**Final Presentation Brainstorming**

**Assignment:**

* 15 minutes (+/-10%) pre-recorded video, that covers the following:
* Project Brief (1 min)
* Requirement Specs (2.0 min)
* Background Research (2 min)
* Preliminary designs/prototypes - (1 min)
* Detailed Final Design (2.5 min)
* Manufacturing Plan (how we intend to build it) (3 min)
  + Quick demo (1 min)
* Evaluation Plan (how we intend to test it) (1 min)
* Extra -1.5m

**Script (Draft): (ps: I have started adding the good parts to the script)**

**Project Brief/Background Research**

Imagine being in a room full of conversations, laughter, and ideas—but unable to join because you can't speak. For the 170 million people worldwide with speech impairments, this is a daily reality. Among these impairments, Cerebral Palsy (CP) is a significant condition. CP is a neurological disorder that affects the brain’s ability to control muscle movement and coordination. In fact, 1/3 to 2/3 of individuals with CP experience speech difficulties or complete loss of speech. To address this, AAC (Augmentative and Alternative Communication) devices were created to help those who can’t communicate through speech. These devices offer alternative ways to communicate—whether through text-to-speech, symbols, or gestures—enabling individuals with speech impairments to interact with their environment and others.

However, while these devices give a voice to those in need, they often come with challenges—bulky, outdated designs that can feel more like barriers than solutions. This can lead to feelings of stigmatization for the user, further isolating them from their community.

We set out to change that. What if assistive technology could be as natural as putting on a pair of glasses? Introducing wearable smart glasses that make communication effortless, intuitive, and empowering—allowing users to focus on expressing themselves, not the device they rely on.

AAC and CP (background research)- mainly use diagrams

This product is mainly designed for individuals with cerebral palsy. Before we get into the design of the product, Cerebral Palsy is a condition which develops quite early and permanently affects muscle coordination and body movement. The need for AAC comes in because the muscles needed to control the mouth and tongue are mostly affected by cerebral palsy. A study done in Sweden, found that more than half of the children with cerebral palsy were affected by speech disorders or entirely nonverbal.

When we initially talked to AAC users, we found out that the means of AAC that were available to them were not very accessible or inclusive, most of them used keyboards, joysticks and tablets but with CP, hand movements are usually restricted and the carrying around heavy equipment is a hassle. With the wearable AAC device we designed we planned to tackle both of these concerns. Let's investigate how we plan on making this happen in more detail

(<https://pubmed.ncbi.nlm.nih.gov/23186066/> , <https://www.ninds.nih.gov/health-information/disorders/cerebral-palsy>)

**Requirement Specification**

Before delving into the device design, it is essential to first establish the requirements it must adhere to.

The core idea behind our design is to replace traditional AAC devices, which are often bulky and impractical as they need to be mounted by a carer on a wheelchair and can be unstable. That’s why we’re focusing on making our device wearable and portable.

Cerebral Palsy patients represent our target audience for this device. For this reason, the design must be easy to use and accessible.

In addition, the device must provide accurate text output to help individuals with speech impairments communicate clearly, with minimal lag or errors.

Durability is a critical aspect of design. Since the device will be used daily for extended periods, it must withstand regular wear and tear, potential drops to ensure long-term performance, minimizing the need for frequent replacements.

Finally, safety is paramount, given that the product will be used in direct contact with individuals.

**Preliminary Designs/Prototypes**

Initially, our idea was to detect muscle movement that corresponds to each sound and turn it into speech. We designed the following 2 designs. For the 1st one we decided to use sEMGs which has electrodes to detect the electric signals in the target muscles. (in the slides- sEMG stands for Surface electromyography) (Figure1). As you can see the mask consists of a detachable collar with a speaker and a mask with several sEMGs.

After talking with an AAC specialist, we learnt that our design was too intrusive, and it might stigmatise AAC users, and it wouldn't be very durable due to the drooling and other symptoms of Cerebral palsy

We then came up with the second design which was as shown below a pair of glasses and headphones, and we decided to use a combination of ExGs and IMUs to better capture the signals with IMUs tracking subtle movements of the jaw and facial muscles and ExG (electromyography) to detect low amplitude surface muscle activity

However, after talking to Pascal, we realised the electric signals from the muscles were too weak to differentiate the sounds and it wouldn’t be safe to have electric components attached to facial muscles. Taking all these into consideration, we decided to go with eye tracking.

With eye tracking we initially considered mini projectors on the user’s shoulders, but we dismissed the ideas due to the need of an undisturbed surface and hence making it difficult to have normal communication and user’s discomfort due to the weight of the projectors

**Detailed Design: ( can have a animation like zooming to each feature )**

* General Overview of the product. The final design consists of a pair of glasses integrating eye-tracking technology that allows the user to speak by typing the words using only his eyes. This device is paired with the use of google Glass, which allows a projection of a keyboard onto a lens. Here is how it looks:
* How it works (user perspective)

Once the user wears the glasses, the Glass will project a keyboard. The keyboard we have chosen is a regular QWERTY keyboard. (maybe explain why). The camera that is embedded in the frame, shown (where) will track the user’s eye movement to determine which key the user is looking at. For the selection to be done, the user must look at the letter (or its region) for a predefined time (1 second for example). As the user continues to gaze at different keys, letters are added to the word. When the user finishes typing a word, they can use a specific gesture (e.g., blinking or a specific eye movement) to indicate that they have completed the word.

* Eye-tracking

For this to work, we have implemented eye-tracking technology: the camera’s data is processed through algorithms that correspond to a letter to the position of the pupil. To achieve this, the camera is connected to the Raspberry Pi to capture real time video of the user’s eyes. Combined with software libraries, we have coded the following that allows eye-tracking:

(insert code)

* Head-Tracking

And here’s where it gets even more intuitive. Our device isn’t just responsive—it’s smart. We’ve integrated **head-tracking technology**, making interaction seamless and effortless for the user.

A head tilt to the left twice will respond to an emergency command asking for help and a head tilt to the right twice will override the earlier command in case it was called accidentally.

The code for this:

At the core of this innovation is an **IMU sensor**, precisely capturing motion and feeding data to the Raspberry Pi in real time. The result? A truly **natural** and **frictionless** experience that puts control back in the hands of those who need it most.

* **Visual feedback**

The device will use a visual feature to notify others when the user wants to speak. This is to ensure that the AAC devices' slower pace does not interfere with the user’s ability to participate in day-to-day communications. This will be done by using an LED that is connected to the raspberry pi with a capacitor and will be programmed to automatically switch on when the user begins to type and switch off when the user is done typing

* **Volume Control**

The user can **seamlessly adjust the volume with the use of a knob,** making interaction with the device effortless. By placing a **precision potentiometer** at the amplifier input, we ensure **smooth, distortion-free** volume control, preserving audio clarity while giving users complete command over their experience.

The product uses rechargeable batteries for user convenience and enhanced sustainability for the user – include rechargeable batteries type

**Parts used in the design and why**

**Raspberry pi zero 2W –** Raspberry pi zero 2W is ideal for this project because it is compact to be wearable even though it has solderless 40-pins and a CSI-2 camera connector (show the picture) to work seamlessly for eye tracking

**Google glasses -** Google glasses operate by projecting the image onto the prism's reflective surface, which focuses light into your eye, resulting in a semitransparent display. The display's resolution is 640 by 360 pixels. This solves the main issue we were combating with available AACs and makes it seamlessly wearable and takes away the need for tablets and computers

(<https://electronics.howstuffworks.com/gadgets/other-gadgets/project-glass.htm#:~:text=Images%20from%20Google%20Glass%20project,world%20on%20the%20other%20side>.)

**IMUs and how it works –** We chose to use an IMU for the head tracking. It has an array of sensors that can detect motion. IMU operates by detecting linear acceleration with accelerometers and rotation with gyroscopes. IMU was chosen over an accelerometer have lesser sensors and can only detect linear acceleration (include pictures)

( - <https://www.jouav.com/blog/inertial-measurement-unit.html>

<https://www.advancednavigation.com/tech-articles/inertial-measurement-unit-imu-an-introduction/>

<https://www.sciencedirect.com/topics/engineering/linear-accelerometer#:~:text=The%20function%20of%20the%20accelerometer,physical%20principles%20involved%20in%20accelerometers>.)

Why IMU:

* The most common user complaints for AR devices are motion sickness and disorientation. To provide the most realistic experience, AR devices need to very accurately match the user's movements in the real world to a computer-generated simulation. Data needs to be transferred as quickly as possible so that there is no interruption between the user's behavior in the real world and what the simulation displays. While a multi-axis IMU can bring low-latency, high-accuracy with fast sampling rates.
* Hands-Free Interaction, Motion Detection

Can choose LSM9DS1(3.5x3x1.0mm, with Magnetometer (9DOF sensor for more stable orientation awareness), reduces head-tracking errors, but higher power consumption and cost) [iNEMO inertial module: 3D accelerometer, 3D gyroscope, 3D magnetometer](https://www.st.com/resource/en/datasheet/lsm9ds1.pdf)

&MPU6050 (Without Magnetometer, Package size(mm): 4 × 4 × 0.91, low power, low cost, and high-performance requirements of wearable sensors) [MPU6050 Module Pinout, Configuration, Features, Arduino Interfacing & Datasheet](https://components101.com/sensors/mpu6050-module) (How to use, e.g. Arduino)

**Camera, we chose and why – Raspberry Pi Camera Module CSI-2 with 3280 x 2464 pixels resolution along with the ribbon cable**

This was chosen because its dimensions are small enough to be compatible with the design and it is capable of high-speed video imaging and high sensitivity. It also improves the quality of the image by reducing smearing and fixed pattern noise (FPN) (<https://uk.rs-online.com/web/p/raspberry-pi-cameras/9132664> )

**We are also using RS pro 8ohms 0.3W miniature speaker and (anything else) – include picture with dimensions**

This was mainly chosen for the design due to the quality it has for its price, and it is compatible with raspberry pi and the design

Include picture of electrical!! - design

**MANUFACTURING PLAN - add**

**EVALUATION**

Before the product is ready to be sold as an assistive technology device, it must be evaluated on its safety, functionality and the overall user experience so how do we plan on doing this?

**Safety regulations**

For the safety evaluation, our product must comply with (mention the standards? Prbly not in a presentation) and therefore will be tested against the safety regulations for safe surface, material, battery, and heat safety and the electrical safety regulations for medical devices and assistive technology. The testing will be done by a third party to improve creditability (ref- ISO 9999). The product will undergo humidity and temperature testing, thermal shock testing, temperature cycling testing, biocompatibility test, Taber abrasion test and drop test and more in accordance with our PSD

( <https://www.pullman.co.uk/PullmanInstruments/ExtraServices/ProductTestingServices>

**Functionality**

**Software based testing**

To evaluate the functionality of the product, we will use a confusion matrix to test the speech output accuracy, latency testing software for real time response and speech to text software for clarity and vocabulary breadth. (maybe explain how these work with diagrams on the slides and then add to the script)

**User Experience Testing**

We intend on using multiple focus groups of people with cerebral palsy to test the accessibility, wearability and affordability of the product. The focus group would involve people with different levels of mobility issues, and all genders, to ensure that we get more inclusive feedback to improve our product better. The individuals in the focus group would be given a thorough questionnaire after they test out the device to give feedback on it.

**Conclusion**

We have successfully completed the SolidWorks model of the frame; the eye tracking and head tracking program and we will work on the text to speech model next and 3D print the glasses. Once the product is fully functional, we plan on adding built-in autocorrect software to improve the efficiency of the device, we will work on ways to make the product more inclusive since that was one of. Our main aim of our project like make it compatible for people with corrective lenses. Even though this project is made for Cerebral Palsy, we want to make it accessible for ALS and other conditions with reduced speech and motor abilities. By doing so, we hope to provide a more effective communication for a broader range of users