VEX VRC HIGH SCHOOl 2022/2023
Reverse Engineering Online Challenge Report

The Evolution Of Hearing Aids over Time

7282Z
Auto Flashes: Zenith
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1. Introduction

Our Robotics Team Consists of 5 extremely hard workers who all try to make our robot, and team, the best it can be. Despite being in one of the most competitive robotics regions in the world, we've never quit. Instead, we've always searched for how we can improve.

Figure 1.0.1 So far During the 2022-2023 Season, We have won a Design, Innovate, and Create Award!

When we first heard about the Reverse Engineering Challenge, We all had various ideas of what item we should reverse engineer. Out of a Nintendo Wii, First generation Ipod and various other devices, we settled on an older pair of hearing aids. One of our team members, Jonathan Reid, is 40% Deaf and typically wears hearing aids, however no one on our team can confidently explain how they work. As a result, we've decided to discover how these machines that have helped our team member throughout his entire life ***actually*** function.

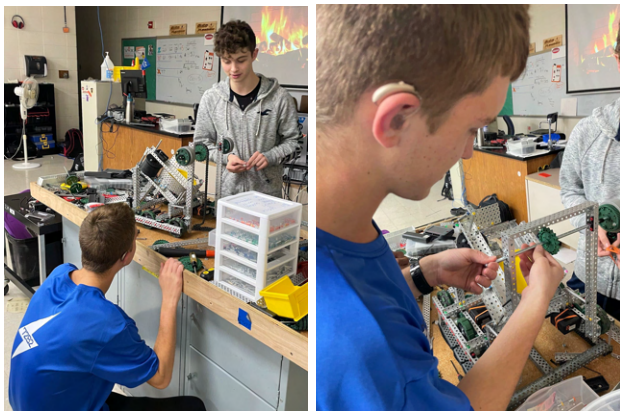


Figure 1.0.2 and 1.0.3: Team Captains Jonathan (left) And Leiam (Right) Working on the Robot while Jonathan wears his newest hearing aids.

1.1

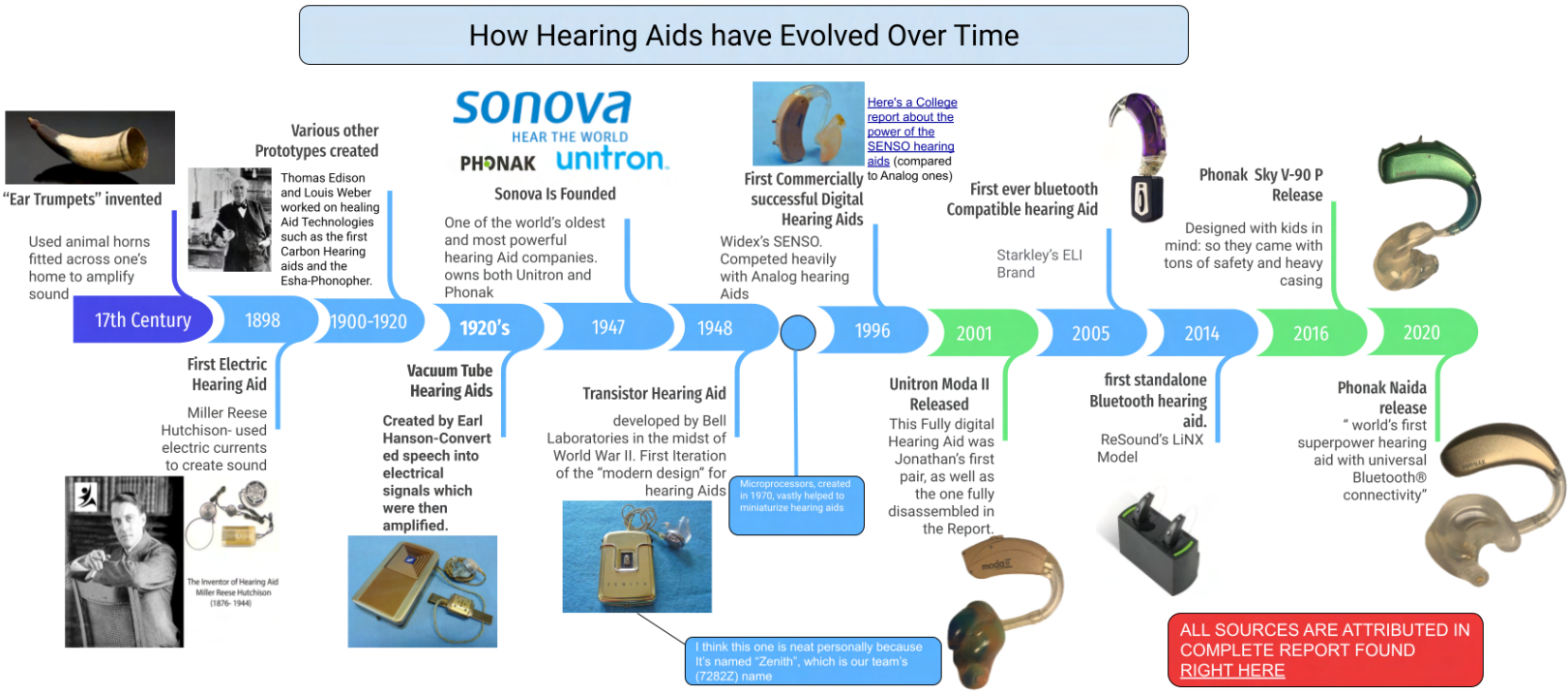
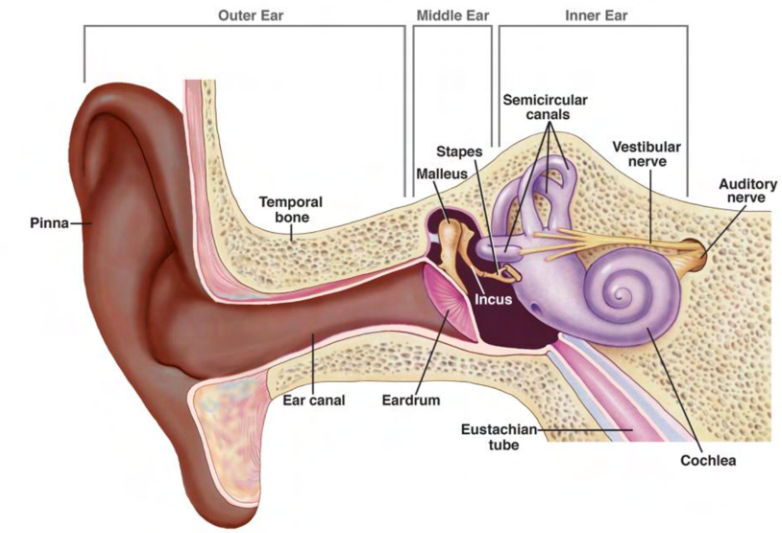


Figure 1.1.1: Before starting this challenge, the team wanted to get a grasp on how hearing aids have evolved ever since their conception before delving headfirst into the hearing aids we will disassemble (shown in green on the timeline). We have always believed that understanding the bigger picture of a concept helps with all the details, hence why we've made this timeline. The timeline template is provided by Slidesgo.

The timeline Can be viewed HERE If one would like to see it in better detail.

1.2

Hearing depends on a series of complex steps that change sound waves in the air into electrical signals. Our auditory nerve then carries these signals to the brain. Also available: Journey of Sound to the Brain, an animated video.



Source: NIH/NIDCD

Figure 1.2.1: This Diagram, Provided by the National Institute on Deafness and Other Communication Disorders, shows how the normal ear works. The sound waves travel into the ear where they are processed by the bones and the cochlea into electrical signals for the brain.

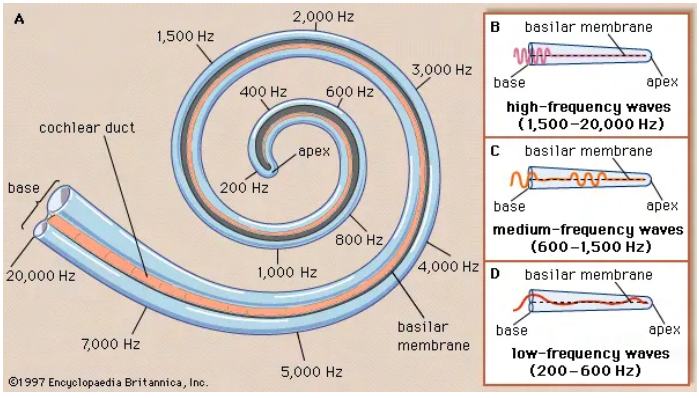


Figure 1.2.2: This Graphic Provides a graphic to show how the cochlea gathers sound pitches normally. Although there is no definitive answer, doctors believe that Jonathan's cochleas don't have enough turns in the spiral structure, causing his hearing loss.

1.3

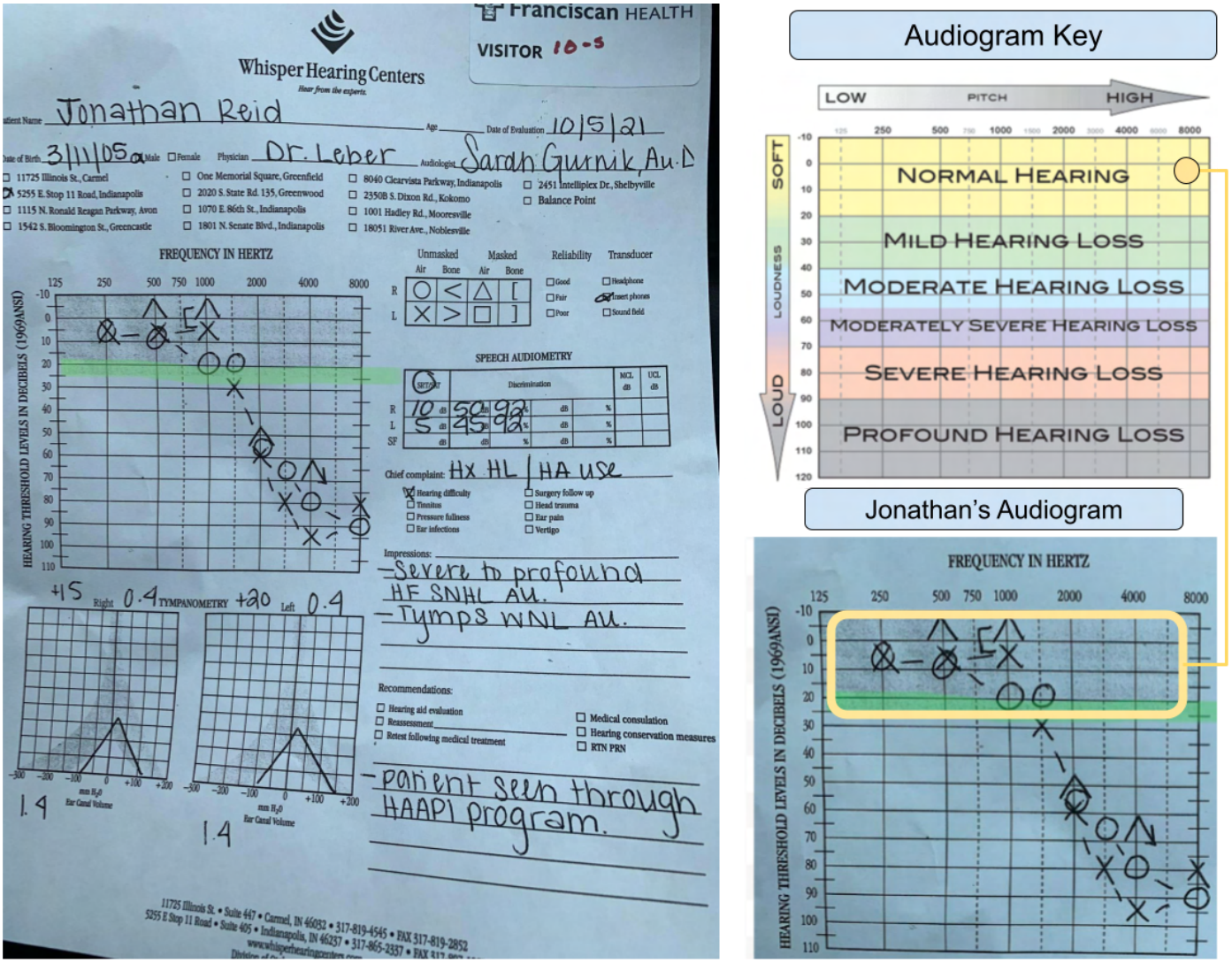


Figure 1.3.1: This is a picture of Jonathan's most recent audiogram, which measures his hearing capabilities. The right side of the graphic simplifies the data, showing that Jonathan's hearing falls into the moderate to severe range past 2000 Hertz.

2. Plan of Action

Before touching anything, we decided to plan out our process as pictured below

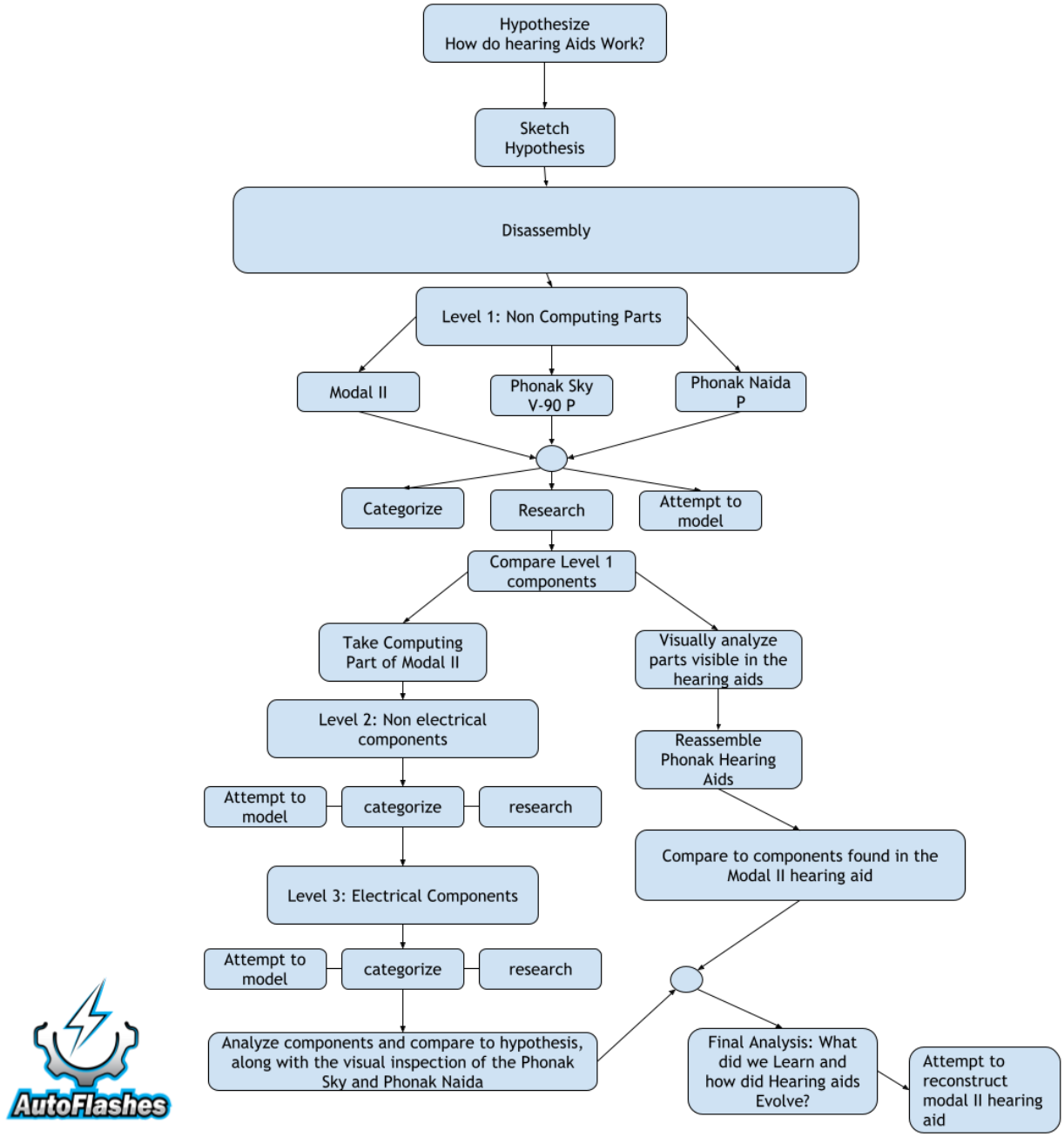


Figure 2.0.1: Process for disassembling and analyzing the hearing aids.

2.1

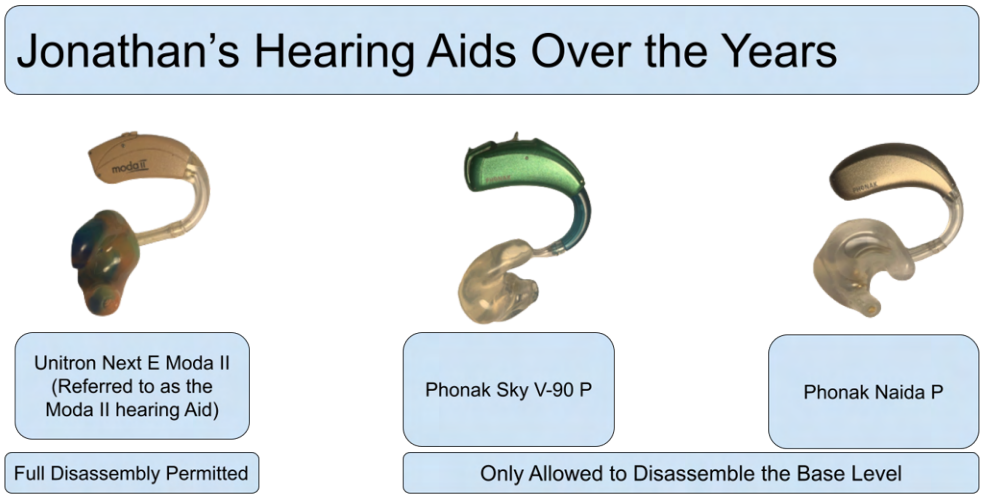


Figure 2.2: It should be noted that Phonak And Unitron are sister companies, both owned by Sonova. This means that technology is or can be freely shared between companies, making a viable comparison between the Moda II's and the other two Phonak Models. All manuals, which give vital information about each hearing aid, are linked in the works cited section at the end of this report.

3. Hypothesis

If sound waves are around the hearing aid, then the hearing aid will amplify the sound because of the microphone and speaker within it.

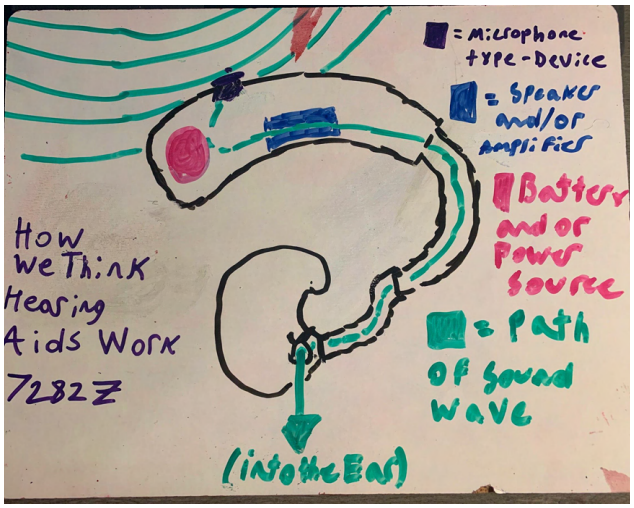


Figure 3.1: Our Visual Representation of how we think a hearing aid works. Sound travels through a microphone, and then is amplified and the new sound waves travel through the rest of the system straight into the ear.

4. Disassembly

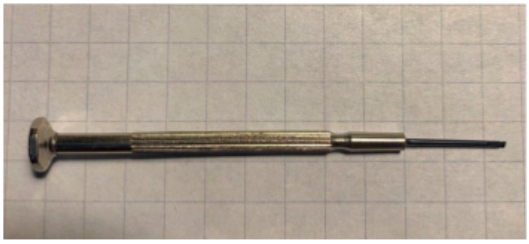
Pre-disassembly questions

- **How does the battery power the System?**
- **Where/how does sound get amplified or transferred?**

4.0.1

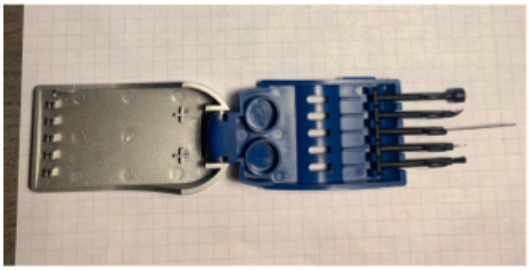
Gerber Pliers

Flashlight



"_____" Screwdriver

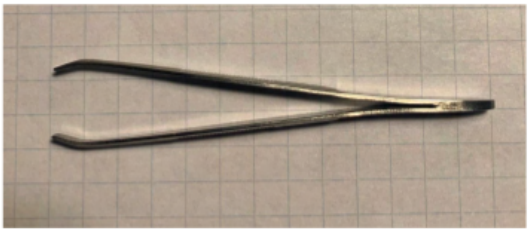
Safety Glasses



Custom Hearing Aid Cleaner

Dial Caliper (for measurements)

15x macro phone lens attachment
Courtesy of the Franklin Central Photography Class



Tweezers

Figure 4.0.1: All of the Tools used To disassemble the hearing aids.

4.0.2

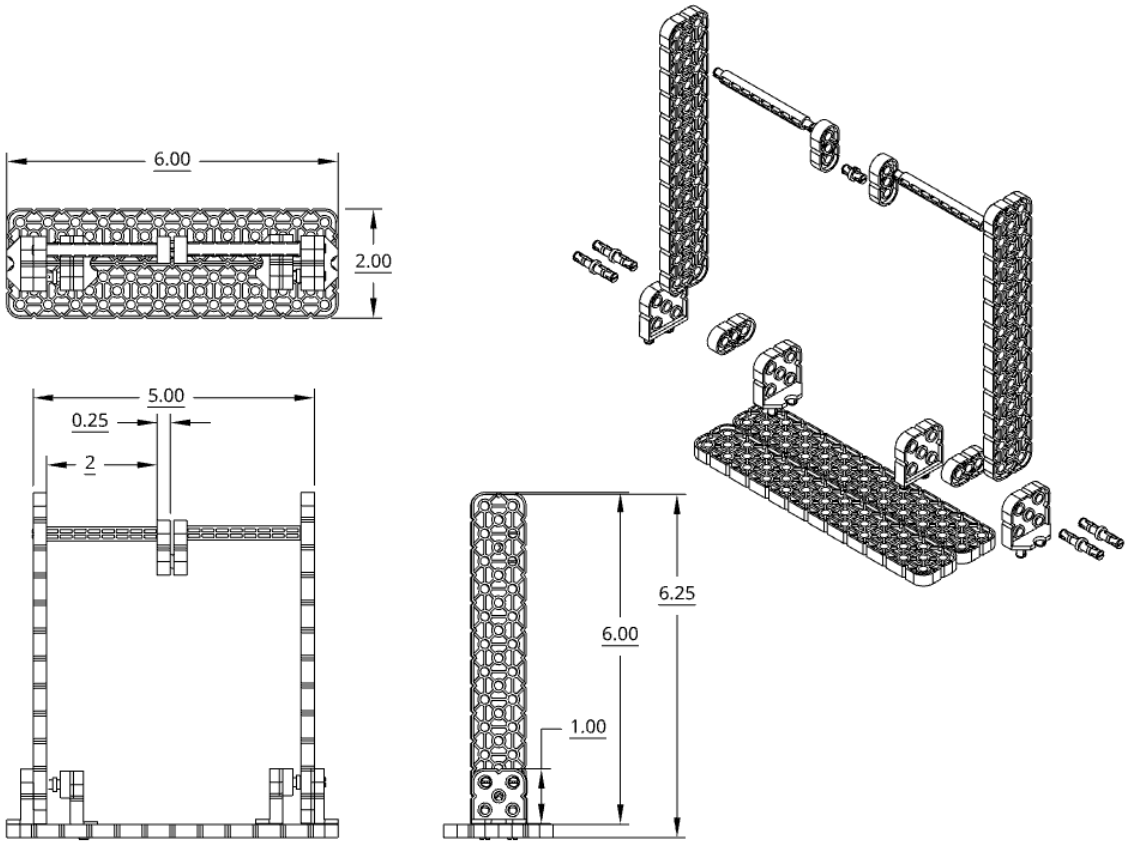


Figure 4.0.1: Here is our plan for a custom Stand to display the Hearing aids if/when they are not being disassembled, as only one Modell II hearing Aid will be disassembled. The Parts Library used is free to the Public and is attributed in the sources. You can view the Onshape Model HERE.

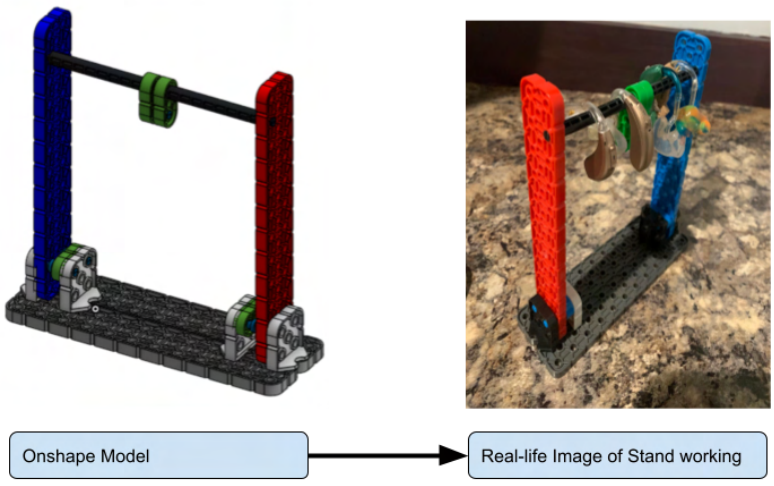


Figure 4.0.2 This is How the stand turned out in real life based on the model we created.

4.1

4.1.1 Moda II Video

Recap:

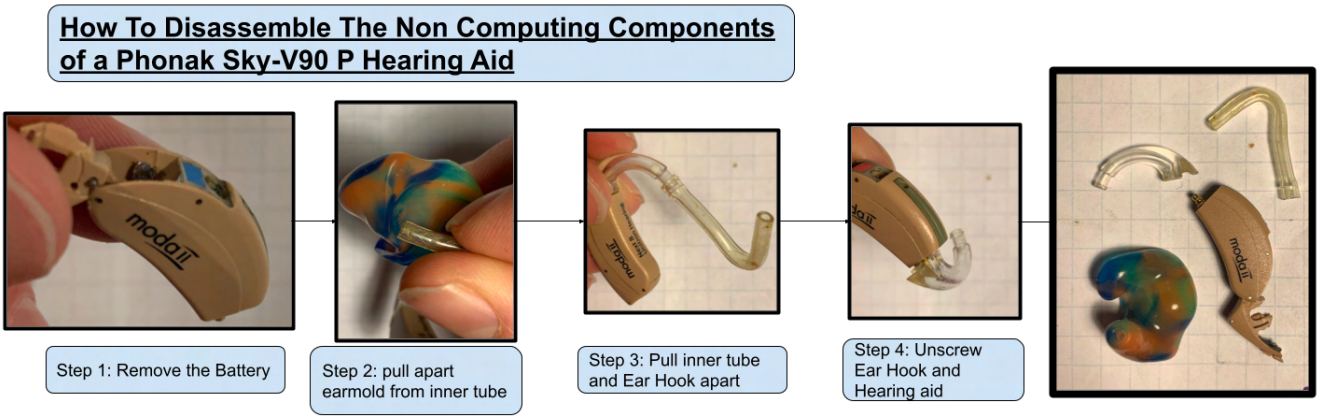


Figure 4.1.1.1: Make sure that the batteries are out of the system before disassembling anything.

4.1.2 Phonak Sky V-90 P Video

Recap:

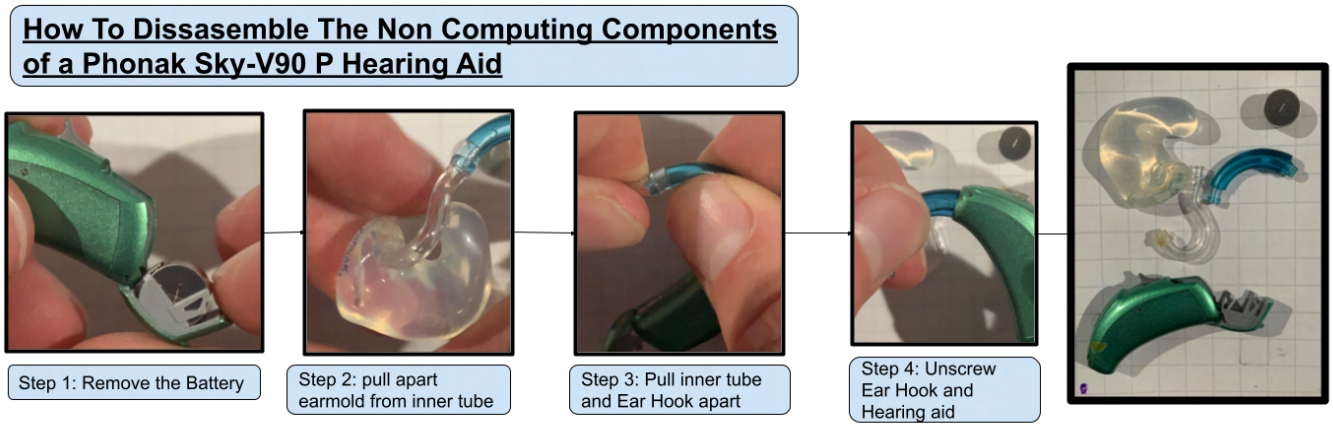


Figure 4.1.2.1: The steps of how to disassemble The Phonak Sky V-90 hearing aids.

4.1.3 Phonak Naida P Video

Recap:

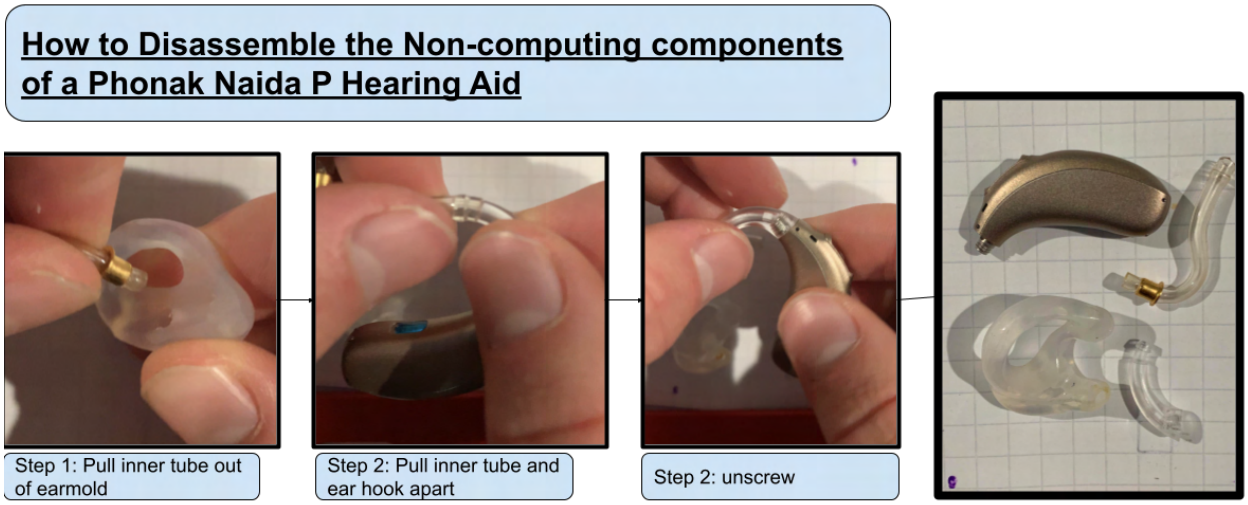


Figure 4.1.3.1: How to disassemble the Phonak Naida Hearing aids. There is no battery here, so you just have to verify the hearing aid is off before starting by holding the power button until the indicator light turns red

From here, we delve into the Moda II hearing aids to see how they operate on a piece-by-piece scale.

4.2

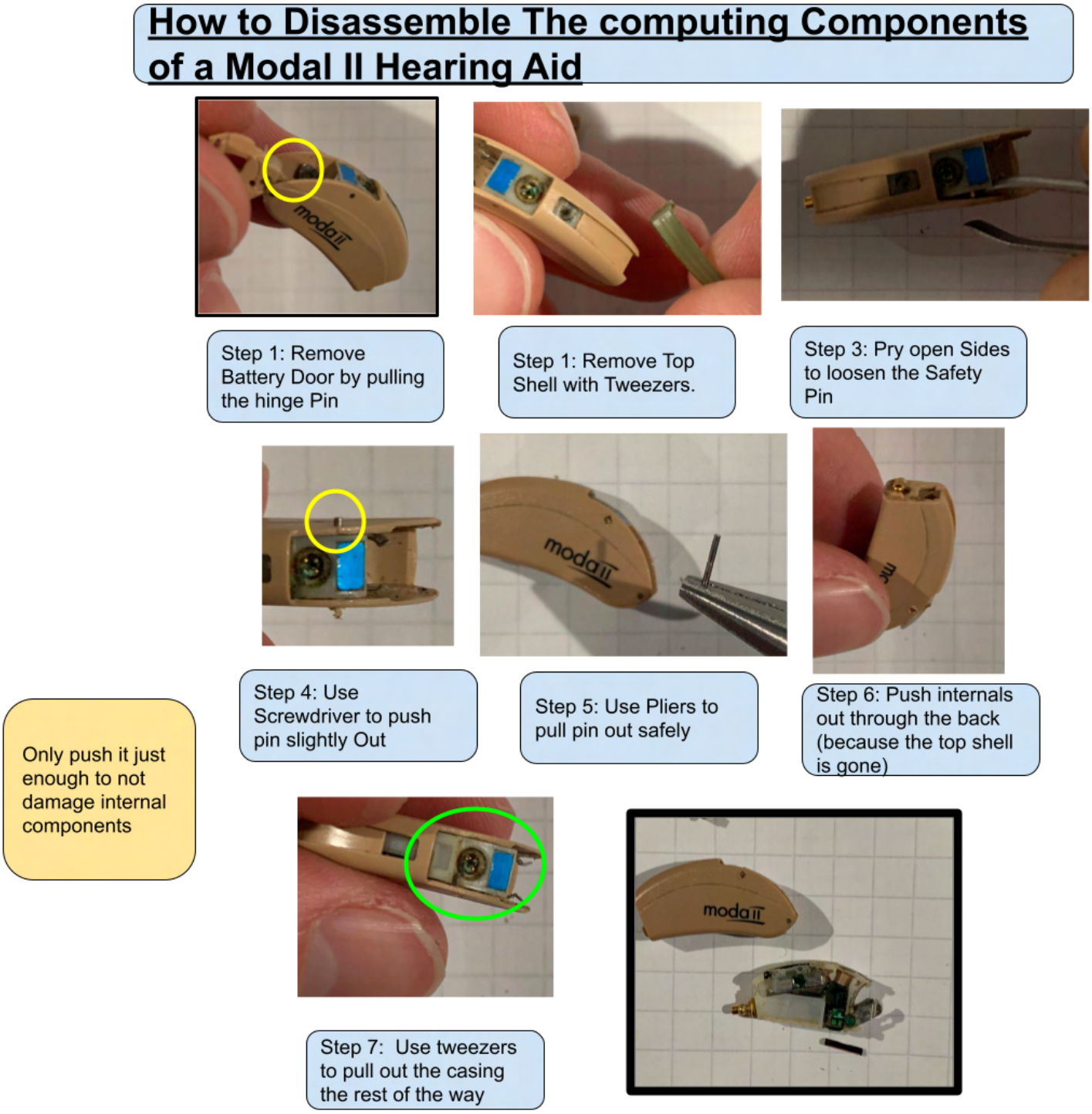


Figure 4.2.1: Our steps for disassembling The hearing aid into the electrical casing.

4.3

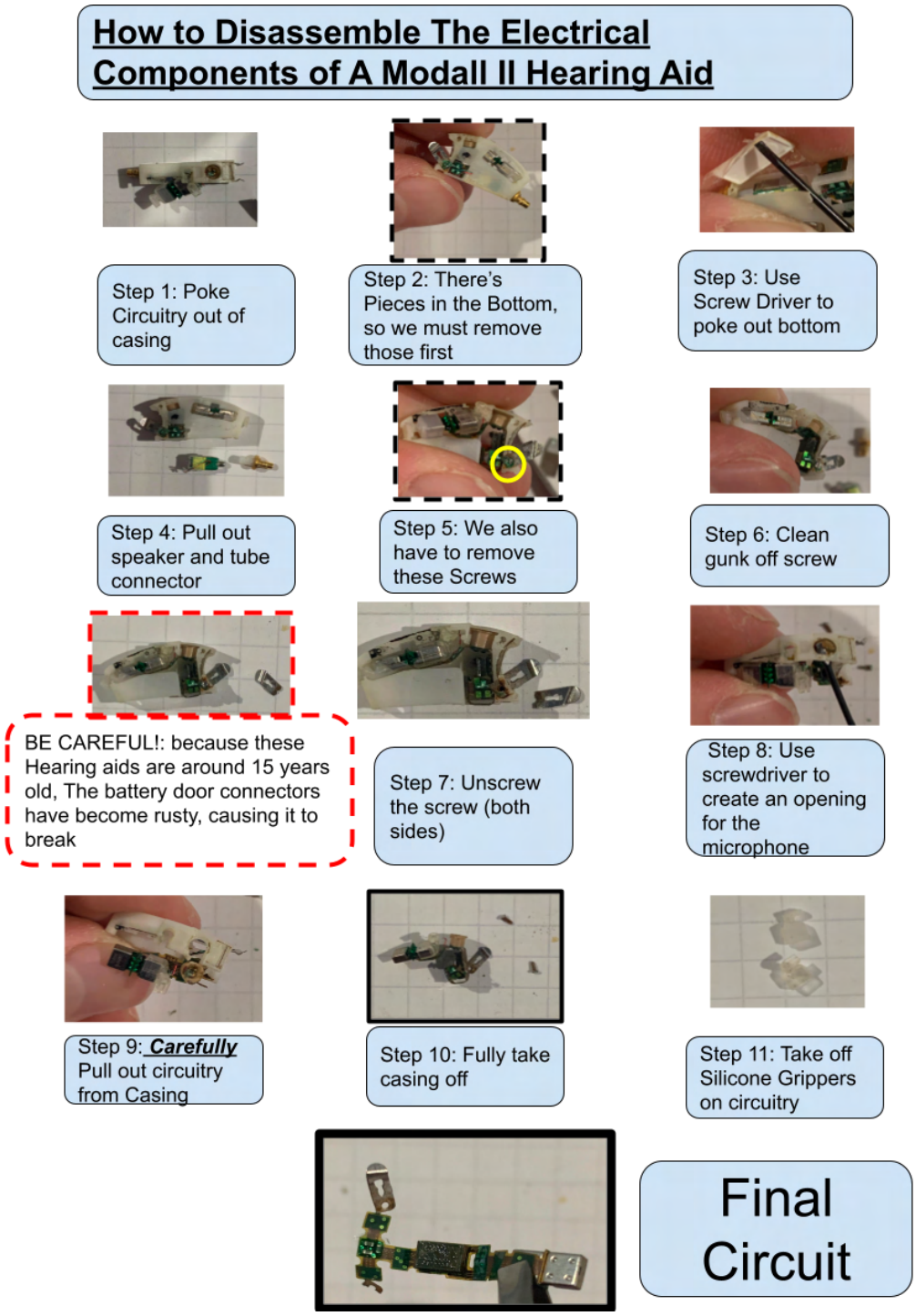


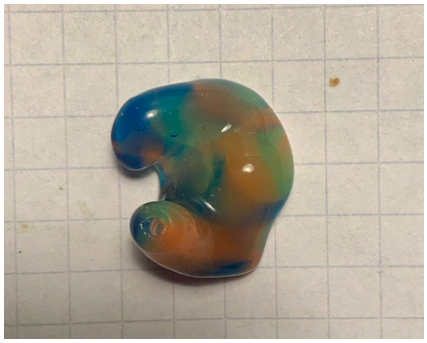
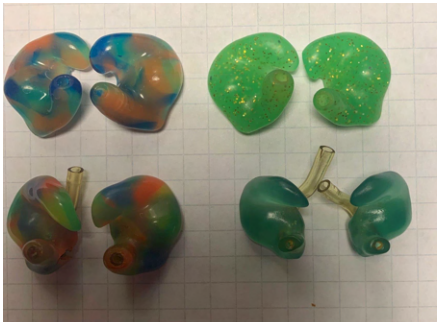
Figure 4.3.1: Our steps for disassembling the electric casing into the circuitry within the hearing aid.

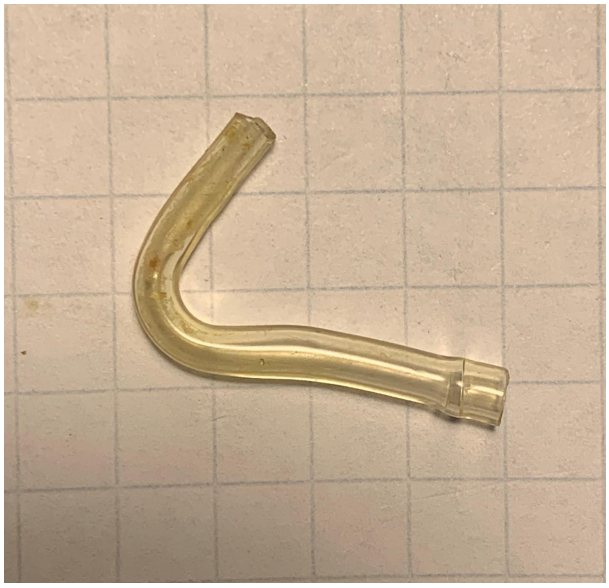
5.Parts lists

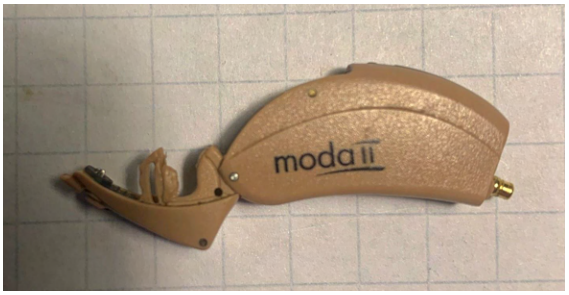
For Dimensioning, we used the Dial Caliper to measure the farthest distances of the approximate length, height, and depth of each part.

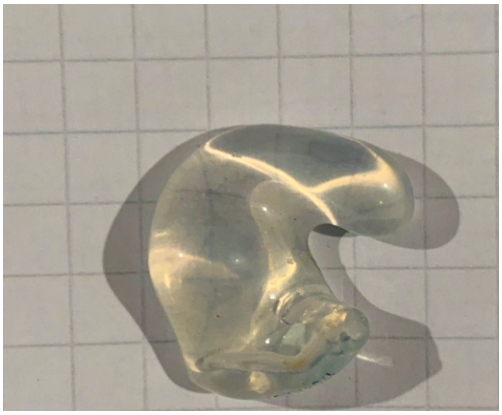
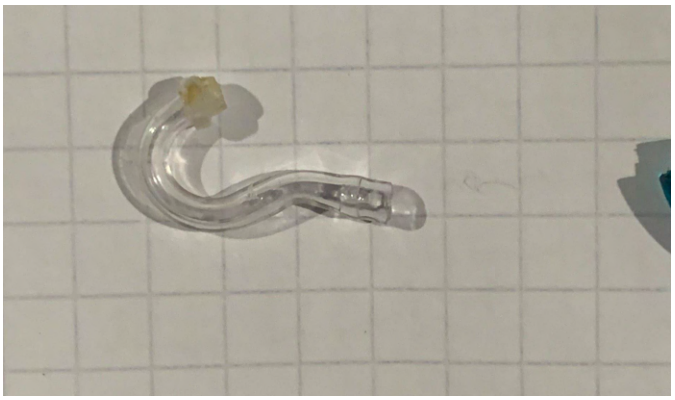
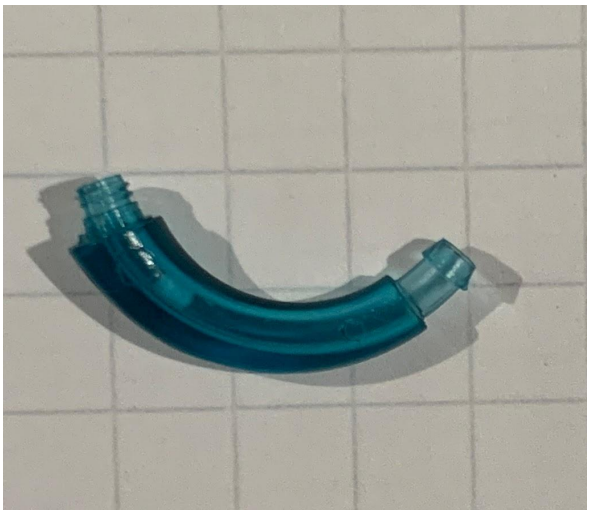
All Measurements are in Inches and labeled by a Length X Height X Depth format

5.1

Part Description and Purpose	Image
Moda II Ear Mold 0.817” X 0.910” X 0.605” Material: Silicone Purpose: Holds the device in your hear/direct sound directly into the ear canal Notable Aspects: Size and exact form are customizable because they Inject your ear with a play-dough type mold to get the size for your ear at the time. This is very similar to die casting for metal, but human friendly. Ear molding Putty Companies like Beltone Create Custom Ear Molds	 

Moda II Inner Tubing 0.915” X 0.550” X 0.175” Material: Silicone Purpose: Direct Sound and connect earmold with Ear hook Notable aspects: Much more flexible which allows for greater comfort but also an easier chance of tearing.	
Moda II Ear Hook 0.885” X 0.310” X 0.210” Material: Silicone Purpose: Connect hearing aid and tubing and provide more structure along the curvature of the ear Notable Aspects: Has a much more sizeable attachment to the hearing aid unit than the Phonak brand ones	

(Assembled) Moda II hearing aid unit Battery Door Closed 1.125” X 0.494” X 0.260” Battery Door open 1.543” X 0.650” X 0.260” Material: It’s… complicated (because it has so many parts within it, which you will see later) Purpose: Receives and amplifies sound. Notable Aspects Product has been discontinued, but can be found for resale on places like ebay. Data Sheet: https://www.unitron.com/content/dam/unitron-2014/documents/english/Older%20Products/Next/specsheet/english-next-specsheet-letter-ne-modaii.pdf	 
Size 312 Battery 0.145” X 0.305” diameter Material: Zinc Purpose: Powers the system Notable Aspects: Here's how batteries work More Information Much smaller than the size 13 battery. (It is approximately 3/4th it’s height in fact) Available online	 

Phonak Sky v90 P Ear Mold 0.877” X 0.135” X 0.4” Material: Silicone Purpose: Hold the device in your hear/direct sound directly into the ear canal Notable Aspects: Clear material allows the earmold to blend in more with one’s natural ear so that they don't stand out as much.	
Phonak Sky v90 P Inner Tube 0.815” X 0.421” X 0.175” Material: Silicone Purpose: Direct Sound and connect earmold with Ear hook. Notable Aspects: Much firmer structure than either of the 2 other inner tubes… We think this is because of a thicker silicone or even flexible plastic layer.	
Phonak Sky v90 P Ear Hook 0.820” X 0.345” X 0.175” Material: Hard Plastic of some sort Purpose: Connect hearing aid and tubing and provide more structure along the curvature of the ear. Notable Aspects: Has threading on it for tighter grip with the hearing aid unit. Available Online	

Phonak Sky v90 P Hearing Aid Unit

Door Closed
1.31 l,0.581 h, 0.335 d

Door Opened
1.742” X 0.762” X 0.335”

Material: Various

Purpose: Receives and amplifies sound

Notable Aspects:

Has a volume control switch on the top, as well as very durable casing

Website overview of a newer innovation of this model, The Sky Marvels

Data Sheet:
https://www.phonakpro.com/content/dam/phonakpro/gc_hq/en/products_solutions/hearing_aid/sky_v/documents/datasheet_sky_v_sp.pdf

Size P13 Battery

0.205” X 0.305” Diameter

Material: Zinc

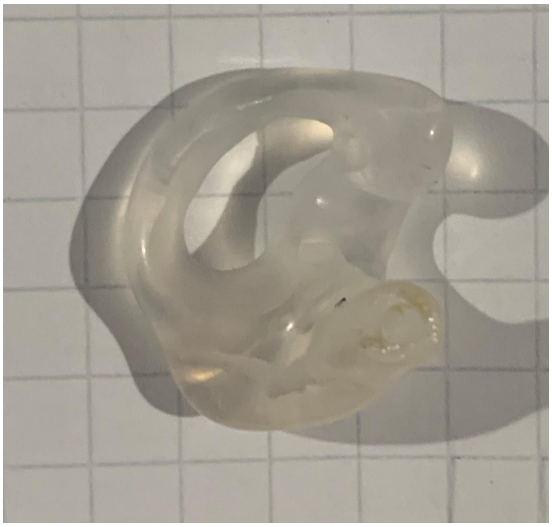
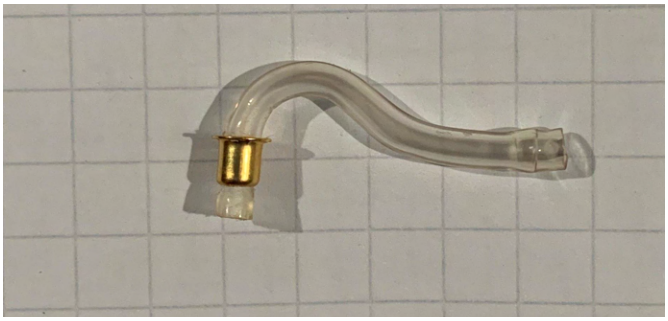
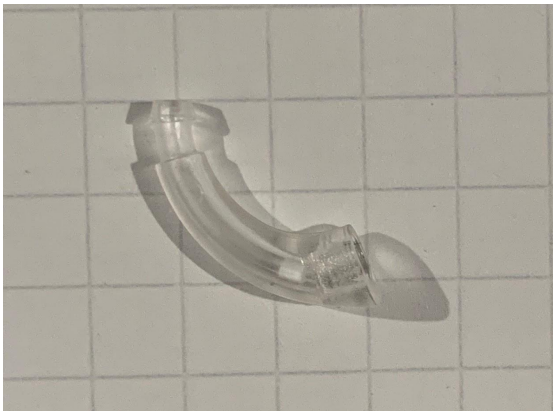
Purpose: Powers the system

Notable Aspects:

Here's how batteries work
More Information

Larger than size 312 batteries by about 0.05 inches, but comparatively it makes a big difference. This battery is about 25% taller than the size 312 Battery used with the Moda II hearing aid.

Available Online

Phonak Naida Earmold 0.755” X 0.943” X 0.591” Material: Silicone Purpose: Hold the device in your hear/direct sound directly into the ear canal Notable Aspects: This is a skeleton Earmold, which has a hole in it that allows for more breathability, but is also more fragile.	
Phonak Naida Inner Tubing 0.841” X 0.54” X 0.200” Material: Silicone and metal (of some sort) for the bearing Purpose: Direct Sound and connect earmold with Ear hook Notable Aspects: Instead of a plastic fitting, this inner tube uses a metal bearing to firmly fit inside of the earmold	
Phonak Naida Ear Hook 0.800” X 0.400” X 0.210” Material: Hard Plastic of some sort Purpose: Connect hearing aid and tubing and provide more structure along the curvature of the ear Notable Aspects: Has both threaded attachment and a bearing type fitting	

Phonak Naida Hearing Aid Unit

1.415” X 1.142” X 0.335”

Material: Various

Purpose: Receives and amplifies sound

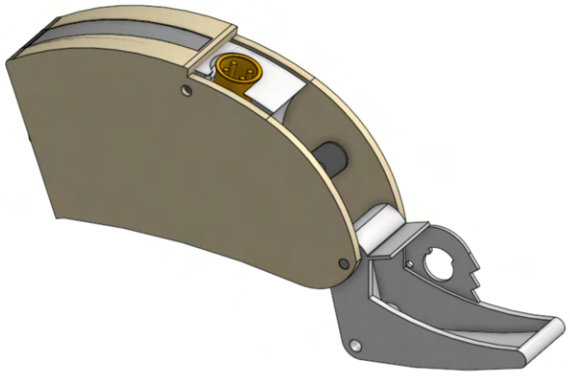
Notable Aspects:

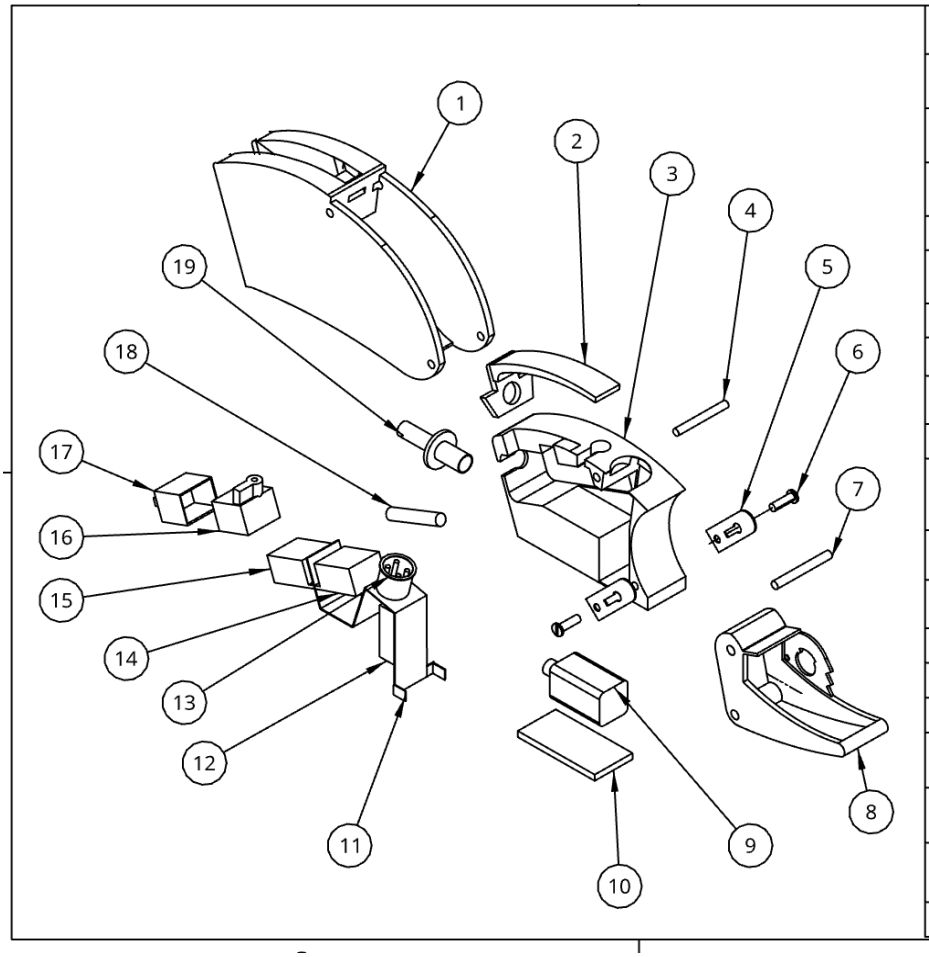
No battery, as it is rechargeable. It also has Bluetooth support as well as its own app you can set custom settings.

Website Overview

Data Sheet: https://drive.google.com/file/d/1UngowFD9Bq56uzjGKNr6Cs0Eiyz8soeB/view?usp=sharing

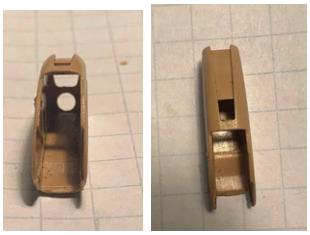
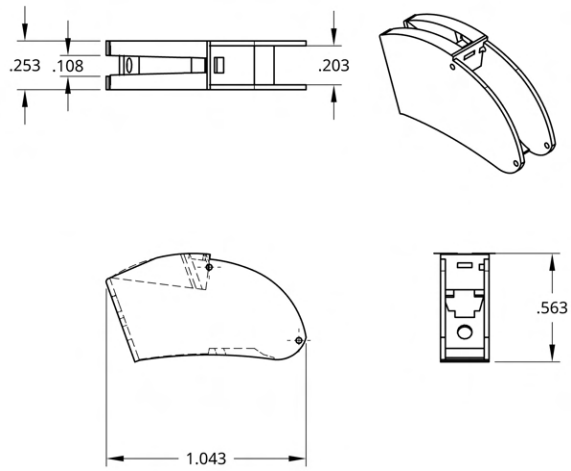
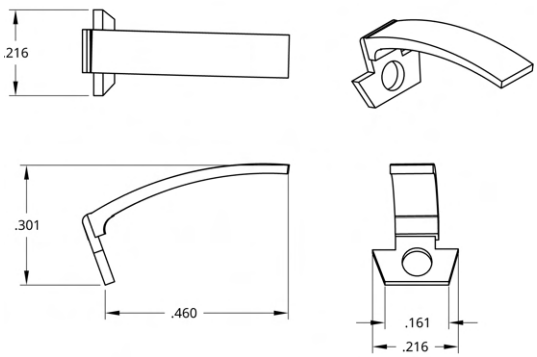
5.2





Balloon #	Part Name
1	Brown cover Shell
2	Top Slot Protector
3	White Casing
4	Hinge Pin 1
5	Battery Connectors
6	Screws
7	Hinge Pin 2
8	Battery Door
9	Speaker
10	Bottom silicone Holder
11	Ribbon Cables
12	Microprocessor
13	Battery Plug
14	Right Amplifier
15	Left Amplifier
16	Right Silicone Holder
17	Left Silicone Holder
18	Sound Transfer Pipe
19	Tubing Plug

Figure 5.2.1 and 5.2.2: This is a complete render and an exploded drawing view of the digital recreation of the Moda II hearing aid using Onshape. WHile it's not as intricate as the real hearing aid, this model provides an accurate representation and visualization on how the parts fit together. VIEW IT HERE

Part Description	Image	Recreated Model Drawing Of Part
Brown Cover Shell 1.004” X 0.455” X 0.250” Material: Hard Plastic Purpose: Hold white casing securely. Notable Aspects: Might have been made using injection molding, based upon a seem we noticed inside the casing.	 	
Top Slot Protector 0.515” X 0.200” X 0.106” Material: hard plastic Plastic *we believe it to be polystyrene, or plastic type 6 based on the number 6 present on the bottom along with material testing* Plastic types Purpose: Protects the microphone and provides a filter so debris doesn’t get in Notable Aspects: Made a different color than brown casing to emphasize it	 	

White Casing Unit

0.71” X 0.585” X 0.175”

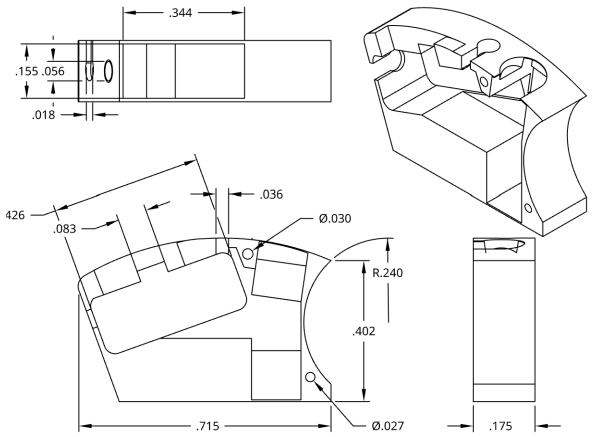
Material: Plastic

Purpose: Hold Circuitry

Notable Aspects:

Serial number of the hearing aid is visible here. However, the hearing aids have been discontinued since sometime in the 2000s. That, combined with patent laws, makes it near impossible to systematically identify the parts in terms of the official company unless they imported it from someone else. We even reached out to Unitron, the manufacturer, to no avail.

The Serial number is 0914XOTE8



Battery Door

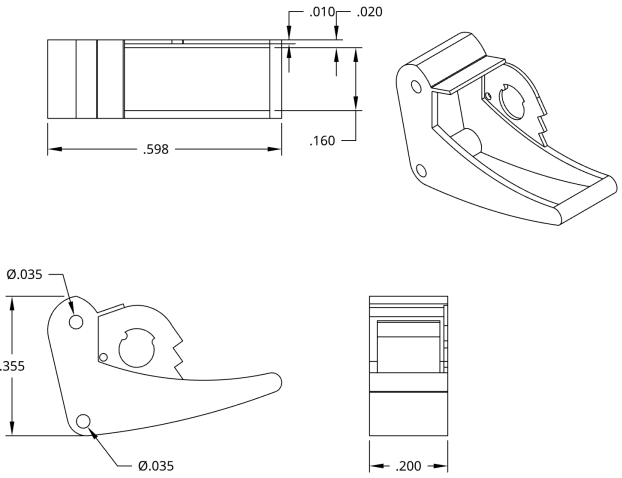
0.645” X 0.388” X 0.246”

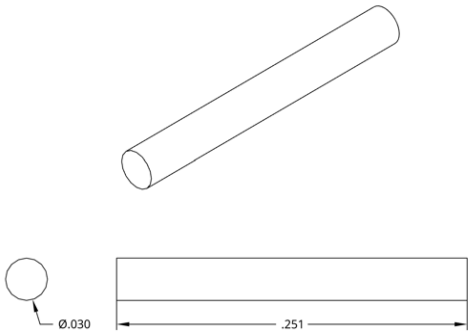
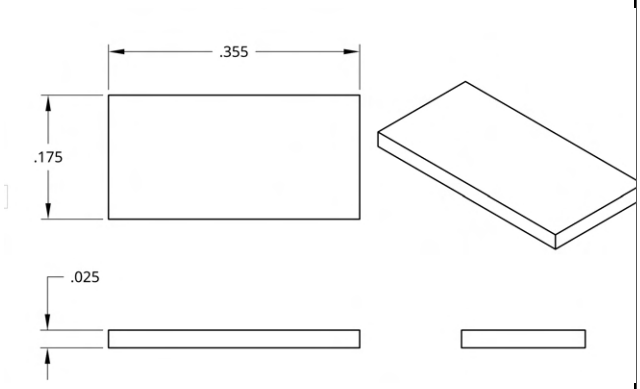
Material: hard plastic
potentially type-6 but no confirmation

Purpose:
Holds battery and compressed it when closed that powers the system.

Notable Aspects:

The top notches at the top plug into the battery plug which helps power the system.



Hinge Pins 0.236” X 0.027” diameter Material: metal Purpose: Hold battery door and white casing Notable Aspects: Tolerance in the hole and pin allows pieces to swivel while being held in tight by the casing.		
Bottom Silicone Holder 0.36” X 0.025” X.17” X 0.165” Material: Silicone Purpose: Protect Speaker and Pipe Plug. Notable Aspects: Held onto the white casing simply by tape.		

Silicone Circuit Holders

Right Microphone/processor

0.145” X 0.185” X 0.1”

Left Microphone/processor holder

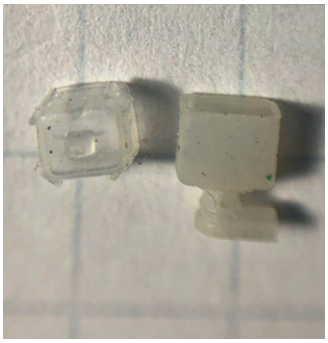
0.143” X 0.145” X 0.125”

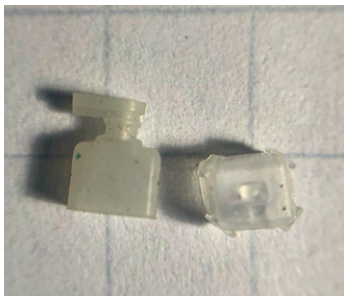
there was another part identical to the one on the right, but it has been misplaced, however, it is evident on the model

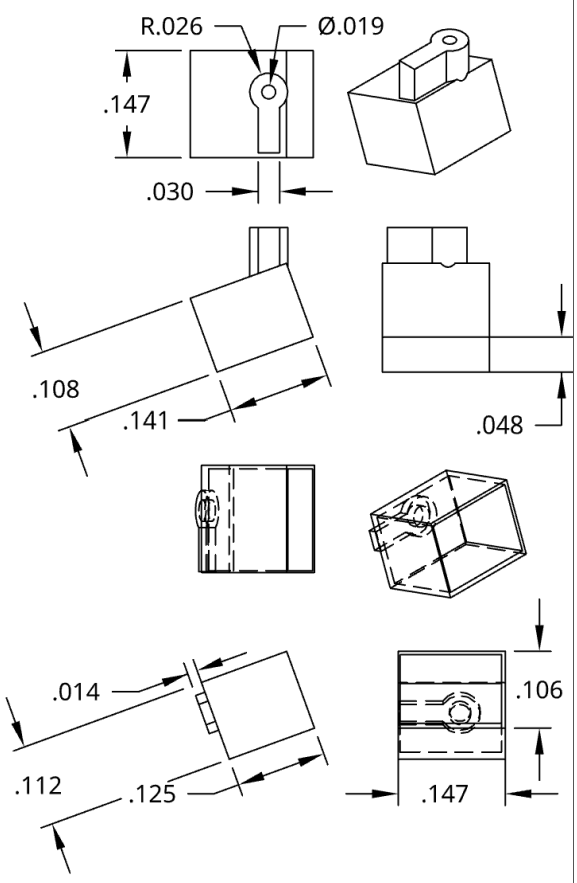
Material: Silicone

Purpose: Holds the microphone/amplifier in a raised position in the white casing

Notable Aspects:
Incredibly Fragile and susceptible to tearing.







5.3

5.3.1

Reverse Engineering Project Help/Inquiry

Jonathan Reid [redacted]
to mediarelations, mediarelations

Thu, Dec 22, 2022, 11:33 AM (13 days ago)

Hello, My name is Jonathan Reid and I am a Senior at Franklin Central High School in Indianapolis Indiana. More importantly, I am a head leader of the Vex Robotics team offered at my school. As a result of being in this program, members are eligible to participate in a variety of "challenges" for a chance to qualify for the International or Worlds event held in May of 2023.

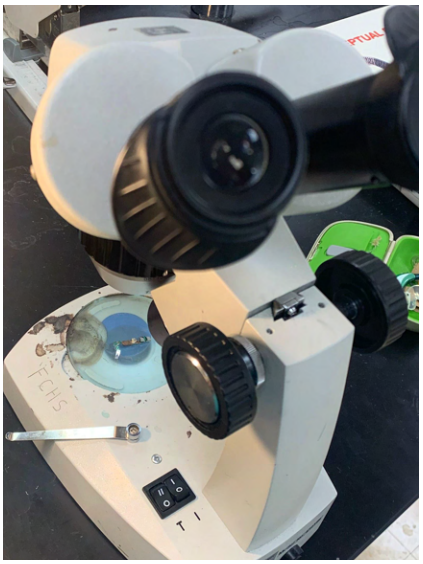
One of these challenges is the vrc-high-school-reverse-engineering-challenge, which asks you to reverse engineer an electronic device to discover how it works. Because of my lifelong hearing loss, I've chosen to reverse engineer my first pair of hearing aids, The Next Essential Moda II BTE as manufactured by Unitron.

However, despite my best attempts at researching the individual parts found, I simply couldn't find an answer to everything. The only electrical piece I was able to find online was This speaker unit used in the hearing aid.

The Current Draft Is Linked or Attached at the Bottom of This Message

If there is any way Unitron or Sonova as a whole could help me in identifying these parts I would be forever thankful, but I understand if it's not feasible because of various Patents or Legal Limitations.

If there's something, **anything**, that can be done to help, please reply to this email as soon as possible.



We tried directly reaching out to Unitron and using a microscope to find part numbers or identifiers for parts of the hearing aid. Both attempts yielded little success due to either company trademarks or the fact that these circuits are custom made for this discontinued brand of hearing aid.

5.3.2

Location of major electrical components of Moda II hearing Aid

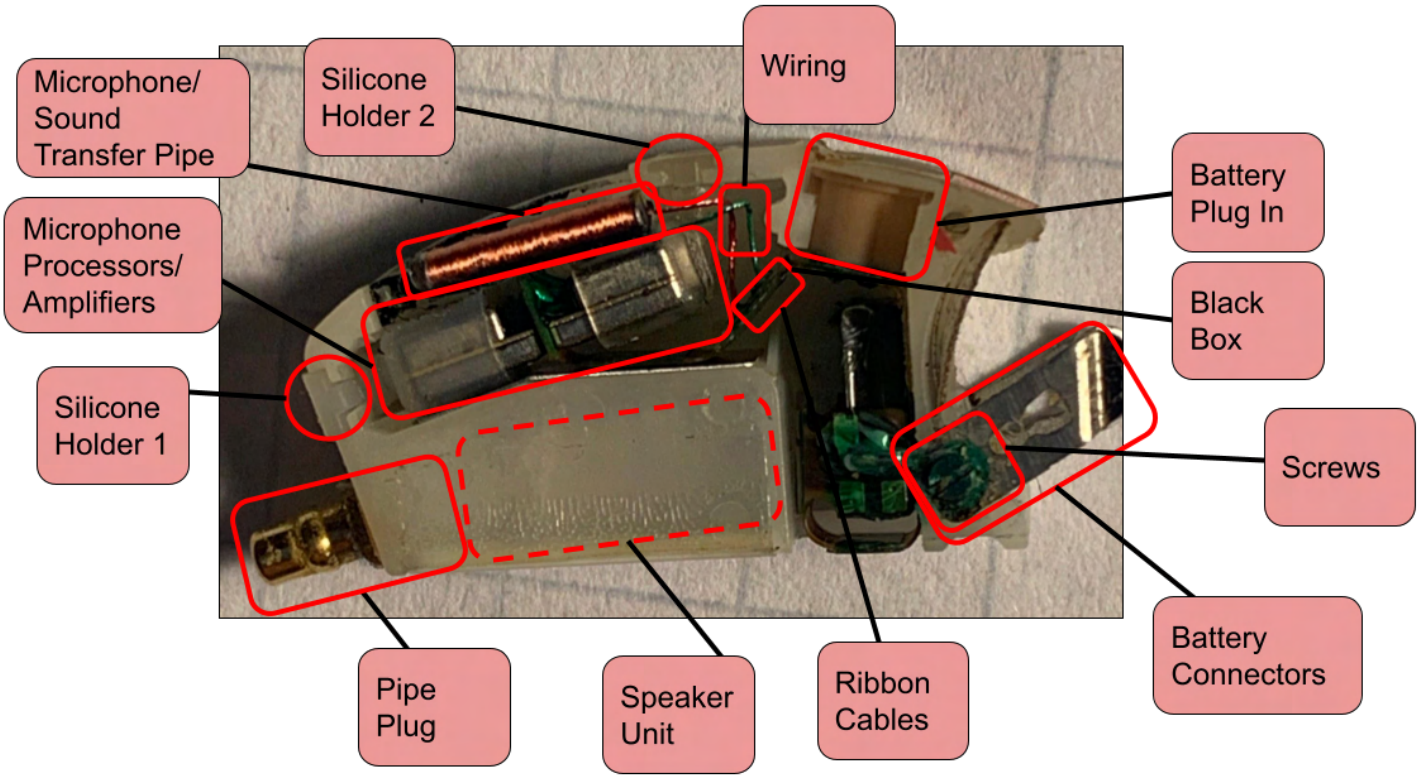
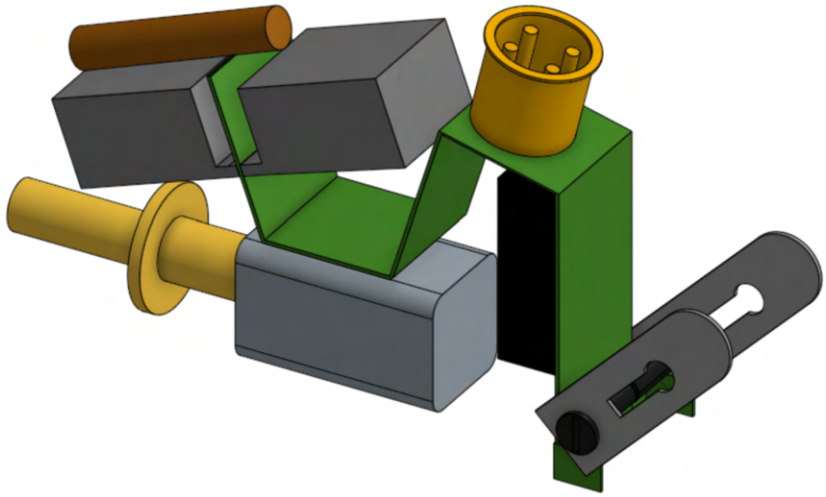
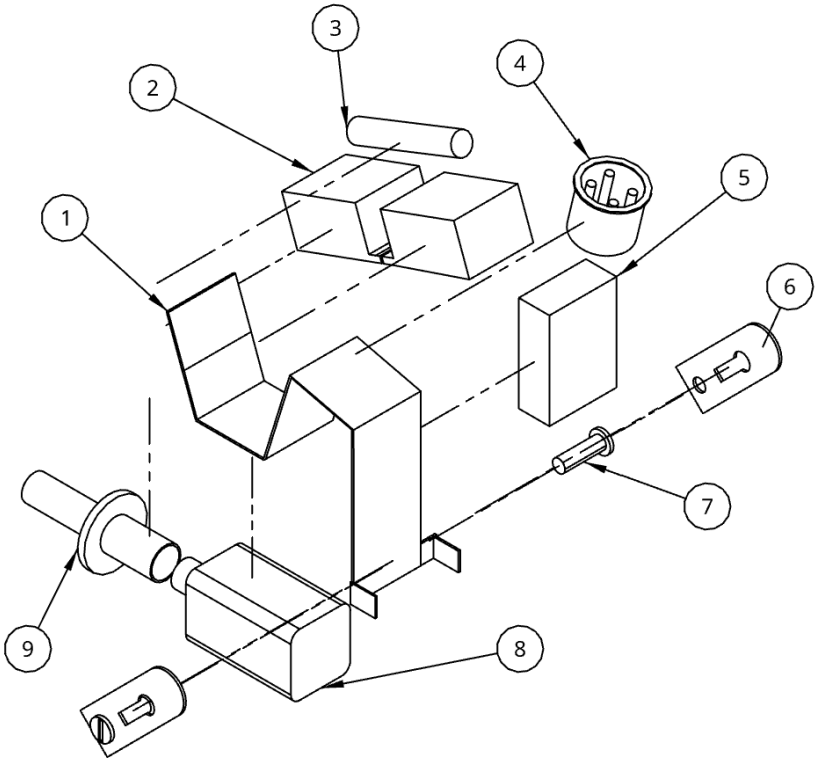


Figure 5.3.2: The locations of all visible components within the Hearing Aid Casing to get a sense a relativity and how each piece works off the others

5.3.3

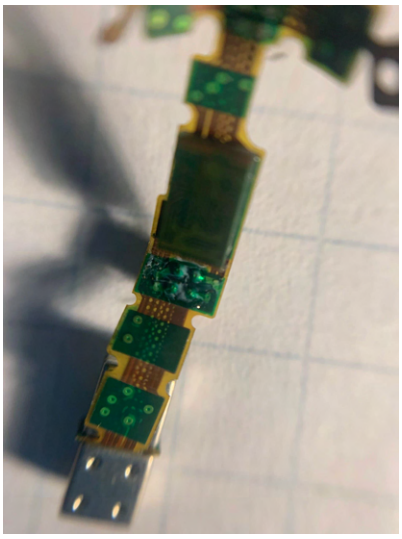
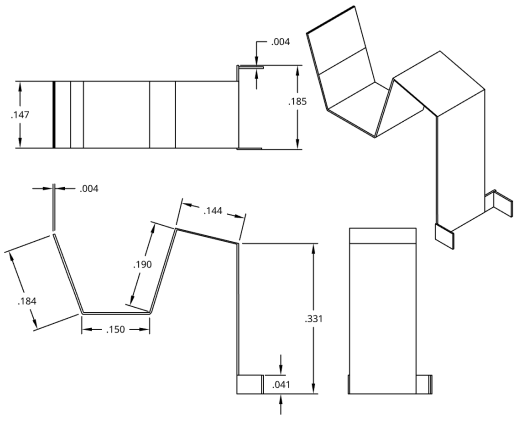
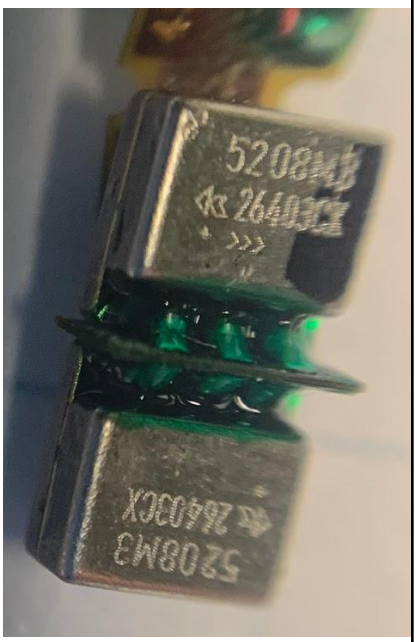
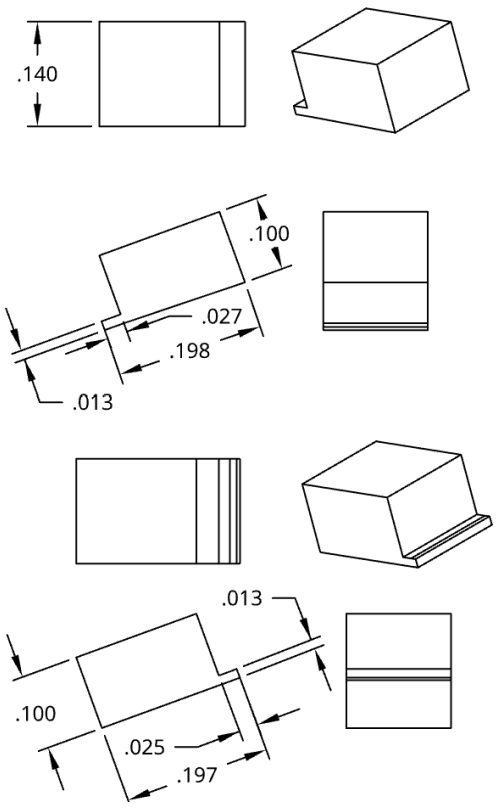


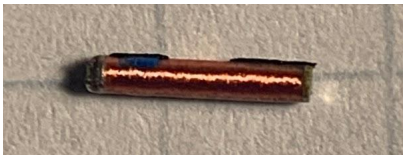
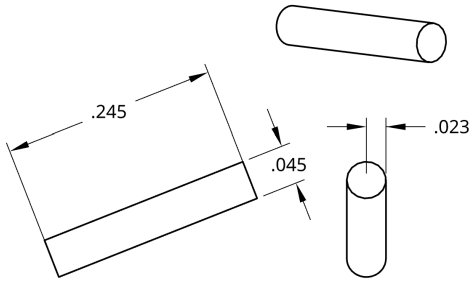
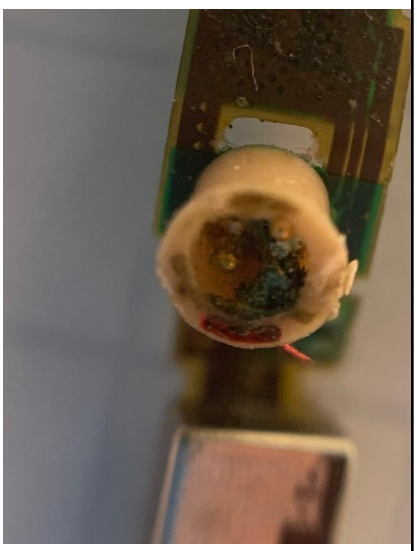
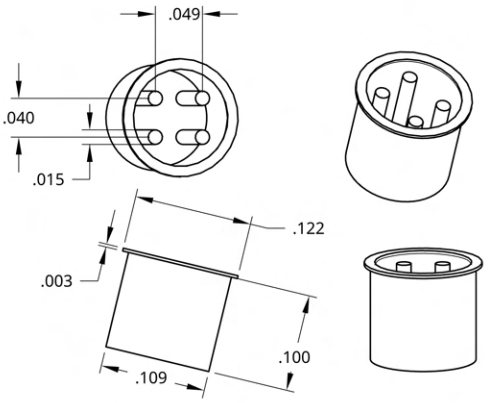
Snippet of our electrical section of our CAD recreation of the electrical components found HERE



Number	Part
1	Ribbon Cables
2	Amplifiers
3	Sound Transfer Pipe
4	Battery Plug-In
5	Microprocessor
6	Battery Holder
7	Screw
8	Speaker
9	Pipe Plug
(not pictured)	Wiring

Figure 5.3.2.1 and Figure 5.3.2.2: Like Before with the electrical casing, here is our rendered recreation of the electrical components as well as the Exploded view and Bill of Materials. VIEW IT HERE.

Part Description	Image	Recreated Model of Part
Ribbon Cables 0.005” X 0.136” Length is unable to accurately determine because of odd shaping. Approximated length is about 0.84 when attempted to lay flat Material: Ribbon Cables and what They are made of Purpose: Transfers power from battery system to amplifier system Notable Aspects: Appears to have three copper strands per cable		
Sound Processors/Amplifiers 0.288” X 0.089” X 0.157” Material: Metallic Purpose: Takes power and likely transfers and amplifies the pitches that the user cannot hear Notable Aspects: We found two inscriptions on the amplifiers, but everywhere we have looked has led to a dead end even after months of research. The inscriptions read 5208MB and 26403CX respectively. Amplifier Explanation 1 Amplifier Explanation 2 Here are some examples of amplifiers we could find online: 1 2		

Microphone/ Sound Transfer Pipe 0.245” X 0.045” diameter Material: Metallic (we want to say copper because of its color and texture, but cannot confirm) Purpose: Transfer base pitches back into the system that doesn’t need processing from the amplifiers. The wires were attached by some bonding material, as marks are left where they were	 	
Battery Plug In 0.109” X 0.110” Material: plastic casing with metal prongs. Purpose: Receive power from battery door. Notable Aspects: We originally thought this to be the microphone, but after further inspection with the completed right hearing aid, it clearly connects to the battery door and adds power to the system.		

Microprocessor

0.210” X 0.070” X 0.151”

Material:

What a microprocessor is made out of

Purpose:

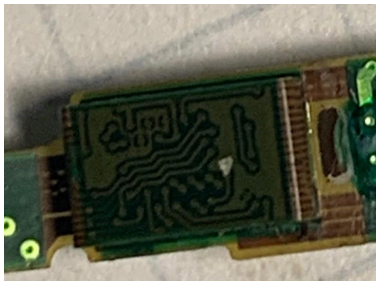
Performs logic (I.E. what pitches are heard and which ones need to be adjusted)

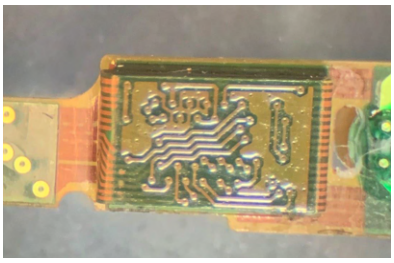
Notable Aspects:

Further Information about microprocessors

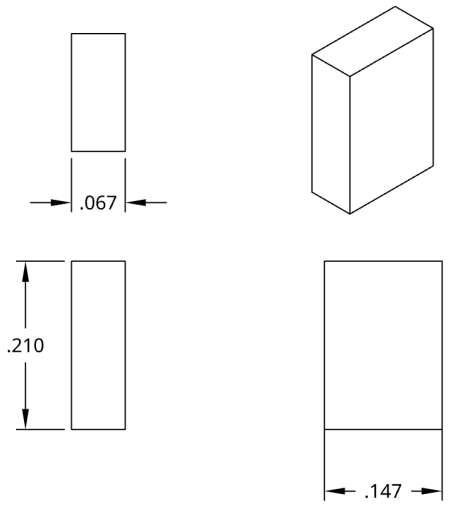
Various Texas Instrument Amplifiers Microprocessors

Shopping link for Microprocessors





This image was taken through a microscope for a better look at the circuitry that is too small to dissect.



Battery Connectors (Metal Plate)

0.241” X 0.088” X 0.005”

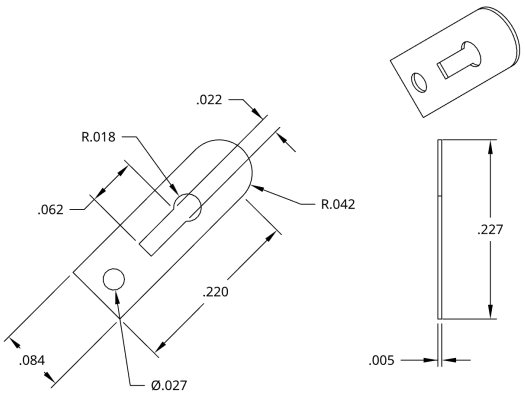
Material:
Metal
Aluminum, Iron, or steel perhaps because of the conductive properties

Purpose:

Hold battery and help direct charge

Notable Aspects:

Fragile because of rusting from age



Screws

0.092” Total Length
0.046” Screw Head Diameter
0.027” Thread Diameter

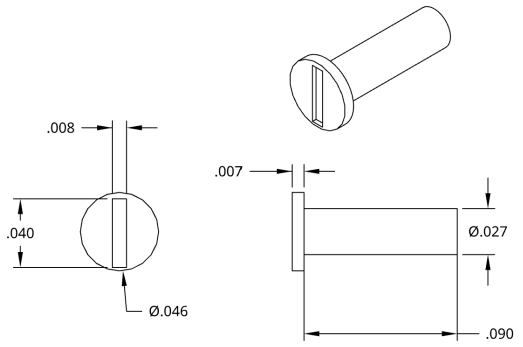
Material:
Metallic (Aluminum, Iron, or steel)

Purpose:

Hold Battery Connectors in tight

Notable Aspects:

Susceptible to Rust



Speaker Unit: Sonion Speaker
26J02/7

0.285” X 0.113” X 0.13”

Material(s): Metal and circuitry

Purpose:

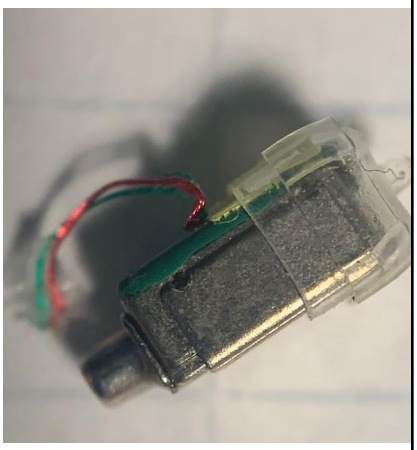
Amplify the volume of the sound and then send it to the “pipe plug”

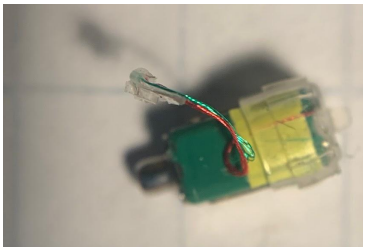
Notable Aspects:

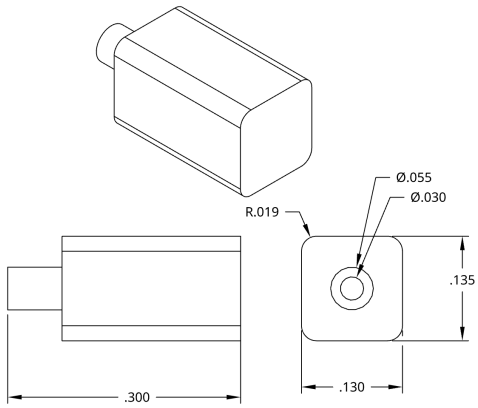
This part was independently bought by Unitron from Sonion for their product so we were able to find it online.

DATA SHEET:

https://www.sonion.com/wp-content/uploads/26J027-2003827.pdf?_gl=1*rvzh3d*_ga*MTA3MDQ1OTEzLjE2NzEzOTQ1MDM.*_up*MQ..







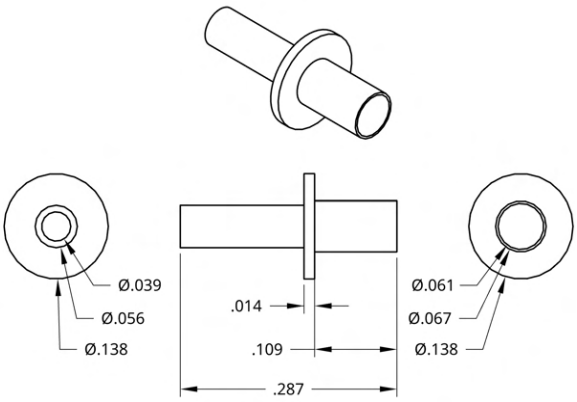
Pipe Plug

0.267” in Length
0.138” ring diameter
0.070” metal diameter
0.067” silicone diameter

Material: silicone and metal

Purpose:

Takes Speaker Noise and transfers it to Hear hook



Wiring

0.002” d

Can’t find the length of wire using dial caliper

Material: small refined copper or any other conductive metal

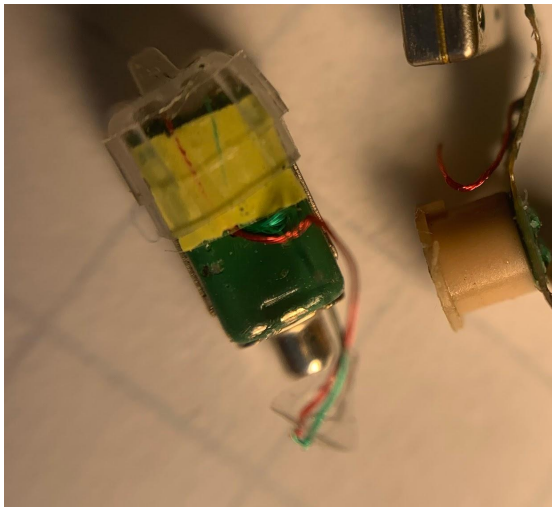
what wires are made out of

Purpose:

Transfer sound and electricity

Notable Aspects:

Labeled by a red wire and a green wire, but we can’t tell why there's a distinction. However, we believe it may be because one wire transfers the “base” sound pitches while the other transfers the “altered” pitches



Model Not Available because of sizing and flexibility issues with extrusions

6. Analysis

6.1

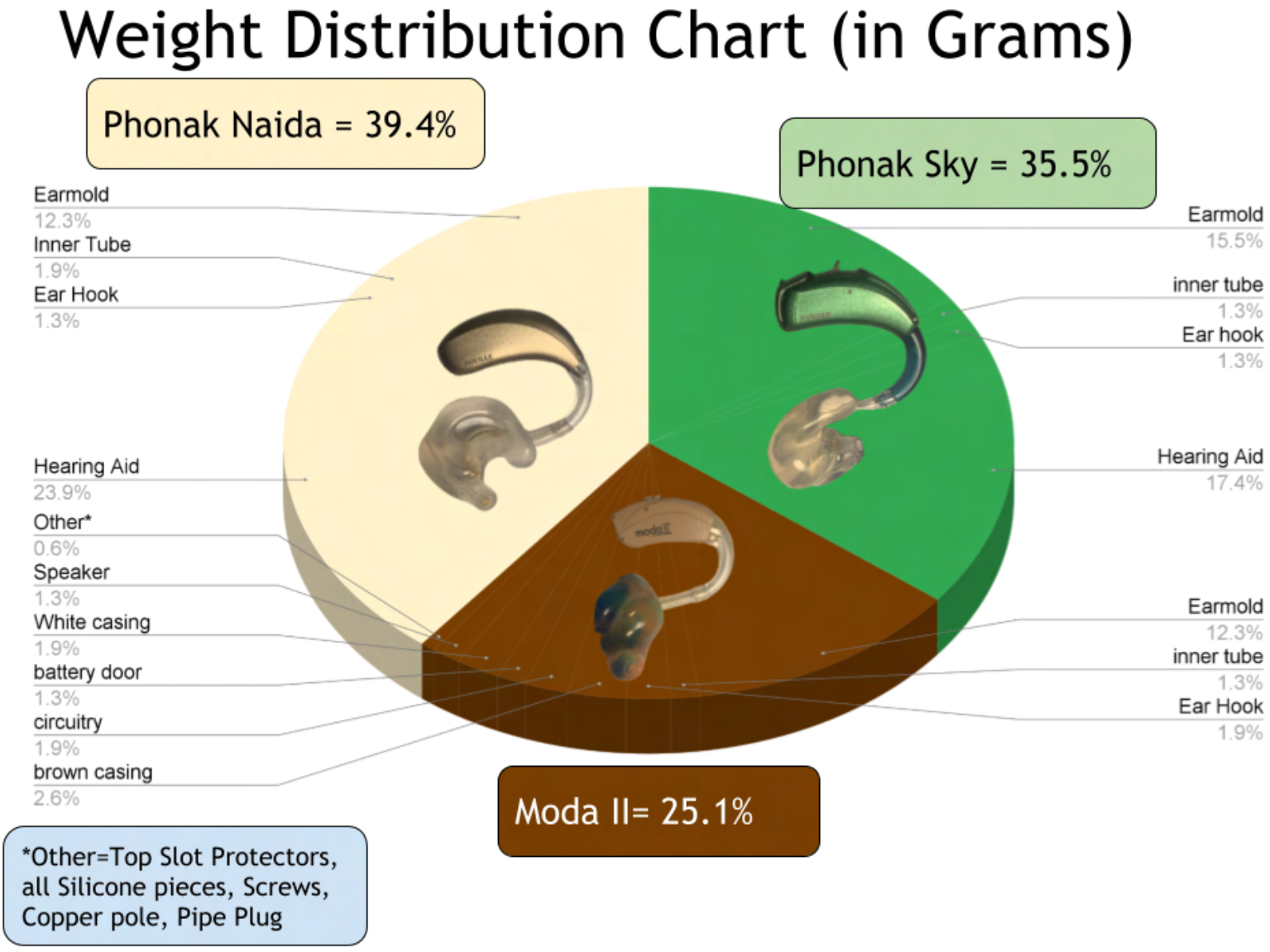


Figure 6.1.1: This a Pie chart showing the weight distributions of each hearing aid as a whole, marked by the color. However,we subsided each chart with all of the disassembled components we found. For example, the Earmold for the Phonak Naida hearing aid was about 12% of the total mass of all of the hearing aids, but only about a 4th of the weight of the Phonak Naida itself.

6.2

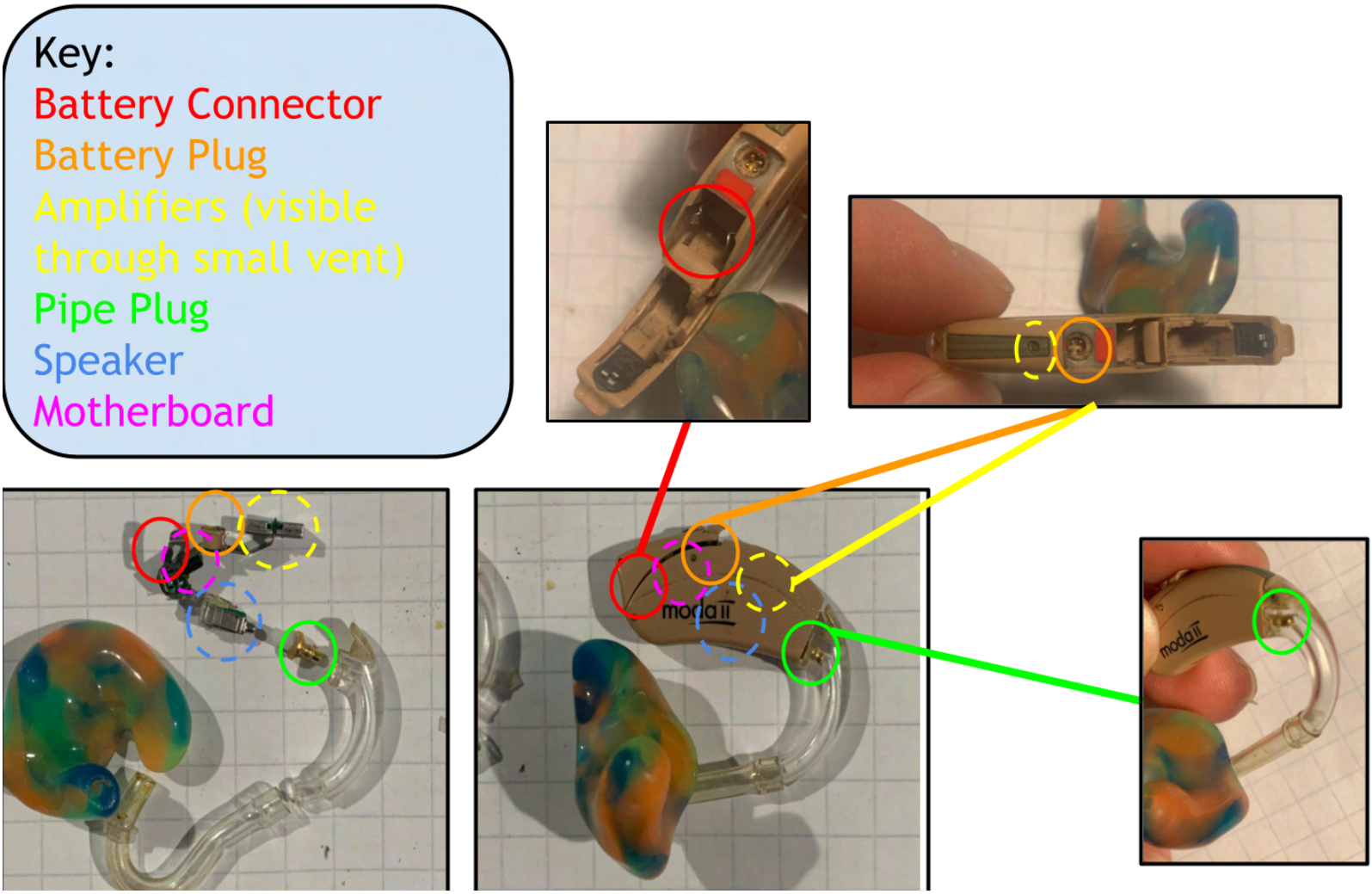
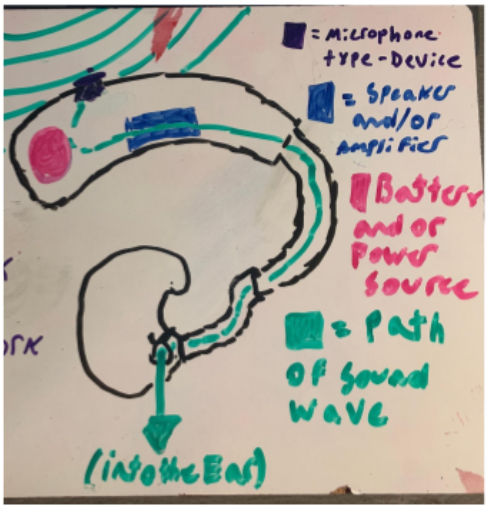


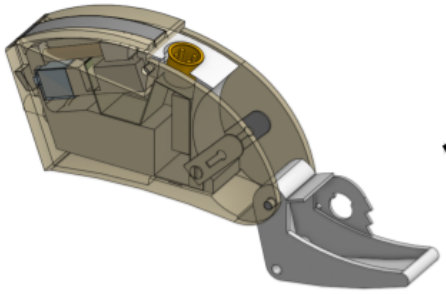
Figure 6.3.1: This is a diagram showing how one can find the electrical pieces we found in our disassembly in an assembled version of the hearing aid. You can clearly see the battery connector, battery plug, and pipe plugs without touching anything. We can also see/infer the location of other pieces, such as the amplifiers, through vent holes protected by the top slot protector

6.3

Hypothesis: If sound is around the hearing aid, then the hearing aid will amplify the sound because of the microphone and speaker within it.

Actual: If sound waves are picked up by the microphone, then the hearing aid will process and amplify certain un-hearable pitches (as defined by the audiologist for the patient) and then send all sounds received out directly into the users ear because of the Tubing systems





What we got Right	What we Got Wrong
There is Indeed a Microphone, but just not where we thought it was	The device on top that we thought was a microphone is actually where the battery door connects to the system
The Speaker System is on the bottom of the hearing aid and does send sound through the earhook and tubing	Sound Pitches themselves are actually amplified because of the Processors in (in relation to to the hypothesis picture, the top right of the hearing Aid)
General Pathing of how Sound was Correct, albeit vastly oversimplified	The battery plays a much larger role than expected as shown through its multitude of attachments to the circuit
	The circuit itself is far more complicated than hypothesized

Brown Case is Translucent for detailing

Figure 6.4.1: Here is an analysis we created to contrast our hypothesis with our actual findings throughout this reverse engineering project.

6.4

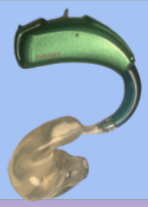
Category	Moda II	Phonak Sky	Phonak Naida
Picture			
Overall Sizing (inches)	2”X 1 ¼” X 1 ⅛”	1 ½” X 2” X ¾ “	2 ⅛ “ X 2” X ⅞”
Weight (in Grams)	4.2	5.4	5.9
Power Sources			
Average lifespan (before replacing and or recharging)	3- 10 days	6- 14 days.	24 hours of continuous use in a single charge
Battery?			
312			
P 13			
Rechargeable?			
Charge Time	Instant	Instant	
Non Computing Parts			
Earmold			
Skeleton Structure?			
Clear?			
Ear Hook			
Threaded Attachment To hearing Aid?			
The *Actual* Hearing Aids Themselves			
Volume Switch?			
Bluetooth connectivity?			
Water Proofing?			

Figure 6.4.1: This is our visual representation of the comparisons we could make between all of the hearing aids Jonathan has owned. The purple cells are ones with variable data for each hearing aid. The blue cells are used as titles and for signifying a hearing aid doesn't have a function, where as the green cells signify that they do.

6.5

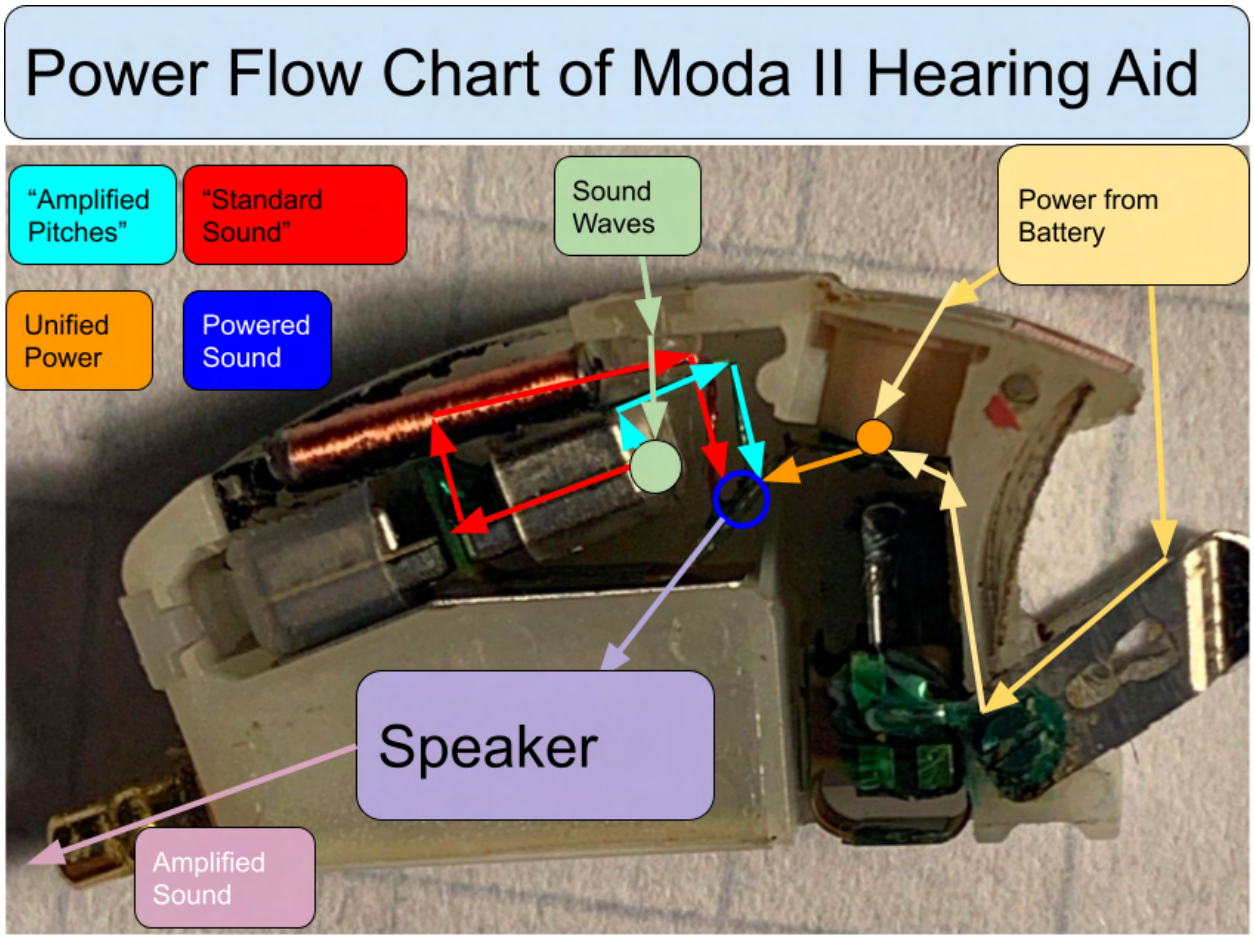


Figure 6.5.1: This is how we believe this hearing aid works with the newfound knowledge of all the components inside of it.

6.6

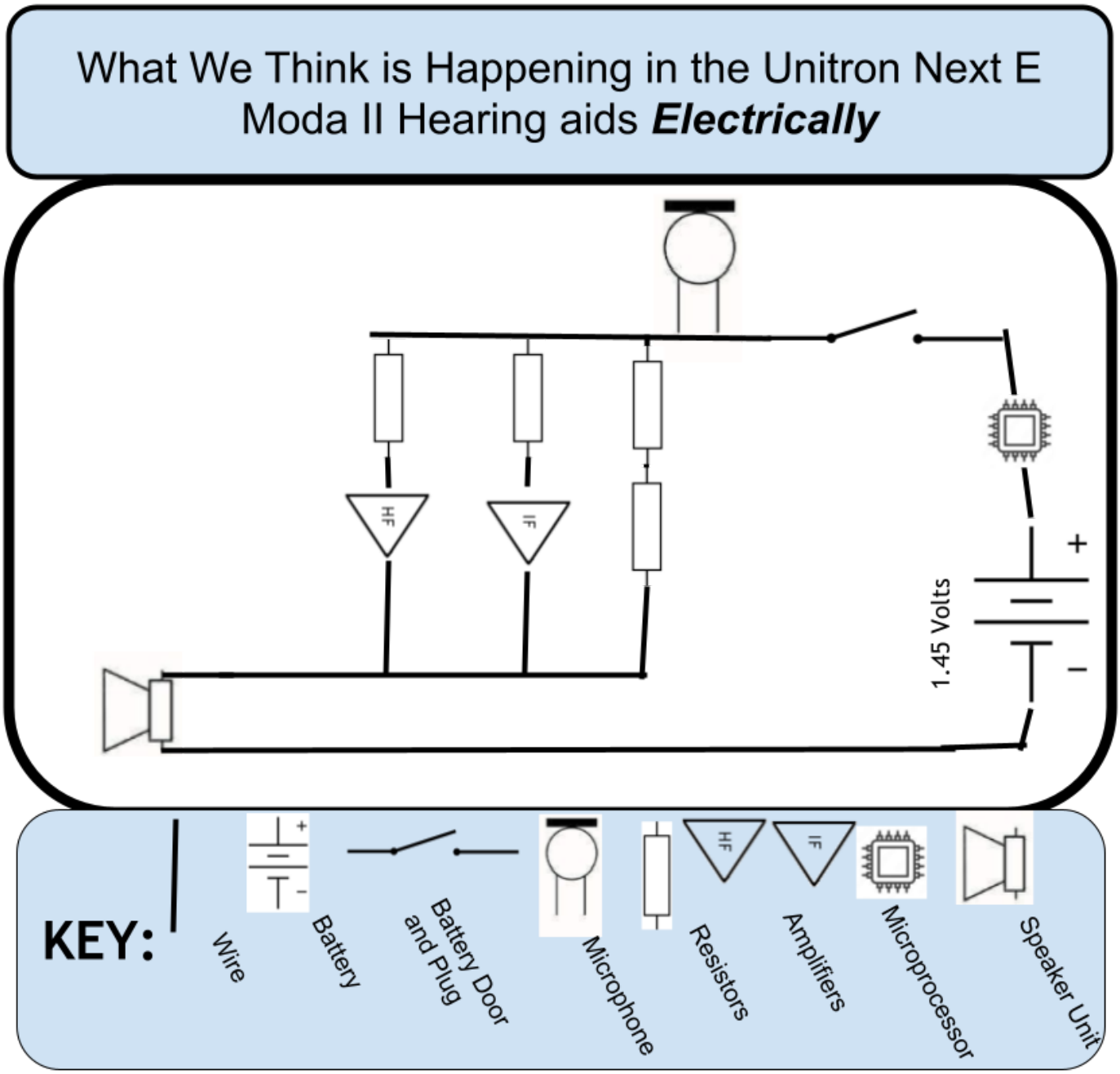
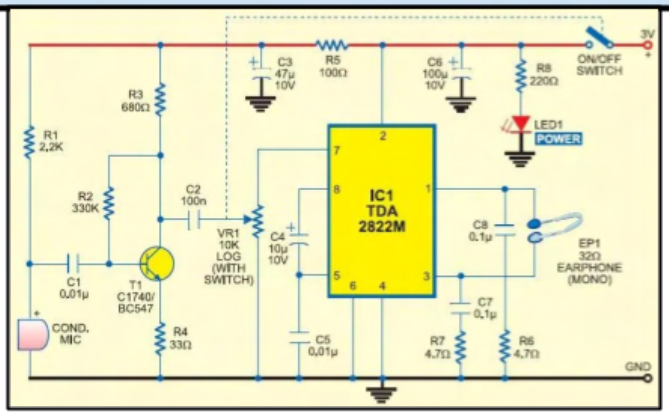


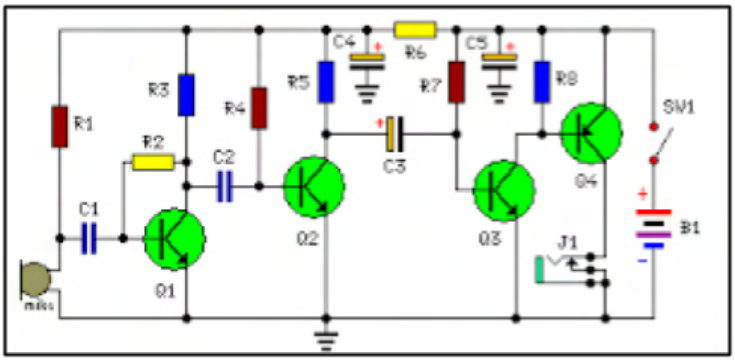
Figure 6.6: this is what we believe a vastly simplified version of the hearing aid would look like on an electrical schematic based on all of our research. The battery would feed directly into the microprocessor, battery plug, and microphone, then split off into various parallel circuits for each of the amplifying tracks. After this, all the connected sound would pass out of the speaker and the remaining electrical signals would go back into the battery, completing the circuit.

6.6.1

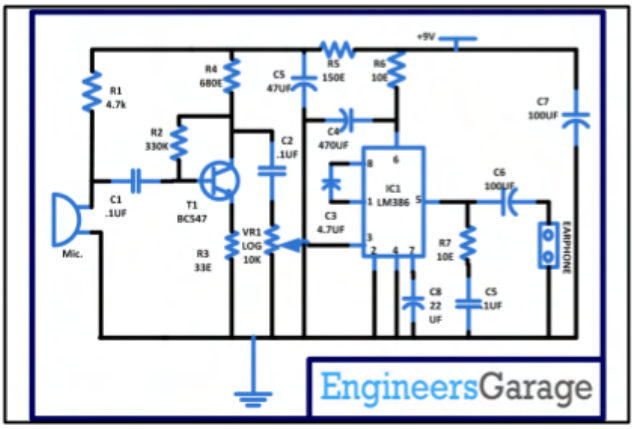
Why We Believe This is What the Circuitry looks like



Hearing Aid Schematic with 2X 1.5 volt batteries



An “inexpensive hearing aid circuit that uses just four transistors and a few passive components.”



Hearing Aid using audio amplifier LM386

Hearing aid recreated on a breadboard by NotionSaturday

Fig 6.6.1: This is the culmination of the research we used as both an inspiration and way to check our work for our own custom hearing aid circuit schematic. Many of these are made to be vastly simplified versions of hearing aids, but some, such as the prototype made on the bottom right by [NotionSunday] shows just how simple a hearing aid could be boiled down too using a breadboard and basic electronic materials.

7. Reassembly Attempt

7.1 Electrical—-> Electrical Casing

Video 7.1: This is our attempt at reassembling the electrical aspects of the hearing aid into the white casing unit. We were largely successful however because of damage from the disassembly, age, or even just tape or glue, it was very hard and potentially dangerous to shove the electricals back into the brown casing…

7.2 Electrical Casing ---> Complete Hearing Aid

Video 7.2: … so we created a second video with the other identical hearing aid to show how that process would ideally work as the electronics were not tampered with on that side.

8. Conclusion

Through this project, we've learned how to safely disassemble, analyze, compare, and reassemble tiny electronic devices. On top of that, we've uncovered a bit of biology and history by analyzing how hearing aids as a whole have evolved over time. We also deepened our understanding of concepts such as CAD and the Engineering design process as a whole by trying to understand how these hearing aids were designed by Unitron. Most Importantly, we learned how technology provides invaluable support for those put into a natural disadvantage, helping them to live their lives to the fullest.

Figure 8.1: All the colors offered for Jonathan's newest hearing aids, the Phonak Naida Paradise

What we've learned:

- Even seemingly simple machines are very intricate
- Small products are often the most compact
- It's crucial to document all steps of a disassembly to track pieces and have an easier reassembly process
- Dial Calipers, while precise, do not measure curvatures nor complex shapes accurately
- Hearing Aids have been innovated upon for centuries
- What A Cochlea is and how it works
- Companies can be stingy with their product to protect trademarks
- How to write and read circuit schematics

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