Team Laser Cutterz
Design Factory Melbourne Aug-Nov 2019

THE JACKSUIT

pool exercise aid

Team Laser Cutterz
Design Factory Melbourne Aug-Nov 2019

THE JACKSUIT
pool exercise aid

Abstract

Introduction: Jack is a 19 year old male with complex needs associated with a degenerative condition called Spinal Muscular Atrophy (SMA). To increase muscle strength and maintain current range of motion, Jack participates in weekly exercise sessions in the pool with an exercise physiologist (EP) and carer. Brief 1.0: Our initial brief was to create a product that enabled Jack to support his body independently in an upright position while doing his exercises in the pool. This product would limit the need for two individuals to assist him when completing his regular exercises. Observing Jack in the pool: After observing one of Jack's aqua exercise sessions and talking to his EP, we became aware that Jack mainly floats on his back, and he needs a) support to keep his neck and torso stable; c) a way to decrease drifting away from the EP during exercises; and d) a product that is easy to put on and take off. Brief 2.0: To enable Jack to float on his back with adequate support for his head, minimal trunk rotation, and preventing him from drifting during exercises. In order to meet Jack's needs in the limited timeframe, we decided to join forces with Double Destiny Design. Solution: the final product, titled The Jacksuit, consists of three parts. Part A, the suit, was Laser Cutter's central focus. Part B (the stablising pillow) and Part C (the anchor) was designed by Double Destiny Design. All three parts combine to form a complete, holistic solution that responds to Jack's current challenges in the pool.

table of contents

Our team, Laser Cutterz, met our need knower, Jack and his carers Janice and Lorraine in Week 1 of Design Factory. Jack is a 19 year old male with complex needs associated with a degenerative condition called Spinal Muscular Atrophy (SMA). He has also been diagnosed with Autism Spectrum Disorder (ASD), an intellectual disability and had his right hip removed at age 14. Jack is supported by a number of people and organisations including Onemda, a team of health professionals and his family.

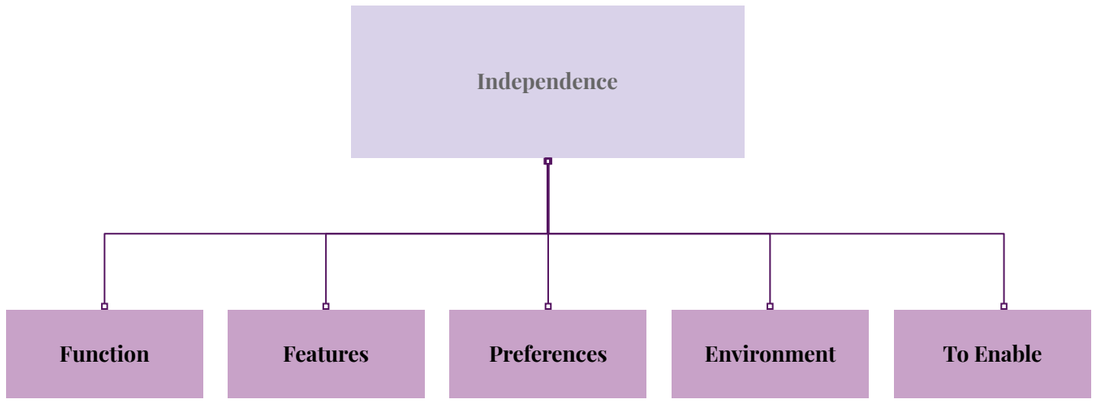
Spinal Muscular Atrophy (SMA) is a degenerative genetic disorder characterised by muscle wasting and weakness (National Institutes of Health, 2019). As a result of this diagnosis, Jack is predisposed to muscle contractures which can significantly impact his range of movement and functionality of his upper and lower limbs (National Institutes of Health, 2019). To increase muscle strength and maintain current range of motion, Jack participates in weekly exercise sessions in the pool with an exercise physiologist and carer.

introduction

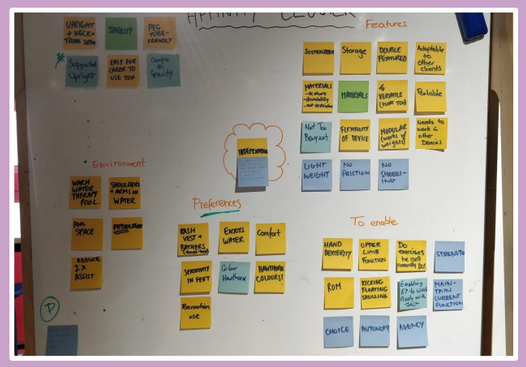
brief 1.0:

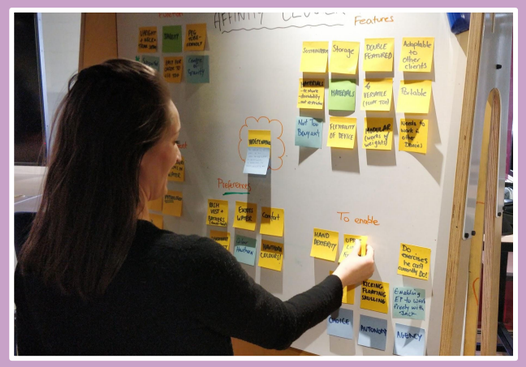
Our initial brief requested the creation of a product that enabled Jack to support his body independently in an upright position while in the pool. This product would enable Jack to work towards his goal of reducing further muscle contracture and maintaining his current function, as well as limit the need for two individuals to assist him when completing his regular exercises.

discovery



Function	Features	Preferences	Environment	To Enable
(what is the foremost purpose of the solution?)	*(what will each of the components achieve and why?)*	*(what does Jack like?)*	*(what kind of physical space will the solution be used in?)*	*(what are the obstacles we are trying to overcome with the solution?)*
Stabillity Peg-tube friendly Easy for carer and exercise physiologist to use as well.	Water-resistant and lightweight materials Modular and adaptable to different exercises Safe and skin-friendly for Jack	Takes into account that Jack experiences sensitivity in his feet Loves Hawthorn Hawks AFL team Jack enjoys being in the water and wears a rash vest and bathers as he finds this the most comfortable.	Jack's shoulders and arms are underwater. Jack works with an exercise physiologist and one other support person.	Exercises that are currently not possible. The exercise physiologist to work more freely with Jack. Current and extended range of motion.





Affinity Cluster

During Week 2 of the project, we undertook several ideation exercises in order to begin the journey towards a robust solution. This phase of ideation entailed casting our net wide and including ideas that could perhaps be perceived as far-fetched or unrealistic - we believed there would still be parts of these ideas that were worth exploring further.

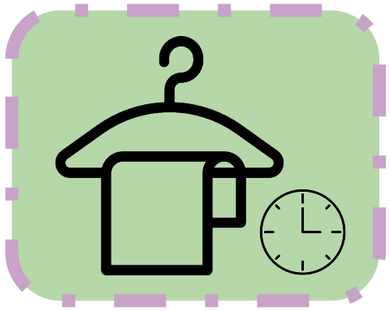
Our affinity cluster greatly aided us in our attempts to cast our ideation net as wide as we possibly could. We centered it around the idea of independence; that ultimately all of the solution's features would work towards achieving a level of agency for Jack in the hydrotherapy environment. 'Independence' specifically referred to being able to stand upright in the pool and participate in exercises that were earlier not possible to carry out.

Even though this part of the brief changed during the second half of the project, our focus remained on putting Jack's independence in the centre of our design thinking and processes - it would just be independence in another form.

As shown by the photos here, the affinity cluster diverged into directions such as 'Function', 'Features', 'Preferences', 'Environment', and 'To Enable'. Some standout ideas from each of these categories which persisted throughout the project and the change in brief are visualised on the left.

discovery

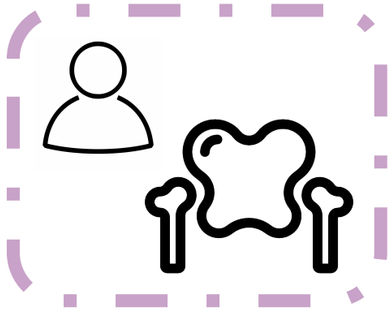
User Journey (before)



Jack arrives at the pool and is dressed for the session, which takes 15 minutes.

Jack is hoisted into the water with the help of a harness.

Jack begins therapy with his exercise physiologist and an additional support person.



Jack's head and hips are supported by the additional support person.

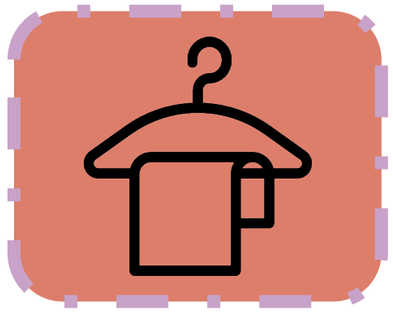
Most of Jack's exercises are done in the supine position.

Jack also does a handful of moving exercises.

Jack does many exercises where he is required to be stable in position.

Jack does a few exercises while sitting on the steps of the pool.

Jack is then hoisted out of the pool and on to a changing bed.



Jack is changed back into his regular clothes.

Jack, a young man with spinal muscular atrophy, needs a way to safely float in the water for his hydrotherapy sessions because currently, he is unable to independently do his exercises.

Point of View Statement

How might we create a way for Jack, a 19 year old man with spinal muscular atrophy to successfully float with minimal assistance in the pool when completing hydrotherapy exercises?

How Might We Statement

research & benchmarking

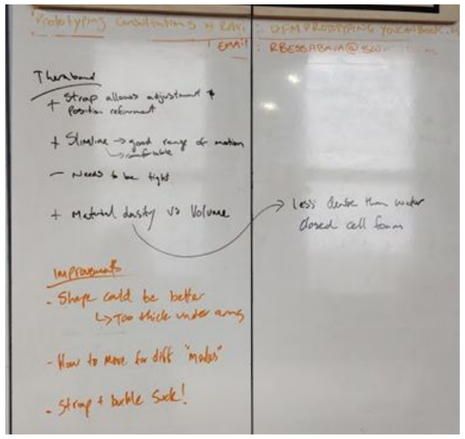
In order to understand and create a solution based on Jack's needs, we needed to conduct a combination of primary and secondary research and benchmarking.

Primary Research

Interviewing Jack and his carers
In weeks 2, 4, 6 and 10 we met Jack and his carers from Onemda. These meetings were invaluable and provided us with key insights that would inform our solution. The key points of these discussions are summarised below:

- Jack attends exercise sessions in the pool every Friday afternoon (approx. 1 hour) in Doncaster, with Lorraine and his exercise physiologist (EP) Sarah
- Lorraine supports/holds Jack's head to prevent water from going into his eyes and mouth
- Jack needs support to stop him from falling forward in the pool
- No one else uses the pool when they are in session
- The pool is chlorinated, and it has both shallow and deep end
- Jack enters the pool via a waterproof hoist and sling
- Sarah, the EP, currently uses a range of equipment in the pool with Jack, including a floaty belt, a ball, and ankle weights. They use a pool noodle occasionally but find that they are not buoyant enough
- Neck support does not have to be buoyant, it just needs to comfortably stabilise the neck
- Collars with foam beads are not preferred because they are uncomfortable, rise into Jack's Jaw, and constrict his neck
- Jack's arms and legs need to be free to be moved by Sarah
- Jack does not like his feet being touched, as this causes pain and uncomfortability
- Jack usually wears shorts and a rash vest in the pool
- Jack enjoys being in the water and finds it relaxing. They hope that the device will allow more time for Jack to be in the pool for recreation as well as exercise
- Jack's favourite sports team is Hawthorn (AFL)

research & benchmarking



Primary Research

Pool test
During the mid-semester break, we visited Hawthorn Aquatic centre to test a range of existing flotation devices. We assessed them for buoyancy, holding position for floating upright, and overall efficacy (see image on the left).

The 'theraband', or 'aquabelt', was by far the most buoyant and stable of all devices – but only when the foam was worn on the chest, rather than the lower back. We then brainstormed the benefits of this device, and how we could improve it to meet Jack's needs (see below image). For example, improving the strap to make it easier to put on and take off.

Secondary Research

Initial secondary research focused on understanding Jack's physical needs, including:

- ➔ Management of, and rehabilitation for Spinal Muscular Atrophy (Mercuri et al, 2018; Oskoui, Darras & De Vivo, 2017)
- ➔ The function of hydrotherapy for individuals with SMA and how it works (O'Connor 2017)

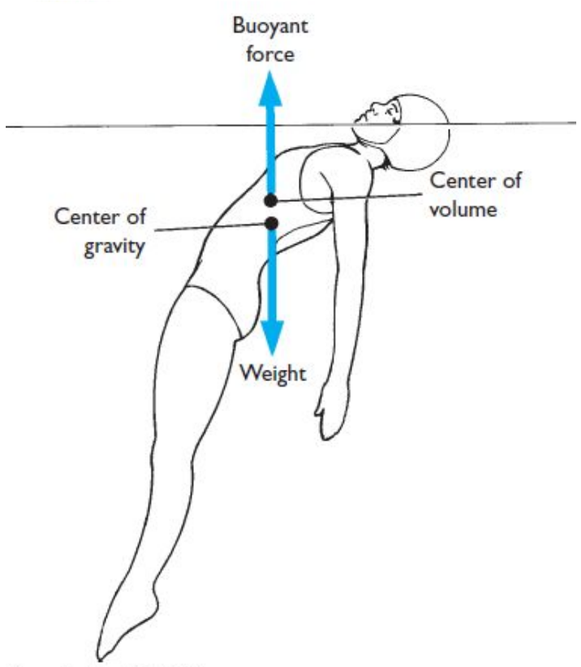
In order to ensure Jack would float safely, and not sink or fall forward in the water, we set about researching how things float, the forces and physics of water, and human biomechanics in water (Hall, 2018).

This research aligned with the results of the pool test. We found that when lying supine in water, the chest is where our centre of weight and gravity lie, and is likely the reason why the theraband/aquabelt provided so much stability and buoyancy when located on the chest (Hall, 2018). This valuable research and insight guided our prototyping process and design thinking.

research & benchmarking

Secondary Research (cont'd)

We also looked into the natural design of marine life such as seahorses, seals and sharks; we researched how these animals are able to maintain stability and decrease thrust while moving underwater (Fish, 2000). For instance, seals have fat bladders that provide buoyancy underwater; while seahorses have fins and air bladders (Fish, 2000). This information was essential for later brainstorming and ideation.



In addition, our research also saw us read and interpret the Australian standards for swimming and flotation aids. This ensured that our product would meet the required safety standards (McCormack, 2017). Key safety standards include:

- ➔ Marking: "WARNING WILL NOT PROTECT AGAINST DROWNING USE ONLY UNDER CONSTANT SUPERVISION" (in block uppercase letters at least 6 mm in height)
- ➔ Packaging: should include the purpose of the flotation aid and the age and body mass range of the person for whom the aid is designed

Benchmarking

Benchmarking continued throughout our entire design process. Initial benchmarking was used to determine the types of products and materials that can be used in chlorinated water (ie. Plastic and closed-cell foam). We looked at existing pool aides used during hydrotherapy, such as:

- Braces with hydraulic fluid (Hein, 2015)
- Exoskeletons/external spines (PolySpine, n.d.)
- Life jackets
- Aqua belts (Clark Rubber, n.d.)
- Floating devices for individuals with cerebral palsy (Theraquatics, n.d.)
- Flotation wetsuits (Airtime Watertime, n.d.)

As the design process continued, we refined our benchmarking searches for specific problems we faced, such as "what zips are usually used in swimwear/wetsuits?" and "what system is the easiest for people to get dressed in?" For example, we looked at 'snap side' clothing that allows an individual to be dressed from one side (Cartner's, n.d.). The results of this benchmarking can be seen in our final design.

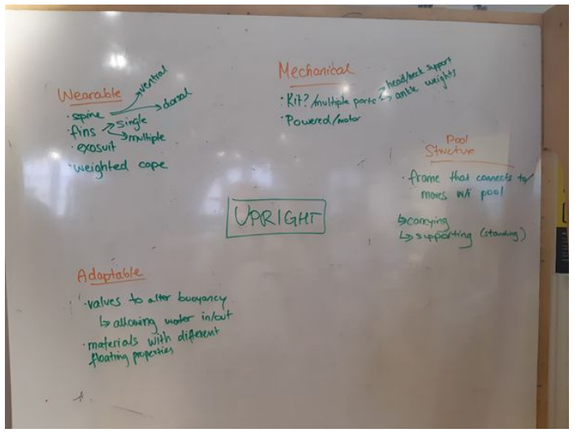
Brainstorming

Brainstorming focused on the initial goal of the project: to allow Jack to float upright in the pool. Further, we attempted to find a way that Jack could easily shift between lying horizontally in the pool, to floating upright. Early ideation led us to brainstorm how we could use the movement of air or water *within* and *throughout* the device, in order to shift Jack's weight depending on the exercise he would be doing. We considered complex systems of one-way valves and tubes or pockets of air. In order to move forward with this idea, however, we needed to create and test a prototype.

Lotus Blossom

The lotus blossom allowed us to map out our initial brainstorming ideas. Key insights from the affinity cluster that have followed into our final design include:

- ➔ The product may be wearable by Jack, or it may be a removable part of the pool structure
- ➔ Due to the complex nature of the brief, the product may need to modular in it's design and come as a kit of parts, with an instruction manual
- ➔ Adaptability is essential in order to ensure that the design is inclusive and universal



Key Design Drivers

We established six key design drivers that were informed by research and ideation:

1. Independence
2. Safety
3. Comfort
4. Ease of use
5. Adaptability
6. Enjoyment

ideation

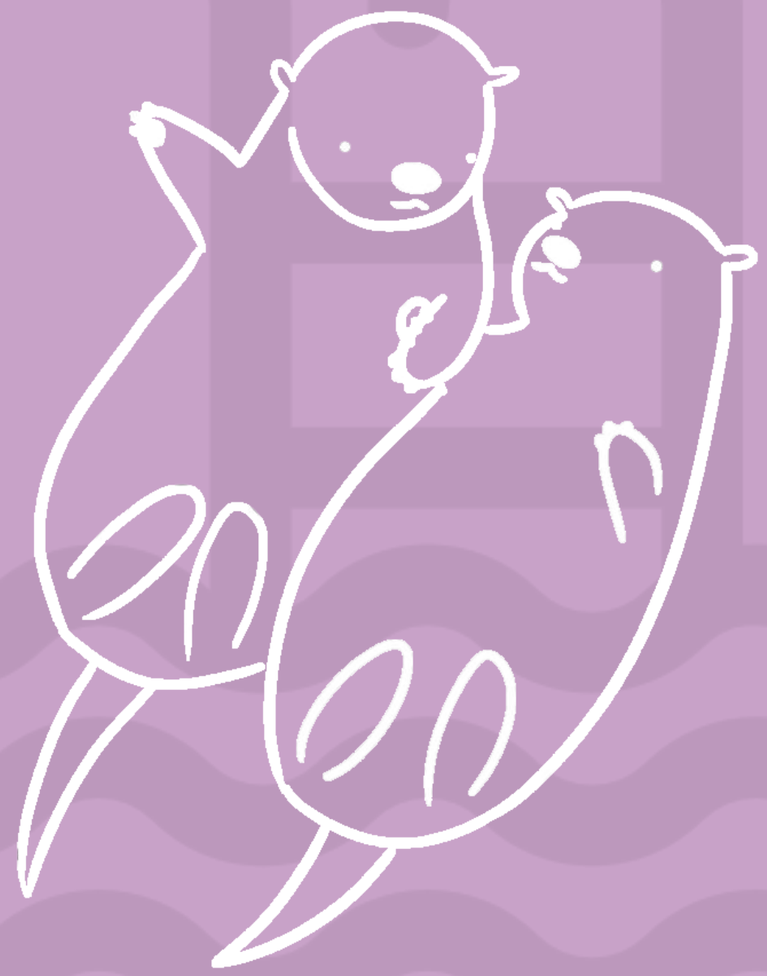
prototyping brief 1.0

Prototype 1

This prototype was constructed after a few weeks of early secondary research. This research was centred around the concept of understanding how sea animals such as sharks, seals and sea horses move, float and suspend upright in water. Consequently, this prototype's point of difference involves a spine feature, with three different compartments that replicate the fins of sea animals. The "fins" each have their own valve that can be opened to allow water to flow into the fin. Therefore, creating the critical function of enabling Jack's level of upright floatation in the water to be modified depending on the needs of the exercise physiologist. The other component of this prototype included a belt like feature that would be positioned around Jack's waist and torso and clipped in to ensure the floatation device remained in the correct position. This allowed the prototype to be stable and modifiable, however we needed to further develop this to include considerations for neck support for Jack.

Prototype 2

The next development in our prototyping focused on understanding the concept of air as our means of floatation, as well as the positioning of the floatation component to allow the person using it to be suspended upright. This arose after our research and consultation with Ravi led us to the realisation that air is a major factor in achieving buoyancy and could be a key feature of our design. Consequently, we wanted to test out this theory on a smaller scale to identify if it could be applied to Jack. Using water balloons filled with air from a syringe; three attached on the back and one on the chest area, we were able to get the figurine to float in a tub of water. To achieve the critical function of getting the figurine to float upright (the desired position), instead of supine or on an angle, we attached coins to its feet to represent ankle weights that can be worn in the pool. This resulted in the successful positioning of the figurine floating upright in the tub of water. We endeavoured to use the information gathered from this prototyping and testing to apply to our solution for Jack on a larger, more life-like scale.



brief 2.0

As part of our user-centred approach, we visited Jack at Onemda to view his pool exercise session firsthand. This was an important step of the empathetic process, where we could see his world and understand his feelings in order to design with this perspective (Kouprie & Visser, 2009). This observation and speaking to the exercise physiologist helped us to clarify a few points that were previously missing in the brief and critical functions. The three main themes derived from speaking with the EP and observing Jack in the pool were:

1. Jack mainly floats on his back
2. Jack needs support to keep his neck and torso stable
3. They require a way to prevent Jack from drifting away from the EP during exercises.

Another key point was also realised when observing Jack's user journey before and after the pool. The process of readying Jack for the pool (mainly with undressing/dressing into his swimming costume) appeared lengthy and required two carers and maximal assistance. It became abundantly clear that a successful solution in this instance, needed to ensure user friendliness and ease of use for it to be sustainable and add value. In developing a product, a significant emphasis needed to be placed on *how* Jack and his carers would use the product before/after his therapy sessions and what ways we could add value to our solution's design (such as time efficiency or reduction in manual handling) that would make a positive impact on the user's experience.

From this visit to Onemda both teams, Laser Cutterz and Double Destiny Design, realised that the brief had changed and that key critical functions, not necessarily captured in Brief 1.0, needed to be included in our solution. Thus, Brief 2.0 was born.

Brief 2.0: To enable Jack to float on his back with adequate support for his head, minimal trunk rotation, and preventing him from drifting during exercises.

With this adjustment, we considered our options in the limited timeframe we had and decided that Laser Cutterz and the Double Destiny Design would join forces. Collaborative design emphasises integration of knowledge, communication and mutual understanding of the goal (Vannella, 2017). After numerous meetings and fast-tracking the ideation process, collaboratively both teams devised a modular solution that would address all three themes mentioned in the previous section. We would all work on one product and one solution but chose different sections to finesse and focus on in more detail.

Questions to re-ask ourselves:

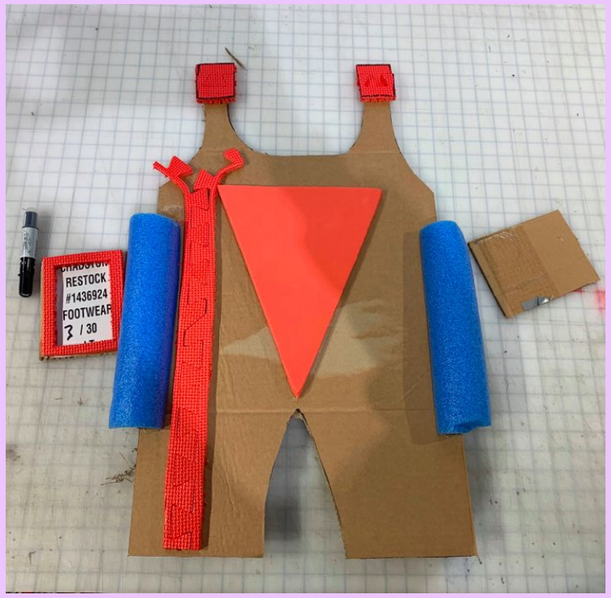
1. **What are the gaps in the concept?**
   What is the best way to keep Jack safely afloat?
   How might we connect all parts together?
   Is it better to anchor to the sides or to the bottom of the pool?
2. **What are the gaps in our knowledge?**
   What are the best types of materials to use?
   How much foam will be needed and where?
3. **What new areas of opportunity are there?**
   Creating a suit with simple floating principles – removing the need for adjusting from supine to upright
   Ensuring comfort and ease by adapting an existing product (wetsuit) to meet the needs of Jack
   Forming a product that can have different parts – attachable head support and anchors
4. **Refine critical functions and experience?**
   Support to float on his back
   Stability for the neck and the torso
   Prevention from drifting away
   Comfortable and easy to wear
5. **New key research questions?**
   What are the best materials for floating in water?
   How much foam is required to support a 56kg person in water?
   How to anchor a person in the pool?
   What are the best zips/clips to use for underwater clothing?
6. **What are our next steps?**
   Revisiting previous ideas that are relevant to the new brief
   Researching and benchmarking
   Creating and testing a new prototype
   Continue collaborating with the other team

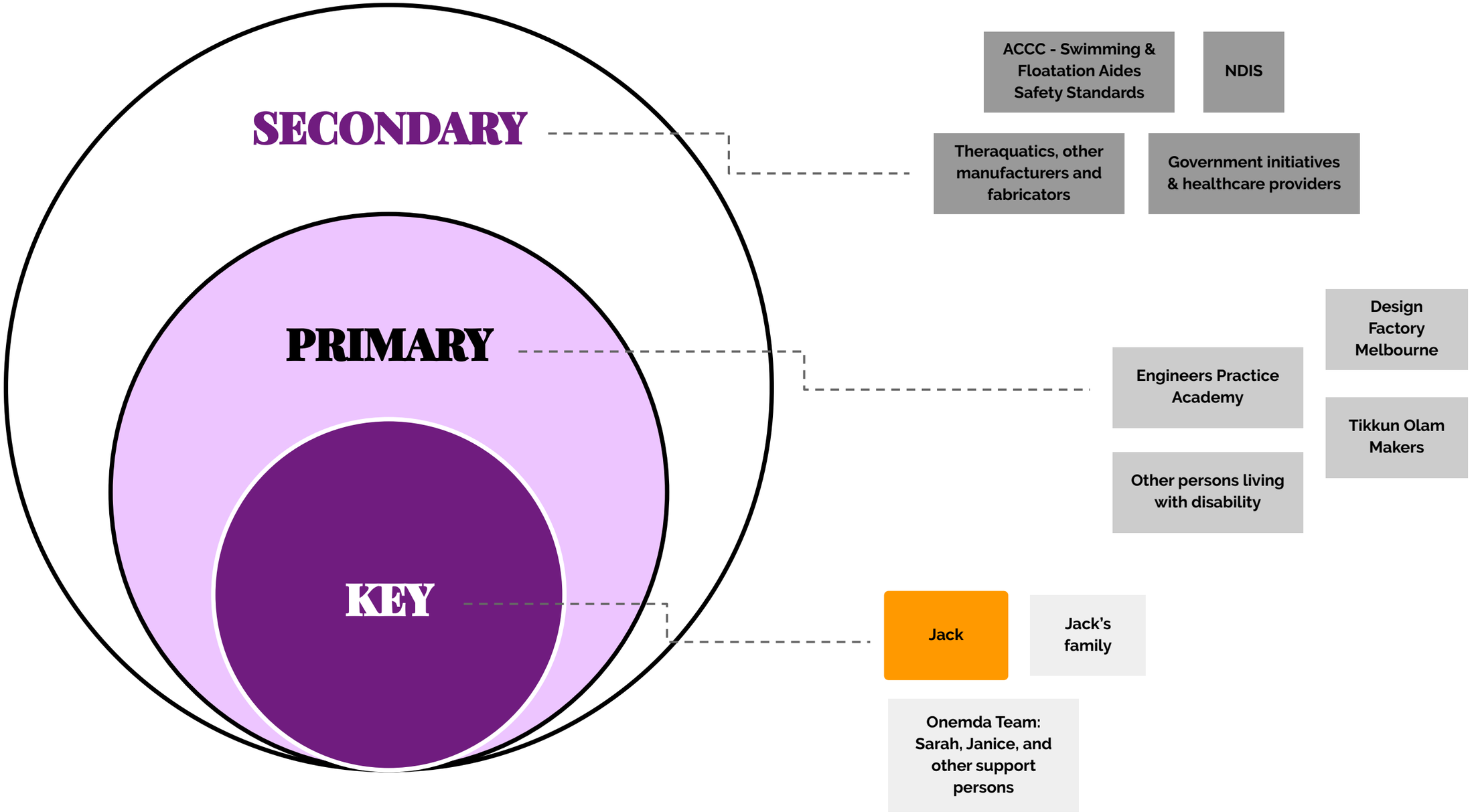
How might we create a way for Jack to float on his back in the pool when completing his hydrotherapy exercises, enabling minimal drift and ease of wear?

prototyping brief 2.0

Prototype 3

This third prototype was developed after the change in our brief occurred and our design no longer needed the critical function of enabling the user to be suspended upright in the water. Instead, the critical function involved enabling the user to float on their back, while being stable enough in the water that the exercise physiologist could complete the exercises without needing the assistance of another person. Our teams part of the complete prototype (Part A) would help keep Jack's body floating in the water and would take the form of wetsuit. Most features on Prototype 3 came to inform our final design and prototype which are explained in the next section.





stakeholders & value proposition

BENEFITS

Modular

Adaptable

Dynamic

Universal

FEATURES

Waterproof

Attachable & detachable components

Wearable

Lightweight

EXPERIENCES

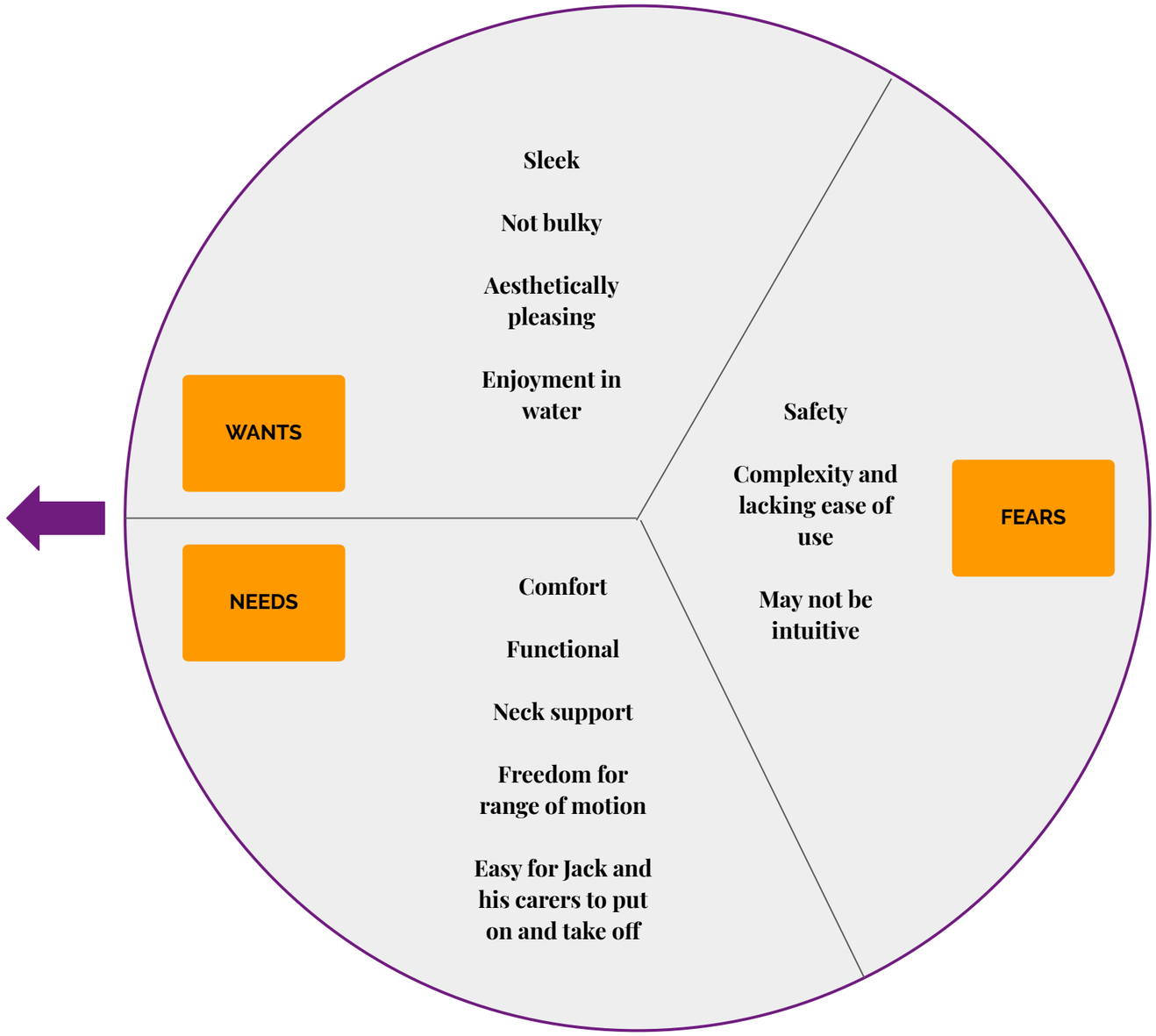
Ease of use

Moving to supine

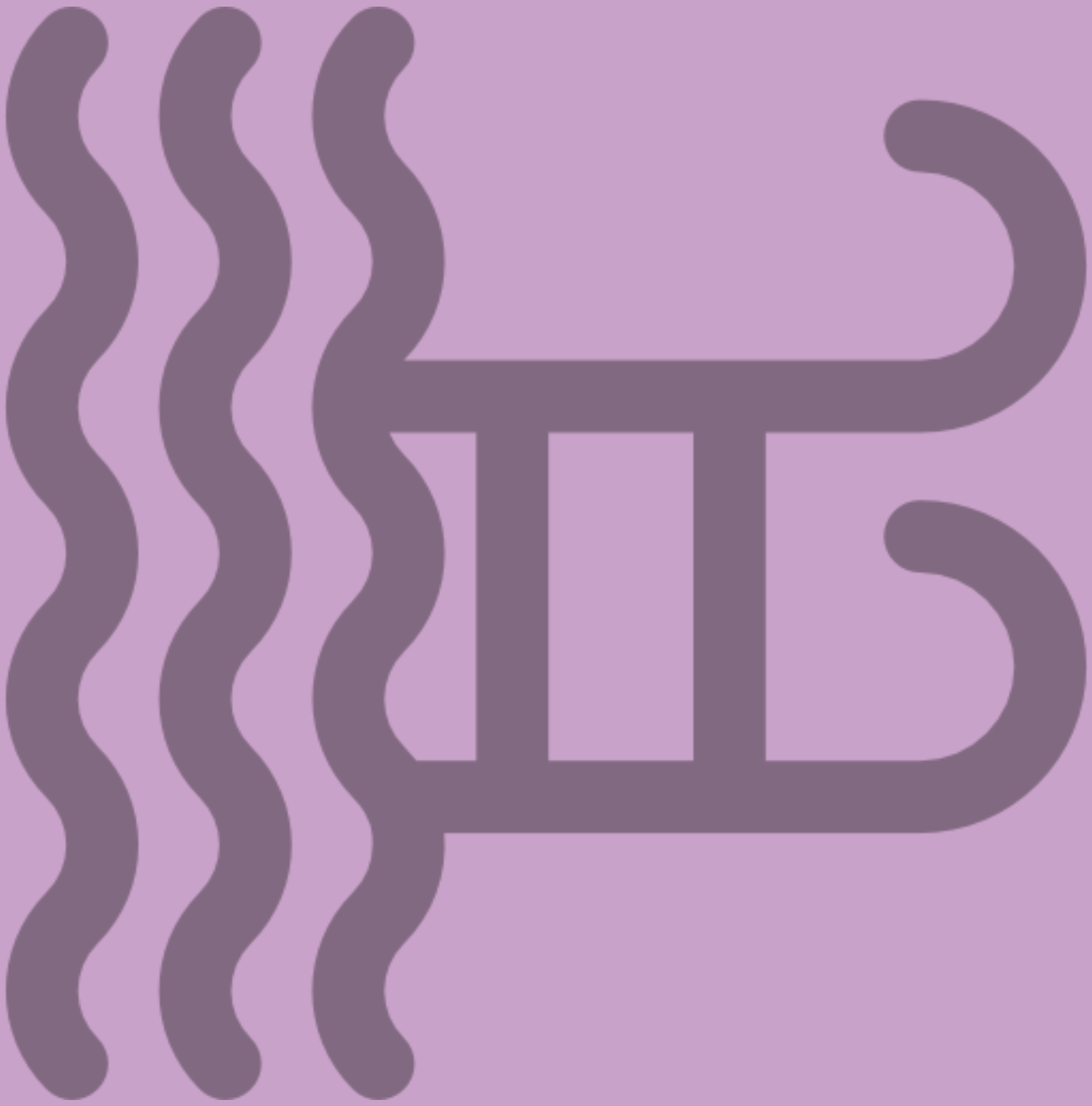
Instruction manual

Social connection

Human-centred approach



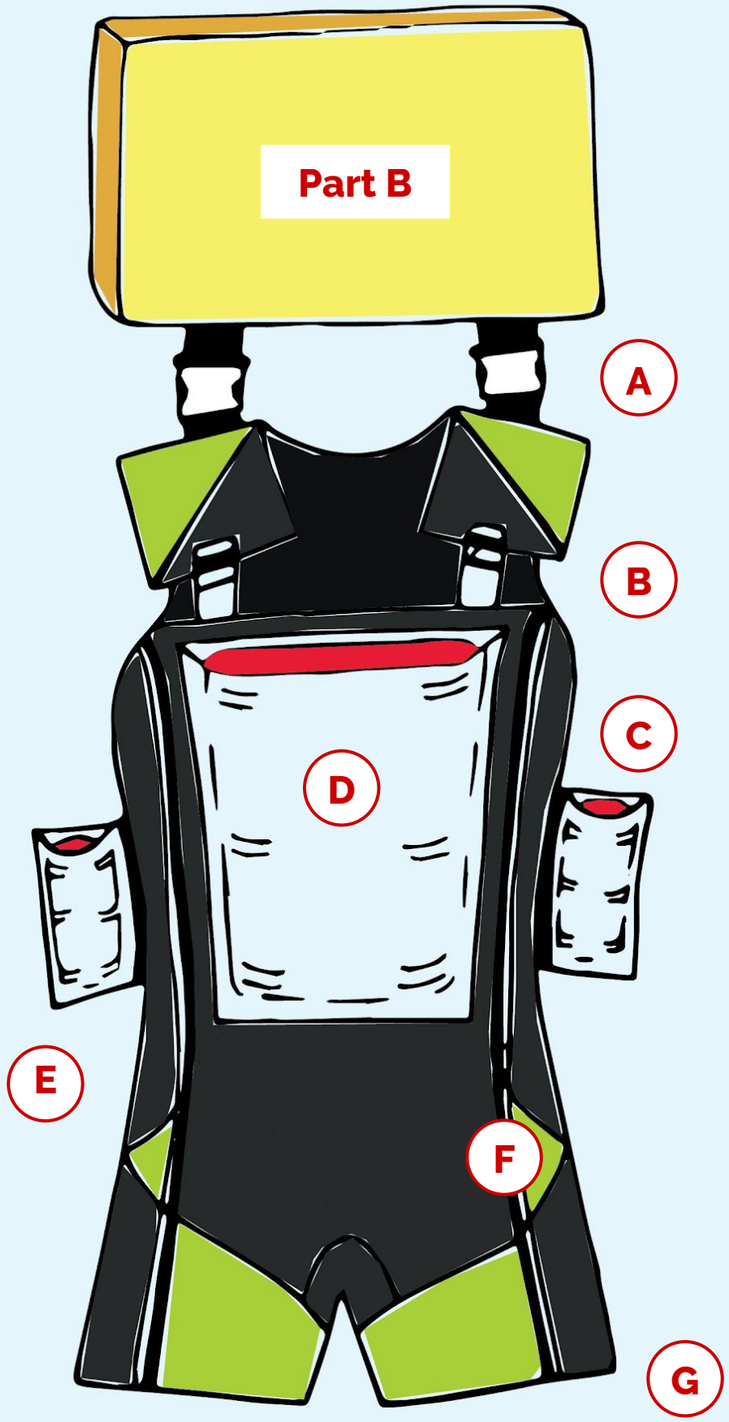
stakeholders & value proposition



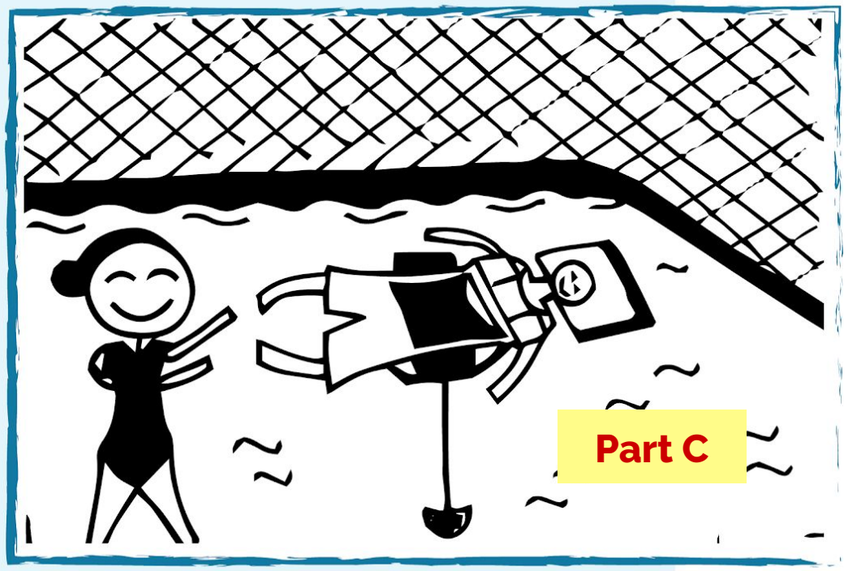
our solution

The Jacksuit

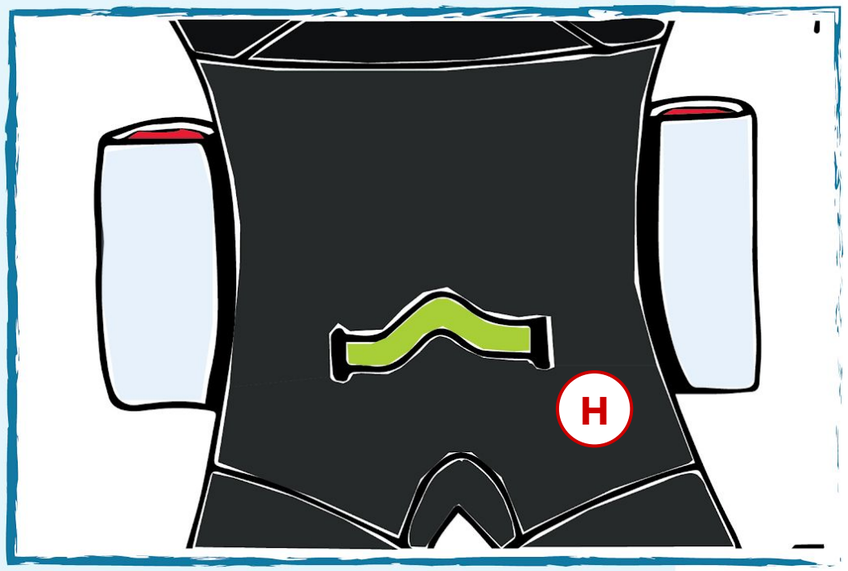
(not to scale)



side view



back view



A. Neck support - attachment to pillow (Part B) through clasps.

B. Clasps to attach central floatation patch to shoulders

C. Detachable foam components on either side to reduce hip and trunk rotation

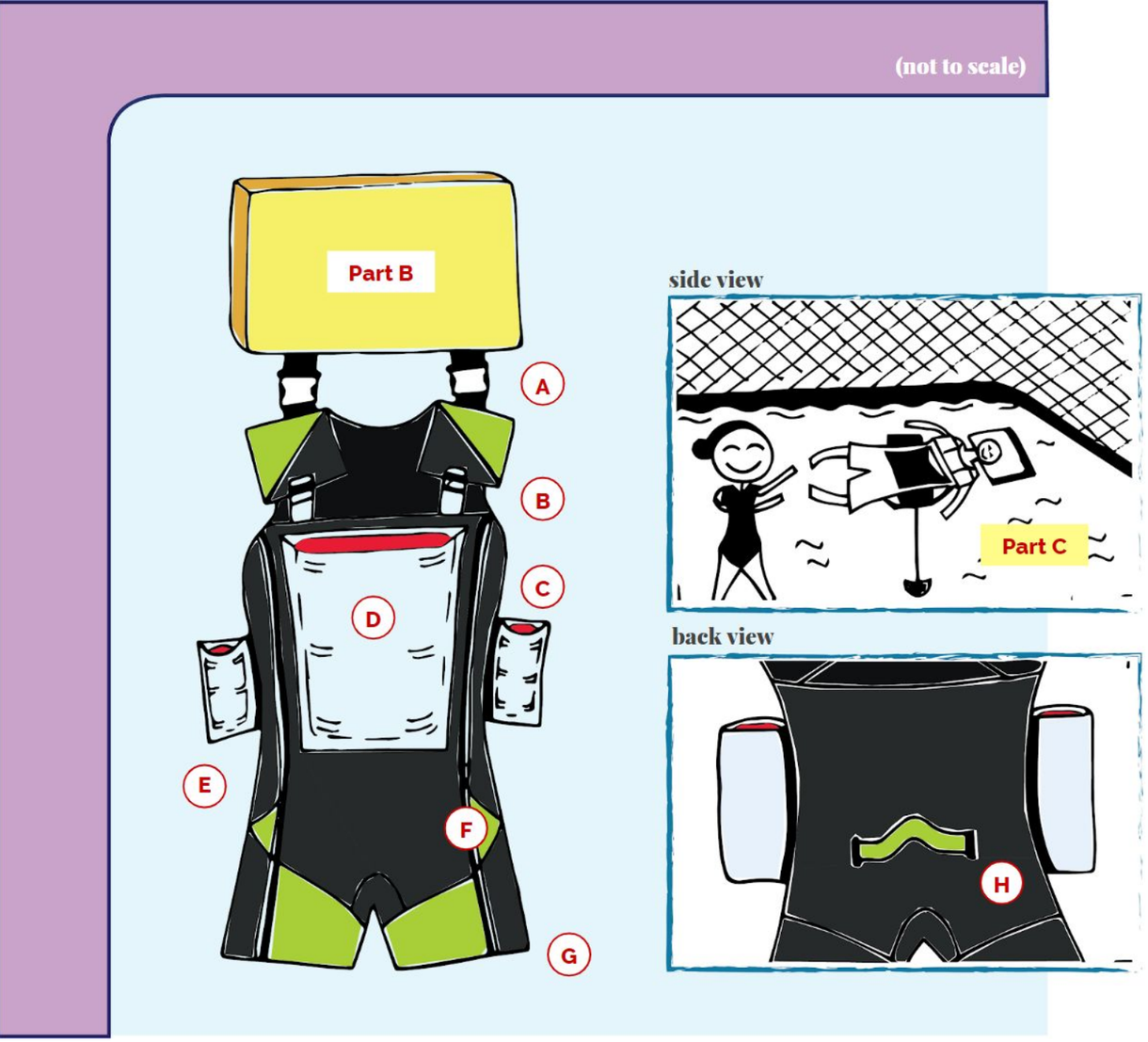
D. Central detachable foam component for buoyancy, which will not rise and constrict Jack's neck like a traditional wetsuit.

E. Neoprene material that is not necessarily skin-tight as it is not designed for warmth.

F. Dual zips on either side of central patch which allows the suit to be completely undone and zipped up around Jack, decreasing the time taken to get Jack dressed.

G. The wetsuit ends at the upper thigh allowing for movement underwater and expressed as a preference by Jack,

H. Loop on the back of the suit to attach to the anchor (Part C).



The Jacksuit is made of neoprene material and is designed to be sleeveless with shorts for ease of use. To ensure Jack mainly floats on his back, blue foam was added to a pocket in the chest compartment of the wetsuit. From our research, we found the desired propositions and thickness to achieve buoyancy was 30mm of blue foam. Two more pockets of blue foam were also added to the side of the wetsuit located above Jack's hips to ensure minimal trunk rotation when doing his exercises. All foam in the Jacksuit is removable, giving Jack's exercise physiologist and carers greater flexibility when determining adequate positioning for Jack in the water.

As noted previously, a key challenge to Jack's optimal functioning when preparing and completing his hydrotherapy exercises was the time it took for him to get in/out of his swimming costume, let alone a suit made of neoprene. Our team spent many weeks considering how to make the Jacksuit user-friendly, comfortable and time efficient for both Jack and his carers (we also wanted to reduce the amount of carer manual handling when getting him dressed for the pool). Thus, we concluded on a dual zip function that means the wetsuit can be completely undone and zipped around Jack. Through research, we have chosen a zip specifically designed for aquatic sportswear, with added lining for comfort called the Aquaseal.

Two buckles, located on the top of the suit help attach Part B, Jack's neck support, to the suit. A small loop located on the rear of the wetsuit allows for a connection to the anchoring system, Part C, that helps keep Jack in place.

Part B - The Stabilizing Pillow

As Part B will be created by Double Destiny Design, we will briefly mention that this part of the overall 'Jacksuit' aims to solve Jack's need for buoyant neck support.

Part C - The Anchor

As a way to prevent Jack from drifting away in the pool during exercises, both Laser Cutterz and Double Destiny Design worked together to develop Part C. Hooking onto the rear of the suit, an anchor (consisting of a small weight and rope) was devised as a simple solution to stop Jack drifting.

Part A

- ➔ **Reduce Drift - attachment to anchor (Part C)**
- ➔ **Neck Support - attachment to pillow (Part B)**
- ➔ **Reduce hip/trunk rotation - Detachable foam located on sides of wetsuit**
- ➔ **Buoyancy - Detachable foam located on chest of wetsuit**
- ➔ **Usability and efficiency - Dual zips on either side allow the wetsuit to be completely undone, and zipped up around Jack. This is expected to decrease the amount of time it takes for Jack to get dressed before getting in the pool and requires less physical burden for carers when assisting him.**
- ➔ **Comfort - the wetsuit material is comfortable and does not need to be skin tight as Jack is not using it for warmth. Both zips will have an inner lining to ensure there is no friction with Jack's skin. As the foam is fitted to Jack's chest and wetsuit, it will not rise to constrict his neck and movement like a traditional life jackets.**
- ➔ **Adaptability - detachable, modular components allow for more/less trunk rotation or more/less buoyancy depending on the exercise.**
- ➔ **Reduce resources - our solution minimises the need for a second person in the pool to assist Jack.**

Materials

1. Suit - Neoprene
2. Zips - Aqua Seal
   https://www.ykkfastening.com/products/search/detail.html?pdid1=AQUASEAL(R)&fbclid=IwAR00WY_3srQcQU2KNqweRgFUvOfoVV0R022F6goDhfMvDA6rC2YRDwYJN_o
3. Velcro
   https://www.bunnings.com.au/velcro-brand-25mm-x-3m-black-heavy-duty-hook-only-tape_p3960036
4. Blue foam
5. Buckles
   https://www.spotlightstores.com/sewing-fabrics/haberdashery/fasteners/buckles-toggles-and-cord/birch-side-release-buckle/80050437002

how does our solution meet jack's needs?

user journey (after)

Note: the purple boxes are points of differentiation in the user journey after implementing the solution.

User Journey (after)

Jack arrives at the pool and is dressed for the session, which takes 5 minutes.

Jack is hoisted into the water with the help of a harness.

Jack begins therapy with his exercise physiologist.

Jack' and his exercise physiologist have more time to try out new exercises and spend more time on old ones.

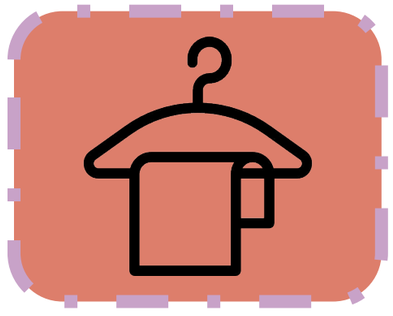
Most of Jack's exercises are done in the supine position.

Jack also does a handful of moving exercises.

Jack does many exercises where he is required to be stable in position.

Jack does a few exercises while sitting on the steps of the pool.

Jack is then hoisted out of the pool and on to a changing bed.



Jack is changed back into his regular clothes within 5 minutes.

Future Considerations

The next steps would be to design this suit based on Jack's dimensions (listed below) so that it can be tested in the pool. As the product has multiple elements, Part B (pillow) and Part C (anchor) could be used universally, although part A (suit) may need to be adjusted based on the size of the person.

Jack's dimensions

1. Shoulder to hip – 50cm
2. Hip to upper thigh (where the suit will end) – 28cm
3. Underarm to underarm (over chest) – 32cm
4. Hip to hip – 45cm
5. Waist circumference – 93cm

According to the Consumer Goods (Swimming and Flotation Aids) Safety Standard, for the final product, all information for its safe use must be either marked on the packaging, or provided in the form of a booklet or leaflet (McCormack, 2017). This information for this product must include the following advice:

1. How to fit the aid correctly
2. A reminder of the requirement for the wearer to be under constant, competent supervision, that the supervisor should be within arm's reach of the wearer, and that the flotation aid will not prevent drowning
3. How to check the aid for signs of wear and tear, and when to replace the aid
4. Care and storage of the aid

The modularity of the suit means it could be adapted to have more foam pockets for extra flotation support to suit unique needs, catering for a variety of users. Additionally, the adjustable straps will allow for different body sizes. These features allow The Jacksuit to be transferable to a wider population.

References

Airtime Watertime Inc. (n.d.). *Airtime Watertime Floater Men's Suit*. Retrieved from https://www.airtimewatertime.com/product-page/airtime-watertime-floater-men-s-suit

Carter's. (n.d.). *Carter's 4PK Side Snap Original L/S Tees - Baby Neutral*. Retrieved from https://www.oshkosh.com.au/products/61323-carters-4pk-side-snap-original-ls-tees-baby-neutral-126G910

Clark Rubber. (n.d.). *Aqua Aerobics Belt*. Retrieved from https://www.clarkrubber.com.au/aqua-aerobics-belt

Fish, F. E. (2000). Biomechanics and energetics in aquatic and semiaquatic mammals: platypus to whale. *Physiological and Biochemical Zoology, 73*(6), 683-698. Doi: 10.1086/318108

Hall, S. (2018). Human Movement in a Fluid Medium. In S. Hall (Ed.), *Basic Biomechanics* (8th ed), McGraw-Hill Education

Hein, T. (2015, October 22). *Spring Loaded Technology's hydraulic knee brace turns disabled legs 'bionic'*. Retrieved from https://www.design-engineering.com/spring-loaded-technologys-hydraulic-knee-brace-turns-disabled-legs-bionic-137159/

Kouprie, M., & Visser, F. S. (2009). A framework for empathy in design: stepping into and out of the user's life. *Journal of Engineering Design, 20*(5), 437-448

McCormack, M. (2017). *Consumer Goods (Swimming and Flotation Aids) Safety Standard 2017 (F2017L01662)*. Retrieved from https://www.legislation.gov.au/Details/F2017L01662

Mercuri, E., Finkel, R. S., Muntoni, F., Wirth, B., Montes, J., Main, M., ... Woods, S. (2018). Diagnosis and management of spinal muscular atrophy: Part 1: Recommendations for diagnosis, rehabilitation, orthopedic and nutritional care. *Neuromuscular Disorders, 28*(2), 103–115. Doi: 10.1016/j.nmd.2017.11.005

Motti, V. G., & Caine, K. (2014, September). Human factors considerations in the design of wearable devices. In P*roceedings of the Human Factors and Ergonomics Society Annual Meeting, 58*(1), 1820-1824. Sage CA: Los Angeles, CA: SAGE Publications. Doi: 10.1177/1541931214581381

National Institutes of Health. (2019). *Spinal Muscular Atrophy*. Retrieved from https://ghr.nlm.nih.gov/condition/spinal-muscular-atrophy

O'Connor, M. (2017). *Use of Aquatic Based Physical Therapy in Treating an Adolescent with Severe Type II Spinal Muscle Atrophy: A Case Report*. University of Iowa.

Oskoui, M., Darras, B. T., & De Vivo, D. C. (2017). Spinal muscular atrophy: 125 years later and on the verge of a cure. In *Spinal Muscular Atrophy* (pp. 3-19). Academic Press

PolySpine. (n.d.). *PolySpine*. Retrieved from https://www.polyspine.com/

Theraquatics. (n.d.). *Aquafit Cerebral Palsy Floatsuit*. Retrieved from https://www.theraquatics.com.au/browse/details.asp?ProdID=124805

Vannella, F. (2017, August). The collaborative design process. *Design Methods and Processes*. Retrieved from https://www.researchgate.net/publication/319393154_The_collaborative_design_process