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TEAM A6

Deliverable J
GNG2101

User Manual
Hear Shield Hard Case Solutions

Lab Section: Wednesday, 8:30 am

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Abstract:

This manual includes the entirety of how the case was made from start to finish. Indicating every portion of the design process that was taken to create a final product. It starts with who our client is and what type of problems need to be solved as it outlined in the Introduction. The Product Description outlines how the final product was generated and the several prototypes it took to get there. The important features section describes in detail what applications were integrated into the product in order for it to successfully satisfy the design criteria of the client. Such things include: Mould and Case, Waterproofing, Bluetooth, and Comfort. The health and safety portion makes reference to the user, since she was a child the final product needed to be child safe and this shows any potential hazards and overall safety of the device. The next portion goes into detail of potential problems that were faced in the initial creation of the product and how to overcome these barriers in the most effective way. This manual also includes what could not be implemented into the device with the current restrictions, the overall dexterity of the process and how the device could be further improved. Lastly this manual includes an appendencie that contains other notes about the process and product, as well as a Bill of Materials and a Bibliography for any needed sources that were used in the manual.

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1. Introduction

Often, the client and user are the same individual. In the case of this project however, they were not. The A6 team worked with a couple who were parents to a young girl, born deaf. Shortly after she turned one, the daughter was accepted to an experimental program at the Sick Kids Hospital which allowed her to receive a Cochlear Implant. Given the choice between two hearing aid devices, the clients decided on the Nucleus 7. Although they were impressed with the existing features of the device, the clients noticed some aspects that were not working for their family.

It was crucial to begin work on a solution for these problems as the girl was still young. It would be easier to integrate a solution into her life now as opposed to when she is older and has already learned to cope. It was also a crucial point in her life as she could behave as any other child would without having to worry about her hearing aid at all.

After developing a clear idea of the problem through analysis and client meetings, the team set to work on developing a solution. Through following the Iterative Engineering Design Process, the team developed possible solutions, integrated client feedback, prototyped, tested, and used methods learned in class, to predict the possible economics involved with developing the product further.

The Problem

Below is a table documenting the client statements from the first client meeting that outline the problems they were having. The table also has the corresponding design criterion developed for the product.

	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 fits without falling off).	**-The product is comfortable to wear.** **-The product is not distracting.**	**3**
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 vibrate more if you turn the wrong way the bar goes down” “Increasing the range on the bluetooth would be helpful”	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 convenient for the client and lower the chance of needing a replacement.	**-The product allows the device to be tracked more efficiently.** **-The product allows the device to be tracked more accurately.**	**3**

These weighted design criterion allowed the team to come up with the following 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

The design concept which was chosen to solve the problem is better than any existing products because it solves all of the client’s problems with one product. There are Cochlear products which waterproof the device but they are only reusable for a certain amount of uses. There are also tracking features that exist for the device but they are inaccurate. With this product, not only does it solve both of these problems at once, but it also allows for a more customizable experience for both the clients and the user as they would be able to choose where to place the device and what colour case they wanted.

After completing each step of the design process, the team presented a final prototype. This product is documented in detail in this report. The key features, instructions for use, and solutions for possible errors are included.

1.1 Indication of Past Work and Where to Find it

Weekly reports were completed documenting the progress of the product from preparing for the first client meeting to the final product and testing. These weekly deliverables have been uploaded to a makerepo project file and can be found at the link below.

https://makerepo.com/escho036/gng2101-project-team-a6-hear-shield

2. Product Description

2.1 Product Development

The development of this product began with a low fidelity prototype using cardboard and tape to develop a case which could store the Nucleus 7 sound processor Figure 1. The sound processor's dimensions were measured and used to create this prototype. The purpose of this first prototype was to establish an idea of how big the end product might be in addition to testing how comfortable the sound processor might be when it is worn on areas of the body other than the ear. The client was shown the first prototype and approved the direction which our team was taking in terms of progressing with product development, and this began the development of our final product.

Figure 1: Low Fidelity Prototype 1

The body of the case was made in AutoCad and consisted of three parts, being, the base, lid, and Pin as seen in Figure 2. Next, polysil was adhered to all openings of the case so as to make it waterproof while also allowing sound to enter the sound processor's microphones. It is important to note that the base of the case was designed with slightly more space than necessary and an interior

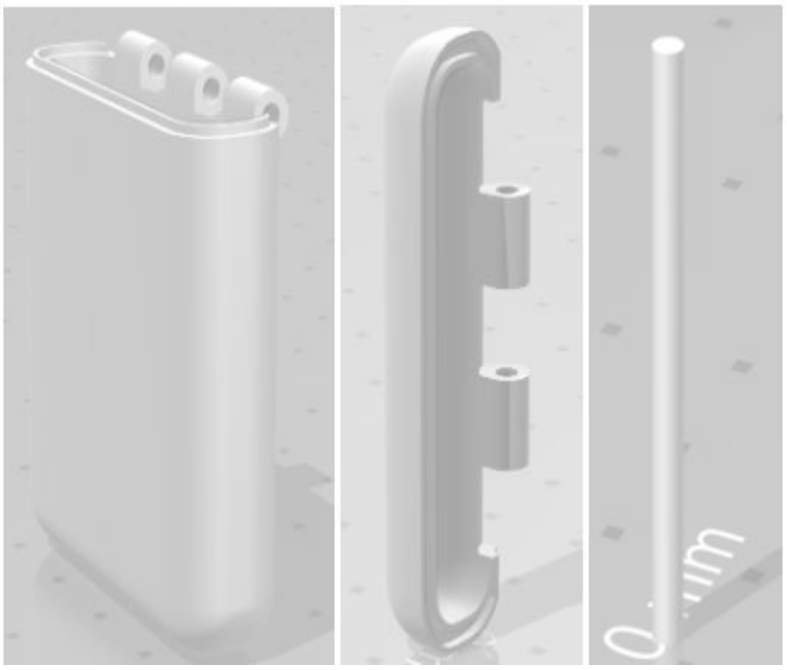
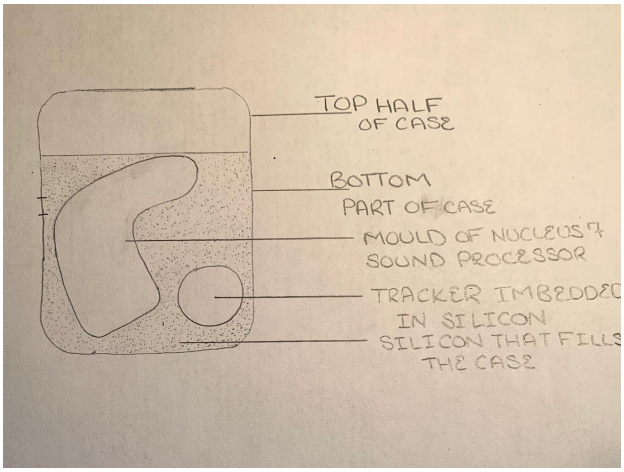


Figure 2: Base (left), Lid (Middle), Pin (Right)

mould of the sound processor was created out of silicon and put inside of the body of the case so as to not let the sound processor move around inside the case. Lastly, a bluetooth tracking device, Rtrivr Key Finder, was purchased and placed inside the mould of the case as seen in Figure 3 to allow for the case to be tracked using the mobile application Rtrivr2. The end result can be seen in Figures 4 (a through d). **Figure 3:** Sketched Case Interior



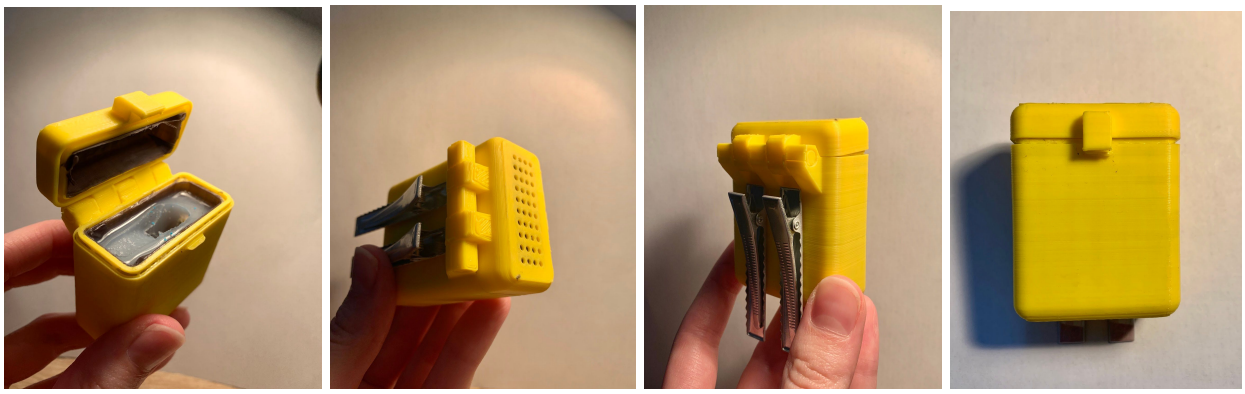


Figure 4 (a,b,c,d): Finished Product

Finally, it should be noted that the product was regularly tested throughout its development in order to ensure it performed its intended function. To begin, the 3d printed case was tested for how well it could protect the sound processor from scratches and drops from head level. The client reported that the sound processor is regularly damaged either through biting, which the scratch test simulated, or by falling which the drop test accounted for. Moreover, it

was important that the case was comfortable on the user as our team was told that they regularly get distracted by the sound processor's current placement on the ear and thus take it off more. Our testing method for this was fairly simple as we clipped the case, with a weight which simulated the sound processor (which we did not have in our possession at the time) , around the body to test if it was uncomfortable or pulled on any clothing. The result of this test was positive as the user had a chance to wear the prototype and did not show any signs of being uncomfortable for prolonged periods of time.

Lastly, the final test performed on this product was to make sure that the case was indeed waterproof and would be successful at protecting the sound processor from any water damage. For this test we simply covered the top of a tupperware with a waterproof material called silpoly (our water impermeable membrane for the case) and poured water over it to see if any seeped through. The result of this test was expected, being that the material was indeed waterproof and in an attempt to make the test scenario more interesting, we used the same setup to test how well sound would be able to travel through the silpoly and reach the microphones of the sound processor on the other side. This ability for sound to pass through the material was essential to our design as the case houses a sound processor after all. In order to test for the sound passthrough of the fabric, we placed a phone recording audio through its microphones on the inside of the tupperware, and on the outside of the tupperware we had a speaker play the same continuous sound. This was done with nothing in between the two devices and with the silpoly layer between them. The results of the test showed what we hoped for, being that sound passed through silpoly with ease.

2.2 Important Features

The final prototype consists of a 3d printed case made of ABS for the sound processor with numerous features built into it. One of the most notable features of the case is the fact that it has a child proof lock incorporated into its design. It can be difficult for young children to understand the importance (and price) of items such as a sound processor. It is for this reason that the built in child proof lock in our product is significant as the lock prevents children from accessing the sound processor and potentially damaging the device.

MOULD AND HARD CASE

In addition to the child proof lock, the case acts as substantial protection against any drops or shock damage the sound processor may normally encounter on a regular basis. It accomplishes this by having the inside of the case be specifically molded for the sound processor to ensure that the device does not move while in the case, in addition to the hard exterior of the case further aiding in preventing any wear and tear to the Nucleus 7.

WATERPROOF

Our product is not just a case which protects the Nucleus 7 from potential damage caused by impacts. The product places extreme emphasis on protection in all fronts and this is seen in the fact that the product is waterproof. The only two sections of the case with openings, being the grill for sound to enter the sound processors microphones and the auxiliary, are lined with polysil which acts as a waterproof membrane allowing for the device to be utilized in or around water without any worry of damage.

BLUETOOTH

Furthermore, our case for the Nucleus 7 features an external bluetooth tracking device which allows for a significant improvement over the range and efficiency of the tracking software which the sound processor uses. This module allows for the case to be tracked, using a mobile application that has a range of 50m improving on the sound processor's 10m tracking radius. In addition, the bluetooth tracking device featured in the case marks points on the map where the device was last located. For example, if the client was running errands the tracker would mark each location the clients stopped at allowing for easy backtracking if the device was left somewhere along the way. The application allows for the client to track the battery life, signal strength, and relative distance (near or far) while also showing the location of the device on a map.

COMFORT

Lastly, comfort was a priority when designing the product as the client complained of the sound processor often being taken off of the child's ear due to them noticing its weight. Thus, our product can be worn anywhere on the body as it features a clip allowing it to be stored on a belt, sleeve or anywhere else. This feature is essential as it allows for the user to have the freedom of placing the processor wherever they find most convenient, whether that be the most comfortable position or the most low profile.

2.3 Using the Device

The product is very simple to use as it is simply a case with added features. Individuals using this product must ensure that the sound processor is firmly placed inside of the interior mold to allow for the auxiliary port of the sound processor to line up with that of the case. If this

is not done correctly then the magnetic auxiliary cord which transmits electronic impulses to the cochlear implant will not be able to connect.

Once the sound processor has been placed inside the case, ensure that the lid is closed firmly allowing for the child proof lock to snap shut prior to moving about with the product. Lastly, make sure to check prior to each use that the bluetooth transmitter of the case is synced with your mobile phone. If you have not yet paired the two devices together, follow the proceeding steps.

1. Install the app (Rtrivr2) on your smartphone or tablet and open it.
2. Press the keyfinder button on the tracker for three seconds to activate it for the first time. Then press the bluetooth symbol in the top left corner of the screen.
3. When the side menu appears, click on the icon that looks like a magnifying glass to connect with the tracker device.

2.4 Maintenance

- Regularly examine the case for any cracks or damage and if any are found consult Hear Shield Hard Case Solutions.
- Check with each use that your mobile phone is connected via bluetooth to ensure that it can track the case in the unfortunate event that it is lost.
- Allow the case to dry for at least 30 minutes after it has been wet before opening it to allow any runoff water to exit cracks or crevices.
- Monitor the battery health of the Nucleus 7 and swap the battery accordingly:
    - First, remove the silicon mold from the hard case.

- Second, remove the tracker from the case and remove the protective plastic exterior by inserting the flat, plastic key into the slot and turning the key to pry open the case (It should open easily).
- The battery (CR2032 Button Battery X1) is a large silver disk and should be easily spotted. Remove the dead battery with tweezers or fingers from the clips holding it in place and place the replacement battery in its spot.
- Put the protective cover back onto the tracker and press the sides together to close. Reverse the steps in order to replace the tracker in the case.

2.5 Health and Safety Guidelines

The product is fairly safe in all regards as it is just a case and the featured child proof lock inhibits children from interacting with potentially dangerous materials such as the silicon mold or the polysil. It can be said that the use of this product actually reduces the health and safety hazards that one might need to worry about when using the Nucleus 7 by itself. One note of concern would be that our final prototype does not feature a locking pin in the hinge of our case and thus the plastic pin could potentially fallout overtime and pose as a choking hazard. In future iterations our product would have a lock in the hinge making sure that this cannot occur. Should significant damage occur to the case and the ABS plastic becomes cracked, chipped, or damaged, small pieces may be able to break off. Should this happen, a new case should be used and the old case discarded safely.

2.6 Common Issues and How to Solve Them

<u>The Tracker is Not Showing Up on My Rtrivr Application:</u> The tracker may need a moment to reconnect with the application. Open the case, remove the device and hold the case near to your

phone to allow it to reconnect. Should this not fix the problem, the battery may be running low on the tracker and will need to be replaced. Please see the maintenance section of this document for instructions regarding this procedure.

The Childproof Lock on the Case is No Longer Holding: Over time, the childproof clip may begin to wear out. If this is the case and the lock will no longer fasten, the case should be traded for a new one in order to maintain maximum security for the device.

3. Conclusions and Recommendations for Future Work

Overall, the final prototype that the team was able to produce within the scope of the course GNG2101 closely matches what the team set out to achieve after speaking with the client and generating the design criteria. While the prototype is high fidelity to what the final product was envisioned to be, it is still not quite a finished product itself. Limitations were placed on the team by several constraints, including time, budget and the restrictions placed by the COVID-19 pandemic. The limited timeframe that was given to complete the project meant that the team could only produce three prototypes. With a longer timeframe, more prototypes could have been created to further improve the fidelity to resemble the final product even more closely. As well, a budget of $100 for the project meant that the materials that were at the team's disposal were not necessarily the best materials to use for the product, or the ones that the team had decided upon using. For example, the team's original plan was to use Cuben fibre as the waterproof material to seal the case with. However, the material used in the final prototype is Silpoly, a material that still works well but was not the original intent. As well, the hard exterior of the case was made out of ABS plastic, which is durable but was still found to be unable to withstand damage caused by teeth in testing, which does not meet one of the outlined criteria. The COVID-19 pandemic

that was occurring as the project was being developed made it difficult for the team to meet in person to conduct meetings and do work. The pandemic also forced the university campus to restrict operating hours of the Makerspace facility, where the team used the available 3D printers to create the case. This limited the amount of work that could be done with developing the prototype and caused setbacks when errors could not have been corrected as quickly as they could have been had the space been available to use normally. Had the team had less restricted access to the printers, a better model of the case could have been printed that could have functioned even better than the final prototype did.

As such, if this project were to continue development, some adjustments and recommendations could be made as to how to proceed. Firstly, more research can be done to determine a better material to use for the hard exterior case. Such a material should be durable and able to withstand not only physical blows and drops but other kinds of foreseen and unforeseen damage, such as biting or crushing. It must also be light enough to be able to be worn comfortably, preferably not exceeding the weight specified in the metrics and the already developed prototypes. As well, efforts could be made to find the Cuben fibre that was originally intended to be used and to test whether it is a better waterproof material to use instead of Silpoly. More prototypes could be created and more tests run to make a prototype that even more closely meets the target specifications that have been outlined in a previous deliverable. The circumstances caused by the pandemic were not entirely within the team's control, but other teams that could take over the development of the project could benefit from finding other resources deemed necessary to complete the project effectively and using them to their advantage, such as access to necessary machinery elsewhere, if possible.

4. Appendices

4.1 Important Notes for Development

-The case itself was not able to close due to the precision needed. There needed to be some adjustments to the design files for the case to account for the hinges. The hinge pin was also an issue which could have been resolved by a precision fit metal hinge pin.

- It may also be easier to produce this product if the design file was adjusted so that it would fit all standard sizes such as the O rings needed.

4.2 Bill of Materials Used for the Product

Part Name	Description	Use in Product	Location of Purchase	Price
O-ring	**Rubber O-ring.**	**Used to help seal the case allowing openings to be water and dust proof.**	**Home Depot**	**$5.76 (For a kit containing four O rings two of each size)**
ABS Plastic	**Plastic used in the 3D printers at the university of Ottawa**	**Used to form the hard exterior of the case**	**This item was not purchased but was used at the university of Ottawa**	**N/A**
Silpoly Material	**Waterproof, silicon impregnated material**	**This was used to line the interior of the case to make it waterproof**	**This item was given to us by our project manager**	**N/A**
Rtrivr Tracker	**A bluetooth tracker used to locate items**	**This was embedded in the silicon in the interior of**	**This item was purchased on Amazon**	**$13.31**

		the case to allow for better tracking.		
Silicon Mold Kit	**This comes in two bottles which must be mixed together before being poured into the case.**	**Used to create the silicon mould of the nucleus 7 sound processor and fill the interior of the case.**	**This item was purchased on Amazon**	**$39.99**
Hair Clips	**Metal clips for hair.**	**These were secured to the back of the case in order to secure the case to an accessory.**	**This item was purchased at the dollarama.**	**$1.41**