INFO 6940 - Niti Parikh - Cornell Tech 2020

Crafts @ Large

Challenge 4

Part 1:

Instructional document to build a prototype of our proposed solution

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Instructional document to build a prototype of our proposed solution

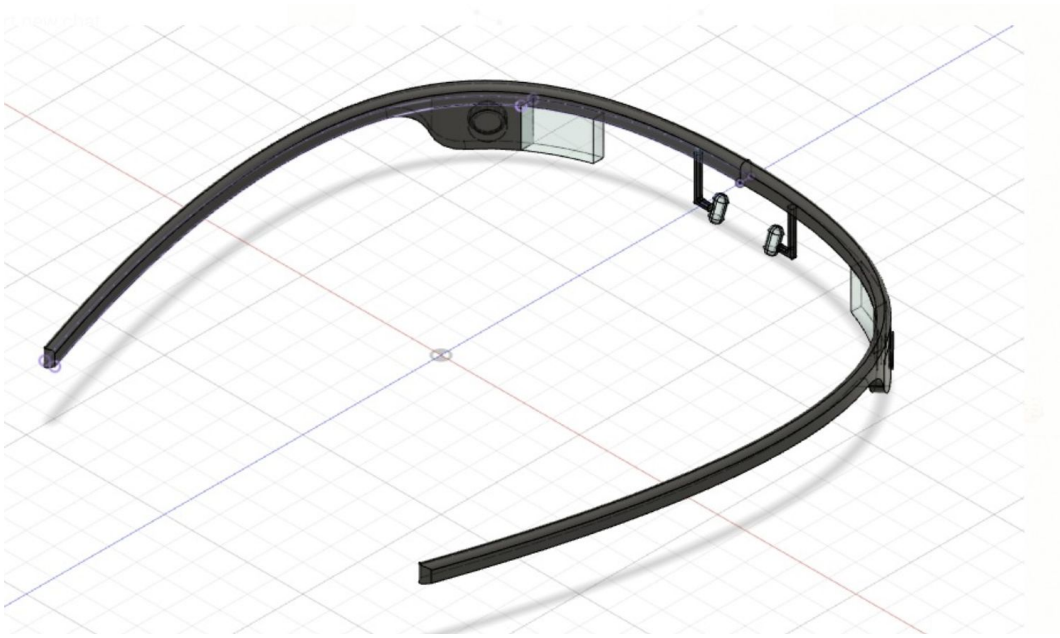
Step by step

There are a lot of tutorials about making smart glasses at home. Basically, we can follow this video How To Make Smart Glasses DIY at Home for the displaying part. Materials we need:

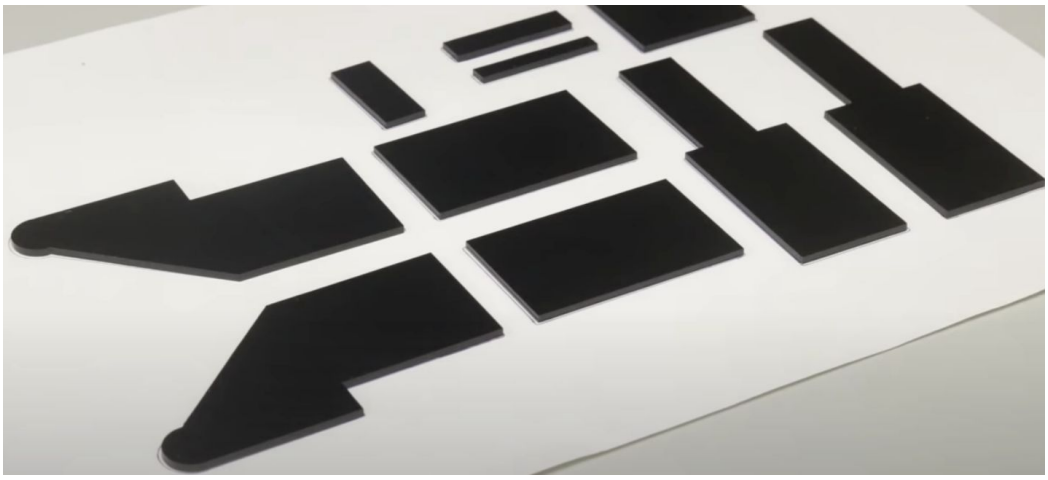
- 3d printing headset
- .95 inch OLED display
- HC -05 Bluetooth module
- arduino nano
- Mirror glass
- 100 mm focal lens
- Software : Arduino
- Speaker
- Bone-conduction sensor

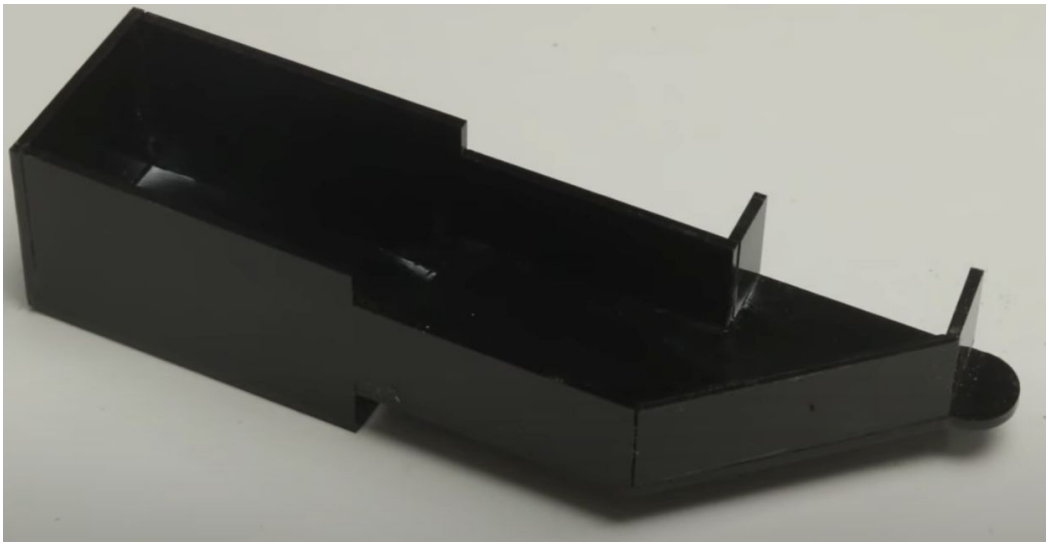
Instruction as following:

1. Build 3D headset model and print it

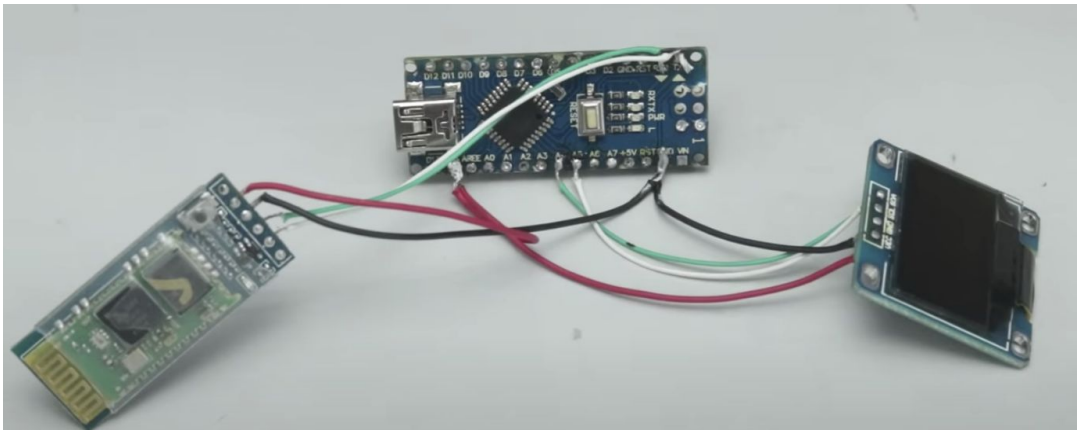


2. 3D print the sensor frame model

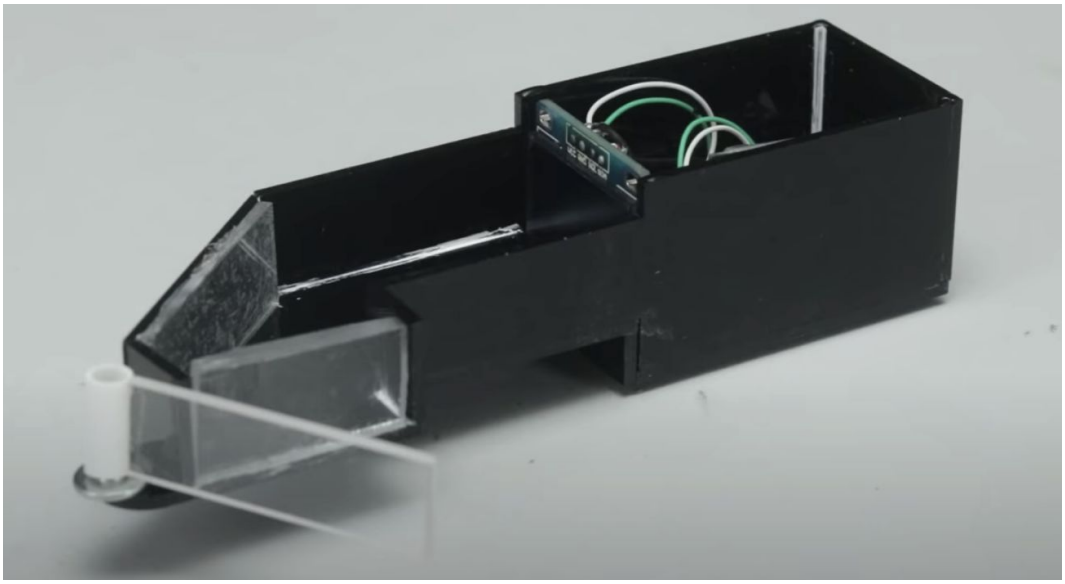




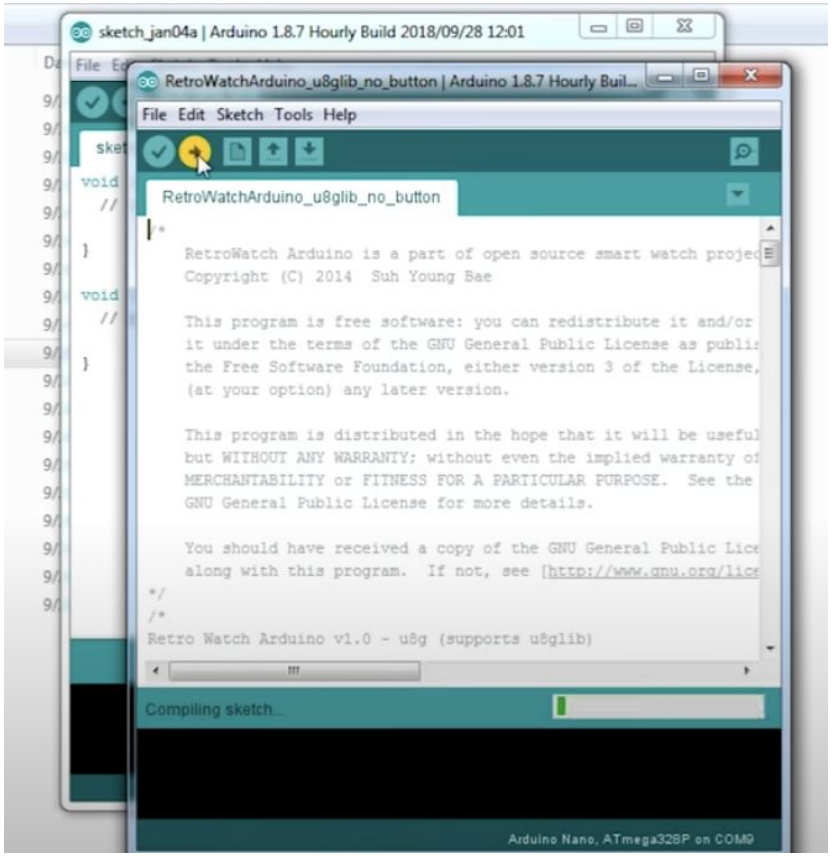
3. Connect the display module, bluetooth, speaker module and arduino nano



4. Connect the bone-conduction sensor and arduino nano
5. Set the modules in the frame
6. Stick the mirror glass and focal lens to reflect information into the wearer's field of view.



7. Use Arduino to program including using speech recognition API to process sound collected from sensors, displaying through lens and playing sound through speaker



8. Stick the frame to the leg of the headset

9. Done!!!

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Part 2:

Notes, sketches, our thinking process, and 3D models

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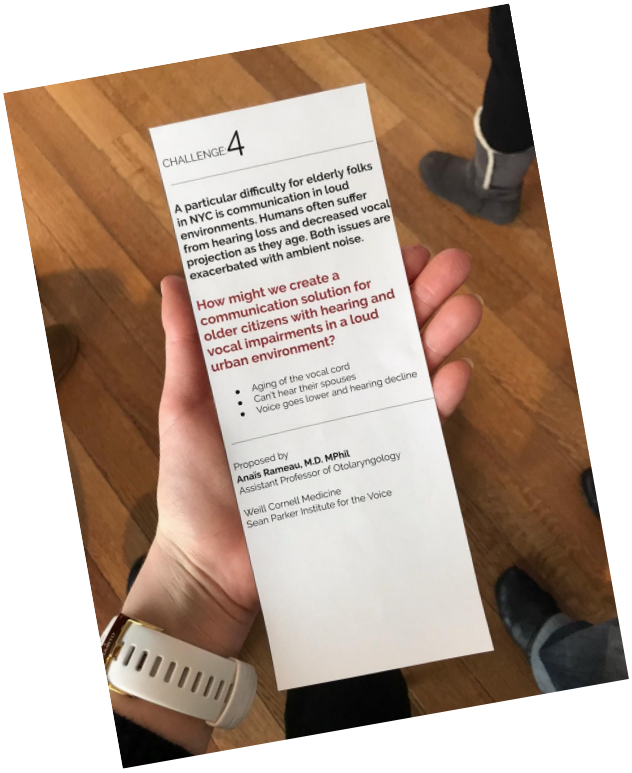
Final presentation Slides Link

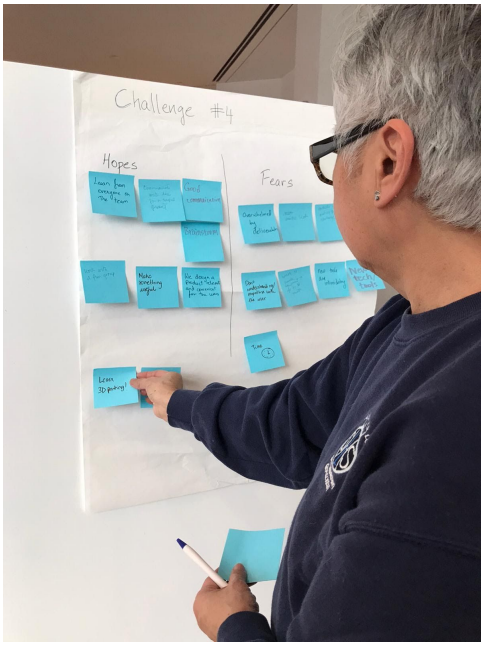
https://docs.google.com/presentation/d/1wbUyKHI564EzVGfq388mzCIfU5xQ71ndqNw7YJN2hu0/edit?usp=sharing

1. Our Challenge

A particular difficulty for elderly folks in NYC is communication in loud environments. Humans often suffer from hearing loss and decreased vocal projection as they age. Both issues are exacerbated with ambient noise.

HOW MIGHT WE create a communication solution for older citizens with hearing and vocal impairments in a loud urban environment?





2. User Interviews

2.1. Key Insights from UI

1. **[AWKWARD]**
   Participants are uncomfortable wearing hearing aid. The use of the device should be in a natural and easy way. Not making people feel awkward.

2. **[PUBLIC SPACES - FREE MOUTH]**
   A device that does not obstruct the path to the mouth. Eating, communicating should be easy!

3. **[+ SOCIAL INTERACTION]**
   Interviewees are eager to have a device that can enhance their social abilities in communicating and hearing in crowded spaces, between family members from one room to another.

2.2. User Interview Notes

Participate 1: Gloria Narduzzo (76 years old)

- The first time she realized that she has hearing difficulty is when she cannot hear her son in the kitchen while she is in the living room
- She cannot hear clearly when a lot pf people are talking at the same time
- Her voice is too low. She tried to speak higher to make her clear
- Especially as elderly people, she does not want to learn sign language
- At her age, she doesn't care whether people noticed that she is wearing a hearing-aid
- She mentioned her aunt has a device that can speak into it and write the words out. She thinks it helps a lot. :)

Participate 2: Viviane Codderrens (63 years old)

- She can talk to others but cannot hear others. If people repeat the whole sentence, it still keeps missing for her.
- She relies on gestures when she talks with others because of lack of sound
- She cannot hear when a lot pf people are talking at the same time
- Sudden sound can hurt her
- Cannot locate the sound
- She thinks it could be awkward if we design devices on the wrist
- Though she try to listen to others, she may lose focus since she cannot understand
- It could be cool for her phone to write voice messages out
- For hearing aid, she hates something in the ear and thinks it could be too close to the brain and make her more deaf

Participate 3: Nancy Brown (78 years old)

- Nancy just has speak difficulty, no hearing loss
- She has tube in the mouth for breathing
- She has a device that can write out what she said. However, the device cannot write it correctly and make her repeat two to three times.
- She found when she talked with people with hearing loss, they cannot understand her, but they can understand others. She guesses people of hearing loss understand others with the hint of connection of lips.

Talk with Dr. Rameau

Purpose: to come up with a device that will help elderly who are suffering from hearing loss and vocal projection.

- Interactions - One-to-one and one-to-many
- Help them in their social life - improve their social life - Quality to their social life

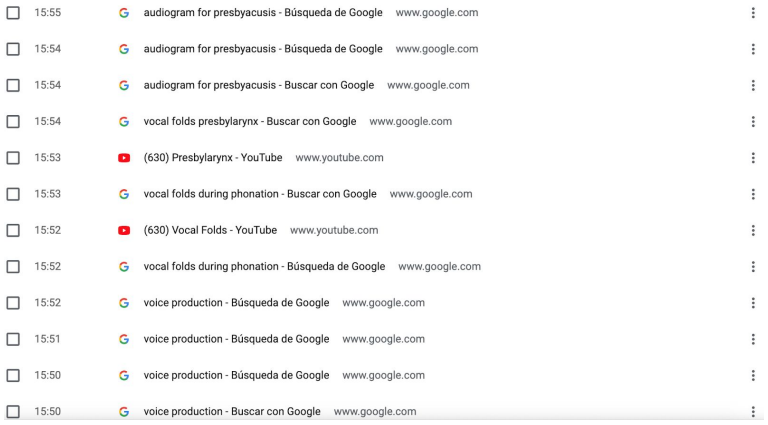
- The device is not intrusive - not medical looking. Aesthetically pleasing. Easy to wear. Ergonomic def of Universal Design

Notes from interview:

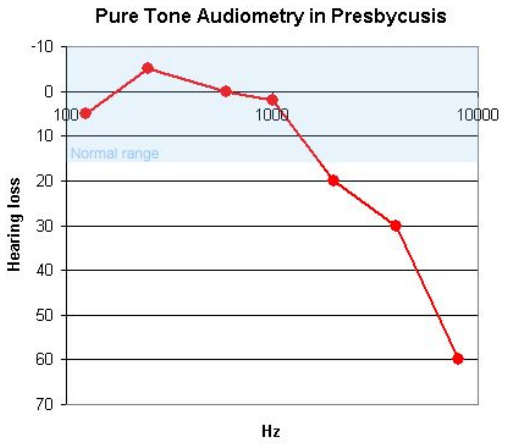
- Patient 1: Age: close to 80s. Underwent heart surgery. Before that she was autonomous, moved around through the subway. Because of prolonged incubation - scarring of vocal chords. Went from having a normal voice to having a hoarse voice. Has to come to the clinic with her son. But she's very social and this is a big change. Dinners with friends - friends have hearing aid, it's hard to go to restaurants. Hard to be heard, voice gets strained and tired, have to take a break from socialising by the end of the outing.
- Patient 2: Woman. Had a benign tumor, it presses onto vocal cords, vocal cords become weak. Hard to project voice. Husband doesn't have hearing aid yet - it's still stigmatized.
- Users would prefer more hidden - maybe behind the ear? Nothing obstructing my mouth (they need to eat with it), easy to take care of and clean. Preferably one device with dual purpose because older people would not want to look after two items
- Look into bone conduction. Further away from face. Or soft tissue. What about a pendant? Or earrings and pendant sets?
- Noise cancelling opposite. Filtering in the right frequencies.
- StartUp : Soundprint - gives you average decibels in restaurants. Recommendations.
- StartUp : EverSound - Cornell startup. Renting out headsets to nursing homes - Hearing device - user has full control of volume - but could that be bad for the user?
- StartUp: Eargo - inside canal hearing assistive device
- Clinic address: 240 E 59th St. corner of 2nd (Sean Parker Institute for voice).

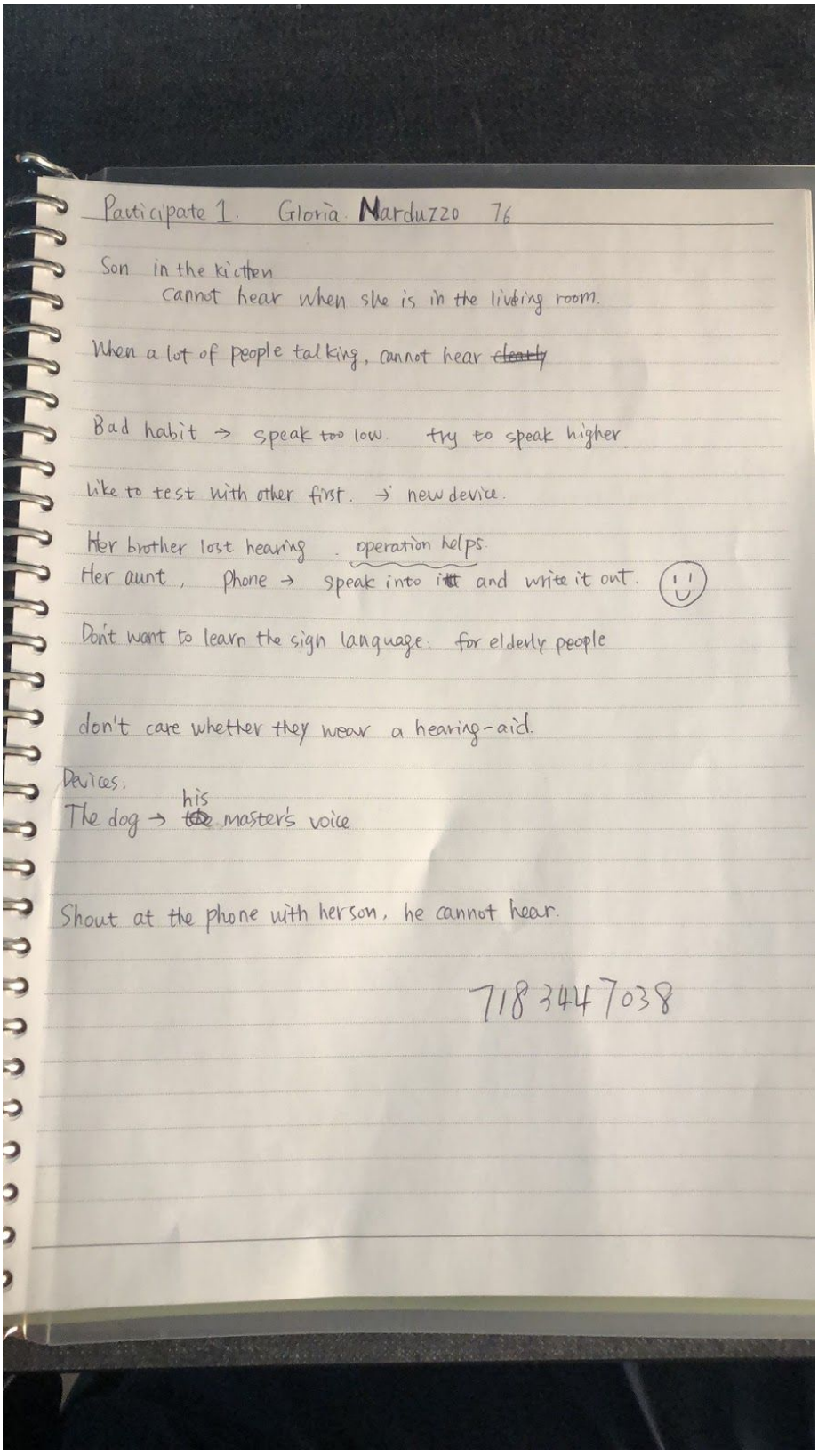
Process followed to condense notes into insights

We interviewed 5 people, and then formed a persona based on the general responses.
We noted down their hopes and frustrations. From these, we were able to build our insights.



Screenshot for us to remember concepts talked with Dr. Rameau


Pure Tone Audiometry in Presbycusis
-10
0
10
20
30
40
50
60
70
100
1000
10000
Normal range
Hearing loss
Hz



Participate 1. Gloria Marduzzo 76

Son in the kitchen
cannot hear when she is in the living room.

When a lot of people talking, cannot hear ~~clearly~~

Bad habit → speak ~~too~~ low. try to speak higher

like to test with other first. → new device.

Her brother lost hearing . operation helps.
Her aunt, phone → speak into ~~it~~ and write it out. ☺

Don't want to learn the sign language. for elderly people

don't care whether ~~they~~ wear a hearing-aid.

Devices.
The dog → ~~the~~ his master's voice

Shout at the phone with her son, he cannot hear.

718 344 7038

Participate 2. 63 Viviane Codderrens

She can talk to others. but cannot hear others.
repeat the whole sentence, ~~can~~ keep missing

Speak too loud.
lung operation

lack of sound → rely on gestures

When many people are talking at the same time, cannot hear.

~~Device~~:
sudden sound → hurt her

Cannot locate the sound

Devices on the wrist → akward

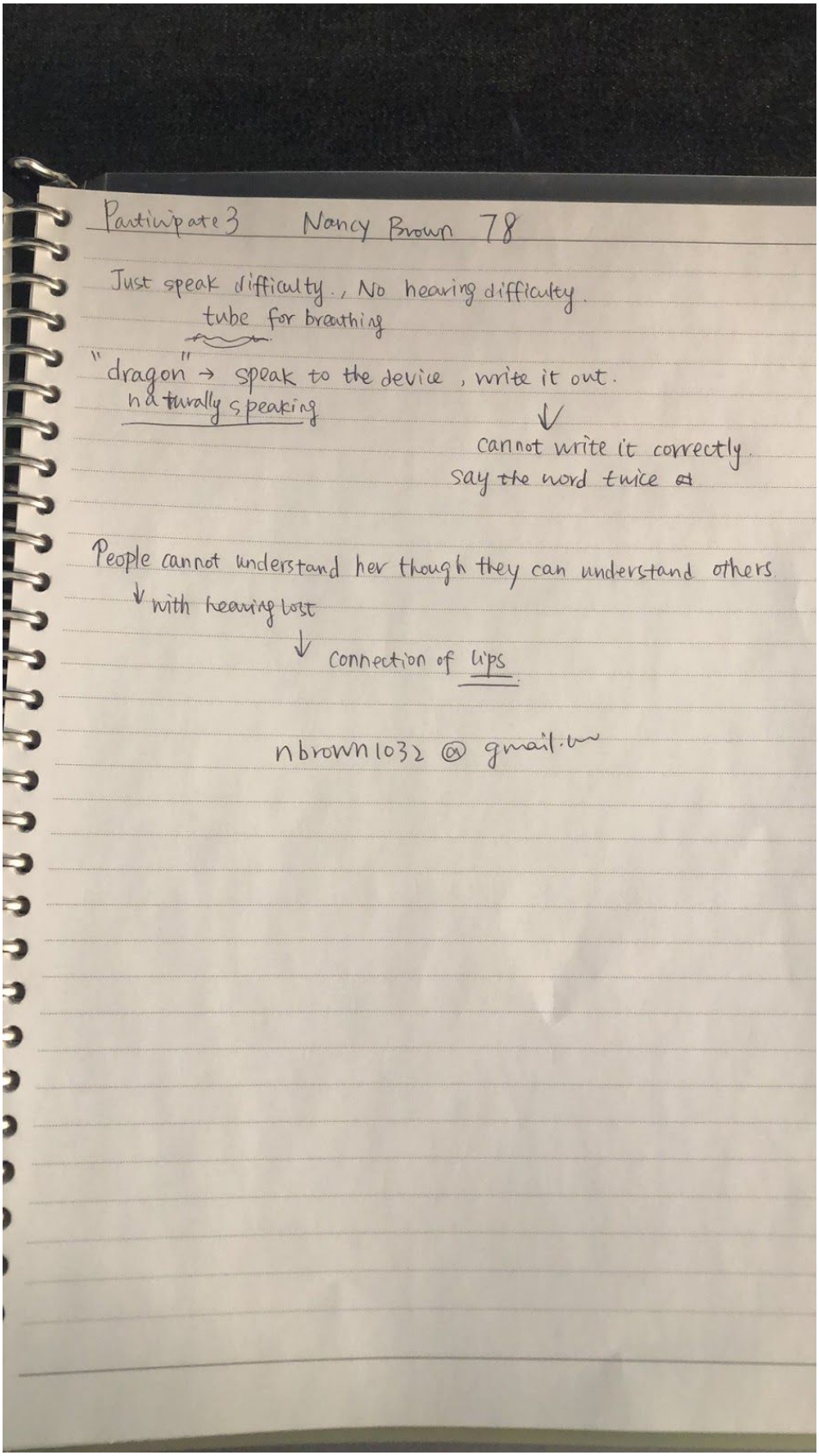
accent, prounoncation.

Lost focus since cannot understand. though try to listen

hate something in the ear.

Voice message → phone write it out 

vivisland044@gmail.com


Participate 3 Nancy Brown 78

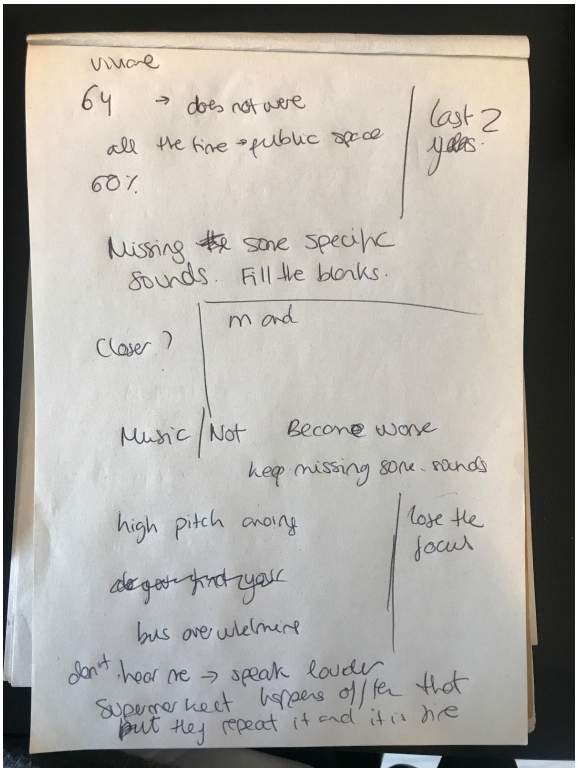
Just speak difficulty., No hearing difficulty.
tube for breathing

"dragon" → speak to the device, write it out.
naturally speaking
↓
cannot write it correctly.
say the word twice

People cannot understand her though they can understand others
↓ with hearing lost
↓ connection of lips

nbrown1032 @ gmail.com

Meeting notes summary:



Viviane 64 - she does not wear hearing aid. She started having hearing difficulties 2 years ago.

Vivianne Coderrenes, a long-time Roosevelt Island resident, age 64, recently experienced short of hearing from one room to another within her apartment, in social gatherings. (more on her background if needed).

She misses some specific sounds when people talk. So, in a sentence, if she has missed some sounds and she asks them to repeat the sentence, if they repeat it the same way she will miss the same sounds again. - she will send us a list of these specific sounds.

It is not a problem of being closer. She finds high pitch annoying. The bus is very overwhelming. If other people don't understand her she speaks louder - She is now used to speaking louder than usual. When trying to understand someone, she loses her focus when there is background noise.

3. Persona

User/ Group Name: Nancy

AGE/RANGE:: >65

WORK: Retirement

FAMILY: Live with her husband

LOCATION: New York

Personality

Independent	Strong will
Warm & Kind	Easy-going

Frustrations

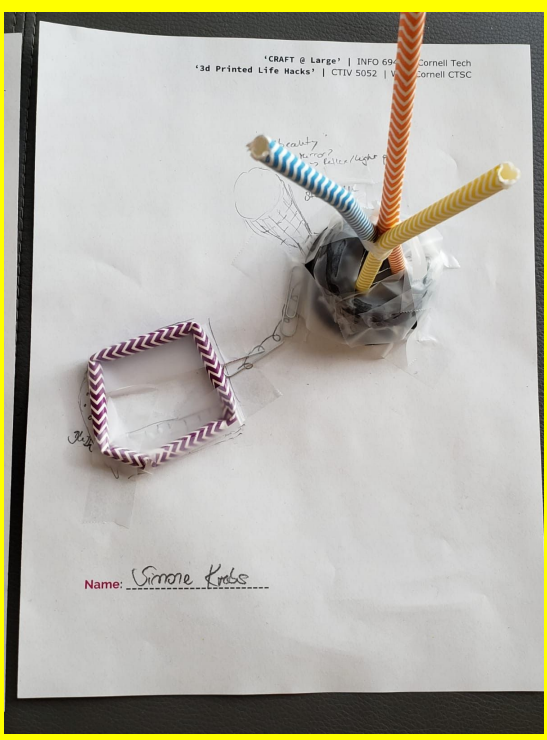
Nancy was a very good listener before, but she is frustrated that she cannot hear and understand others now.

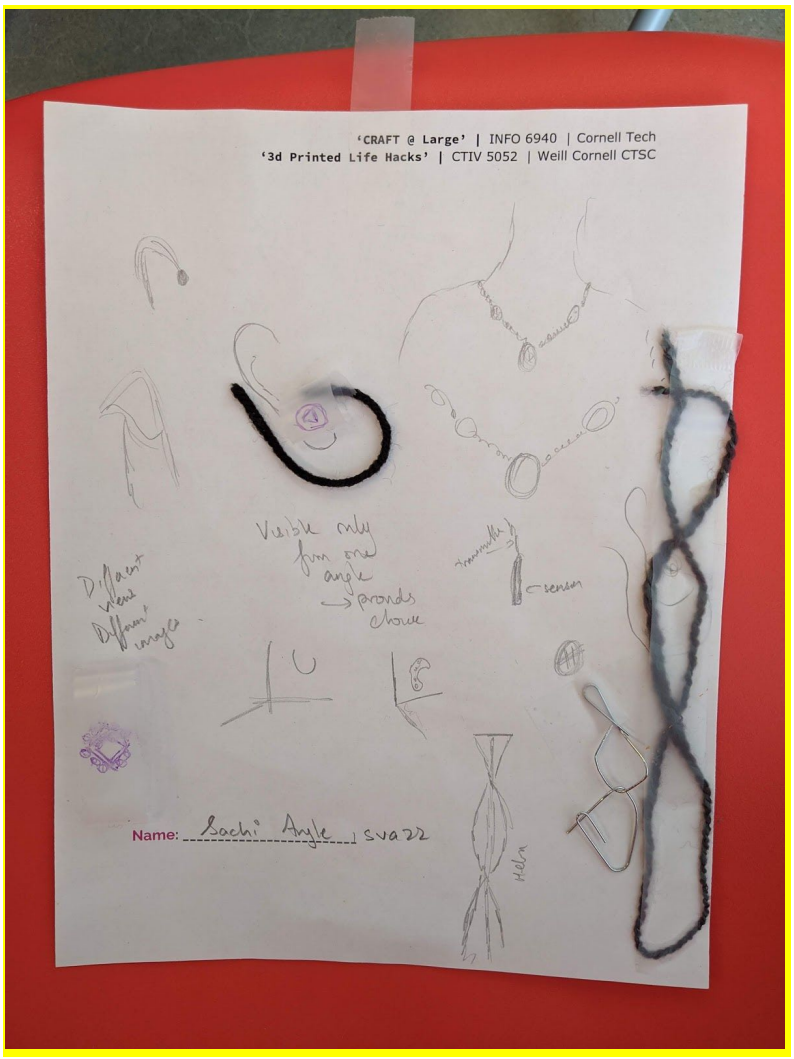
Immediate Goals

She hopes to join her community friends in a dancing class.

4. Inspiration from Artist Maholy Nagy

<https://www.youtube.com/watch?v=vBZj4Me3RK8>



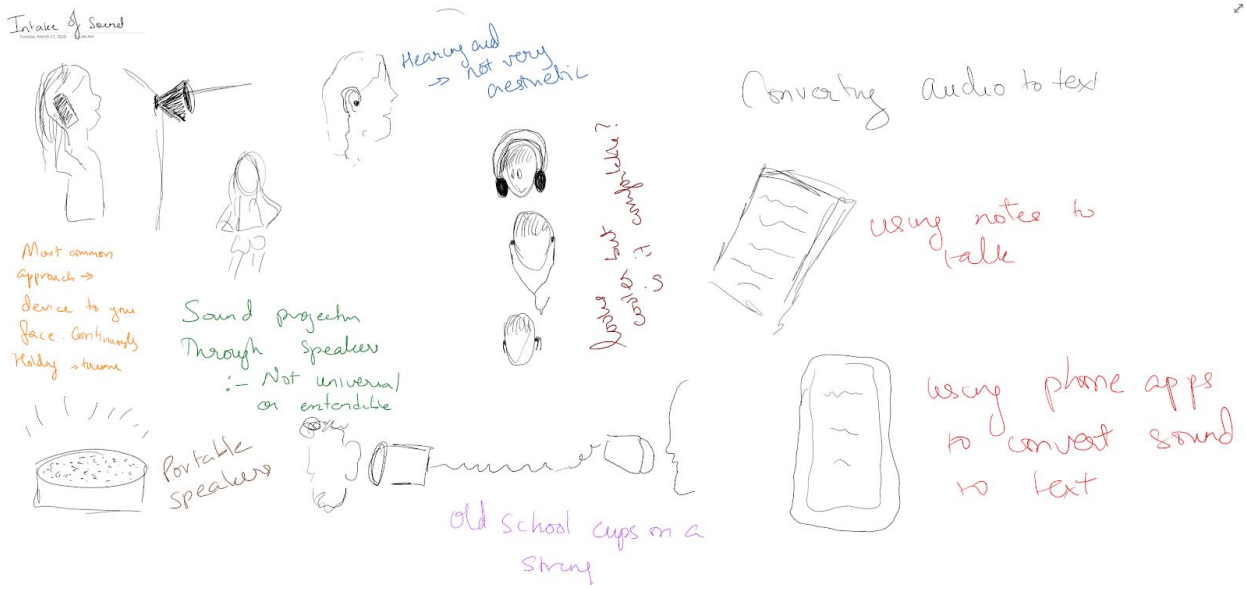


Sachi's Key Inspiration taken away: **Invisibility**
From User Interviews it was clear that our users want a product that isn't very visible or doesn't look very awkward. Some of the artist's work focused on art that looked different when viewed from different angles. My main takeaway was to make something that doesn't look very visible from angels that people are usually viewed from. Instead, the bulk of the device could be in the most infrequent direction.

5. Scenarios

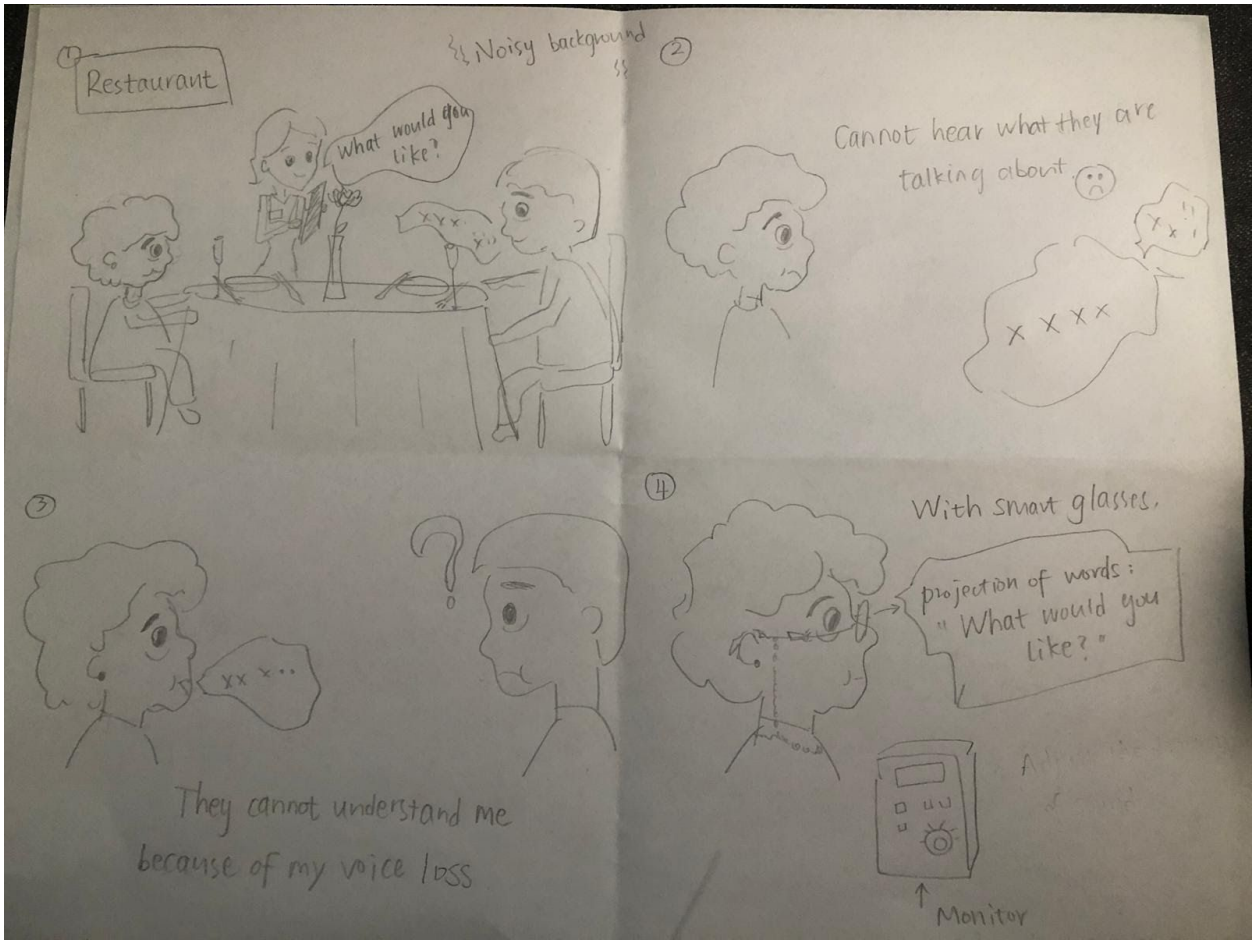
Sachi:
The first Scenario shows a couple spending time with an activity together, in this case, playing a game of cards. In the first two panels, they are using out device, which fits in and behind the ear, and does not obstruct the path to the mouth (which would cause isues while eating) or does not need to be help up with your hand (cause issues while doing any activity).
The next three panels describe what could happen if the device was not used - which would just be utter confusion.
The next scenario shows a lady, dressed to the nines for a grand family event. Her relative is complimenting her earrings, which look like a set of statement jewellery stud earrings. These studs in fact are used to hold together a device with the help of the ear. The part behind the earring, which holds it to the ear, rests on the bone behind the ear, assisting her with her hearing.

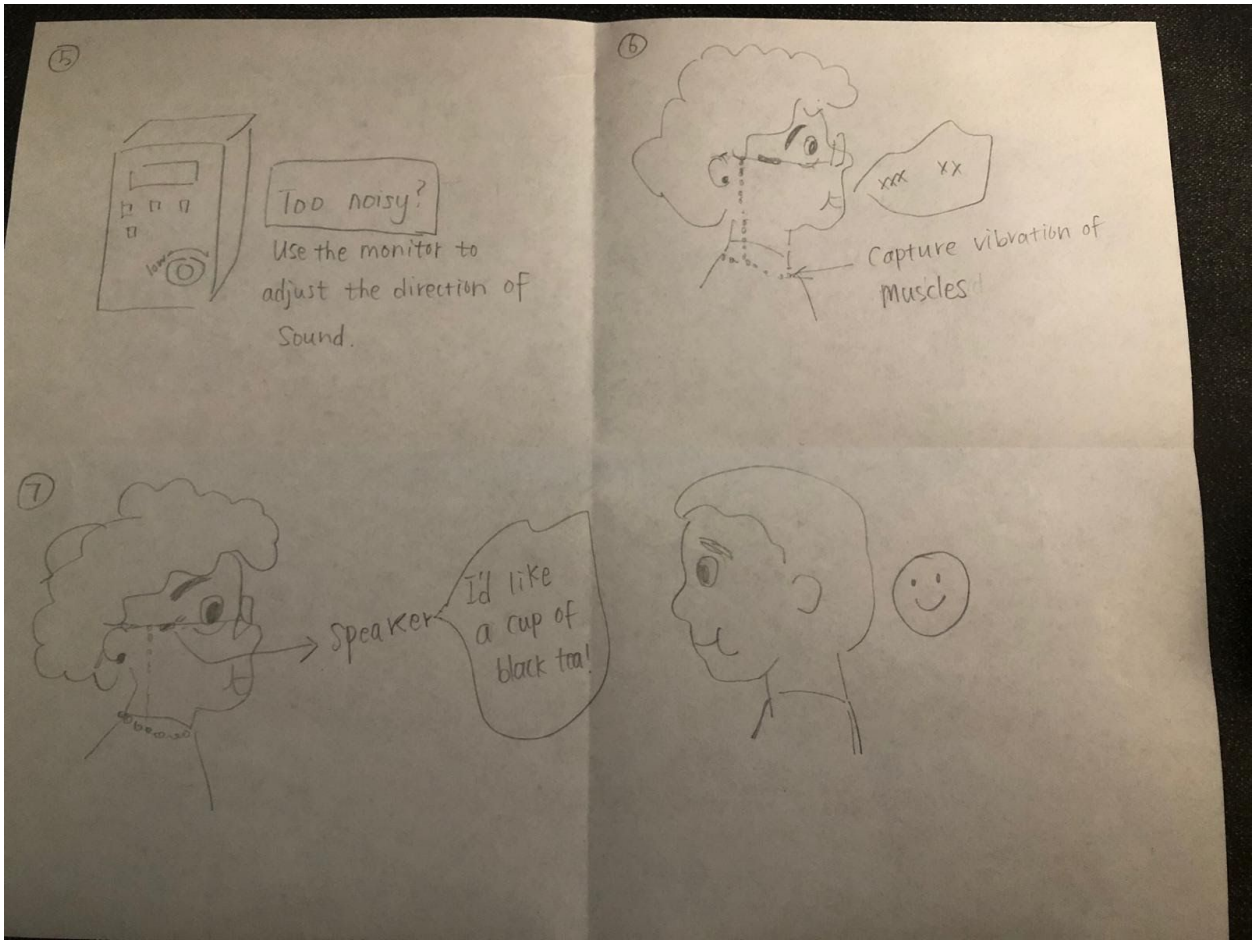

Those are pretty earrings
Hearing device fixed to bone
Held in place by earring


Intake of Sound
Hearing aid → not very aesthetic
Most common approach → device to your face. Continuously Hearing → trauma
Sound projection Through speakers :- Not universal or entendible
Portable speakers
Old school cups on a string
Converting audio to text
using notes to talk
using phone apps to convert sound to text

Jiaxin:

The following pictures show the scenario in a noisy restaurant with smart glasses. It focuses on the case where multiple people are talking to the old lady at the same time. The old lady has vocal and hearing impairments.
The designed smart device looks like a pair of glasses with sensors and speakers on the legs. It is inspired by my research in hearing aids that some advanced hearing aids can control the direction of sounds collected. For our smart glasses, users can use a monitor to adjust the direction of sound so that they can hear others even in a noisy background. At the same time, the sound collected is turned into words that will be projected by the glasses. That is to say, users actually “see” the sentences others are saying.
Additionally, a metallic chain is used to capture the vibration of the user muscles to understand what she is trying to say. The chain looks like a decoration around the neck of the user. After processing what the user is trying to say, the speaker will say the sentence clearly so that others can understand the user.




⑤
Too noisy?
Use the monitor to adjust the direction of Sound.
⑥
xxx xx
Capture vibration of Muscles
⑦
Speaker
I'd like a cup of black tea!

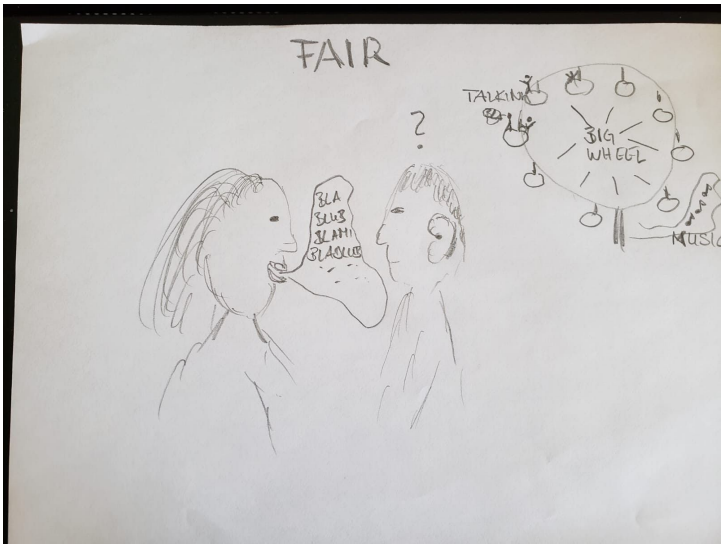
Simone:

The following first two images describe common scenarios in daily life.

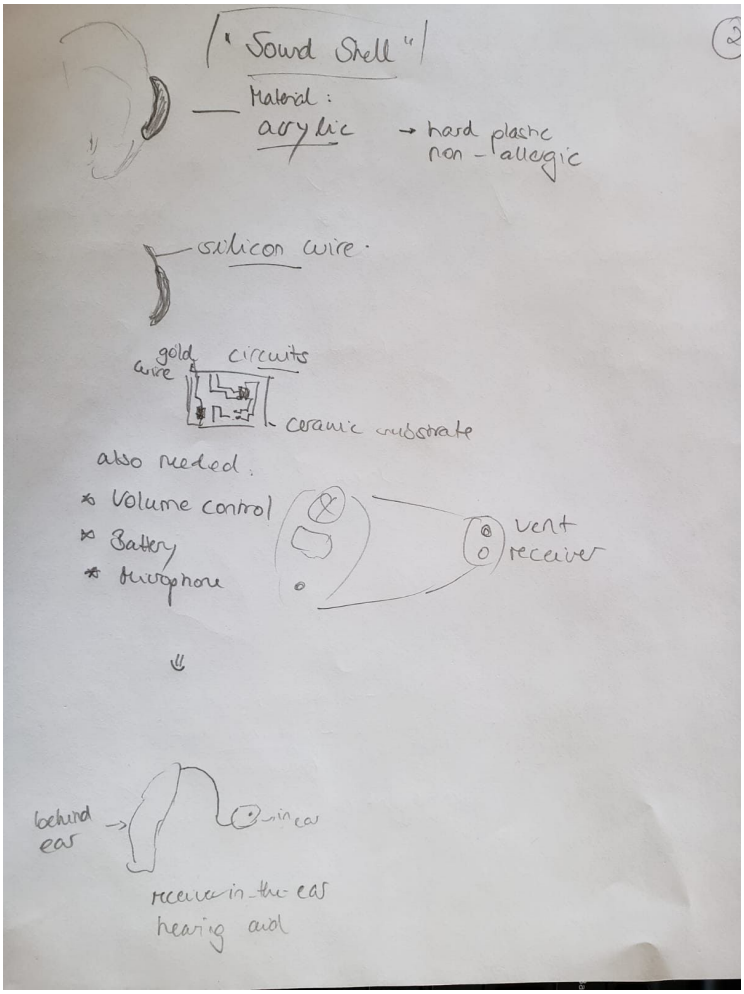
Picture 1) BUS
The hearing impaired person (lady on the middle right) wears earrings that function as hearing aids. Despite the background noise (by other surrounding passengers, eg in the front and the back) the lady will probably still be able to understand her friend talking to her (bearing ponytail) as her friend speaks straight into the hearing aid (ear ring) and, thus, this signal is being amplified most. The hearing device (ear ring) is not intrusive but rather serves as a nice accessory that the lady feels comfortable to wear in public.

Picture 2) FAIR
Here, we have a more “complex” situation related to noise. From a big wheel in the background, there is music being played at a loud level (comprising a variety of frequencies - high - low). Furthermore, people on the big wheel are not only talking but as well screaming in between. The hearing impaired man (front right) wears a hearing aid behind his ear. His friend is talking to him - but not in a direction that is optimal for the hearing device to be caught and implied. Instead all kinds of noises are amplified leaving the hearing impaired man in a confused state - unable to interact with his friend.

Picture 3: MATERIALS to consider for making a hearing device
For making a hearing device (hearing aid) you need to use materials that are non-allergic and non-toxic/safe for human use. Latex is potentially a suitable material - however, many people react allergic to it. An alternative could be “acrylic” - a non-toxic, non-allergic material, that is as well sturdy/robust/durable. Other components could be made of silicon-embedded wire, teh circuit itself could be embedded in a ceramic plate containing gold wires. Other items that will need to be included are the - volume control, - battery, - vent, - receiver, - microphone.


FAIR
?
BIG WHEEL


NOISY
BLA
Hearing too!
BUS NY



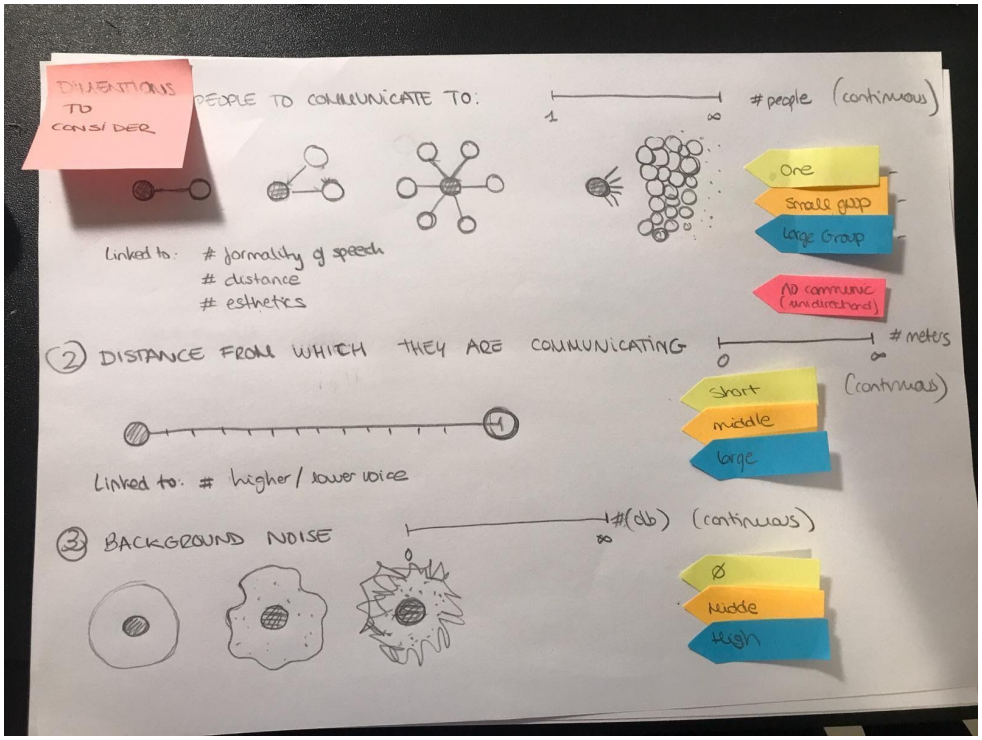
Irene:

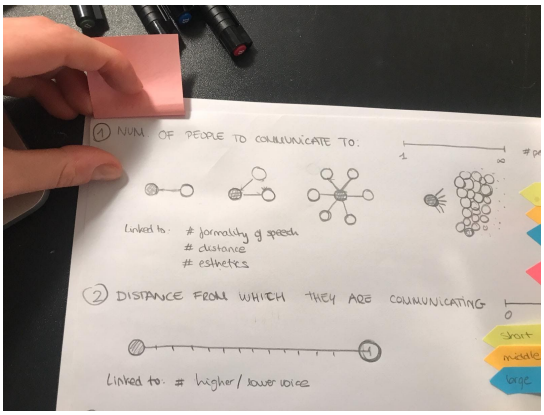
To organize the amount of possible situations, I have created different variables in which our situations can be defined. These variables are:

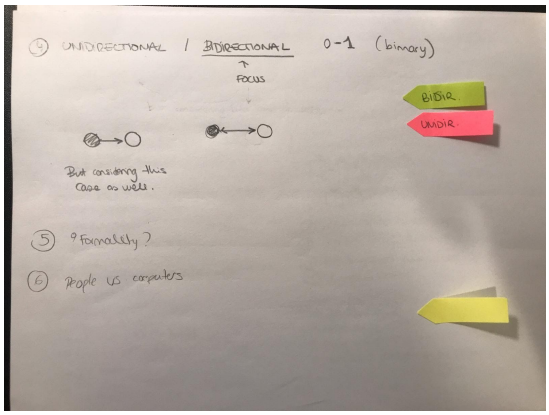
1. Number of people communicating (from 1 to inf) / discrete variable
2. Distance from which people are in communication (from 0 to inf meters) / continuous variable
3. Background noise (from 0 to inf db) / continuous
4. Uni-directional / Bi-directional communication (0 or 1) / binary
5. *(Level of formality ? Not sure about this one affecting our design. Tbd)*

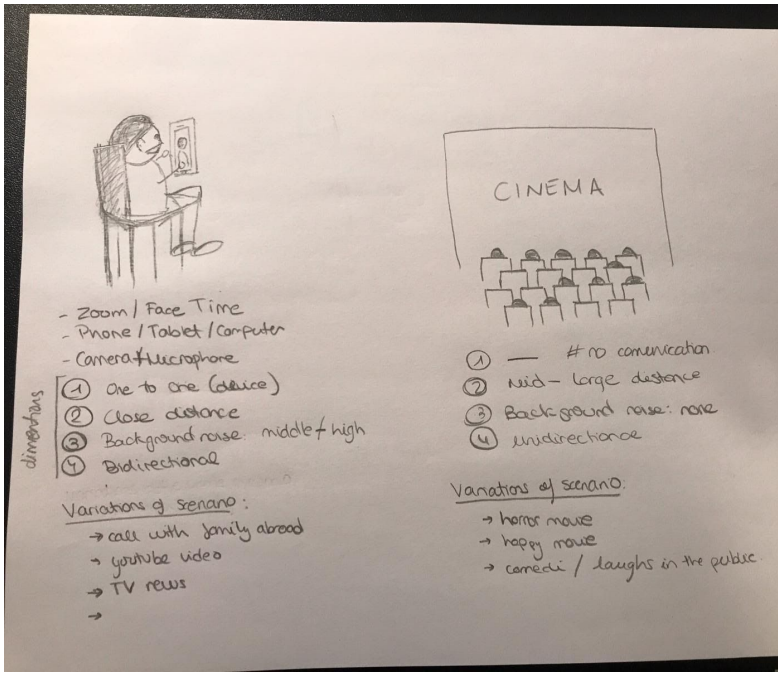
With these variables defined, each proposed situation can be categorized in a space. Ideally, we could have enough user interviews to know in which space the real problem is.

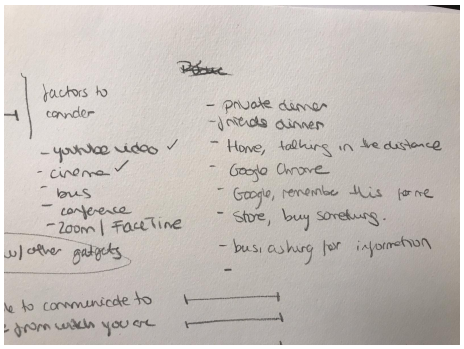
You can see, the “watching a movie in the cinema” and “face-timing family over the phone” situations are defined by these 4 dimentions established.


DIMENSIONS TO CONSIDER
PEOPLE TO COMMUNICATE TO:
people (continuous)
1
∞
One
Small group
Large Group
NO communic (unidirectional)
Linked to: # formality of speech
distance
esthetics
(2) DISTANCE FROM WHICH THEY ARE COMMUNICATING
meters
0
∞
(continuous)
short
middle
large
Linked to: # higher / lower voice
(3) BACKGROUND NOISE
#(db) (continuous)
0
∞
0
Middle
High

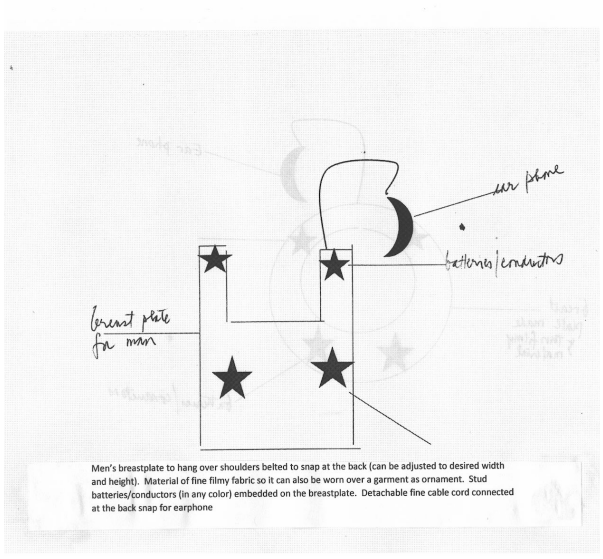

(1) NUM. OF PEOPLE TO COMMUNICATE TO:
Linked to: # formality of speech
distance
esthetics
(2) DISTANCE FROM WHICH THEY ARE COMMUNICATING
Linked to: # higher / lower voice

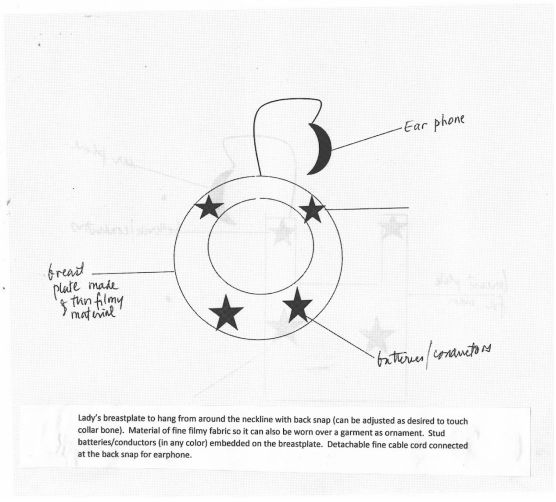

(4) UNIDIRECTIONAL / BIDIRECTIONAL 0-1 (binary)
Focus
BIDIR
UNIDIR
But considering this case as well.
(5) ? Formality ?
(6) People VS computers


CINEMA
- Zoom / Face Time
- Phone / Tablet / Computer
- Camera + Microphone
dimensions
(1) one to one (device)
(2) close distance
(3) Background noise: middle + high
(4) Bidirectional
Variations of scenario:
→ call with family abroad
→ youtube video
→ TV news
→
(1) — # no communication
(2) Mid - large distance
(3) Back-ground noise: none
(4) unidirectional
Variations of scenario:
→ horror movie
→ happy movie
→ comedi / laughs in the public


factors to consider
- youtube video ✓
- cinema ✓
- bus
- conference
- Zoom / FaceTime
- private dinner
- friends dinner
- Home, talking in the distance
- Google Chrome
- Google, remember this for me
- Store, buy something.
- busi ashing for information

Marie:

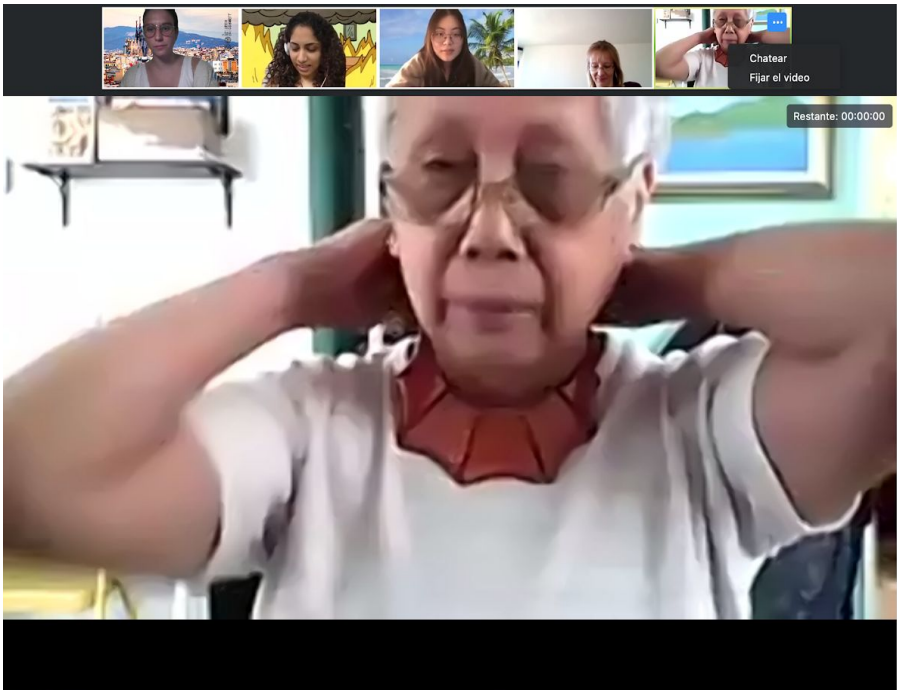

ear phone
batteries/conductors
breast plate for man
Men's breastplate to hang over shoulders belted to snap at the back (can be adjusted to desired width and height). Material of fine filmy fabric so it can also be worn over a garment as ornament. Stud batteries/conductors (in any color) embedded on the breastplate. Detachable fine cable cord connected at the back snap for earphone


Ear phone
breast plate made of thin filmy material
batteries/conductors
Lady's breastplate to hang from around the neckline with back snap (can be adjusted as desired to touch collar bone). Material of fine filmy fabric so it can also be worn over a garment as ornament. Stud batteries/conductors (in any color) embedded on the breastplate. Detachable fine cable cord connected at the back snap for earphone.

6. Product 1 - Jewellery

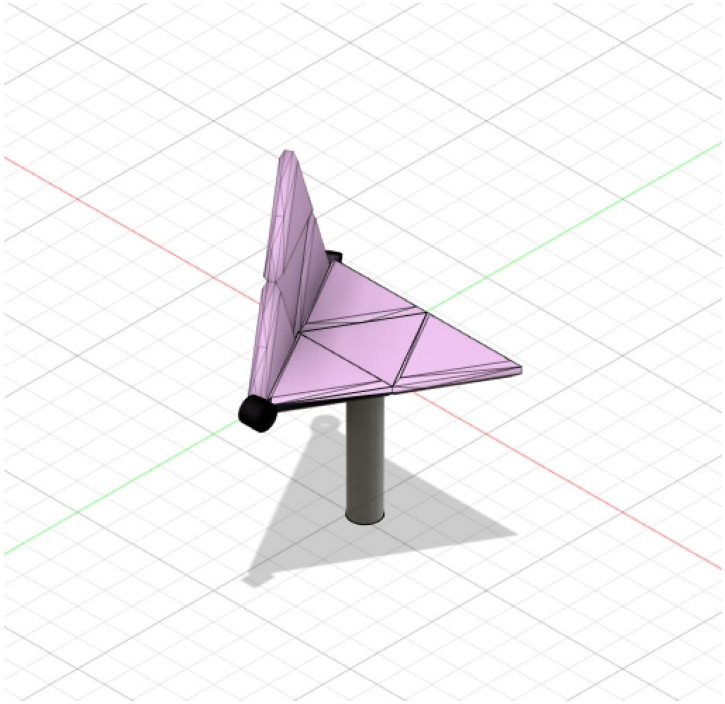
Visual sample of lady's ornamental device.

Visual sample of man's breast plate made of fabric.

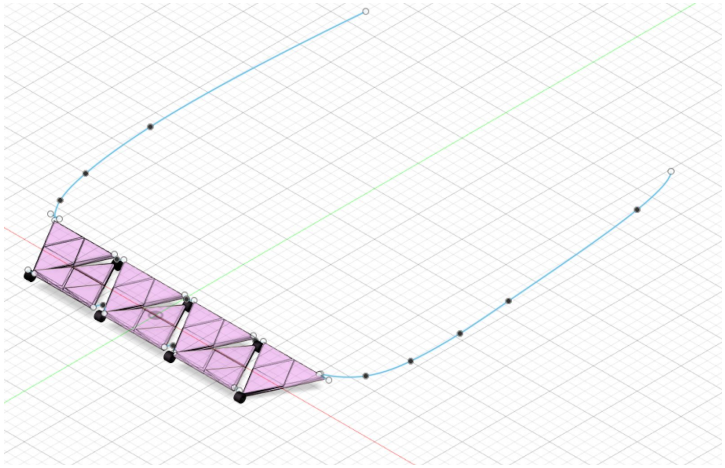


We designed a product that enhances the users hearing ability, and helps people around them hear their words better, while looking like jewellery. This product is designed to no only not look conspicuous, but to enhance your outfit. The jewellery set consists of a pair of earrings and a necklace. The earrings sit on your ear, and are large so they also sit on your jawbone. The "bolt" of the earrings that holds it on the ear sits on the mastoid. Using bone conduction, the sound can be transmitted. The necklace sits on the collar

bone and can be used for sound transmission too. A microphone in the necklace can assist in amplifying the sound. However, this product may ot be a convenient option when the user does not want to dress up, and it restricts its users to people who like wearing jewellery. Another flaw in this product - sound conduction through the collarbone is very weak.



The upper triangle of the earring lies on the mastoid. The lower triangle lies on the earlobe.



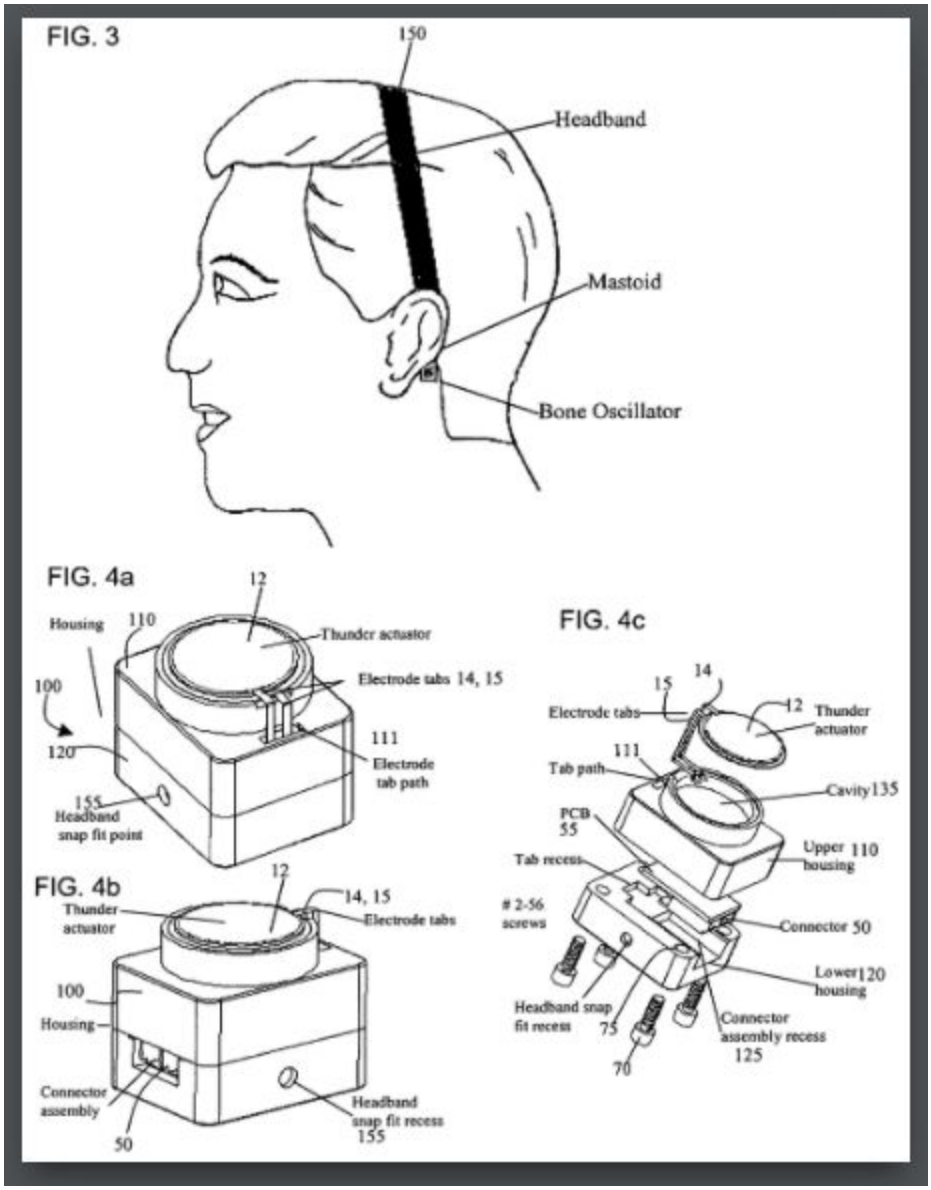
The triangle of the necklace falls on the collarbone. With a microphone within, it also assists in the user's speaking ability.

Bone Conduction - Mastoid

1. Bone-conduction hearing-aid transducer having improved frequency response

Stimulation is received at the skull by placing a transducer either on the mastoid region behind the ear to be tested or through transducer placement on the forehead.

These objects are accomplished by the present invention in which a piezoelectric type bone conduction transducer using a flextensional type actuator is placed in the tip of a specifically designed housing and is energized to generate mechanical vibrations. This transducer shape is adapted to be positioned against the skin over the skull of the hearing impaired person, preferably over the mastoid area of the temporal bone of the skull behind the ear of the patient, for transmission of mechanical vibrations generated by the piezoelectric actuator placed in the contact area between the transducer and the mastoid (see FIG. 3).



2. [Bone Conduction Microphone: Head Sensitivity Mapping for Speech Intelligibility and Sound Quality]

The goal of the study was to assess intelligibility and quality of speech recorded through a bone conduction microphone (BCM) located at various points on the talker's head. Ten words spoken by a female and a male talker in a quiet environment were recorded through a BCM placed at eight different locations on the talker's head. The sound levels of the recorded signals were normalized and the signals were presented to 33 listeners through a pair of AKG K240DF headphones. In two separate listening sessions, the participants were asked to evaluate the speech intelligibility and sound quality of each

word. A total of 640 signals were presented to each listener during each session (2 talkers x 10 words x 8 locations x 4 repetitions). The results of the study indicated that BCM placement on the forehead and temple of the talker resulted both in the highest intelligibility and quality of the recorded speech with rating scores significantly higher than those for all other locations.

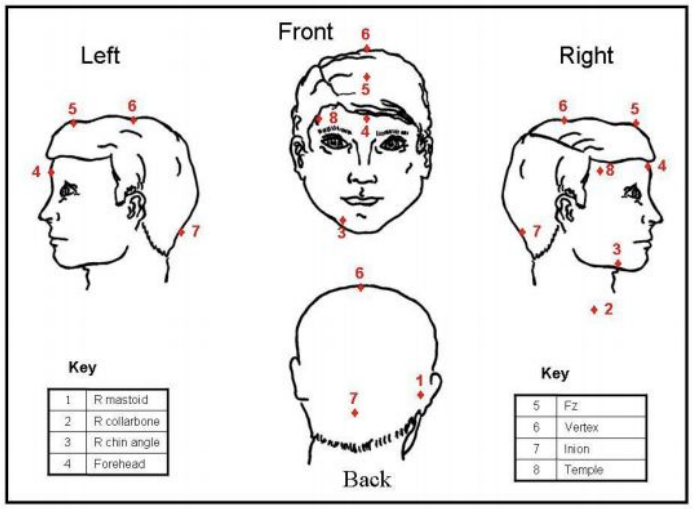
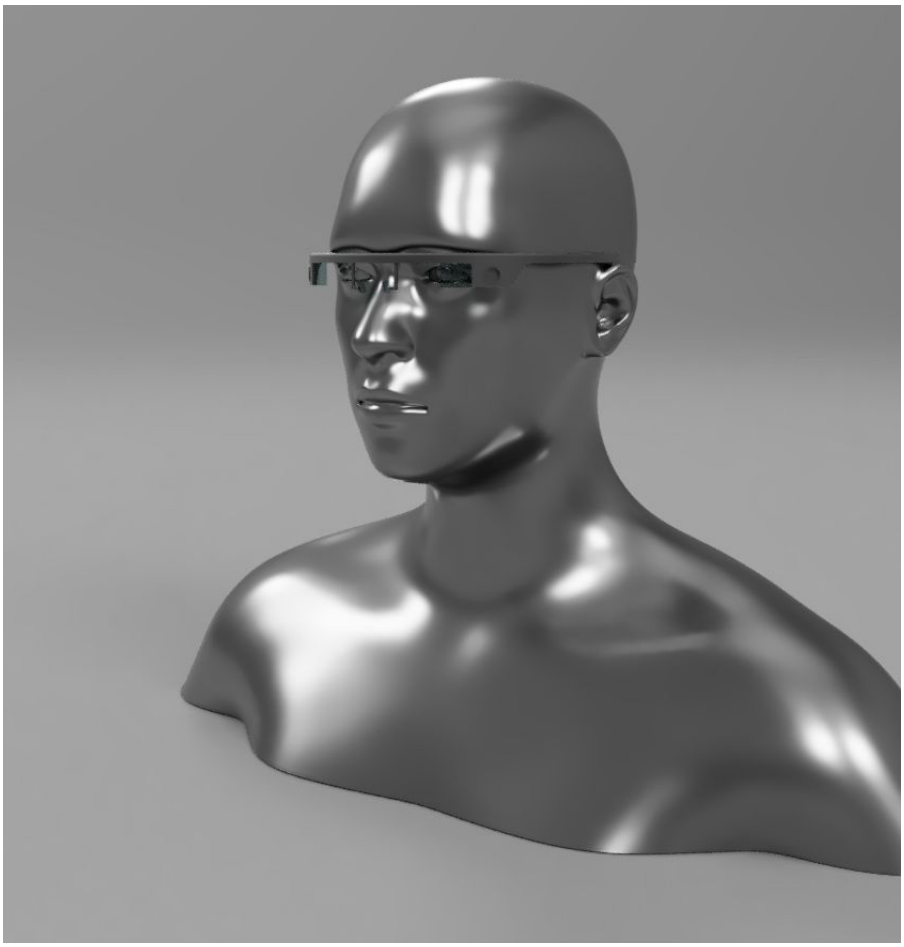


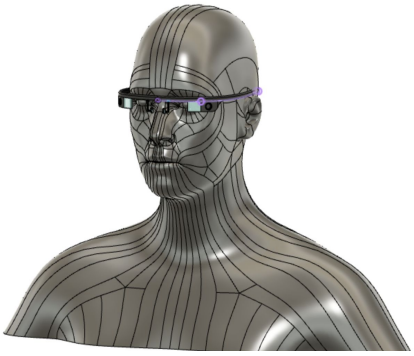
Figure 1. BCM locations investigated in the study.

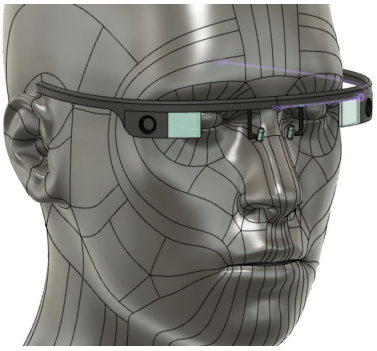
Table 2. Sorted overall rated means of speech intelligibility and sound quality for BCM location.

Intelligibility (0 to 100)		Quality (1 to 5)	
Location	**Mean**	**Location**	**Mean**
Forehead	88.2	Forehead	4.1
Temple	82.2	Temple	3.7
Mastoid	71.9	Mastoid	3.3
Fz	69.2	Fz	3.2
Vertex	66.8	Vertex	3.1
Inion	66.2	Inion	3.1
Chin angle	63.1	Chin angle	2.9
Collarbone	40.0	Collarbone	1.9

7. Product 2 - Smart Glasses

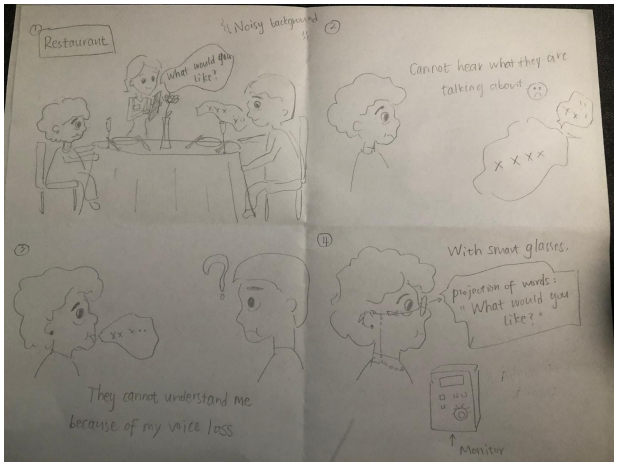


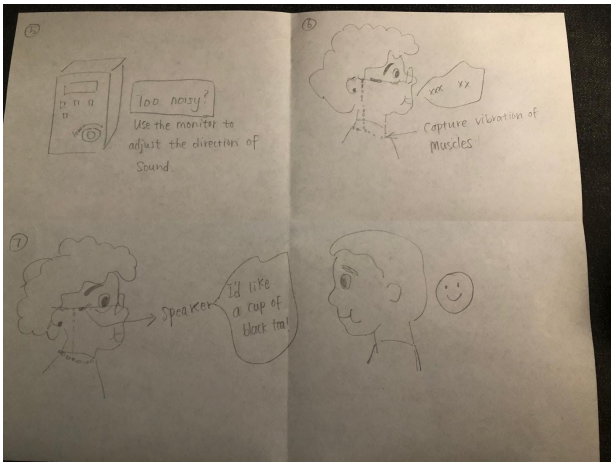




These are two free 3D models from open source websites put together using Fusion360.

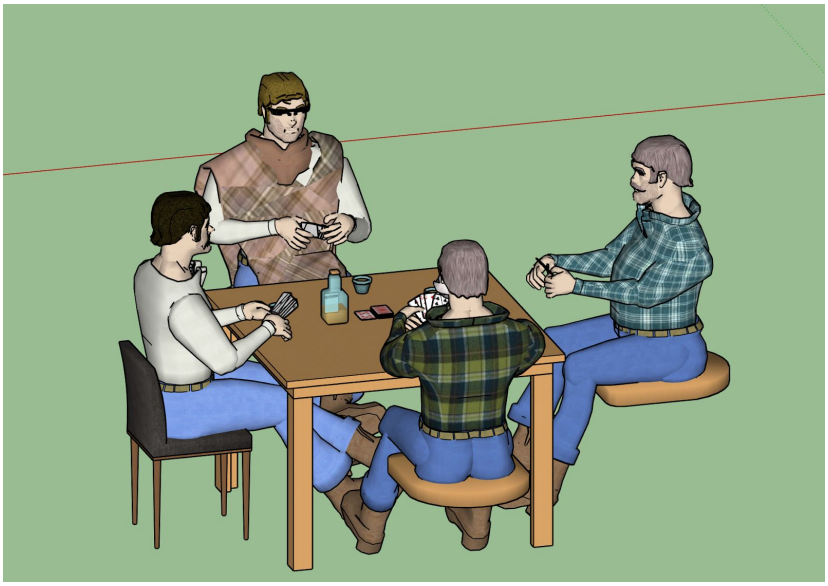
Our second product –and the **final choice**– is a little bit of a moon shot, however, it was very liked by Dr. Rameau, and we feel that with enough time and resources it could be done, as it is technically feasible. Check Part 1 of this document to know how to build it step by step.





How would it work? Let's look at a real scenario:
In a noisy background like a restaurant as shown in this sketch, the lady with hearing and speaking issues cannot communicate well with her partner. Using smart glasses, it can

project the words of other people that the user is talking with. So the user can actually see the sentence that others are speaking. There is a **speaker** on the leg of the glasses that can **collect sound** from others. Also, for users who have vocal issues, we use **mastoid bone conduction microphone** to collect the user sound and then the speaker will play the sentence the user is trying to say.



Free 3D models from open source website, modified chairs and different elements of the sceen to make it more realistic. Inserted our smart glasses.
All the changes have been done using SketchUp.

INFO 6940 - Niti Parikh - Cornell Tech 2020

Crafts @ Large

Challenge 4

Part 3:

Individual contributions and insights out of this project

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Sachi

The user insight that stuck with me was that although hearing devices exist, the elderly don't want to wear them, especially in public spaces, unless they absolutely need to. They don't like to be associated with a "medical" hearing device. The device we design for them has to be something that would be worn by anyone, and not just people with hearing disabilities. As it is to be used in social settings, it should not obstruct the path to the mouth. This could obstruct the user's eating and conversing abilities. The focus on these insights led us to agree that designing jewellery or smart glasses would be the best approach.

Jiaxin

The design idea was quite inspired by user interviews. Getting to know what really troubles users and their expectation of the products. For this challenge, simple hearing aid sometimes cannot solve the problem since users might have different concerns. Additionally, some damage inside the ear makes it impossible to hear through the ear system. Thus, we try to solve the problem from different angles like combining cues from

other senses. During the user interview, they also mentioned digital devices that write words out and speak words instead of master. We combined all these insights with technology like 3D print and artificial intelligence to make it possible.

Irene

When this problem was presented to us I immediately felt engaged as my grandparent came to my mind. He has Parkingson and he struggles when talking, writing, and remembering things. I have always wanted to build a Google Home like device to help him remember his daily tasks. I even bought him a Google Home but, as he has trouble speaking, it could not recognize his voice and, therefore, it was useless.

I feel this real story (and close to me) was a bit of our team's motivation to keep working on this problem, which might have appeared so far away from us –young people without hearing or speaking problems– at the beginning. I would like to say this has been the hardest and the most interesting part of the project for me: designers must have empathy and, if the problem you are trying to solve does not personally affect you, you **must** talk to people who it does. Talking to a wide range of RI residents was incredibly inspiring and eye-opening. In that sense, Marie was an indispensable member of the team. Lastly, I feel so sorry at the end we could not take them for dinner to experience first hand their daily problems. I feel doing this user research experience “on the field” could have been a game changer for this project.

Thank you for making us part of a small part of you, RI residents.