GNG2101 Report

Waterproof Hearing Aid
Project Deliverable C

Submitted by

GNG 2101 Team A4

OMOLOLA OMOWA, 300130234

Benjamin Losier, 300051021

Brandon Joseph Broderick 300128727

Rehana Lawrence, 300124577

André Lacroix, 300117612

Date October 4th, 2020

University of Ottawa

Table Of Content

Introduction

In this deliverable each team member was assigned to create at least three solution concepts, which would fulfill our customer needs and adhere to the design criteria that was derived in deliverable B. The concept that best adheres to the problem statement and design criteria was chosen as the final concept and was properly analysed. A detailed feasibility analysis of the final concept is included in this deliverable.

High-Level Functional Decomposition

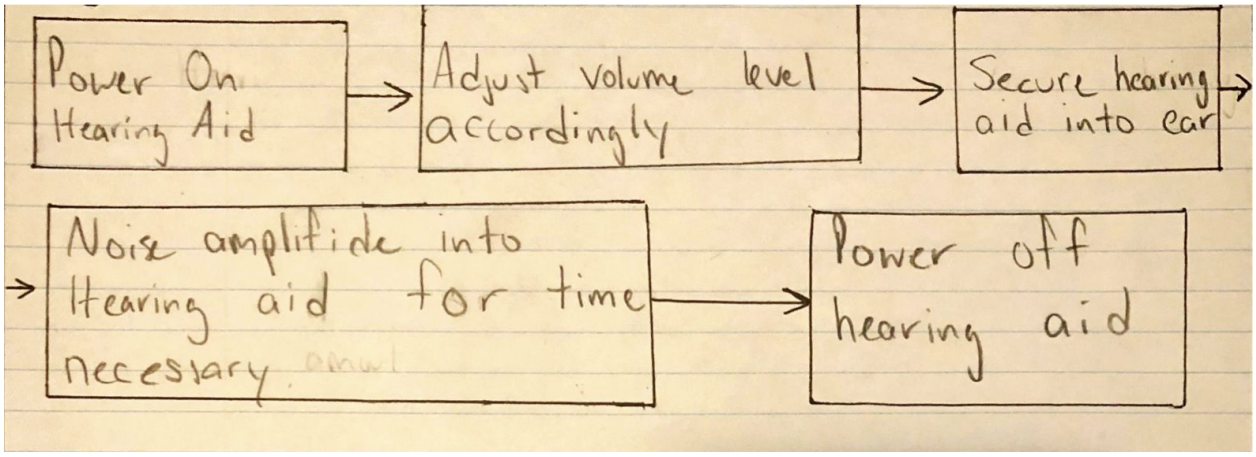


Figure 1: High Level Functional Decomposition

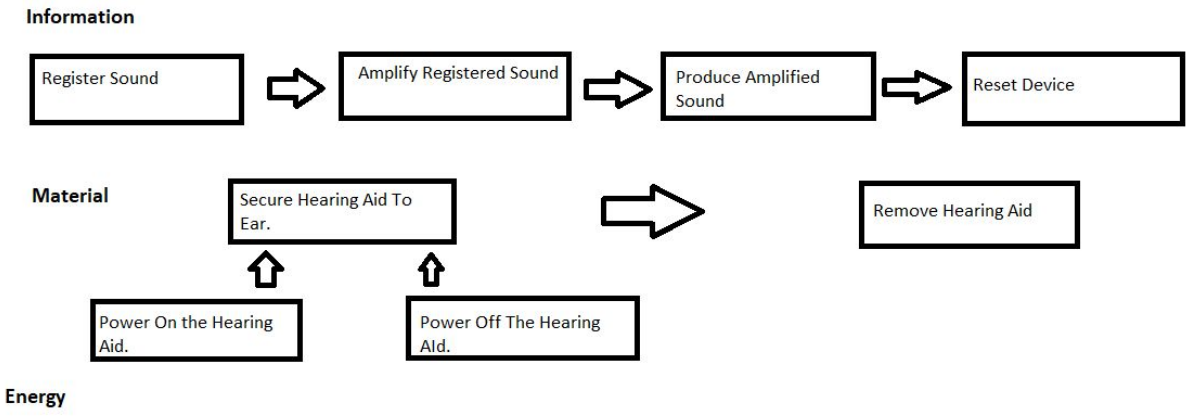


Figure 2: Detailed functional decomposition

The image above illustrates the core functionality of the hearing aid, developed on the information from our client. Each sub-function needs to be achieved in order to satisfy the client's needs.

Concept Generation

As a group we generated three different concepts each. This concept will allow us to generate lots of ideas.

Brandon Joseph Broderick

Concept 1:

- Water resistant hearing aid, with a wire connecting to an external device. This device will be responsible for powering, displaying battery percentage, controlling sound levels, and turning devices on and off.

Concept 2:

- Water resistant wireless earbud. This will be a discreet design that will connect to an app on your phone via bluetooth. The app will display the battery percentage, and the volume level of hearing aid, and the app will also be responsible for volume control. The earbud will have an external button to turn the hearing aid on or off.

Concept 3:

- This design has all the necessary control options right on the hearing aid, no phone or external device is required. The earbud will have two buttons, one button to power the device on and off, and the other button to control the volume .The hearing aid will also have one LED light which has three states. Dark green meaning sufficiently charged, light green meaning less than 50%, and the LED will turn off when the battery is less than 10%.

Omolola Omowa

Concept 1

- This concept consists of small earbuds that fit comfortably in the ear. It consists of a rechargeable case. Both the case and the battery have separate battery life. The settings are controlled via bluetooth on a mobile device. Both the hearing buds and wireless case are water resistant.

Concept 2

- It consists of a water resistance behind the ear device. It has a built in sound receiver, volume control and power switch. It has a USB connection which allows it to be charged via a usb cable. It has an ear hook that allows it to rest comfortably behind the ear.

Concept 3

- This water resistant hearing aid is worn fully inside the ear. It connects to a mobile device via bluetooth. It is barely visible. It can be recharged via its own charging dock. Consists of a power switch. Notifications and settings are accessible via bluetooth on mobile devices

Rehana Lawrence

Concept 1:

- Flanged earbuds idea. Flanged earbuds fit deep into the ear canal and help to block out any incoming water and because it goes so deep in the ear it guarantees great sound. Earbud needs to be made of waterproof materials. It has a long lasting and durable changeable battery.

Concept 2:

- (Focused more on the functionality) waterproof hearing aid that can be recharge
- able through case(almost like AirPods) so that just in case they die, it is possible to recharge them. Would have to connect to an app via bluetooth to tell her about the battery life, sound, quality etc.

Concept 3:

- Waterproof hearing aid where regular hearing aid is coated or enclosed with a waterproof material. The hearing aid is hooped around the ear with light weight material for

comfort.Case has the feature to help charge the hearing aid. Hearing aid will be able to make a sound when a certain amount of power is left.

Benjamin Losier

Concept 1:

- Receiver in the ear type hearing aid, microphone and speaker are in the receiver portion which fits in the ear like an earbud whereas the computer and battery are in a compartment behind the ear. Placing the computer behind the ear provides sufficient room for a battery capable of powering the unit for long time as well as the bluetooth components. The unit will be made out of waterproof plastic with charging ports sealed like waterproof bluetooth earbuds and the microphone/speaker will use a hydrophobic mesh to prevent any water from entering while allowing sound to pass through.

Concept 2

- Behind the ear bone conduction, unit mounted behind the ear transmits sound directly from cheekbone to the inner ear.

Concept 3

- Waterproof sheath which wraps around the ear protecting the hearing aid underneath. Compared to the other concepts this one does not replace the client's existing hearing aid but rather is added to the existing hearing aid to protect it from water damage.

Analysis Of the Concepts

The table below is designed to compare all of our concepts, this will help us decide which one to continue with based on which concept has the highest total. We defined a design to use as our baseline for ranking the concepts in each design criteria. This criteria includes
Comfort - 5
Cost - 4
Weight - 2
Battery - 3
Size - 1
Highest ranking - 10 (Desireable
Lowest Ranking - 1 Undesireable

Joey

Concept	Bluetooth	Comfort	Battery	Cost	Weight	Size	Total
1	No	2 (10)	7 (21)	3 (12)	3 (6)	3 (3)	15 (52)
2	Yes	4 (20)	2 (6)	2 (8)	7(14)	8(8)	23 (56)
3	No	5 (25)	5 (15)	5 (20)	5(10)	5(5)	25 (75)

Omolola Omowa

Concept	Bluetooth	Comfort	Battery	Cost (More expensive = lower value)	Weight	Size	Total
1	Yes	7 (35)	7 (21)	2 (8)	3 (6)	5 (5)	29 (75)
2	No	5(25)	5(15)	4 (16)	9 (18)	5 (5)	28 (79)
3	yes	3 (15)	4 (12)	4 (16)	6 (12)	6 (6)	23 (61)

Rehana

Concept	Bluetooth	Comfort	Battery	Cost (More expensive = lower value)	Weight	Size	Total
1	No	2(10)	2(6)	7 (28)	4(8)	5(5)	20 (57)
2	yes	5(25)	6(18)	2 (8)	5(10)	4(4)	22 (65)
3	no	6(30)	5(15)	6 (24)	4(8)	4(4)	25 (81)

Ben

Concept	Bluetooth	Comfort	Battery	Cost (More expensive = lower value)	Weight	Size	Total
1	Yes	5 (25)	7 (21)	2 (8)	4 (8)	4 (4)	23 (66)
2	Yes	7 (35)	6 (18)	2 (8)	4 (8)	4 (4)	23 (73)
3	No	5 (25)	5 (15)	9 (36)	5 (10)	5 (5)	29 (91)

Our Solutions - Analysis

Proposal 1 (Benjamin Losier)

The idea of bluetooth connectivity although requested by the client will be discarded for now to allocate more of the budget to audio quality and battery power. Borrowing ideas from Omolola's Concept #1 and Rehana's Concept #2 the carrying case will double as a power bank for the hearing aid, both the hearing aid and the carrying case will use the same type charging port so the hearing aid does not depend on the case for charging.

The hearing aid itself will be a "behind the ear" style in which the external portion houses the microphone, the battery, audio/power controls and a battery indicator LED from Joey's third concept. The audio output portion of the hearing aid will borrow the flanged earbud idea from Rehana's first concept to minimize chances of the aid being dislodged by moving water while swimming. Material selected for the exterior of the hearing aid will be a waterproof polymer, a hydrophobic mesh will cover areas where sound must enter or exit the hearing aid.

The carrying case will be a simple plastic case housing a battery with two LED power indicators on the outside, one showing the power of the case, the other showing the power of the hearing aid.

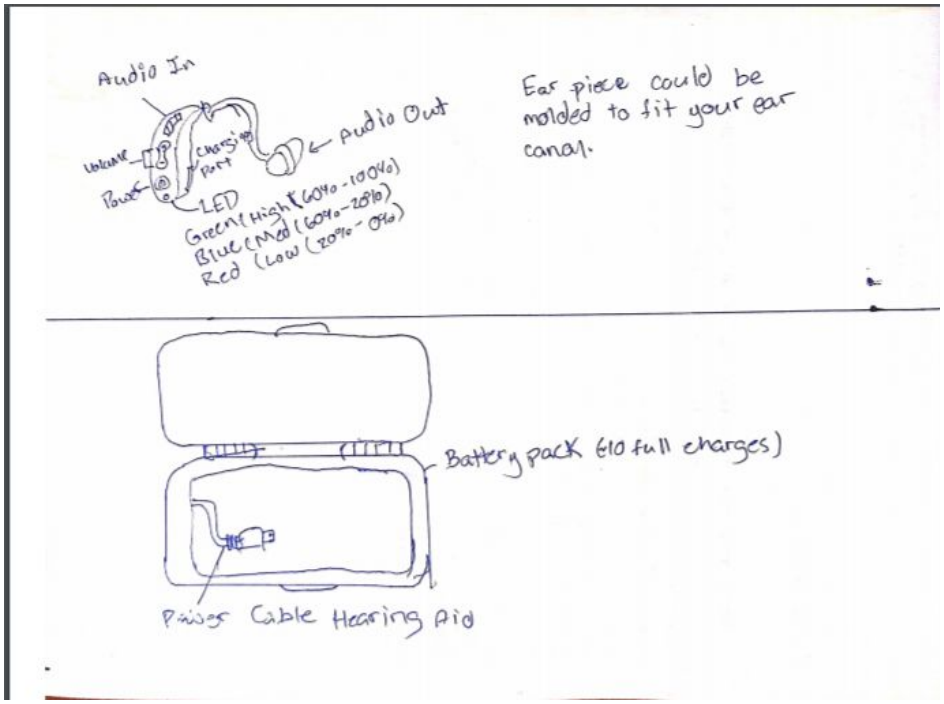


Figure 3: Proposal 1 Sketch

Proposal 2

Our second proposal is a protective shield for our clients current hearing aid. We will find all the necessary dimensions of the hearing aid and design a case that will be used specifically to repel water. The client will have the option to take off and put on the case accordingly. This may be the best proposal since the user will not need to carry multiple hearing aids for different occasions, therefore this would be a very convenient design.

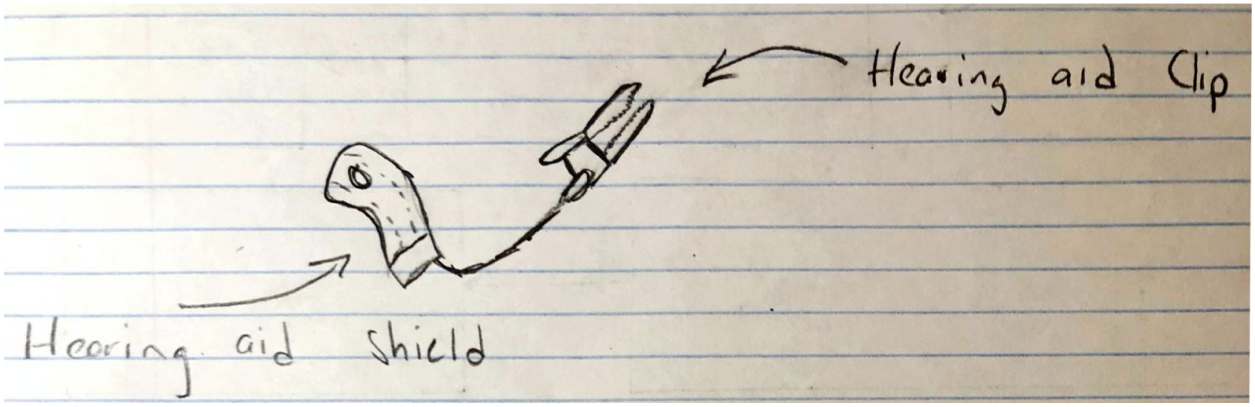


Figure 4: Proposal 2 Sketch

As the design sketch displays, the shield will be a basic case that simply slides on and off. The case will also have a clip to attach to the clients swimsuit as she swims, this will ensure that the hearing aid does not completely fall off into the water unexpectedly.

Feasibility Study

The main uncertainties and risks associated with this project are as follows:

1) The final product can only resist water to some extent (ie. not completely waterproof). We know of material that can repel water effectively; however, nothing can 100% protect equipment against water damage.

2) We do not know the best design to keep the hearing aid secure while swimming. An over ear hook on the earbud is usually sufficient for general hearing aids, since most people just walk and maybe exercise with them on. In our case the client will be swimming with them on, and it is possible the over ear hook will not be able to keep the earbud secure in these conditions.

3) The user needs to request that the hearing will be able to hold a charge for 8-10 hours. This will require significant power storage to satisfy this need. Finding a battery small enough to fit discreetly in the hearing aid that will provide enough power for the required time may be challenging and expensive.

Proposal 1 - Analysis

Technical: This concept will require a strong grasp of circuitry to ensure optimal functionality, strong CAD ability to design the product and knowledge of acoustics to ensure sound is delivered effectively. With the help of our PMs I am confident our team will have the technical ability to create this product.

Economic: This product can offer a great cost/benefit ratio by limiting the amount of "wants" to maximize the needs. Discarding the power bank case idea to increase funds for the hearing aid is a possibility with this project.

Legal: Existing patents will have to be studied to ensure our design does not infringe on any previous similar products.

Operational/Other: All team members are not currently living in Ottawa, this could pose a challenge while building the physical final product. However most of the work could be done electronically through CAD to facilitate the physical work needed.

Scheduling: Similarly to the cost analysis the rechargeable case idea can be discarded to allow more time to focus on the hearing aid if necessary. Deliverable submission dates along with presentation and design day dates are fixed deadlines that we can meet using project planning tools such as microsoft project.

Proposal 2- Analysis

Technical

For this concept our goal is to make a water0proof protector for the hearing aid. We will need to further our research of compatible waterproof materials. We will also need the client's existing hearing aid to make the shield for it. We are confident that we will be able to make the shield with the use of SolidWorks and a 3D printer.

Economical

This solution has a very low budget. The material for the shield will be the only aspect of the project that will require us to spend money. The solution being very inexpensive allows us to have the opportunity to add features in the future.

Legal

This project has been done by other groups in the past. We have to make sure that we do not copy any previous years work. We are doing this by ensuring to use completely different material and a different design for the shield. We have to do further research on any other products in the market but to our knowledge, there are no products out like this.

Operational

Team members are not within close proximity of each other which may be a set back to the success of our final product. We will have to do some additional research on waterproof materials that will work with the hearing aid. We will need to figure out how to integrate the material without affecting the quality of the hearing aid itself. We will somehow also need to get our clients hearing aid so that we can obtain the correct measurements for the shield. This may be hard due to the fact that we are not able to meet with our client.

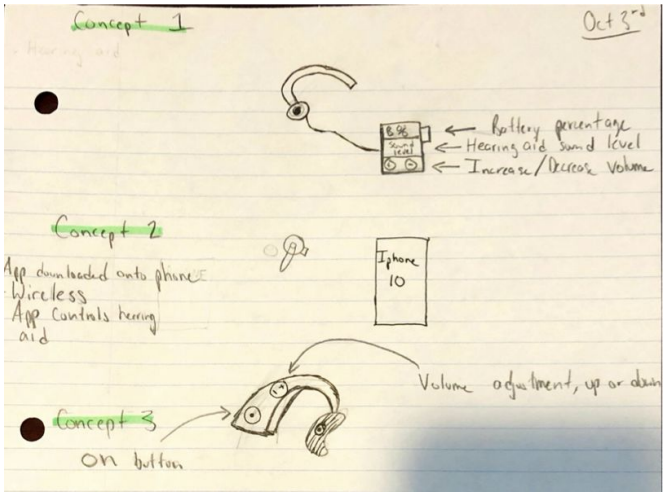
Schedule

The deadline for this project is December 3rd 2020. It is very realistic that we will be able to complete this project if we continue to meet deadlines. We have had a setback with a late client meeting but we have been able to get things back on track for our next deliverable which will be our first prototype. With the ongoing pandemic and the fact that our team is nowhere within close proximity to each other, we know that there may be issues with testing our product. We know that the next few weeks are critical towards the success of our project so we have to be diligent and focused. We are aware that we all have equally demanding courses that we need to focus on as well. We have agreed to dedicate time throughout our week for this project. If all team members are able to equally contribute to the project, we are confident that we will be able to produce a solution for our client.

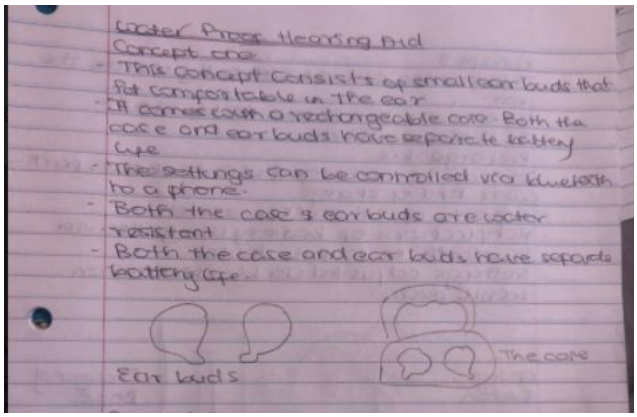
Appendix

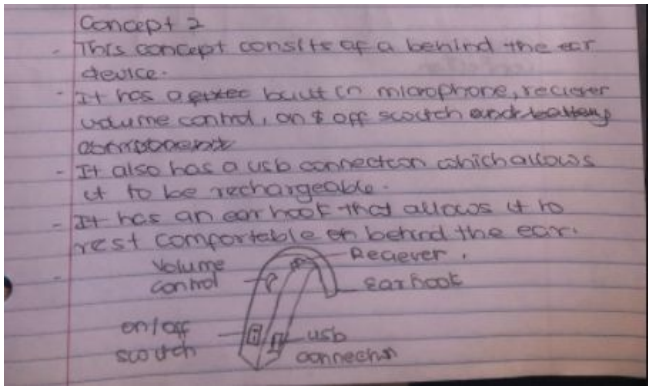
Diagram representation of the conceptual design

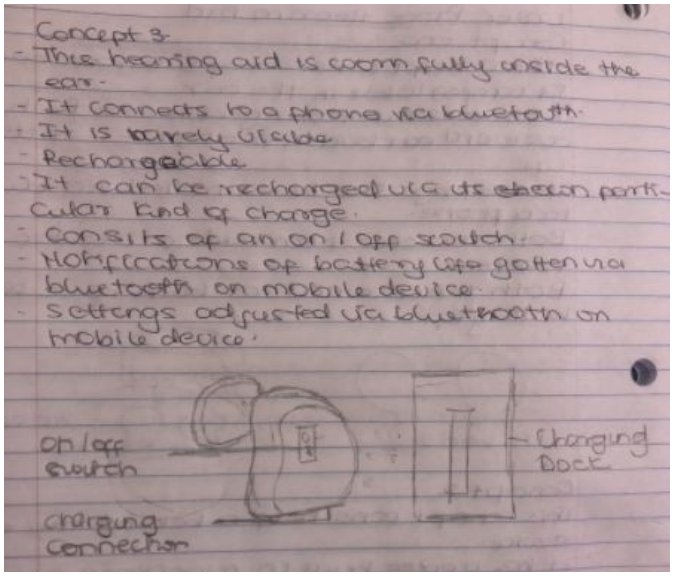
Joey 300128727



Omolola Omowa 300130234

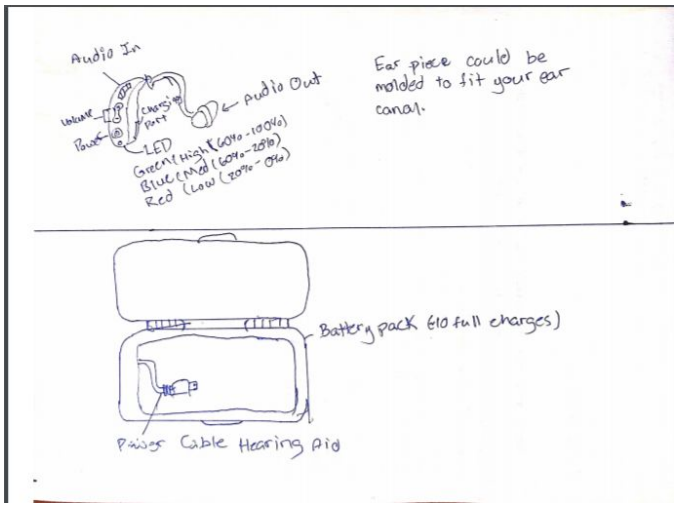




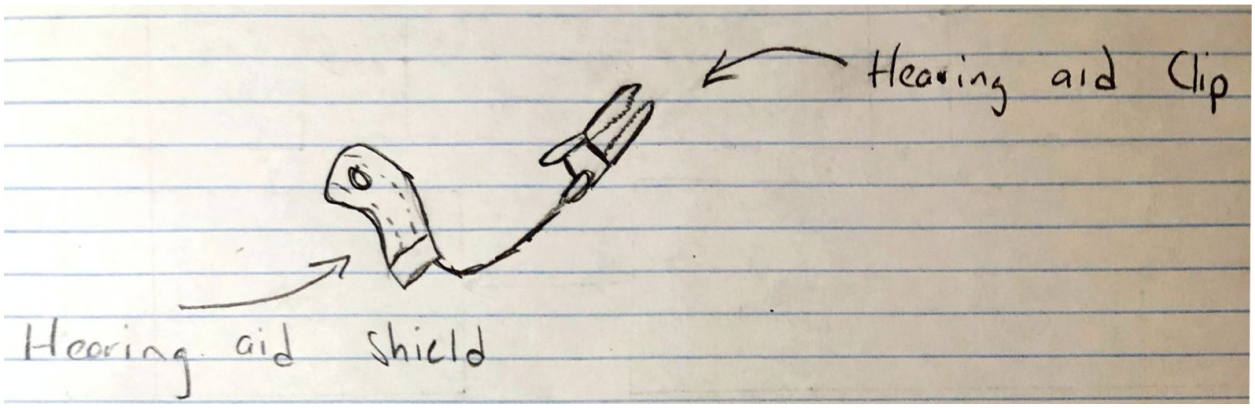


Diagrams of Proposal

Proposal 1



Proposal 2


Hearing aid Clip
Hearing aid shield