GNG2101

Deliverable D

The Lifeproof Hearing Aid

GNG2101

Group A6

Lab Section A02 (Wednesdays 8:30 AM)

Detailed Design, Prototype 1 and Bill of Materials

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Introduction

During our last client meeting, our group presented three possible concepts for product design. The clients expressed their likes, dislikes, and concerns for each one while we took notes. This feedback was incorporated into the design concept that we will be going forward with. Our team was able to amalgamate multiple concepts to meet all of the design criteria, target specifications, and new feedback while still keeping the risks and costs minimal. In this report, we will be documenting our finalized concept for the product design, the prototyping used to explore our biggest uncertainties, and the conclusions that were made based on testing. Details such as materials, costs, and the project plan will also be discussed. The information gathered in this report allows us to continue to move forward with developing a product that **is a low profile, comfortable, and durable addition to Freyja's Cochlear implant that does not hinder the device's existing features.**

Client Feedback

After the concept generation stage, three concepts were chosen to be presented to the clients by the team during the concept analysis stage. The first concept included a lockable, hard case that would contain [redacted] device. The second concept was a material the team researched, Cuben Fibre, which the team was hoping to use to meet the waterproof design criteria. The third, and final design concept presented by our team was a tight, waterproof silicon case which would slide over the existing device.

After hearing these three concepts, we asked [redacted] to rate each design on a scale of ten. [redacted] gave the first concept a five out of ten and the third concept a seven out of ten. [redacted] gave the first concept a six out of ten and the third concept a seven out of ten. The second, material concept was known to the clients and they agreed it would be an interesting design component to look into.

Overall, the clients expressed their greatest interest to be in a design concept that combined the two concepts. Both clients really liked the concept of a lockable case that could be hidden under clothes from the first design. They thought this concept may also

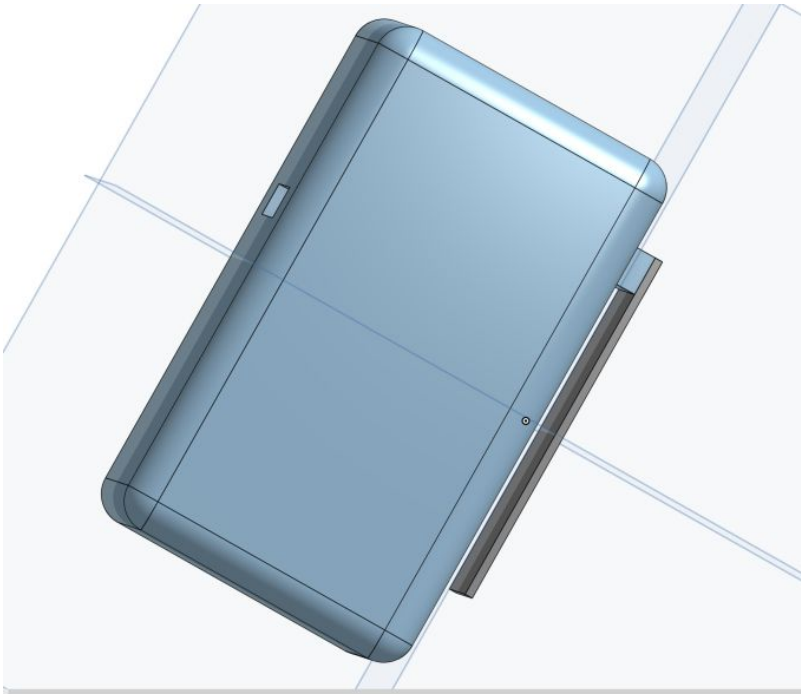
benefit her as she gets older. Their biggest concerns for this design were the size and bulk that could accompany it. They were also concerned about the length of cord they would have access to. They enjoyed the customizable feature of the third concept and they thought it would be more comfortable and less bulky than the hard case. Their biggest concerns with this design concept was that it would not be “toddler proof” enough.

Their feedback also revealed that they live in Northern Ontario where it is very cold. They were concerned about how the materials would resist very cold weather if this were to be used as a permanent fixture for the device. The clients seemed to be pleased with the designs and said they were excited to see what we brought them for the next meeting.

In light of this feedback, the team brainstormed and developed a combined concept design which was chosen to go forward in the design process. This product combines the hard case design made from a durable, lightweight, material that will be lined with a waterproof membrane on the interior of the case as in concept 3. The solution also features a silicon cover for the hard case to customize the product and make the case more gentle on her skin. Overall, our team took the client feedback and reevaluated our concepts to find one that addressed each concern and met each preference.

Updated Design Concept

The design concept that will be taken through the remainder of the process is a hard case for [redacted] existing device. While the materials have yet to be chosen for our design, some of the options that are being looked into are listed below in our bill of materials section. This product meets all of our design criteria and client feedback that has been received up to this point.



Exterior

The exterior of the case will be a rectangular prism shape with rounded edges. The case will be made of lightweight, hard material. The exterior of the case will be finished with a smooth surface finish so as to increase comfort as much as possible. The colour of the plastic is relatively easy to select and so it will be a natural colour (white, black, brown or skin colour for example) which can be selected by the client in advance. The top of the box will open on two small hinges to expose the interior. Carefully placed holes will allow sound, and necessary cords in and out of the case. The openings for cords will be sealed with O rings and the speaker holes will be covered in a semi permeable membrane.

The Lock

The lock will be a childproof lock and permit[redacted], or some other adult to remove the case but prevent [redacted] or another child from opening it. This will be similar to other child proof locks on the market. It could also replicate a closure like an otterbox case design. This would also help to seal the device from the elements.

The Clip

A clip will be secured to the back of the case so as to attach the device and product to clothes, an arm band, headband, or any other type of clothing or accessory. This clip will need to be sturdy and well made. It must be as lightweight as possible and distribute the weight of the case as evenly as possible. The clip will be fastened into the case so that it cannot break apart from the device. A product design similar to the fitbit clip would be useful as the design is lightweight, small, designed to be durable, and secures nicely to clothes even during physical activity (as pictured).

The Seal

Any gaps where water may leak in when the device is under water will be fitted with a tight seal O ring. This will allow the case to be opened but tightly and securely seal the case when closed. Areas where water may leak in but do not need to be moved or opened will be finished with a seal.

Interior

The interior of the case will be filled with a light weight material that will have a cut out that is molded to fit [redacted] device perfectly. This would mean that when the device was put into the case it would be snuggly surrounded by the case. This will allow for extra insulation from falls and prevent the device rattling around in the case. We have been benchmarking Apple airpods and hope to create a similar, molded interior customized for [redacted] device.

Covering

Time permitting, the team would like to create a thin, customizable, silicon covering for the hard case as pictured below. The silicon covering would be customizable and colours would be chosen by the clients prior to the creation. The case would be finished smooth and soft and would be very thin and pliable. It will fit tightly over the case and grip it so that it does not fall off. Holes must be placed on the covering to align with the holes in the hardcase as picture below.

Semipermeable Membrane

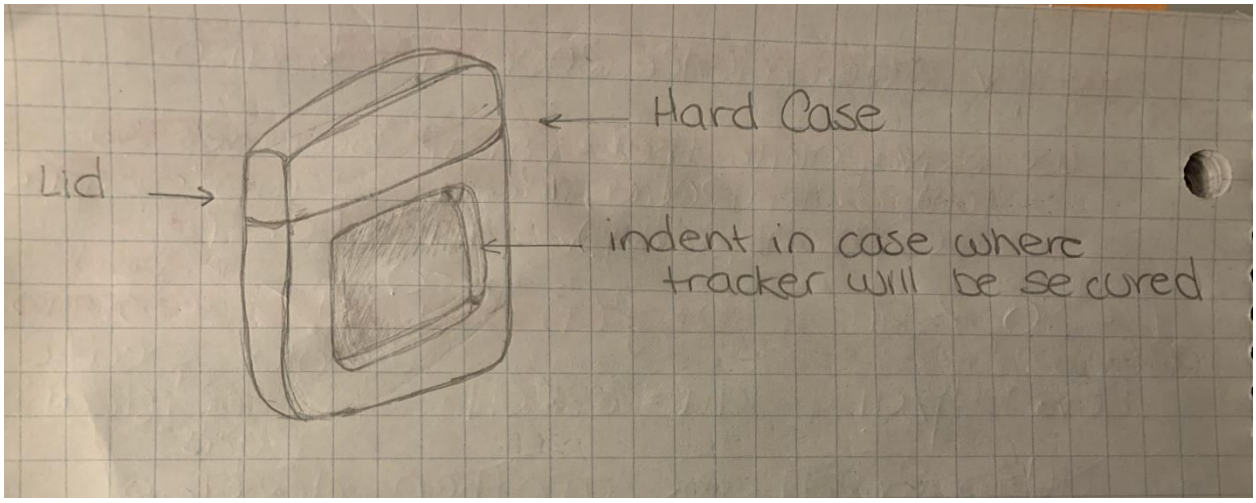
[redacted] device must still be able to pick up sound waves from the exterior world while in the case. It is for this reason that there will be small holes in the tops of the case. The location of the holes will be chosen to line up with the microphones on the device which pick up sound when the device is securely in the case.

Due to the waterproof design criteria, the holes for the speakers will be covered from the inside by a semipermeable membrane which will allow sound into the case while keeping dirt, dust, water etc out. This membrane will be very similar to the membrane used in some waterproof earbuds on the market today.

Tracking

A small groove in the exterior of the hard case will be removed so that the tracking piece fits snuggly into the groove. The tracking piece will then fit into the exterior of the hard case so that it is flush with the edge of the hard case. Integrating the tracking chip into the case will eliminate catching on clothing etc. and improve aesthetics and bulk.

The idea is to integrate an existing tracking device and phone application into the case. Examples of such systems are the Wunderfind app and compatible tracks or the Tile trackers and app. This app and device chosen will be more efficient and accurate than the existing device's tracking.



Product Assumptions

The product will be able to hold the device without hindering its function (mic, speaker, etc).

The product will be durable enough to withstand physical blows.

The product will be lightweight and not add unnecessary bulk.

The product will adequately and effectively protect the device from water.

The product will be childproof to prevent [redacted] from accessing the device within.

The product will be strong enough to hold on to clothing or an accessory without falling off and getting lost.

The product will effectively track the device to locate it in case it gets lost.

The product will be discreet enough to not hinder normal mobility and not attract attention.

Prototype

While our proposed product design was approved by the client, they did address some concern when it came to the size and weight of the product. They stated that if the case for the Nucleus 7 was too large or heavy then it might be uncomfortable for the user. Thus the goal of our first prototype was to develop a low fidelity product prototype which was centered around being able to showcase to the client a tangible depiction of the design product's estimated size and weight. Cardboard was utilized in order to develop all components of the prototype as it was the most relatively available material and satisfied the purpose of the experiment. The supplied measurements of the Nucleus 7 sound processor were used in making the prototype resulting in a case with dimensions being approximately 46x40x12mm which easily fits the sound processor with spare room for when, in future iterations, the inside of the case is filled with plastic except for the mould of the processor where one can insert it. In order to account for extra weight from using plastic instead of cardboard in the final build, extra weight was added to the inside of the case in any tests. It should be noted that the tape lining the device is purely for aesthetics as the cardboard used was from an Old El Paso Taco box which, if left uncovered, might not give the prototype the most professional appearance. Also, the mock sound processor was coloured black as that is the colour of [redacted]'s current device. Moreover, the final product is expected to take up slightly more volume as a bluetooth tracking device will be implemented in order to address the client need of a more efficient means of tracking the sound processor.

Figure 1: Front Prototype Case View

Figure 2: Side Profile of Case

Figure 3: Case With Sound Processor

As shown in Figures 1-3, the actual dimensions of the proposed case will be extremely comparable to that of popular wireless earphone cases currently being used all around the world. With this said, it is clear that the proposed design will satisfy the client's need for a low profile product, in addition to it being lightweight.

Prototype Testing Results and Analysis

The purpose of developing the first prototype was to get an understanding for the dimensions and weight of the product and to test its usability in different scenarios (varying placement of the product on different areas of clothing). Prototype one seeks to meet some, but not all of the target specifications listed in Deliverable B, and is the ground for further development of future prototypes. Testing began initially by weighing the prototype on a small food scale, to see how close we came to the real product's weight. The mock-up Nucleus 7 that we created weighed 5 grams, which is close when compared to the 9 grams that the real product weighs. The case prototype weighed approximately 11 grams which is reasonable seeing as the final product will be made from a lightweight plastic and will not contain many extra components. We tested the prototype by placing the mock-up Nucleus 7 and a 6 gram coin inside the case prototype. All together the prototype during testing weighed approximately 16 grams. The testing of the device pulling on clothing was conducted by placing double-sided tape on the back of the prototype and letting the device hang from different areas on a shirt. These areas included the base of the shirt, the edge of

the sleeve, and the collar area. These images are displayed below.

Figure 4: Shirt pull testing

As the photos suggest, the device presented a negligible amount of pull on the clothing and would not be uncomfortable if securely fastened with a proper clip (will be implemented later on). This test was followed by checking the ability to be placed in a belt loop and be covered by the base of the shirt. The belt loop was created by using tape and fastening it to the back of the case prototype. The device was found to fit extremely well in this position and could be easily hidden with a shirt or jacket. This test was paired with the connection of a wire from the case to the head's temple area where [redacted] magnet is situated. The test was carried out by placing a headphone wire in the case and running it up to the head area both outside and through the shirt (in separate tests). All of these images are displayed below.

Figure 5: Belt loop positioning and wire test

Finally, the ability for the device to blend in with clothing was both directly and indirectly tested. To begin, the device was found to be easily coverable in scenarios like it being worn on a belt or under the shirt. An indirect test that showed that the device was discrete was how the colour affects the visibility of the device depending on the colour of the user's shirt or clothing. To illustrate this better, compare the images in Figure 4 where the user is wearing a white shirt, and how much less noticeable it is in contrast to the image in Figure 5 where the user is wearing a maroon coloured shirt. The customizability of the device was

presented to the client in the form of silicone coverings for the case which can be easily produced in a variety of colours or patterns. This indirect test for its ability to blend with clothing further justifies the feasibility of the product with regard to looks. All of these testing methods were essential for conveying the size and usability that the final product will have. The ability of the prototype to meet the target specifications is presented in the table below.

Table 1: Meeting Target Specifications

	Design Specification	**Relation (<, >, =)**	**Value**	**Units**	**Verified (Y/N): Method**
	Functional Requirements				
1.	The product should be easily trackable	>	10	Meters	No: Test
2.	The product should be able to withstand a child biting on it without denting	=	yes	N/A	No: Test
3.	The product should be as waterproof as the Aqua Kit+.	=	1.5 30	Meters Minutes	No: Test
4.	The product should have a significant rechargeable battery life	>	14	Hours	No: Test
	Non - Functional Requirements				
1.	The product must blend in with the user's skin tone and/or hair.	=	yes	N/A	Yes: Observation

2.	The product must be able to stay connected and be comfortable	>	yes	N/A	Yes: Observation
	Constraints				
1.	Cost($)	<	2	% of device cost	No: Analysis
2.	Add least amount of bulk to Nucleus 7	=	yes	N/A	Yes: Measurement/ Analysis
3.	Cannot hinder the current magnetic connection	=	yes	N/A	Yes: Observation

Next Client Meeting

The next client meeting is intended to show and demonstrate the prototype our team has created. Since one of our team members has a personal connection with the client, she will be able to deliver the physical prototype to them and have them interact with it before the next scheduled client meeting. We will be letting them know that this is only the first prototype and it is not made of the same materials that we will be using in the final prototype, therefore it will not have the durability or waterproofing levels that the final product requires. We are hoping to get feedback on the initial prototype. We will be asking for pros and cons of the design, what they like and don't like about it, its strengths and weaknesses and areas or aspects to improve. We will be incorporating this feedback into the next prototype in order to improve the design and create a next prototype that will be more similar to the final design.

Bill of Materials and Parts

Material	Use in final prototype	Cost	Link
1.1oz Silpoly	Waterproof lining inside case	CAD $8.99/yard (a lot more than we will need based on the size of the product)	https://hofmanoutdoorgearsupply.ca/tarp-fabric/26-11oz-silpoly.html#/5-color-charcoal_grey
ABS plastic	Hard exterior of the case	USD $26.16 for a 1 in x 4 ft rod of ABS, which should be about enough to print the case with dimensions of 3.5 x 4.5 x 1.1 cm, making sure we have enough	General information: https://www.curbellplastics.com/Research-Solutions/Materials/ABS Cost: https://www.curbellplastics.com/Shop-Materials/All-Materials/ABS/ABS-Rod#?Shape=CRBL.SkuRod
O-rings	Seal vulnerable parts of the case	Ranges between CAD $2.99 and $16.87 per package (packages contain between 1 and 100 rings and vary in sizes, specific size must be determined)	https://www.mcmaster.com/o-rings/water-and-steam-resistant-epdm-o-rings-6/
Metal clip	Used to clip on to clothing or accessories	USD $0.59 most likely per clip as this website only sells in bulk)	https://measuretape.en.made-in-china.com/product/OKmJvlEdEhcq/China-Custom-Size-Metal-Steel-Belt-Clip-for-Measuring-Tape.html

Cochlear Cord	Extends the existing cord to reach the end of the case (Potential for minimum 25 extra cm)	Price is unknown unless you have a cochlear account	https://store.mycochlear.com/store/index.php/usb2c/cochlear-implants/nucleus-7/coils-cables/cochlear-slimline-coil-w-cable-n22.html
Tracking Chip	Tile trackers are slim, lightweight and durable. The chosen tracker is the smallest that they have. It is waterproof, adhesive, and has a three year battery life which integrates nicely into our design and will fulfill the tracking design criteria. Team members know from experience that the tile devices are very user friendly.	The chosen Tile Sticker comes in packs of two and is $39.99.	https://www.thetileapp.com/en-ca/store/tiles/sticker

Project Update

The MS project file with our updated project plan was submitted as a separate file with with this deliverable submission.

Conclusion

Through client feedback our team was able to finalize a concept for the solution to our problem statement. In this deliverable we were able to go into detail on the concept specifics and create our first prototype based on these specifics. The team then used the prototype to do testing on the details of the product that we were most concerned with. Tests allowed us to pursue this idea as had the product weighed too much or was too large we would have needed to come up with a new solution. Through a low fidelity, localized

prototype we were able to confirm that this was a viable option. The goal is to create a product that is easy for the clients to use while helping [redacted] enjoy her childhood years as carefree as possible. With this prototype, we are one step closer to achieving this goal.