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NEEDS, PROBLEM STATEMENT, METRICS, BENCHMARK, TARGET SPECS

Engineering Design
GNG 2101
A6

PROJECT DELIVERABLE B
Life Proof Cochlear Implant

Lab Section: Thursday, 8:30 am

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Introduction

Our clients, [redacted], are looking for a product to enhance the features of their daughter's cochlear implant. [redacted] was born with a condition that causes swelling in the vestibular aqueduct. This swelling applies pressure to the cochlear duct and over time, causes damage to her ear. This condition resulted in unilateral hearing. Essentially, she was born deaf. [redacted] was accepted to a Sick Kids, experimental, cochlear implant program in 2019 and received her implant on July 21st, 2020 at the age of one. Although [redacted] selected the most advanced device offered to them, they have noticed some issues since the surgery. Our goal is to create a cost-effective product that better fits their lifestyle while keeping a low profile to enhance [redacted] connection with her everyday interactions. This report details our findings from the first client meeting, our interpretation of the client's needs, and the research that will help us better solve the problem.

1. Needs Identification

1.1. Translating Needs to Design Criteria

Reading the Table:
Our team ranked the design criteria based on two factors. One factor being what the client said was important; the second factor being what we gathered was important to the client due to cues throughout the interview. The scale we used is 1 being the least important to 3 being extremely important.

	Client Statement	Description of Interpreted Needs	Design Criteria	Importance (1-3)
1	"[Our worst experience with her hearing device is] keeping it on her"	It would be useful for the product to be easy to keep on her (ie. it is comfortable and not distracting for her and	**-The product is comfortable to wear.** **-The product is not distracting.**	**3**

		fits without falling off).		
2	“[We] went with the more advanced device because it has a rechargeable battery, bluetooth, and sound selection and increase”	The clients chose the nucleus 7 device for its features. The device allows Freyja to participate in regular activities. For these reasons, the product should not interfere with its purpose (ie. the magnet connection, the bluetooth feature, and the rechargeable battery).	**-The product enhances the device rather than hindering its available features.** **-The product allows the magnet to connect properly.**	**3**
3	“Plastic and rubber are covered in teeth marks which makes it uncomfortable” “She loves water and will just walk into the shower before we can notice” “In the winter she may drop it in the snow so more water resistant and durable would be great”	It would be helpful for the product to be more durable and childproof to better fit her lifestyle (ie. waterproof, resistant to dropping, and provides protection to the battery).	**-The product has an attribute that allows it to be resistant to falls.** **-The product has an attribute that allows it to be resistant to physical abuse.** **-The product is resistant to water.**	**3**
4	“We’ve lost the device and magnet a couple of times” “The app tracks it to the last place I connected to it my phone was telling me it was in the grocery store where I last connected but my wife’s said it was in the house” “It is a bar [that acts like hot and cold] if you turn the right way it will fill up the bar and	A product that allows the device to be tracked more efficiently and accurately would help in the case of the device being lost. The combination of making it less easy to lose and easier to find will be more	**-The product allows the device to be tracked more efficiently.** **-The product allows the device to be tracked more accurately.**	**3**

	vibrate more if you turn the wrong way the bar goes down" "Increasing the range on the bluetooth would be helpful"	convenient for the client and lower the chance of needing a replacement.		
5	"[Aesthetics are] pretty important because we are really worried about her being bullied when she gets older" "Her aunt is deaf and was bullied for having visible hearing aids" "Right now they tried to match the colour to her hair colour"	The clients are very worried about Freyja being bullied as she grows older. They wish for the device to be as low profile as possible. Colour choices to match her colouring and focus on reducing product size are important factors to consider.	**-The product features colours which match her natural colouring.** **-The product is slim and unobvious.**	**2**
6	"I'm worried about the cost of replacing it if it is lost"	A product that makes the existing device less easy to lose such as providing aid in keeping the pieces together could be useful.	**-The product helps to hold the individual pieces of the device together.**	**2**
7	"It is an expensive device" "I am more worried about the cost of replacing it" " We are worried about the cost if it is lost"	The cost of the product should be relatively low. Compared to the cost of the device however, the cost of a product that can prevent the need for replacement can be flexible.	**-The cost of the product is very low in comparison to the device itself.**	**1**

2. Problem Statement

A need exists for the development of a low profile addition to Freyja's Cochlear implant that is comfortable, durable, and does not hinder the device's existing features

3. Benchmarking

The products in the table below are a comparison of the benchmarked products in order to find how well they individually solve each of the seven client needs. In order to rank the significance of each product’s ability to solve the given need, a colour red, yellow or green is assigned. Green meaning it fully solves the need, yellow meaning it partially solves the need, and red meaning it does not solve the need. Numerical values are assigned to the colours red, yellow and green, being 1, 2, and 3 respectively. A final calculation for the significance of the product’s ability to meet the client's needs is made by multiplying the colour’s numerical value with that need’s importance for each product, then these weighted significance values are summed, for the total significance value out of 51.

Need	**Weight (1-3)**	**N7**	**xFyro xS2**	**Nucleus 7 Aqua+ Kit**	**Pixie Finder**	**Advanced Bionics: Neptune**
1	**3**	The product is 24% lighter and 25% smaller in comparison to the previous model, being the Nucleus 6. This could lend itself to being less noticeable for the user while wearing it.	The device is designed for users who would be moving around a lot and working out. It comes with multiple eartips to make sure the device can fit inside the users ear, and will provide a tight and comfortable fit.	The product is designed to be a perfect fit for her cochlear implant device. Despite this, reviews from swimmers said it was uncomfortable due to hard plastics used.	The trackers are shaped like guitar picks and can be stuck to flat surfaces such as phone cases or hung from keychains. However this does not allow them to be placed directly on hearing devices, but rather inside the box	The device uses a “ freestyle™” design, meaning that the user can decide where to place the device when using it (eg. In the hair, on your arm, under the collar, in your pocket etc.) It can be fitted directly to Freyja’s lifestyle

					where they are stored while not in use.	
2	**3**	This is the device currently being used by Freyja.	This device comes with a carrying case to recharge earbuds, however alone these earbuds have a 50 hours of listening time. Has Bluetooth 5.0 and connects from 30 feet away. Not to mention it if fully waterproof with a IP67 rating.	The sleeve allows the hearing device to function almost normally as it was designed specifically for this device. Reviews said that sound controls needed to be adjusted for this.	Has both auditory and visual cues to help locate items. A Bluetooth tracker that has a system similar to GPS tracking. However, the battery is not rechargeable and not replaceable, so the tags will need to be replaced once the battery dies (battery lasts up to 12 months). Cannot be attached to hearing devices directly due to size so will not work if the device is lost directly.	The device is inherently waterproof and therefore does not require any accessories, so all of the features will be accessible all the time. No worry for magnet connection.
3	**3**	There are no specifications given by the company Cochlear which describe the durability of the product, however Kevin had stated that it is meant to withstand drops from the ear. Freyja chewed on the device when she was younger, resulting in teeth	The device's website does not speak of the entirety of the device's durability, however it is waterproof and dust proof. The device is made of aluminium and silicone, as well as being lightweight, it can be assumed that the device could take being	The product does not provide any protection from abuse or falls but does advertise being completely waterproof. Kevin had stated that it had not worked quite as well for them as dips in water tended to be spontaneous.	The product is waterproof and dustproof. Since it is designed to go on either phone cases, keychains or even pet collars, it can be concluded that it is durable and can withstand falls and physical blows.	The device is IP68 certified meaning it is waterproof for up to 30 minutes in water at a depth of 1.5m. It also means that it is fully dust, sand, and particle resistant. The device is “Built Kid Tough™” so it is resistant to physical abuse. Its ability to be worn in multiple areas

		marks which make the device less comfortable. In addition, the device is rated IP57, meaning it is dust protected and can withstand temporary submersion for 30 minutes at a depth of 1 meter.	dropped more than once.			on the body makes uncomfortability due to abuse a lesser issue.
4	**3**	The Nucleus 7's companion smart phone application has a feature which helps to find a missing device. The feature showcases a bar in the app which fills up the closer to the sound processor one is. It is important to note that this functions using bluetooth between the phone and processor and the app cannot track the sound processor if the individual is further than 10 meters from the N7. The sound processor must also be powered on.	The device has bluetooth 5.0 and can be used from 30 feet away, this means that with a third party app like "Wunderfind" it can be discovered from the allowed range. Uses a better, more compass like director.	This product does not allow the device to be tracked any more efficiently or accurately.	The product is a tracking device for lost items. It works like a GPS tracker, where the app triangulates the position of the item with Pixie points (teardrop shaped devices). Uses both auditory and visual cues (using AR) to locate the item. The main tag goes on the phone and connects to the app, which becomes the main source of the signal. Another tag goes with the item you would like to track. As you scan the room with the app, it offers a visual cue to pinpoint the approximate location of the item, then as you	The Neptune does not state that it is trackable using any app. It is however connectable via an app for adjusting sound etc.

					start to move towards it it turns into a pointer. When you are within a specific range it begins to make noise, indicating that you are close. It can tell your exact distance from the item in feet and inches. Covers an area of up to 30-50 ft indoors, up to 150 ft outdoors. Can also show previous locations of the item.	
5	**2**	The N7 is customizable when it comes to colours, with individuals having the ability to customize the coil and processor independently. Each component has 5 colour options (black, white, beige/sand, brown, and grey) to match different skin tones or hair colours.	This device looks sleek and comes in 3 different colours, red, blue, and black. It was made for the majority of people in mind. However Freyja is quite small so the earbuds would stick out of her ears until her head grows.	The sleeve is clear and would show a muted colour of the natural device.The sleeve does add an extra layer of bulk to the device however, reviews say that it is slim in comparison to other accessories.	The tag is black with up to four accent colours. Dimensions of 1.88 by 1.4 by 0.13 inches (slightly bigger than a guitar pick). The slimmest tracking device currently on the market, only slightly protruding from a surface like a phone case.	The Neptune comes in a plethora of colours and varieties, so it makes it easy to match the colour of the device to the colour of Freyja's hair. The device can also be worn on the arm or collar of a shirt, and in many other ways, so the device may be easily hidden.
6	**2**	The product, without any accessories, is composed of 5 parts (the sound processor, battery module, cochlear	This device was made to be completely free of wires and therefore only consists of the two earbuds and	The product does not help to hold the pieces of the device together.	Consists of the app and the tags, one for each item plus the main tag. Would not help hold pieces together, and	The device has two forms of use, either the waterproof power casing connected to the headpiece, or the over-ear

		earhook, coil, and magnet). Kevin has reported that these parts do not always stay together as Freyja has lost the magnet or coil while still having the processing unit.	cannot be held together to prevent loss.		would in fact be another piece.	power casing connected to the headpiece. The device is inherently waterproof so no accessories are required. Versatility in wearing style allows for it to be kept together more easily depending on the activity.
7	**1**	The device itself costs $13,000 and is expensive to replace as a whole or individual pieces. They currently have a warranty which covers some replacement.	This device is currently 99$ US which as of the transition from US to CAD as this is being typed would be 132.591$	Advertisements say the Aqua Kit + can be used "up to fifty times" The cost for an Aqua+ Kit on the Cochlear website as well as alternate seller websites is $275.	Amazon lists the devices at $49.99 for a pack of two tags and $82.70 for a pack of four, not including shipping. The app is free to install. However, the batteries, while lasting up to 12 months, are not rechargeable and not replaceable, so the tags will need to be replaced once the battery dies.	The device is a complete sound processor, so although the exact price is not known, it can be assumed that it is close in price to the Nucleus 7 (Freyja's current device)
Total		**35/51**	**40/51**	**31/51**	**38/51**	**43/51**

4. Target Specifications and Metrics

	Design Specification	Relation (<, >, =)	Value	Units	Verification Method
	Functional Requirements				
1.	The product should be easily trackable	>	10	Meters	Test
2.	The product should be able to withstand a child biting on it without denting	=	yes	N/A	Test
3.	The product should be as waterproof as the Aqua Kit+.	=	1.5 30	Meters Minutes	Test
4.	The product should have a significant rechargeable battery life	>	14	Hours	Test
	Non - Functional Requirements				
1.	The product must blend in with the user's skin tone and/or hair.	=	yes	N/A	Observation
2.	The product must be able to stay connected and be comfortable	>	yes	N/A	Observation
	Constraints				
1.	Cost($)	<	2	% of device cost	Analysis
2.	Add least amount of bulk to Nucleus 7	=	yes	N/A	Measurement/ Analysis

3.	Cannot hinder the current magnetic connection	=	yes	N/A	Observation

5. Conclusion

The client meeting was very helpful in terms of understanding the situation and needs of the user and the client. This meeting outlined various questions that we had asked and got us to have a deeper understanding of what we were truly aiming to work on. This helped speed up both the process and the results as our team was still unsure what we were going to be making with the change over from our original client. During the meeting we got to meet both our client [redacted]) and user [redacted]). Seeing the client and user interact with one another and getting a small glimpse into their lives gave us a more firm idea of what we should be designing as it showed us the outlined needs in action. We also got to see the device she currently uses firsthand. [redacted] is a lively girl and seeing how she interacts with both her current device and her surroundings helped us outline our prioritizations more effectively. Overall the client meeting was successful and very informative.

6. References

Evan’s Links:
https://store.mycochlear.com/store/index.php/usb2c/cochlear-implants/nucleus-7-aqua-kit.html
https://www.cochlear.com/us/en/home/products-and-accessories/our-accessories/water-safe-accessories
https://cicadaqld.com.au/wp-content/uploads/2018/04/Nucleus-7-Accessory-Order-Form.pdf
http://www.cishop.net/contents/en-uk/d161_Aqua_.html
http://cochlearimplantonline.com/site/aqua-review-by-an-avid-swimmer/
https://cochlearimplanthelp.com/2012/10/10/cochlear-aqua-accessory-review/

Liam’s Links: https://advancedbionics.com/in/en/home/products/processors/neptune.html

Nick’s Links:
https://www.cochlear.com/ca/en/home/products-and-accessories/nucleus-system/nucleus-sound-processors/nucleus-7

https://reactual.com/portable-electronics/understanding-ip-code.html#:~:text=The%20solid%20particle%20protection%20is,is%20completely%20dustproof%20and%20waterproof.

https://pronews.cochlearamericas.com/nearby-functionality-on-the-nucleus-smart-app-helps-patients-find-missing-sound-processors/

https://www.cochlear.com/us/build-your-own-n7

Evan’s Links:
https://www.xfyro.com/products/xs2
https://www.xfyro.com/blogs/news/top-8-best-waterproof-earbuds-for-swimmers

Sofia’s Links:
https://getpixie.com/tech/pixie-finder-review/
https://www.amazon.ca/Pixie-4-Pack-Tracker-Luggage-Included/dp/B06XXT8Q9W?th=1
https://getpixie.com/tech/use-iphones-augmented-reality-to-find-your-lost-items/
https://www.clearliving.com/hearing/technology/pixie-review/