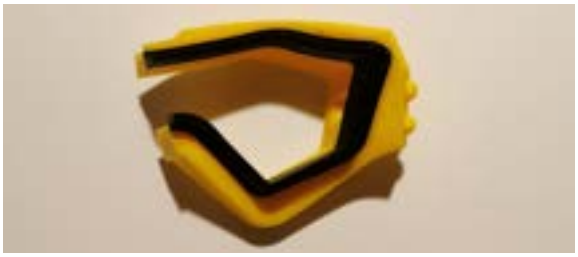


Goggle Seals Printed



Goggle Main Frame Printed

Various printed components.



Fitment of goggle seals

Filling of holes before priming

Received finished pair of flippers from Agile

Taping off of areas that don’t need to be painted

10 layers of acrylic paint added

Acrylic was a bad idea to spray painting

Fully primed flippers

Orange top area covered & painted yellow

Removal of the tape & covering	Removal of the tape & covering
 Painting of the orange portion	
 The measured piece from referenced kids swim shirt	 Cutting of back piece of vest template
 Modifying sleeve opening to personal design	 More measuring/cutting of template pieces

Traced general sleeve dimensions & modified to Swave vest design

Required template parts all traced/measured and modified to Swave design

(Figure 33 - Physical Model Fabrication)

Chapter 5 - Final Design

5.1 Summary

Swave is a set of progressive swim equipment that is used to help enhance the learning experience of the young swimmer and to alleviate pain points that swim instructors and young swimmers face. Swave allows the swim instructor and the swimmer to stay in touch no matter the pool distance between them through visual and tactile feedback.

Lessons will be taught in a current manner but with an additional instructor who utilizes Swave from the pool deck. If a swimmer forgets how to do a certain stroke or does it incorrectly even after receiving feedback from the instructor in the water, the instructor on the shore can connect to the individual swimmer to provide additional help. Either through visuals telling the individual what to do correctly or through vibrations in the vest in the designated areas that require corrections. Swave acts as a piece of support equipment that helps enhance the overall learning experience.

The smart goggles of Swave can provide visuals to help aid the individual. The goggles support a range of visuals including stroke feedback, distance counter, collision warning and user disorientation. The biggest feature would be that the goggles are connected directly to the vest. The vest records the general movement pattern of the swimmer and when stroke feedback is turned on, will display the swimmer's swimming pattern visually through the goggles. The setting will show what the swimmer is

doing & visually recommends how to improve. The setting will update every 5 strokes letting them know how they are progressing.

The main feature of the vest includes giving vibrations to both the upper and lower arm and the back of the individual. The instructor can vibrate certain areas of the vest manually if the swimmer requires it in the designated area. Strokes that require arm feedback include front crawl, back crawl and breaststroke. Due to the tight nature of the vest, the additional benefit includes keeping the swimmer warm in the cold pool conditions.

5.2 Design Criteria Met

The section mentions how the design meets the criteria placed on the thesis project. How users interact with the product, design material choices, processes and implementation will be highlighted.

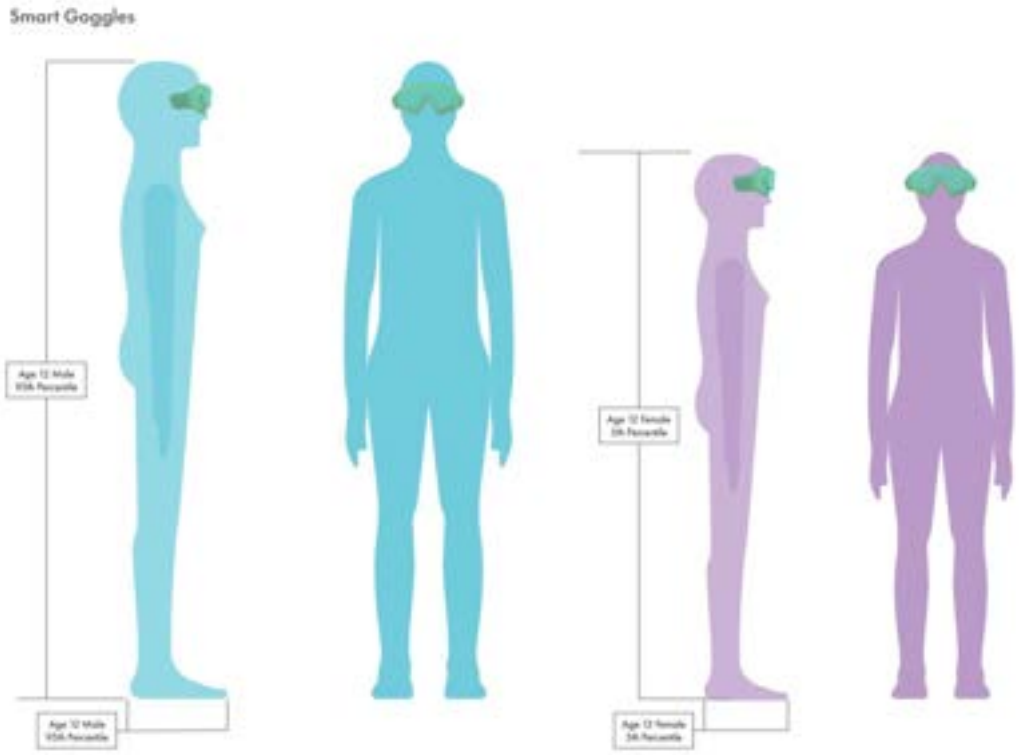
5.2.1 Full Bodied Interaction Design

Ergonomic dimensions of the final product were created for the 95 percentile twelve-year-old male and the 5th percentile twelve-year-old female. Sizing of the smart goggles, smart vest and adjustable flippers were created.

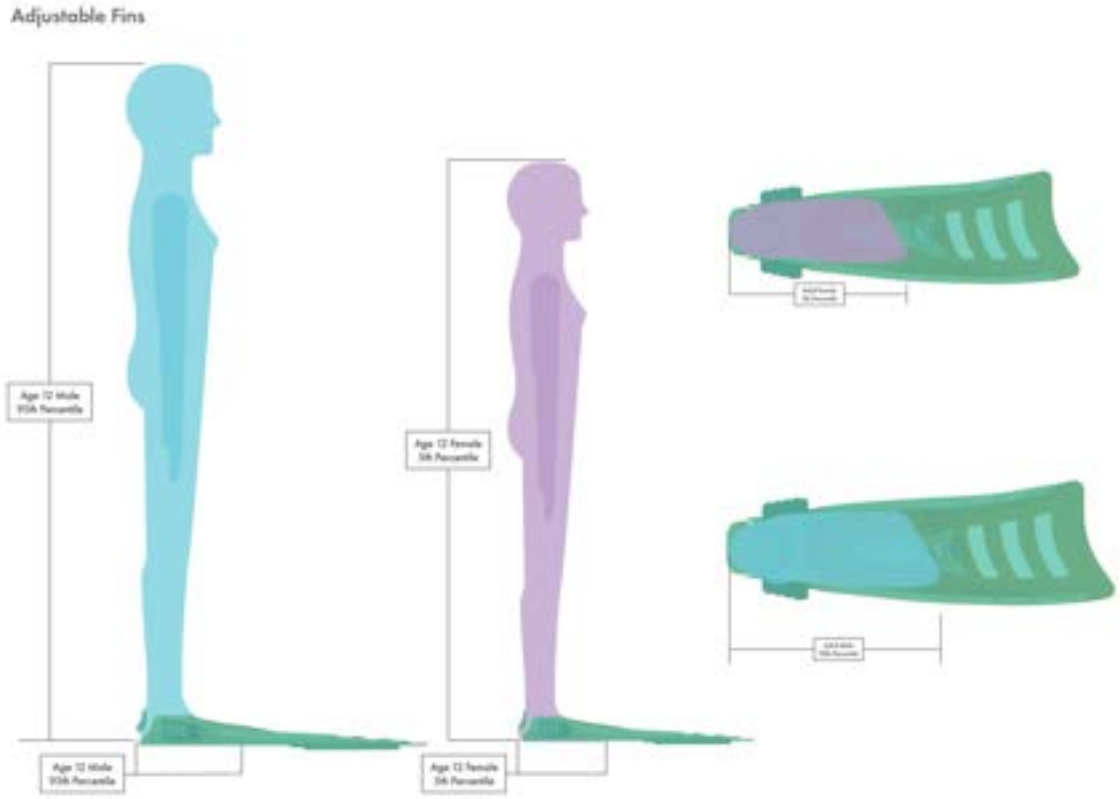
The design meets the selected full-bodied interaction by touching more than three major body parts. The goggles are secured tightly to the swimmer's head providing visual feedback through augmented reality. Individuals can adjust the strap by utilizing the quick release mechanism.

The vest covers the entire body of the swimmer. The tactile feedback sensors are located at both the lower and upper arms and the user's back. Through the pads, vibrations are given off to remind the swimmer to remind them of what they missed or had done incorrectly.

Lastly, the flippers secure to both the swimmer's feet. Users can adjust the knob using their hands to either increase or decrease water resistance. Swimmers can adjust the tightness of the strap using the quick release mechanism.



(Figure 34 - Full Bodied Interaction 1)



(Figure 35 - Full Bodied Interaction 2)

5.2.2 Materials, Processes and Technology

Material:

The materials used in Swave vary depending on the piece of equipment. The materials include ABS for the smaller components and housings, silicone for the flippers and goggles seal and polycarbonate for the lens of the goggles. The smart vest utilizes different colours of neoprene. To connect the skins of the parts together, the *Double Overlock Stick* will be used due to the durability of the stitch.

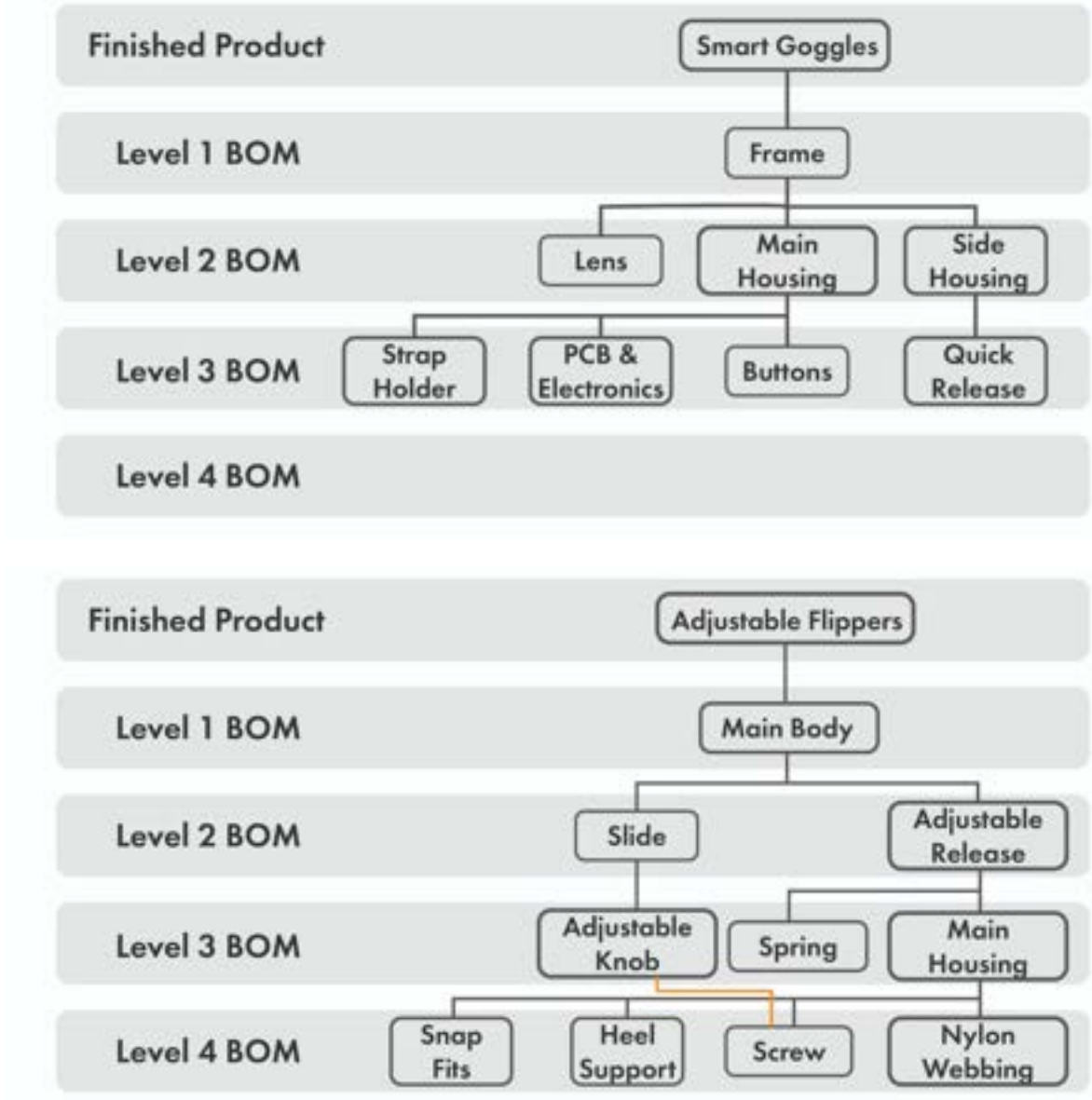
Technology & Processes:

The manufacturing processes used include the main flippers that will be utilizing the hot press. Sheets of silicone rubber in the colours orange and yellow can be pressed together to achieve the desired form and colours.

The smaller components from the quick release for both the goggles and fins and the main housing of the fin, goggle seals, heel end cap and goggle lens will utilize injection moulding. The precision of injection moulding allows for parts to be produced in large volumes in a very short amount of time.

5.2.3 Design Implementation

The major categorization of the design includes the smart goggles, smart vest and adjustable flippers. Parts were categorized by: importance, assembly procedure and size. The general overview of these items can be found below. Further details of the build of materials can be found in Appendix H1 and H2.

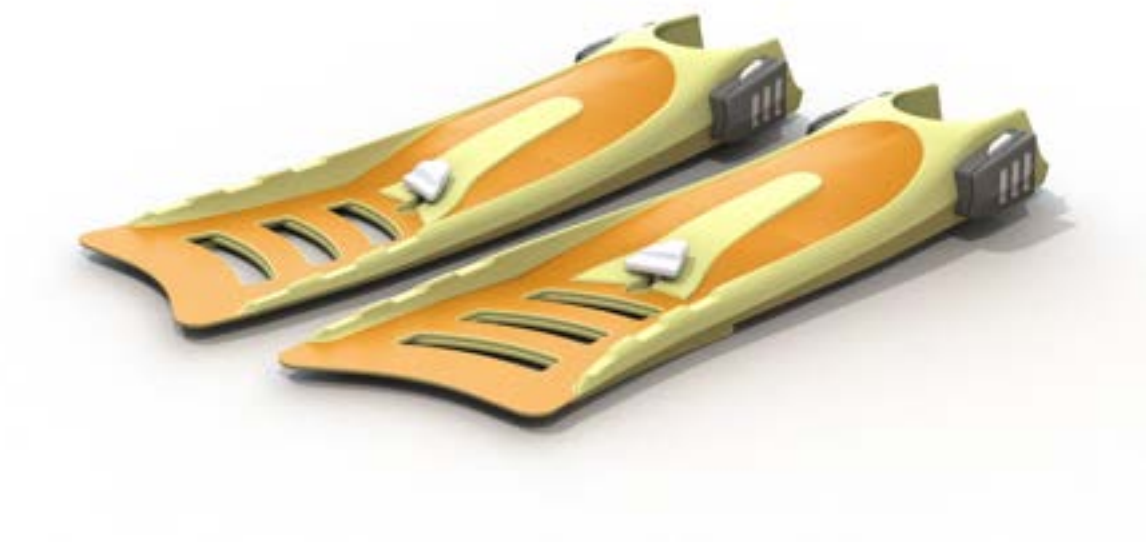


(Figure 37 - Build of Material Levels)

5.3 Final CAD Rendering

(Figure 38 - Goggles CAD)

(Figure 39 - Goggles CAD Human Reference)



(Figure 40 - Flippers)

5.4 Physical Model

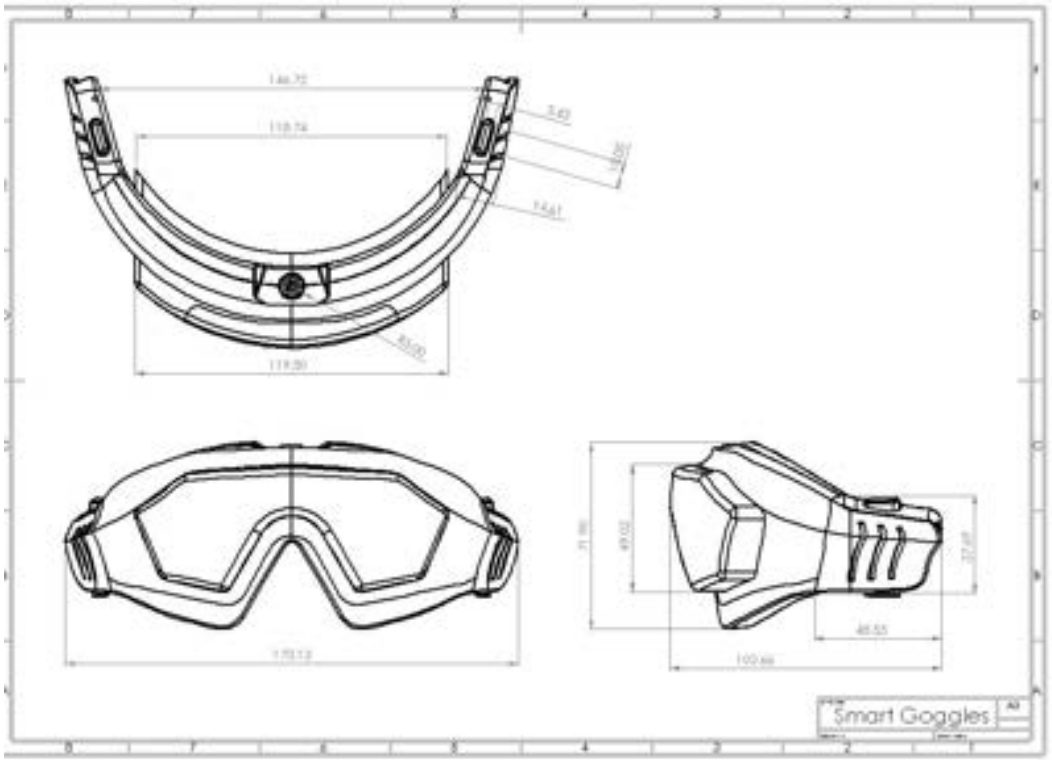
(Figure 41 - Front of Smart Vest)

(Figure 42 - Back of Smart Vest)

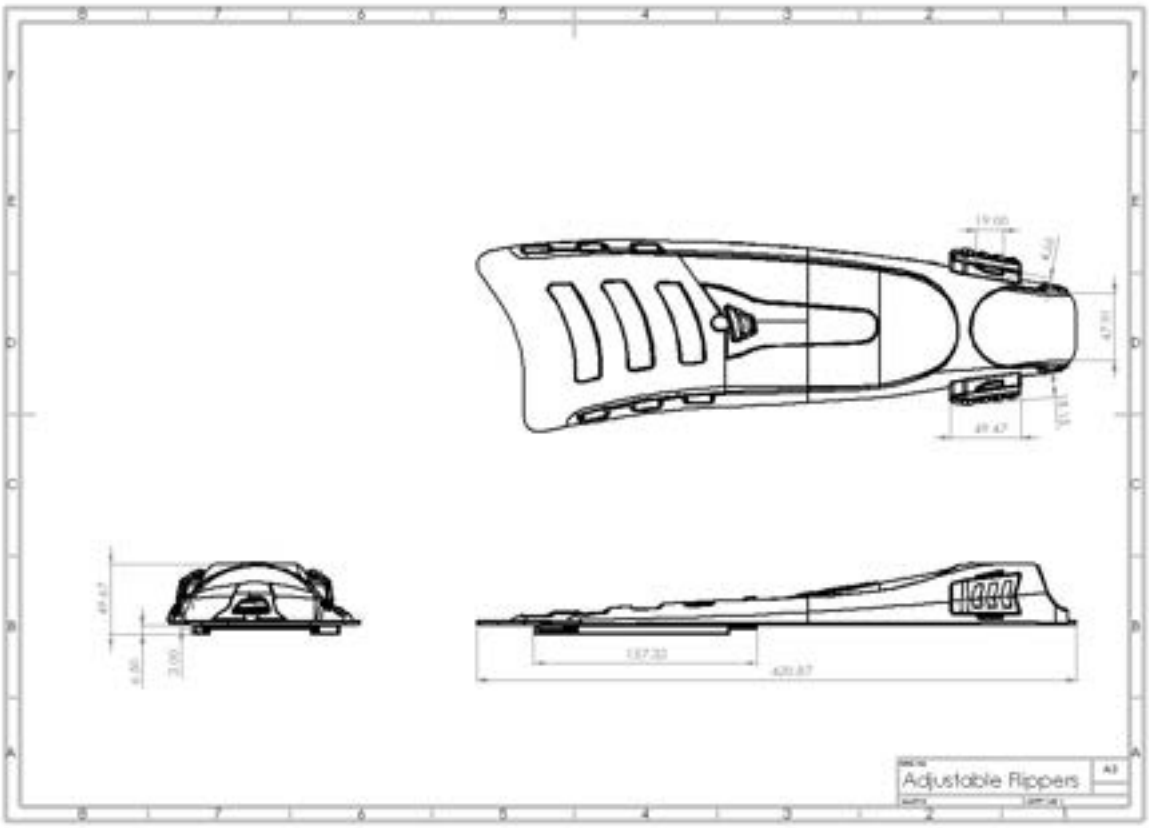
(Figure 43 - Flipper mockup)

5.5 Technical Drawings

Below are the most important dimensions of the smart goggles and flippers.



(Figure 44 - Goggles Technical Drawing)



(Figure 45 - Flippers Technical Drawing)

5.6 Sustainability

The plastics (ABS, Polycarbonate, Silicone) have the capability to be recycled and reused in other applications. The way Swave is designed utilizes snap fits and screw bosses to allow for an easier opportunity to disable and separate the components to be recycled. The use of Swave helps eliminate the need for parents to purchase their own swimming shirts or goggles for swimming lessons as the swimming aids such as the goggles, vest and flippers will be provided to the swimmers by the center. By eliminating the necessity to purchase swim equipment by parents, the acquisition of an additional product that will potentially meet its end in a landfill will cease. One less product ending up in a landfill means a reduced carbon footprint for the end-user.

Chapter 6 - Conclusion

Swave enhances the learning experience for the young swimmers learning to swim. Swave keeps a clear line of communication between swimmers to instructors regardless of pool distance allowing for constant communication. The communication of the goggles and vest is provided by the instructor

through the Swave app. The instructor can give both visual feedback/reminders through the augmented reality (AR) of the goggles, or tactile feedback through vibrations of the vest to the swimmer. Through increased feedback and reminders, swimmers can improve their strokes in reduced time. The flippers help improve the swimmers' flutter kick, a kick vital to both front crawl and back crawl. The flipper features the ability to allow the swimmer to reduce the water resistance. Through the reduction of water resistance, swimmers will have to work harder to maintain a good form of flutter kick. The Swave flippers bridge the gap between regular flipping with swimmers having issues and swimmers kicking with flippers without having any issues.

(Figure 46 - Young Swimmer In-Situation)

(Figure 47 - Flippers Pool In-Situation)

(Figure 48 - Flippers Pool In-Situation)

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Hui, L. (2021). [Figure 51 - Form Goggles] [JPEG] Lewis Hui

Hui, L. (2021). [Figure 52 - Noodle] [JPEG] Lewis Hui

Hui, L. (2021). [Figure 53 - Flutterboard] [JPEG] Lewis Hui

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Chapter 7 - Appendix

Appendix A - Discovery

Background:

In 2020, there were 152 fatal drownings recorded by the Lifesaving Society. Even if an individual survives, near-drowning incidents can result in life-long disabilities. Ontario is surrounded by four major bodies of water and is home to a variety of water-related activities throughout the year both in or near water. The activities could include, swimming, boating, fishing, skating, ice fishing, dip in the lake and water skiing. Learning to swim at a young age is important as it helps keep children safe around aquatic environments.

However, for young swimmers, learning to swim isn't easy. Young swimmers face many issues from both physical and cognitive limitations, short attention spans or occasionally past traumatic water-related incidents. Due to these limitations, swimmers have less stamina to do constant laps, and cognitive abilities to do proper techniques/strokes.

How might we enhance the learning experience for young swimmers?

Needs:

Swim instructors need a better way to help young swimmers learn how to swim. A way to help overcome the limited feedback that is given per session to each individual due to time constraints and distance. Swimmers need a way to stay motivated and assistance to do the proper technique for skills to accomplish complete strokes.

Addressing the Problem:

Currently, the main strokes that are required to be learned are broken down into smaller components by the swim instructor. Through progressions of using different drills and types of equipment, the skills are gradually taught to the swimmer. Verbal feedback and physical manipulation is given to swimmers that require corrections to improve the stroke.

Methods:

To gain an understanding of the user groups, open-ended in-depth interviews over a phone call were made with people who have experience teaching swimmers how to swim. Open-ended interviews allow the interviewee to recall their lived experiences instructing swimmers how to swim.

Due to pandemic regulations, in-person observations were replaced with video observations. Problems from the user grounds were recorded and analyzed.

Empathy Mapping:

Through research data gathered from the in-depth interviews, empathy maps of both the swim instructor and the young swimmers were constructed. Two personas were created as both were important. Swim instructors are the ones who teach swimmers how to swim while the swimmer won't be useful if the individual doesn't have a mentor to guide them.

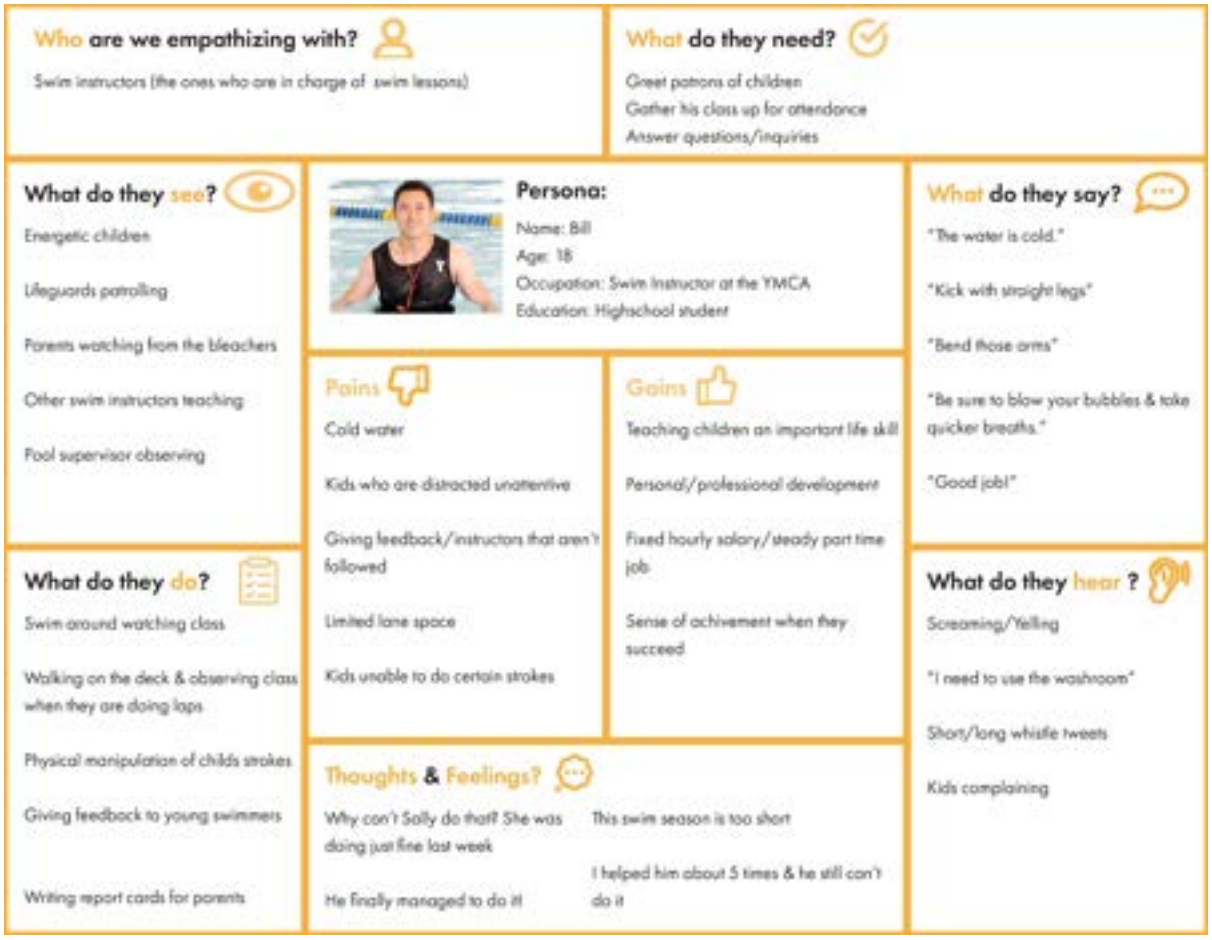


Table 11 - Empathy Map of Swim Instructor

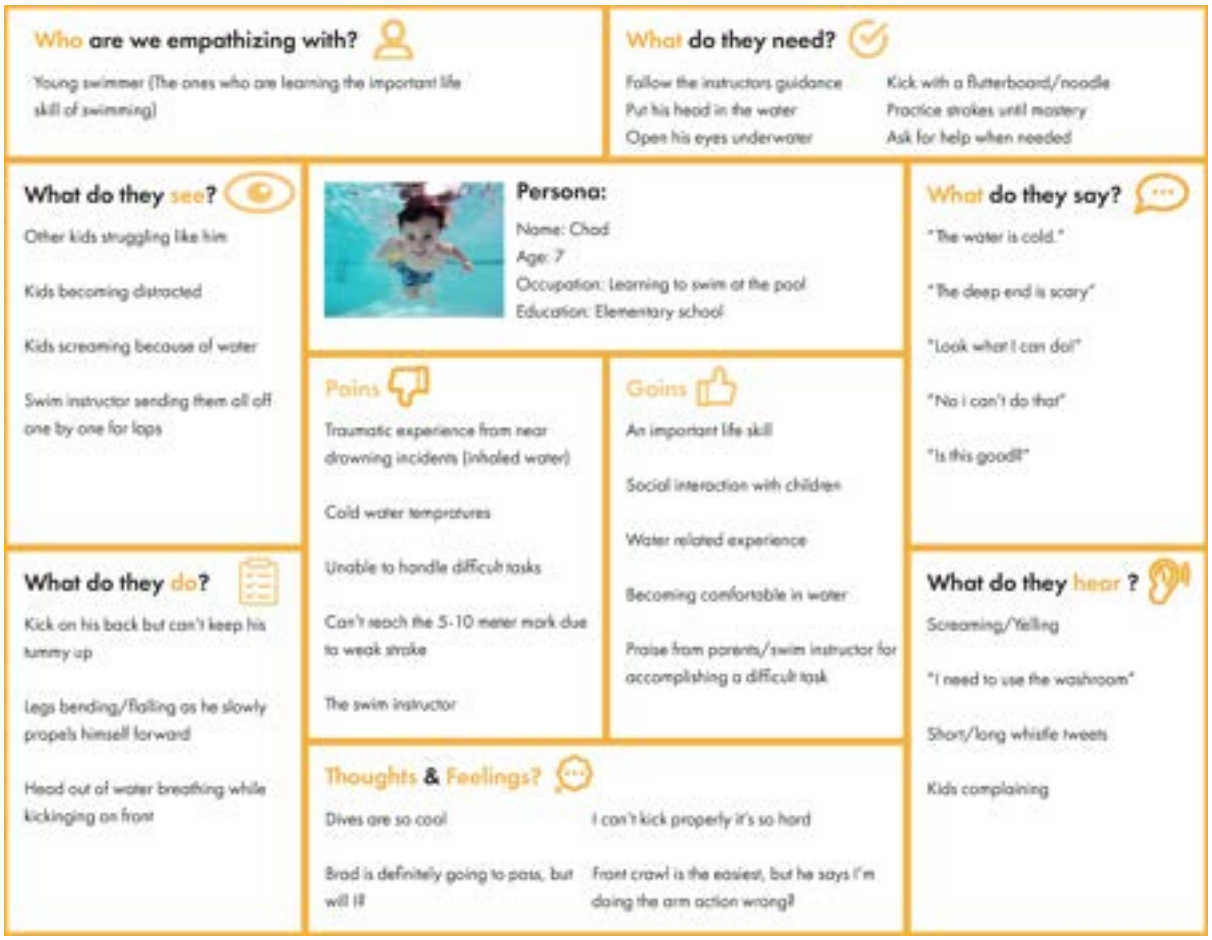


Table 12 - Empathy Map of Young Swimmer

Appendix B - Contextual Research

Findings:

Category	User	Description
Primary	Young Swimmer	The primary user is the children who use swimming equipment during swimming lessons. Can be eager or nervous depending on how comfortable they are in the water.
Secondary	Swim Instructor	The secondary user assists the primary user by distributing swim equipment and providing demonstrations on how to use the said equipment.
Tertiary	Pool Supervisors	The tertiary user is the pool supervisor who overwatches the primary/secondary users. Tertiary user also makes sure the swim equipment is adequately supplied and stocked.

Table 1 - User Profiles

User Data	Primary User: Young Swimmer	Secondary User: Swim Instructor	Tertiary Use: Pool Supervisor
Equipment use frequency	Often	Often	Minimal
Equipment use Duration	Varies depending on class & competency level (Est: 15 - 20 minutes total)	Handing out swim equipment or demonstrating with it (Est: 5 - 10 minutes total)	Varies depending on how often they have to hand out equipment (Estimated: 0 minutes)
Age	5-12	16 - 22	28 - 40
Education	Kindergarten- Elementary	High School - College	College/University
Physical/Mental/ Cognitive Aspects	Physical limitation due to size Developing brain Limited attention span Limited motor skills Limited understanding on swimming skills/strokes	Almost developed brain Good motor skills Clear understanding on swimming skills/strokes	Fully developed brain Good motor skills Very clear understanding on swimming skills/strokes
Behaviour	Has a hard to focusing & becomes easily sidetracked Activities have to be engaging Can be anxious & shy	Professional through personal relations Demonstrates	Professional through personal relations

Table 2 - Demographics

Demographics:

There is a wide range in ethnicities for children who are signed up for swimming lessons.

The age distribution can vary depending on whichever user base the swim lesson is catered to.

User Behaviour:

Swimmers tend to be very energetic overall and to some have a limited attention span which affects how much feedback or instructions can be taken in. Due to swimmers still developing, cognitive and physical issues do appear from being unable to do a certain stroke consistently to being too tired from a few laps.

Appendix C - Field Research (Product)

Methods: Product benchmarking was utilized to sort through a variety of swim equipment. The product benefit and features were listed along with general product information. Non-swimming equipment was also later researched including the Form Goggles, Focal Smart Glasses and Google Smart to analyze the general size and roughly how everything works. The objective of the product research is to collect vital data on the items which include:

- Buoyancy vs Streamlined: How equipment affects the user's swimming abilities
- Dimensions: General sizes of preexisting products & constraints they posses
- Technology: Analysing manufacturing methods, materials & mechanisms that are used
- Prove of Concept: To show that the technology has been utilized or for safety concerns

1] Fins

https://www.amazon.ca/Speedo-Rubber-Training-White-Large/dp/B005FYF97K/ref=sr_1_7?dchild=1&keywords=fins&qid=1633459549&s=sports&sr=1-7

Figure 49 - Flippers

Description:

Looking to change up your swimming workout regimen? Fins can add a new dynamic to your time in the pool by adding another element to your stroke.

Specifications:

Long curved fin blade	Soft, orthopedic pockets

2] Goggles

https://www.amazon.ca/Speedo-Hydrospex-Classic-Goggles-Smoke/dp/B011PLOIB4/ref=sxin_13_ac_d_rm?ac_md=1-1-c3dpbW1pbmcgZ29nZ2xlcw%3D%3D-ac_d_rm_rm_rm&cv_ct_cx=goggles&dchild=1&keywords=goggles&pd_rd_i=B011PLOIB4&pd_rd_r=d3a4e1f0-472c-4881-a558-8e9d98054c47&pd_rd_w=hBjf0&pd_rd_wg=AdjLq&pf_rd_p=a0a092d0-be28-4709-aa8a-0a41ba531cee&pf_rd_r=B5R6YQCNVGMRQ71HFS11&psc=1&qid=1633459831&sr=1-2-12d4272d-8adb-4121-8624-135149aa9081

Figure 50 - Goggles

Description:

Enhance pool training using a performance-driven goggle designed to keep you focused on the laps ahead. This mirrored essential features an innovative system that provides a universally comfortable fit and anti-fog lenses with UV protection, so your eyes are safe from chlorine and the sun.

Specifications:

hypoallergenic comfort seals	Polycarbonate lens
easy adjustment	Single split silicone head strap

3] Goggles

https://www.amazon.ca/FORM-Activity-See-Through-Anti-Fog-Swimming/dp/B00RGYI55K

Figure 51 - Form Goggles

Description:

Never count a lap again. With FORM, you can make every swim count with real-time metrics displayed right in your goggles. See your distance, time, pace, and more as you swim—no watch or clock required. Review your swims in the FORM Swim App to see areas of improvement and celebrate your progress.

Specifications:

Thermoplastic Rubber frame	Chemical Resistant Coating coating
Glass lens	LONG BATTERY LIFE
SMART DISPLAY	

4] Noodle

https://www.amazon.ca/Deluxe-Floating-Noodles-Swimming-Assorted/dp/B08F5HZ4F2/ref=sr_1_5?dchild=1&keywords=pool+noodle&qid=1633458500&sr=8-5

Figure 52 - Noodle

Description:

Deluxe Foam - Sturdy and Durable With a Wonderful Array of Colors! Wet Water Fun for Everyone!! Designed for Floating in the Swimming Pool, Splash Sabers and Toys. Dozens of Other Uses in Craft Projects - Even Insulation! Use them at Your Next Pool, Lake or Beach Party and then Let Your Guests Take Them Home as Party Favors!! PACK: 3 Deluxe Foam Pieces SIZE: 52" x 6.5" x 2.25" Inches Diameter Assorted Colors

Specifications:

Sturdy	Durable
Insulation	Multiple Use Cases

5] Flutterboard

https://www.amazon.ca/Speedo-Team-Kickboard-Blue-Size/dp/B0172GZZNG/ref=sr_1_4?dchild=1&keywords=flutter+board&qid=1633458349&sr=8-4

Figure 53 - Flutterboard

Description:

Ideal for kicking drills, this lightweight kickboard strengthens legs so you swimmers can power to the finish line faster. It's also great as a resistance tool for in-water vertical fitness exercises. Constructed of textured EVA foam, it features side finger scallops for a comfortable, no-slip grip.

Specifications:

Lightweight	Textured EVA
Comfortable	Non-slip grip

6] Pull Buoy

https://www.amazon.ca/Buoy%EF%BC%8CSwim-Training-Strength-Aquatic-Exercise/dp/B081JR74H6/ref=sr_1_7?dchild=1&keywords=water+pull+buoy&qid=1633459356&s=sports&sr=1-7

Figure 54 - Pull Buoy

Description:

The Pull of Excellence A core pull buoy is a critical tool in any competitive swimmer's arsenal. Held between the legs, it assists in keeping the legs afloat without the need to flutter kick. Now you're able to practice body position without taxing your limited oxygen supply. Supporting the legs also helps isolate the muscles in your upper body, so you can focus on strengthening the back, shoulders, and core. Whether training for high school, college, or adult competitive swimming, you can craft your perfect stroke, master breath control, and swim efficiently with a pull buoy. FANZEOS sturdy EVA foam construction offers a flexible, comfortable accessory for swim training.

Specifications:

Strengthening	Breath Control
EVA Foam	Flexible
Comfortable	

7] Lifejacket

https://www.amazon.ca/Stohlquist-Infant-8-30-Yellow-Blue/dp/B071VVGCXG/ref=sxin_13?asc_contentid=amzn1.osa.dc1a0279-50e6-40ca-bb21-a5a5beacab47.A2EUQ1WTGCTBG2.en_CA&asc_contenttype=article&ascsubtag=amzn1.osa.dc1a0279-50e6-40ca-bb21-a5a5beacab47.A2EUQ1WTGCTBG2.en_CA&creativeASIN=B071VVGCXG&cv_ct_cx=life+jacket&cv_ct_id=amzn1.osa.dc1a0279-50e6-40ca-bb21-a5a5beacab47.A2EUQ1WTGCTBG2.en_CA&cv_ct_pg=search&cv_ct_we=asin&cv_ct_wn=osp-single-source-pecos-desktop&dchild=1&keywords=life+jacket&linkCode=oas&pd_rd_i=B071VVGCXG&pd_rd_r=d721d0e1-22a6-430f-8559-a3a668a34292&pd_rd_w=pGcKL&pd_rd_wg=vpwmi&pf_rd_p=cc87287e-6713-499f-a678-051f7edaf8d4&pf_rd_r=E4QTYGB0FGTH90HKSCH2&qid=1633459326&sr=1-2-c26ac7f6-b43f-4741-a772-17cad7536576&tag=bccanosp-20

Figure 54 - Life Jacket

Description:

This jacket was designed to keep your child safe and comfortable. Fully adjustable straps and an easy-entry front zipper with a security buckle ensure the best fit. As your young one begins to paddle and kick in the water, this PFDs design allows for freedom of movement so they can start a lifelong love for "play in the water"!

Specifications:

Fully Adjustable	Easy to use zipper
Secure buckles	Freedom of movement

Findings:

It is found that each system served a specific purpose for a user at a specific level of learning. Depending on the age and swimmer level, certain items will be more effective at enhancing the learning experience whereas using simpler to handle swim equipment will not be of any benefit to the user. The information from the research servers as a benchmarked level on what can be improved further or what could be designed to help fill missing gaps in enhancing the user's swimming lessons.

Objective: To enhance the learning experience of swimmers and alleviate pains faced by both the swim instructor and swimmer during swim lessons.

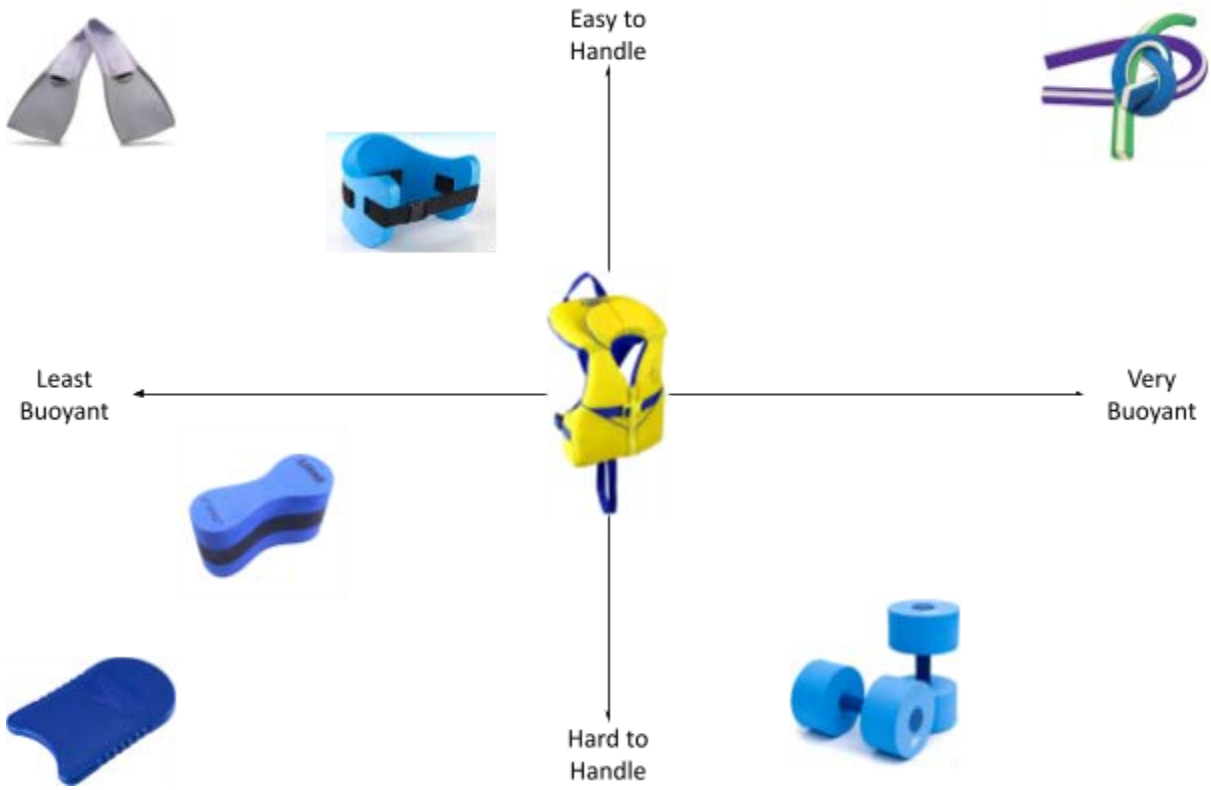


Table 5 - Product X-Y Graph

Appendix D - Result Analysis

Interviews:

Objective:

The objective of the open-ended in-depth interview is to understand the pains swim instructors face when teaching young swimmers how to swim. Through the interview, the interviewee can explain their livid experiences which will help push the direction of the project.

User:

A young adult who had worked part-time as a swim instructor during high school. The interviewee had 4-years of teaching experience teaching a variety of different swimmer levels under the Lifesaving Society curriculum in Canada.

User Background:

Asian descent, a young adult from Toronto, formerly a swim instructor.

Methods:

Interview questions were constructed by trying to understand the user, what they do, their experience, the pain points they face and why things went the way they did.

1] Can you tell me the background of the work you did at the pool?

2] What was your usual work schedule like for a shift?

3] How many people did you work with at a time?

4] Have you taught young children to swim before?

5] How many people did you teach at a time per class?

6] Did you receive any assistance or volunteer help?

7] What has your past experience teaching young children to swim been like?

8] How did your lessons flow from the first class all the way to the end of the session?

9] What general skills were being taught at this level?

10] What common physical/psychological problems/limitations did they face when teaching young children to swim? Elaborate.

11] What physical/psychological problems/limitations did you face when teaching young children to swim? Elaborate.

12] When teaching specific skills (ie: front/back crawl), what were some common problems faced? Elaborate.

13] What swimming equipment did you usually use & why?

14] Did the swimming equipment help improve or hinder the abilities of the children in question?

15] What reasons made the child's swimming experience bad?

16] What was the physical layout of the pool like?

17] Were the areas divided & did it benefit the people you were teaching?

18] Anything else you wanted to mention?

Interview Method:

The interview method was done over a zoom call. The interview was recorded by personal phone device. Key points and takeaways were typed up on google docs.

User Observation:

Objective:

To locate the pain points and troubles which both the instructor & the swimmer's face.

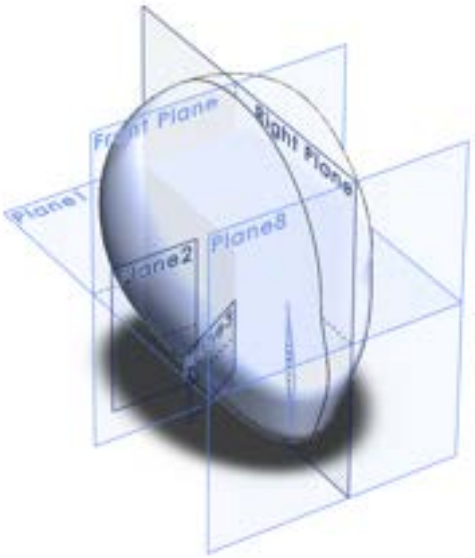
Method:

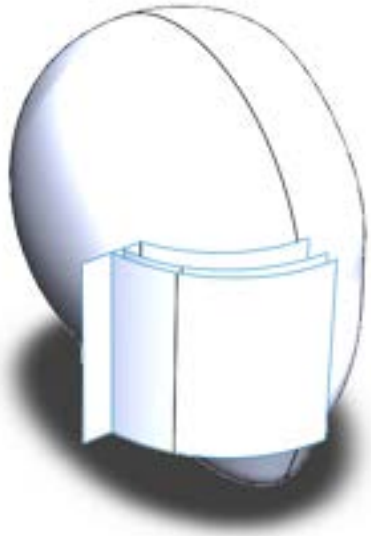
Through a video, snips of key points were taken from the timeline and placed in chronological order.

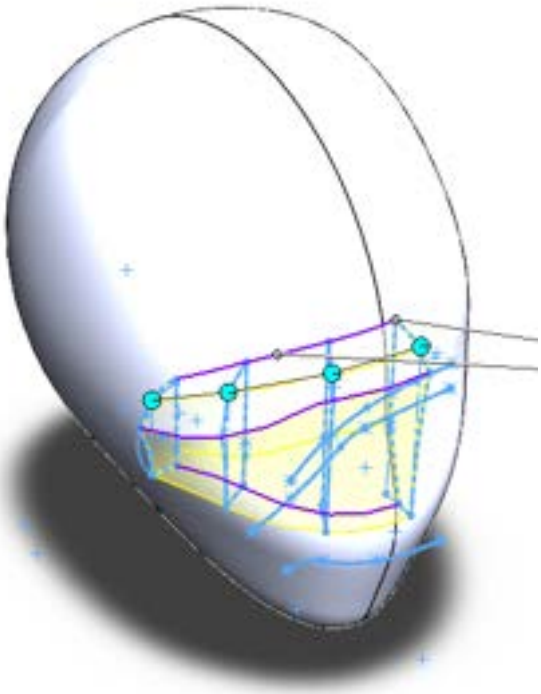
Takeaways:

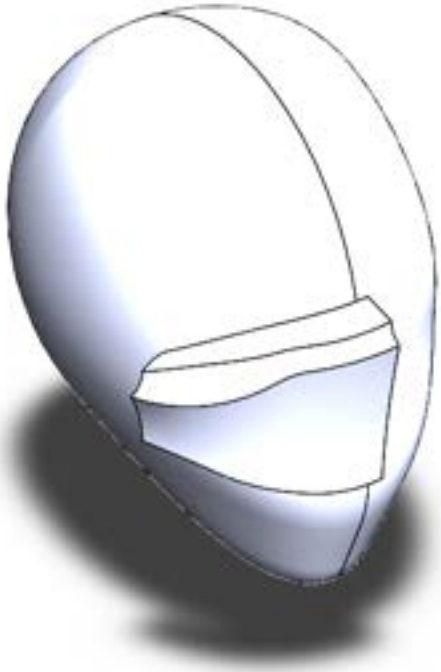
The young swimmer faced cognitive issues including trouble keeping a straight kick for a flutter kick. Due to a weak flutter kick, the moment the swimmer loses momentum, the swimmer came to a halt and flippers and later struggled to recover to continue with the drill. The swimmer was unable to hear the instructions coming from the instructor due to being underwater.

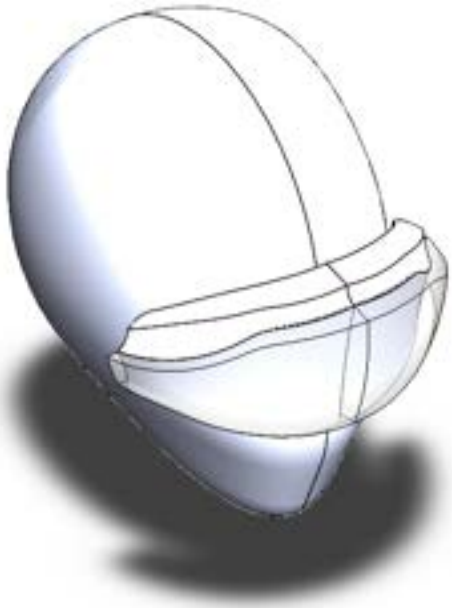
Appendix E - CAD Development

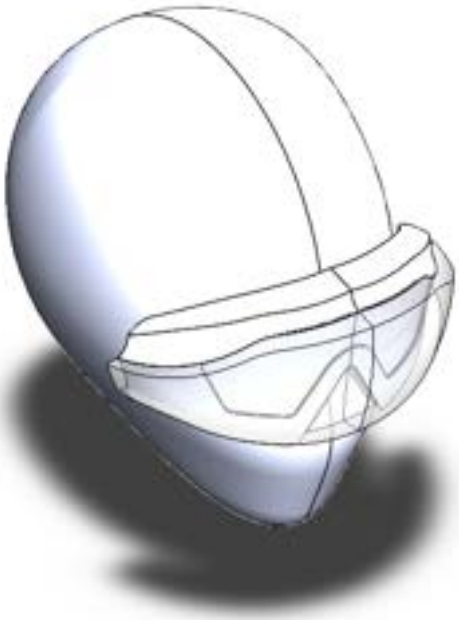


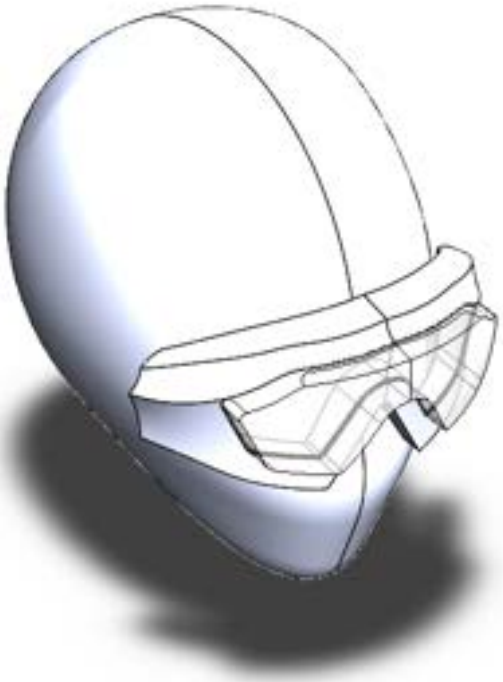


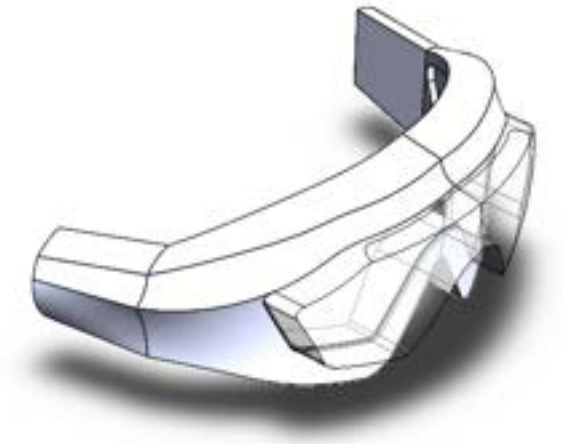


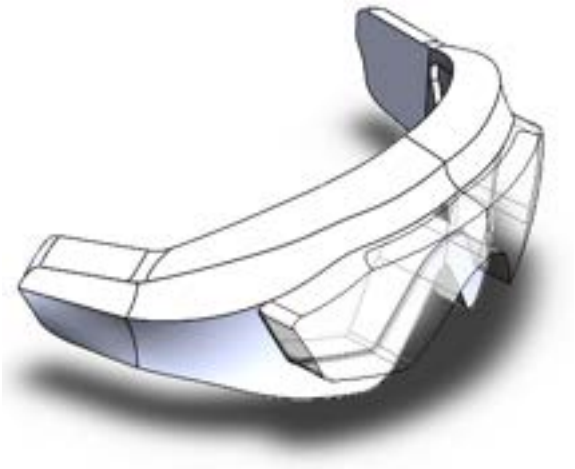


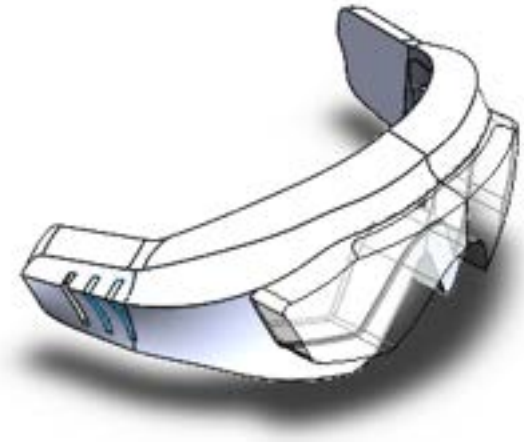


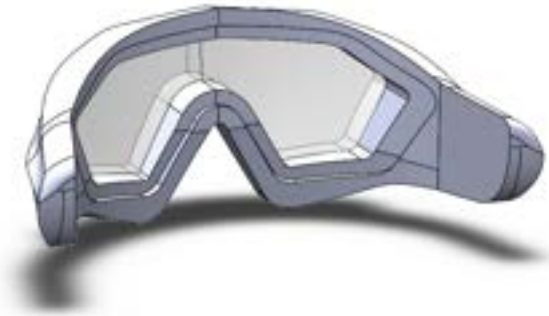


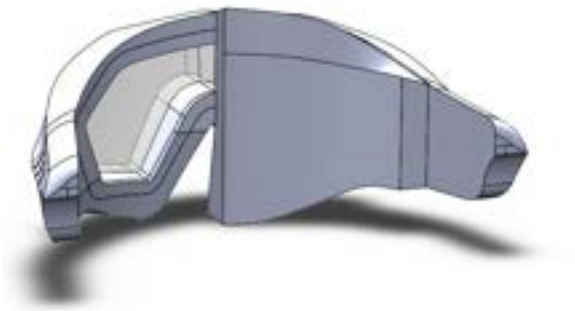


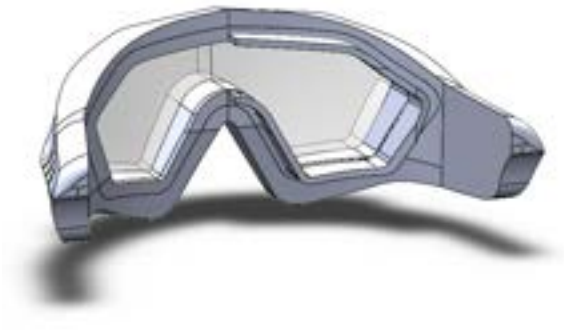


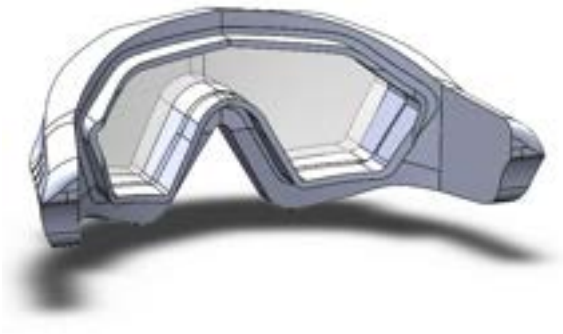


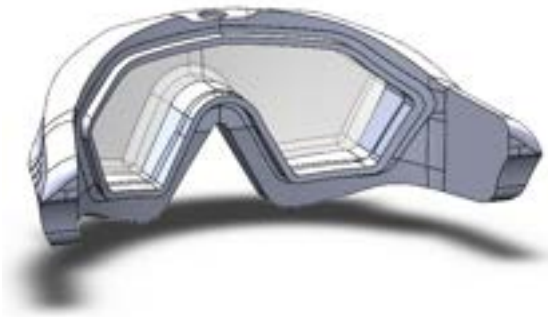


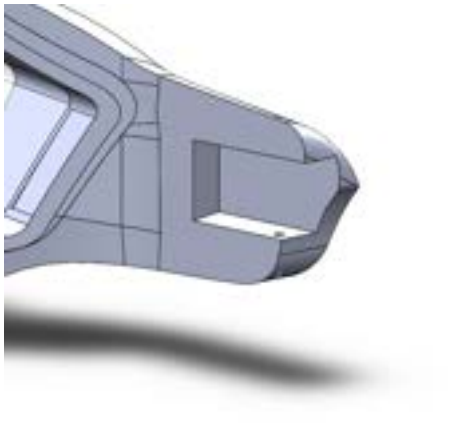


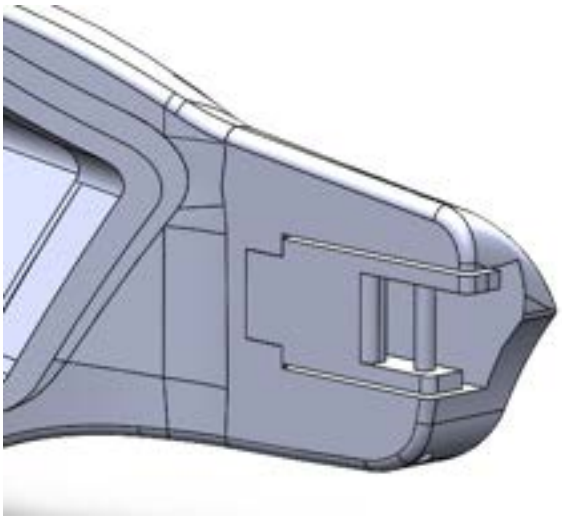


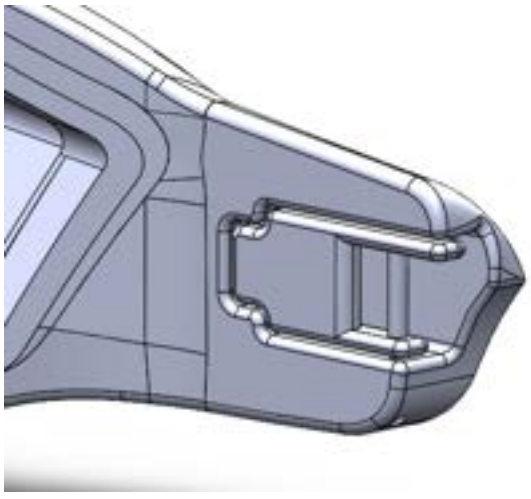


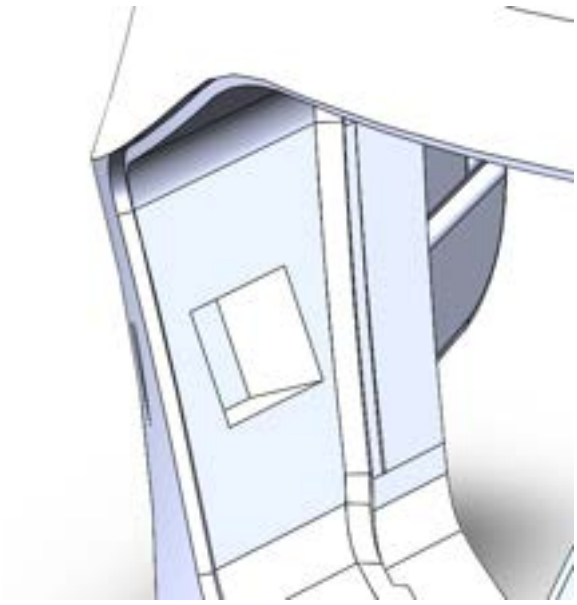


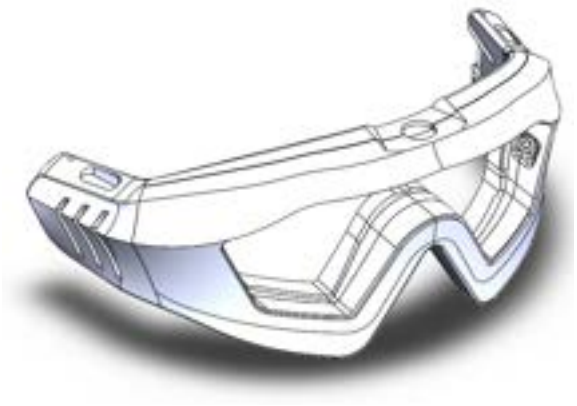


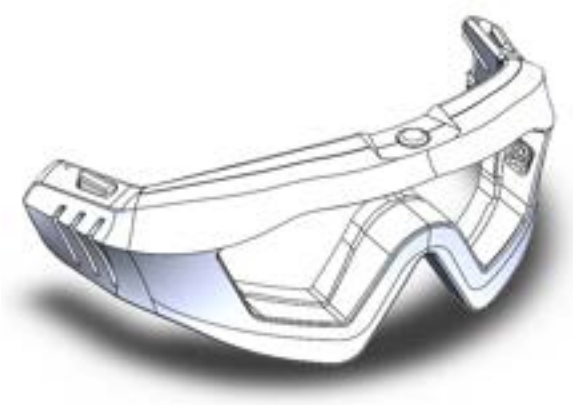












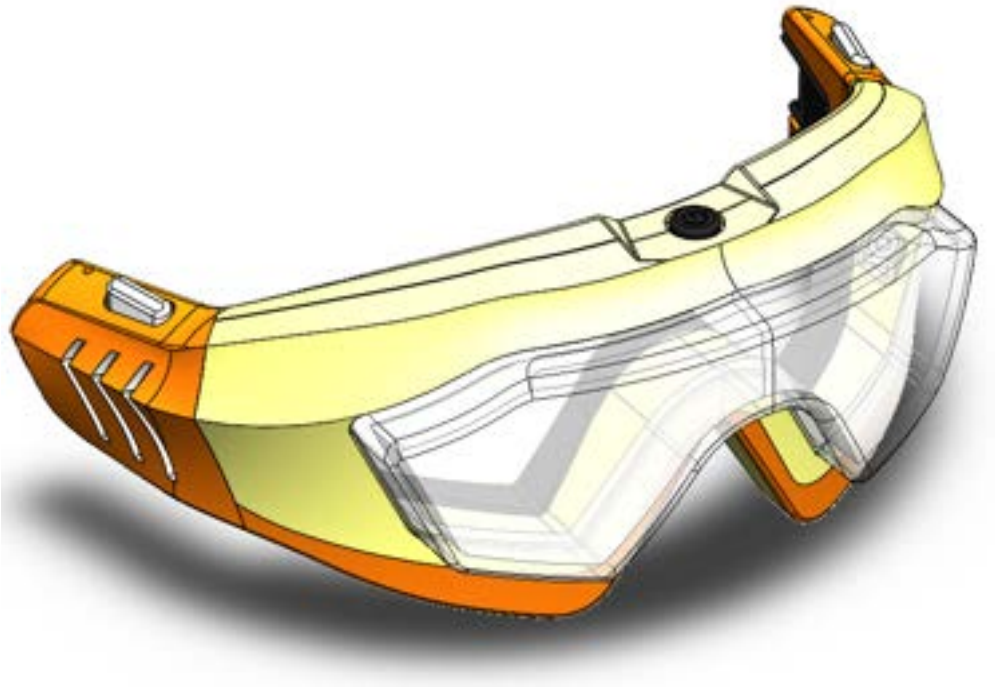


Figure 55 - Goggles CAD

Appendix F - Physical Model Photographs

Front of Goggles

Side of Goggles

Top of Goggles

Rear of Goggles

Quick Release Strap Holder

Projector Portion

 Front of Fins	 Top of Fins	 Side of Fins
 Snap-Fit	 Close Up Of Release Mechanism	 Close Up Of Release Mechanism

Table 12 - Physical Model Photograph

Appendix G - Technical Drawings

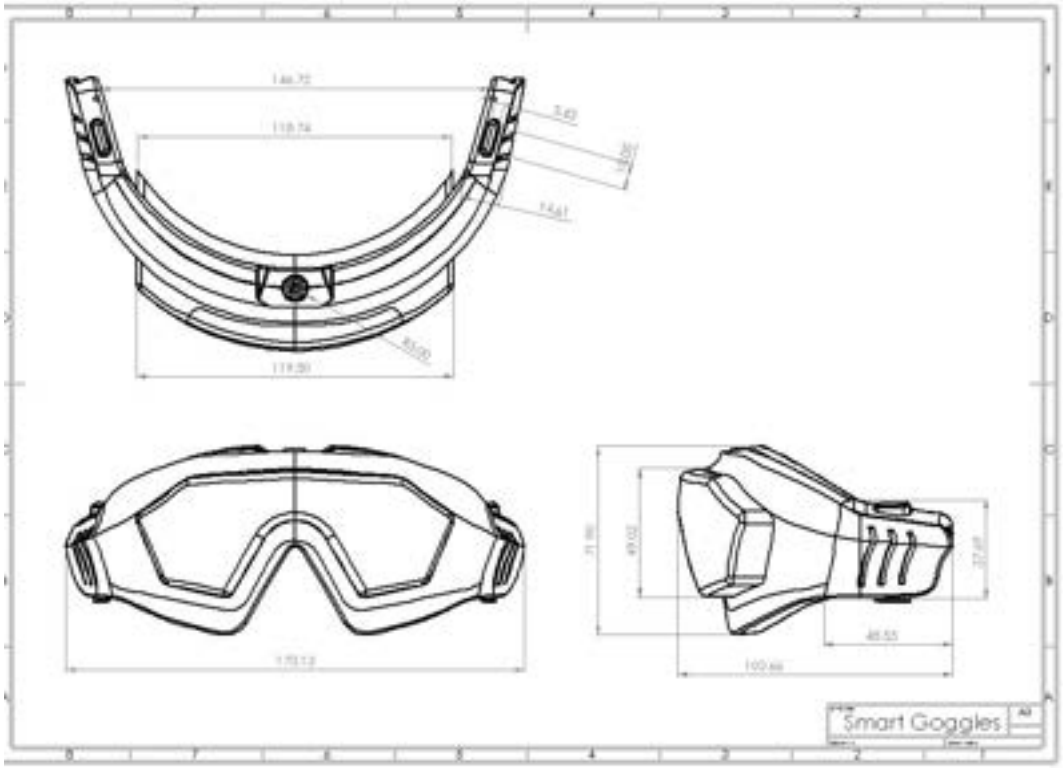


Table 13 - Goggles Technical Drawing

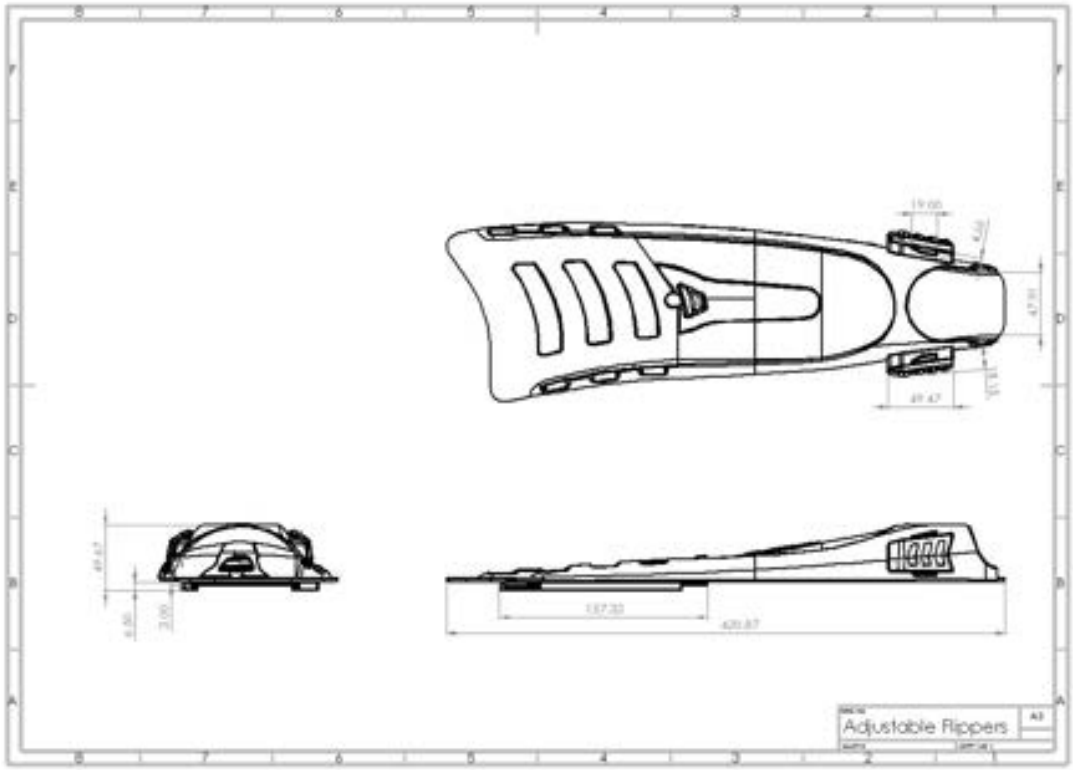
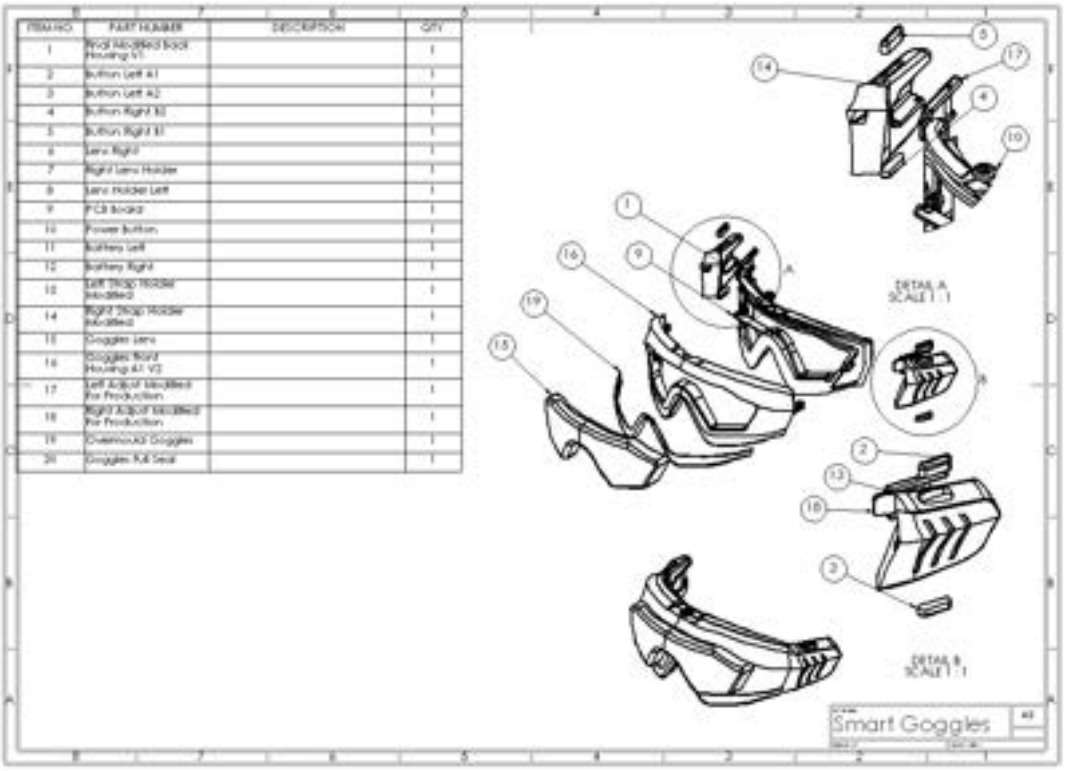


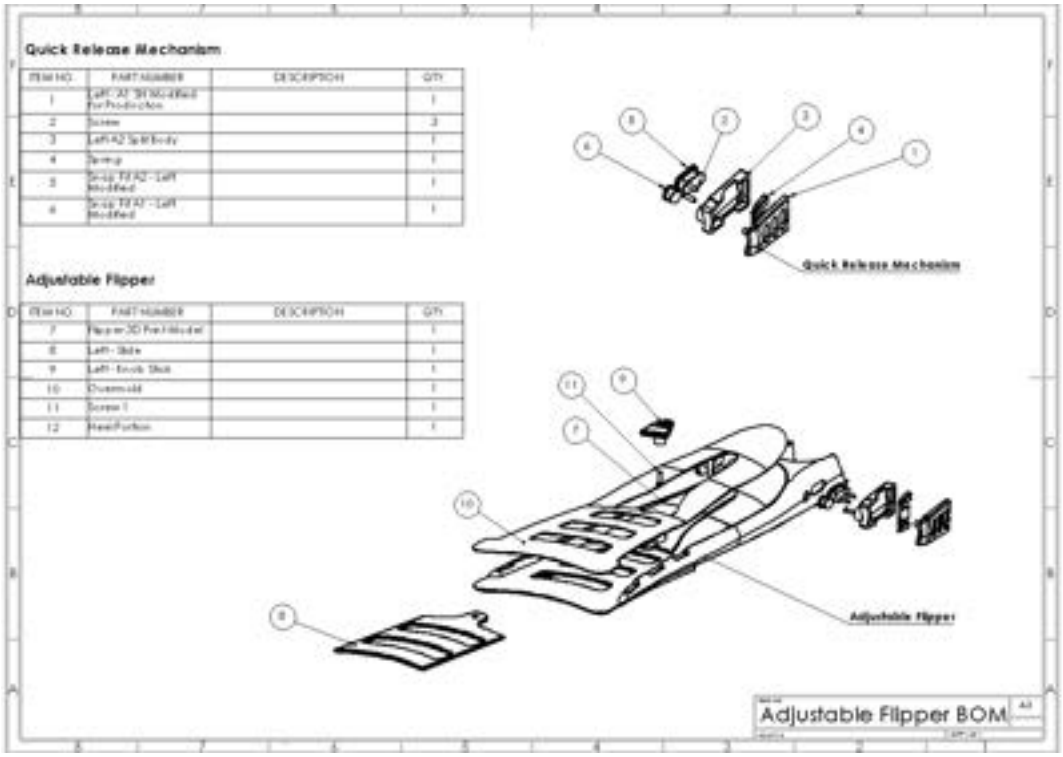
Table 14 - Flippers Technical Drawing

Appendix H - Bill of Materials Info/Data



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	Right Modified Back Housing V1		1
2	Button Left A1		1
3	Button Left A2		1
4	Button Right B2		1
5	Button Right B1		1
6	Lens Right		1
7	Right Lens Holder		1
8	Lens Holder Left		1
9	PCB Bracket		1
10	Power Button		1
11	Battery Left		1
12	Battery Right		1
13	Left Strap Holder Modified		1
14	Right Strap Holder Modified		1
15	Goggles Lens		1
16	Goggles Body Housing A1 V2		1
17	Left Adjust Modified For Production		1
18	Right Adjust Modified For Production		1
19	Overmould Goggles		1
20	Goggles Rubber Seal		1

Table 14 - Goggles Build of Material



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	Left A2 Modified For Production		1
2	Screw		3
3	Left A2 Split Body		1
4	Spring		1
5	Strap T2 A2 - Left Modified		1
6	Strap T2 A2 - Left Modified		1

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
7	Flipper 3D Part Modified		1
8	Left - Slide		1
9	Left - Knob Slide		1
10	Overmold		1
11	Screw 1		1
12	Head Portion		1

Table 15 - Flippers Build of Material

Smart Vest

Reference Image		Description	Colour	Fiber Content	Size | Width Weight	QTY	UOM
Fabric		Neoprene | Cold protection, flexible	Yellow	Synthetic Polychloroprene	150	165	CM
		Neoprene | Cold protection, flexible	Orange	Synthetic Polychloroprene	150	125	CM
		Neoprene | Cold protection, flexible	White	Synthetic Polychloroprene	150	40	CM
Threading		Thread T40	White	100% Polyster	Na	Na	CM
Zipper		Derlin Plastic moulded teeth | UV & Corrosion Resistant	White	Na	45.72	1	CM
Mini DC Vibrator		1.5 - 3 V | waterproof | 8000 - 24000 RPM | 0.01 - 0.06W	Na	Na	0.7 x 0.25	5	CM

Table 17 - Smart Vest Build of Material

Appendix I - Sustainability Info/Data

Product End of Life

At the end of the product's lifecycle, the individual components can be separated and later recycled and repurposed for other applications.

Appendix J - Approval Forms & Plans

THESIS TOPIC APPROVAL:

Student Name:	Lewis Hui
Topic / Problem Definition:	How may we improve the learning experience for young swimmers?

TOPIC DESCRIPTIVE SUMMARY (Preliminary Abstract)

Learning to swim is an important life skill that allows users to potentially save themselves in unexpected conditions whether it is falling off a boat or into a pool. Due to this parents have been signing up children to learn how to swim at a young age which can be costly/expensive. Children are at an initial disadvantage due to limited attention spans, cognitive/physical limitations as well as potential past traumatic water-related experiences. On top of this, some common hindrances include being unable to kicking with flexed feet, floating on their back or being unable to do multiple actions at a time. Due to these drawbacks, learning the important life skill of swimming is delayed. Standards set by the Lifesaving Society are used to teach children the necessary steps to learn how to swim. However many types of equipment do have unique problems which hinder their learning experiences. By finding unique problems and solving them, the process of learning to swim as well as the cost associated with swimming could be reduced. To further data collection, observations and interviews will be conducted to analyze the problems in depth. This will be done by checking out community centers during swimming lessons as well as conducting interviews with past/current swim instructors/lifeguards within this field of expertise. Through interviews, the interviewee could relay experts with extensive swimming knowledge within this field for further investigations. Through these findings, groups of experiences can be themed and potential problems can later be identified and solved.

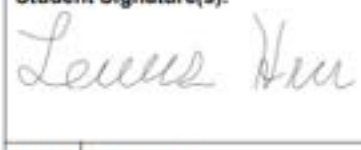
Student Signature(s): 	**Instructor Signature(s):** 
Date: 26 / 09 / 2021	**Date:** 07 October 2021

Figure 56 - Approval Forms & Plan

IDSN 4502
SENIOR LEVEL THESIS TWO

Humber ITAL / Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / WINTER 2022
Catherine Chong / Sandro Zaccolo

CRITICAL MILESTONES: APPROVAL FOR CAD DEVELOPMENT & MODEL FABRICATION

Student Name:	Lewis Hui
Topic / Thesis Title:	PROGRESSIVE SWIM EQUIPMENT

THESIS PROJECT – DESIGN APPROVAL FORM

Design is reviewed and approved to proceed for the following:	X	**CAD Design and Development Phase**
Comment:	- Initial CAD started reasonably as of week #7/February 22nd, continue with detailing and refinement. - Refinement and development coming along as of week #8/March 8th. - Need to get started on CAD for mask and finishing for suit development. - Advised completion latest by week #9 (March 17th).	

Design is reviewed and approved to proceed for the following:	X	**Model Fabrication Including Rapid Prototyping / 3D Printing and Model Building Phase**
Comment:	- Cannot approve of model fabrication until CAD development at 90% completion of all components > advised completion latest by week #9 (March 17th). - Once CAD is completed, can move forward to model fabrication from week #10 onward.	

Instructor Signature(s):	
Date:	22nd March, 2022

Figure 57 - CAD & Physical Model Fabrication Approval Form


PANEL ON
RESEARCH ETHICS
Navigating the ethics of human research

TCPS 2: CORE

Certificate of Completion

This document certifies that

Lewis Hui

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

n01300424

Date of Issue: 28 September, 2021

Figure 58 - CTCPS 2: Core Form

Appendix K - Advisor Meetings & Agreement Forms

HUMBER
Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / FALL 2021 & WINTER 2022

IDSN 4002 /4502
SENIOR LEVEL THESIS ONE & THESIS TWO

PARTICIPANT INFORMED CONSENT FORM

Research Study Topic: How may we improve the learning experience for young swimmers?
Investigator: Yue Kan Lewis Hui | (647)-232-8323 | lhui@hotmail.ca
Courses: IDSN 4002 & IDSN 4502 Senior Level Thesis One & Two

I, Jennifer Evans *(First Name/Last Name)*, have carefully read the Information Letter for the project How may we improve the learning experience for young swimmers?, led by Lewis Hui. 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 Lewis Hui at any time during the project.

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

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

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

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

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

I understand that I can verify the ethical approval of this study, or raise any concerns I may have by contacting the Humber Research Ethics Board, Dr. Lydia Boyko, REB Chair, 416-675-6622 ext. 79322, **Lydia.Boyko@humber.ca** or « insert student Name /Phone Number /Email Address ».

Verification of having read the Informed Consent Form:

☑ I have read the Informed Consent Form.

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

Jennifer Evans — Participant's Name
Participant's Signature
Dec. 17/21 — Date

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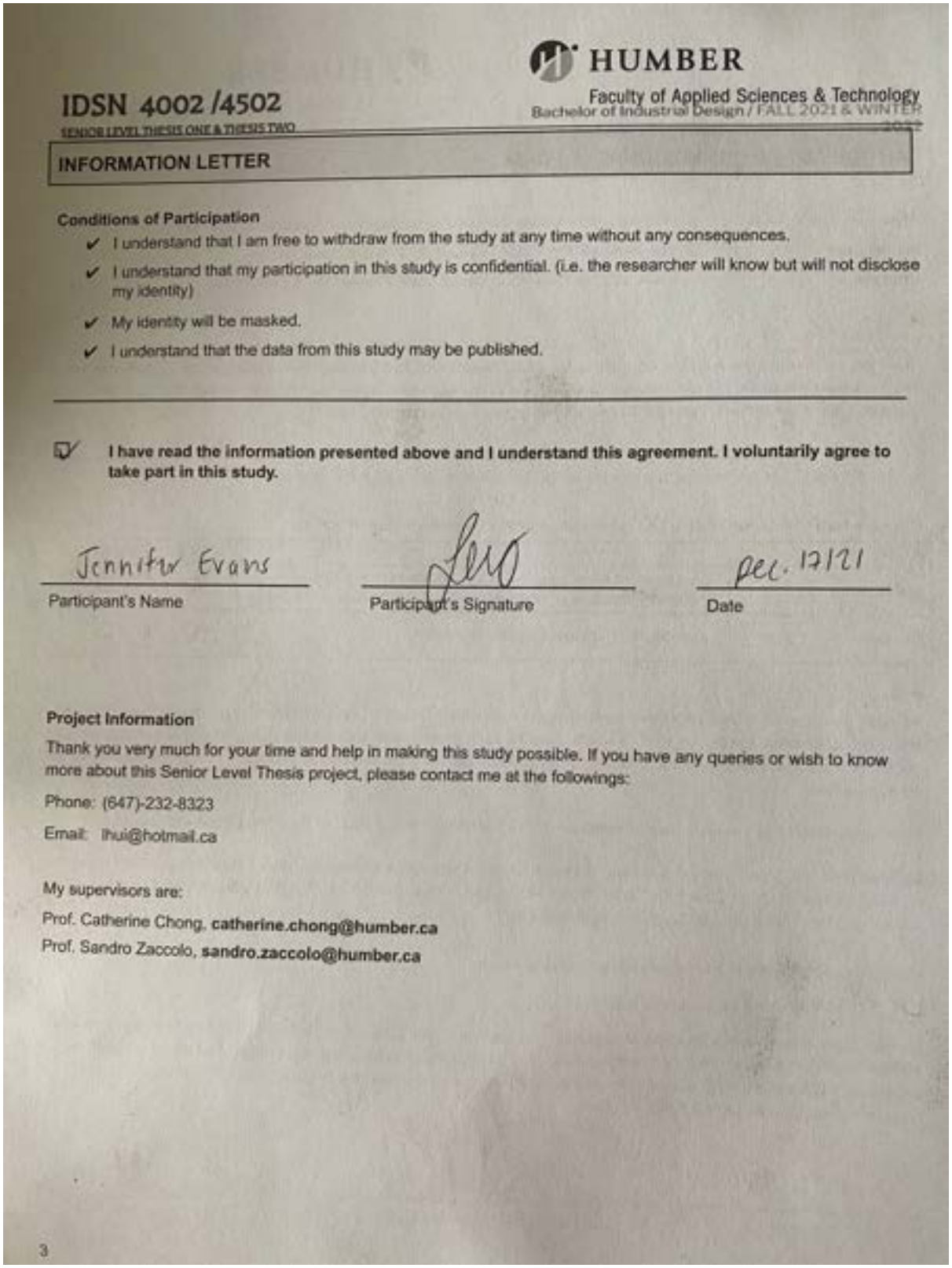
Figure 59 - Participant Consent Form 1



HUMBER
Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / FALL 2021 & WINTER 2022

IDSN 4002 /4502
SENIOR LEVEL THESIS ONE & THESIS TWO

INFORMATION LETTER

Conditions of Participation

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

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

Jennifer Evans — Participant's Name

[signature] — Participant's Signature

Dec. 17/21 — Date

Project Information

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

Phone: (647)-232-8323

Email: lhui@hotmail.ca

My supervisors are:

Prof. Catherine Chong, **catherine.chong@humber.ca**

Prof. Sandro Zaccolo, **sandro.zaccolo@humber.ca**

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Figure 60 - Participant Consent Form 2

Research Plan & Advisor Initiatives:

Stages of the research plan and advisor initiatives were taken.

Stages	Progress/Steps
Participants Search	8 participants were found: ○ All former swim instructors ○ with 2 - 4 years of teaching experience Plan: ○ Ask the participants if they know of anyone who may voluntarily participate ○ Check with the cities pool to see if the pool coordinator knows of anyone who may volunteer for the interview
Advisor Search	1 Advisor found Plan to find an advisor: ○ Contact the cities pool coordinator ○ Ask if they can be the advisor or can refer to anyone who might voluntarily participate
User Interviews	8 interviews were conducted: ○ Pain points of the general problems faced as a swim instructor were taken ○ Livid experiences from a instructors point of view of a swimmers account were also taken ○ Unique experience/problems were taken note of
User Observation	2 user observations were conducted ○ Not in person but replaced with video observation of the users ○ Problems the instructor and swimmer faced were documented Plans moving forward: ○ Have an experienced person review the content to be a second pair of eyes seeing the problems and highlighting missed content

Table 17 - Research Plan & Advisor Initiative

Interview Notes of Jessica:

Ahead of time interview questions were created to identify the end user and the problems they face. The words were transcribed manually.

Lewis: Can you tell me the background of the work you did at the pool?

Jessica:

I taught kids how to swim I think I taught kids from when they were young like parents and tot so they are like babies. Parents will bring them in. I also taught older kids how to swim as well as leadership courses. I am also a lifeguard as well as cash work. them when they were young.

Lewis:

let's go into the swim instructor part of it, what's the average age you would teach swimmer level-wise?

Jessica:

I guess from 3 years old to 13.

Lewis:

So basically just young children overall?

Jessica:

Yup

Lewis:

Overall when teaching those young children, what were some of the problems you encountered?

Jessica:

No space in the pool, if you teaching younger kids and when a lot of them are scared you want to stay in the shallow end. But because they squish all the classes in, you are forced to go into the deep end which isn't ideal when most of your kids are afraid of water. So that’s one. Another one would be class sizes. Some classes can be very large. Those are the two big ones.

Lewis:

But in terms of kids just being scared how do you cater to that? What do you do?

Jessica:

It's hard like when people are first learning how to swim. I think it's normal that they're scared and ideally, if they're learning, you wanna be in the shallow end but there's is no space so you're just stuck in the deep end. There's not too much you can do but stay near the wall and go slower and have them go one by one instead of sending them down and swimming and practicing. So things are just slower.

Lewis:

Just one by one? Seems inefficient but definitely keeps them safe and there's nothing you can do.

Jessica:

Slows down the pace and goes one by one.

Lewis:

During classes, did you receive any assistance or volunteer help to assist your classes?

Jessica:

Sometimes

Lewis:

Were they helpful or did they help in the way you wanted to? How did they help for a particular stroke?

Jessica:

Ya have somebody to help teach kids I think it does. Especially the younger ones with them being scared. If you had another instructor watching them it helps. It also helps pick up the pace instead of going one by one. Due to having two instructors you can now help 2 kids.

Lewis:

That’s good you received help and it's not like one person has to attend a 12 kid class. On top of that, in terms of strokes, what were the most problematic strokes you found. Or just general problems when teaching skills?

Jessica::

I think the hardest to teach is treading.

Lewis:

Please elaborate

Jessica:

When you're trying to stay still near the wall. Kids just kinda gravitate towards holding the wall or when you're trying to tread and there's a big class, kids are just crashing into each other.

Lewis:

What did you try to address these problems? Or was there any solution you found that was effective?

Jessica:

I guess take half a class at a time. Or keep them further away from the walls.

Lewis:

Due to that circumstance it just doesn't work in your favour. Could you tell me what a general lesson would be like? Like for any general level you can think of past experiences from the beginning to the end?

Jessica:

Like a normal class which is 45 minutes. You'll take like younger kids and go to say hi then you play a game to get them warmed up to get used to the cold water. They don't want to get into the water due to it being cold so you play a game. For practice or strokes, you usually go into progressions before going into strokes so kinda like baby steps. If you're trying to practice front crawl, then you first practice kicking and then do your arm strokes, then you bring it together. Near the end, they usually do some treading or dives just something in the deep end.

Lewis:

On top of that one question off of that. In terms example front crawl. Let's bring it into specifics what would you do step by step and what potential problems did you face when teaching like progressions for front crawl?

Jessica:

Step by step I would get them to do maybe a lane of kicking to practice their kicking with a flutterboard. Afterwards, we will bring in their arms with a flutterboard. Afterwards, we'll go without the flutterboard and I guess the issue that I faced was that it might be harder to see incorrect strokes. Like you'll send them down, you might be standing in the middle of the class in the middle of the lane. You might not be able to see all the strokes being done. If theirs an error, I might have not caught it.

Lewis:

Are you able to give feedback if you give them in the middle of the lane once you send them off?

Jessica:

Not really, if I'm in the middle of the lane I see it then yes.

Lewis:

Where would you be positioning yourself, in the water or on the deck?

Jessica:

In the water.

Lewis:

So the water in the middle of the lane and if they pass by you, you stop and tell them they messed up and give corrections?

Jessica:

Or I'll just move their legs in the right way or their arms in the right way.

Lewis:

Off of that even when you use physical manipulation as mentioned. Then you let them go again to continue. Are they usually able to do it on the first try or able to do it as instructed after?

Jessica:

I guess some kids are able to, like if it depends on the correction. Like some kids you have to show them and move them the right way then they'll continue on and that's fine. Some kids are just struggling more and so those won't be able to catch on the first try.

Lewis:

How long does it usually take to for let's say from the perspective of the kid who needs more help. How long does it take them to do it even when you physically manipulate them to help them out. How many tries before they succeed at the top of your head?

Jessica:

There really isn't an average. If kids don't get it they have to retake the course. So I'm not really sure if there's an average for the learning pace.

Lewis:

So it'll take them many times and a lot of assistance to do it. So unfortunately if they don't make it they have to take the course again and do it from square one?

Jessica:

Ya I think those kids who have to retake it. I think the problem is that they're scared and I don't think they can't learn or anything or scared or anything. They're just not ready because they're scared.

Lewis:

On top of that in general, what have you noticed from teaching young children how to swim. Do they have any physical/cognitive limitations they face that you might have noticed?

Jessica:

The biggest one is if the kid is afraid of the water, then really you can't teach them anything until they get over that fear. Even if they're able to do it for a short distance, it's really hard for them to move on to the next level. There is a psychological issue that comes up that the kid is scared of the water.

Lewis:

So it's up to them to get over or I'll hinder them from learning to swim?

Jessica:

Ya they'll have to spend more time in the water or something. But 30 minutes a week and 5 plus kids and if a kid is scared, then it's probably unlikely that I'll be able to give them enough attention for them to get over their fear. So that's when some parents might need to come in to play with them in the water and stuff like that.

Lewis:

On top of that what swimming equipment do you use to help assist kids who are learning to swim?

Jessica:

Lifejackets, toys, flutterboards, noodles.

Lewis:

Adding on, with the equipment you use, are there any downsides that slow down the progress of the child learning to swim that you might have noticed?

Jessica:

By using the equipment?

Lewis:

Yup

Jessica:

No, I don’t think so, if anything equipment is fairly useful in teaching kids how to swim. I would never say equipment never slows down kids learning to swim. If anything it speeds the progress up.

Lewis:

What was the physical layout of the pool and did it enhance or slow down teaching kids how to swim?

Jessica:

I think all pools are very similar. 25m length pools and they separate it by lanes. I think they're all the same pretty standard. I don’t think there's is any way to describe it and it's rectangular for the most part.

Lewis:

Adding on when they divided it into lanes, did it benefit or hinder your teaching methods?

Jessica::

I don't think it hindered anything. But the biggest thing is the pool if there are too many classes going on you might be pushed out from the shallow end. The shallow end is easier to teach kids who are scared of the water. That is the only thing I can think of that hinders teaching. Maybe if there was a more shallow area, it would be good for teaching.

Lewis:

Those are basically all the interview questions. Is there anything you just want to mention overall when teaching kids?