2021 ANNUAL REPORT

Enabling Engineering

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Disability is one of the most important issues in the contemporary society, with the likelihood increasing as individuals age. Supportive resources for individuals with disabilities are oftentimes costly, inaccessible, and reduce an individual's ability to perform specific tasks independently. Additionally, insurance often fails to cover expensive devices or services needed to carry out everyday tasks.

We seek to support this population via low cost, customized solutions that empower individuals by giving them greater independence, reducing medical burdens, and increasing social connectedness.

This annual report serves as an overview of our projects but is by no means exhaustive. Much of our work is dependent on our collaborators, clients, and supporters and we want to express deep gratitude for all of those who have helped us make 2020 such a successful year.

ENABLING ENGINEERING

Who we are: Enabling Engineering is a Northeastern University student group that designs and builds devices to empower individuals with physical and cognitive disabilities.

What we do: Our students collaborate with clients on projects that provide greater independence, reduce medical burdens, and increase social connectedness. We help family members, clinicians, and teachers care for people with disabilities.

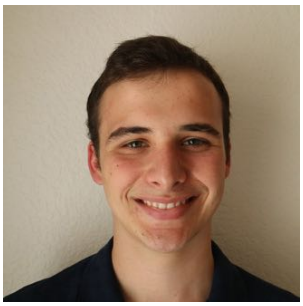
By giving students the opportunity to participate in Enabling Engineering projects, we are training the next generation of engineers to be knowledgeable about, and aware of, the needs of individuals with disabilities.

an inside look at the

ENABLING ENGINEERING TEAM

Management Team

Tyler Hill



Liam Sullivan

Pragnya Kalidindi

David Ewen

Arianna Ranalli

Program Assistants

Ronak Patel, 2020

Kedar Sharad Khardikar, 2021

OUR IMPACT

- “I began my time with Enabling Engineering as a young sophomore without many skills under my belt. I joined the management team and had no experience working on a project. At first, I was nervous because of this, but the management team welcomed me with open arms. They made sure I was comfortable and helped guide me through the process. I learned so much in that first year. How to organize meetings, lead a client meeting, and help students who needed guidance on their project. I also developed a close relationship with the projects that I managed, and although I had never been on a team, these projects took me in as their own. As the years progressed, it was nice to return the favor and help guide newer management team members when they first joined. I can happily say that being with Enabling Engineering for 4 years has shaped me to be the engineer I am today. This club helped me to develop my leadership, presentation, and problem-solving skills. These skills became very useful in my past three co-ops. I went into my co-ops feeling confident and prepared for what was thrown at me. This past year during the pandemic, I even took on the 3D printing assistant role having little knowledge about 3D printers. I learned through trial error, a lot of YouTube videos, and I left feeling like a well-rounded 3D printing assistant. I gained a lot of friends through this club and even hang out with them outside of club hours/meetings. I owe this club so much for all the opportunities it has offered me, and I’m so thankful I joined.” Tyler Hill, Mechanical Engineering Major
- “I joined Enabling Engineering the fall semester of my second year here at Northeastern and each semester since then has been more rewarding than the last. Enabling provided me with my first real project experience through which I have been able to build my technical skills and gain an understanding of the ins and outs of project management. It's a great opportunity for students to learn and grow into engineers while working in a creative and collaborative environment.” Arianna Ranalli, Mechanical Engineering Major
- “As someone who's been involved with Enabling Engineering since my freshman year, I can say confidently that I've become a better engineer both technically and professionally. The exposure to real-world problem solving is amazing and getting to work together with the client and eventually lead a group of engineers with different ways of thinking to design and construct a solution opens your mind to so many ways of thinking and reveals areas of interest you never knew you had. However, during my time at XMAX, my biggest motivation has been helping our client, Max, and working to complete this project so he can play Xbox. This simple dynamic is something unique to Enabling Engineering that anyone interested in this field of client-based work should be a part of.” - Sebastian Ardila, Mechanical Engineering

COVID-19 Response

Due to COVID-19, lab access has decreased, and lead time for ordered parts increased. Enabling Engineering understands that the safety of students and clients is of utmost importance, so we are taking all the necessary precautions to ensure everyone’s safety. We have restricted the lab use to 4 students to ensure 6 ft healthy distancing per government regulations, mandated students to wear masks in the lab, and prohibited eating or drinking to ensure safety. To decrease lead time on ordered parts, we started parts delivery to students directly to avoid delay.

As we move forward and plan for the normal Fall term, we will continue to monitor the latest health and safety guidance and adjust our protocols accordingly. Thank you for your support and understanding,

EYERIS

Overview: Light weight, low-cost obstacle detection system for visually impaired

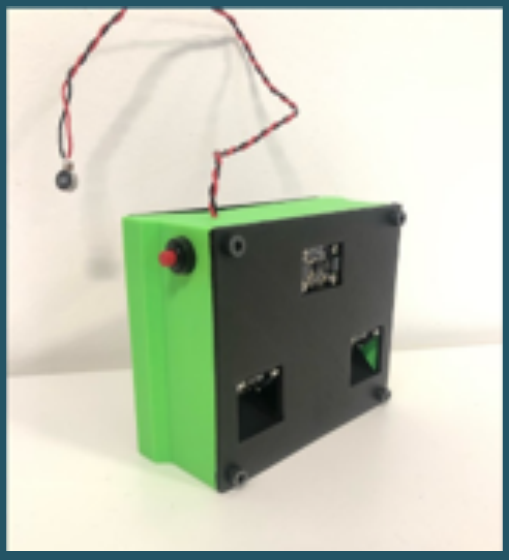
Status: Completed

Members:

Celine Estrada, Muhammad Ghafoor,Jemin Park, Sashank Srinivasan, Kevin Yu, Vincent Zhao

Client:

Visually impaired lawyer in New York City



The Need

285 million people in the world are visually impaired: 246 million have low vision and 39 million are blind. The elderly comprise 85% of the visually impaired and navigation is heavily reliant on sight. The most popular solution is to use a cane which can help users detect obstacles within 1 m of them by tapping or sweeping the cane from side to side. Canes cannot help with obstacles above the user's waist.

The Solution

Eyeris is a lightweight, low-cost enhanced obstacle detection system that attaches to a user's cane and appropriately alerts the user of obstacles in their path. It offers seamless connection with a smartphone application for additional assistive features. It helps users to regain their independence safely and reliably.

DEVICE TO HELP PUT ON A MASK

Overview: Device for quadriplegic individuals to put on a mask in COVID-19

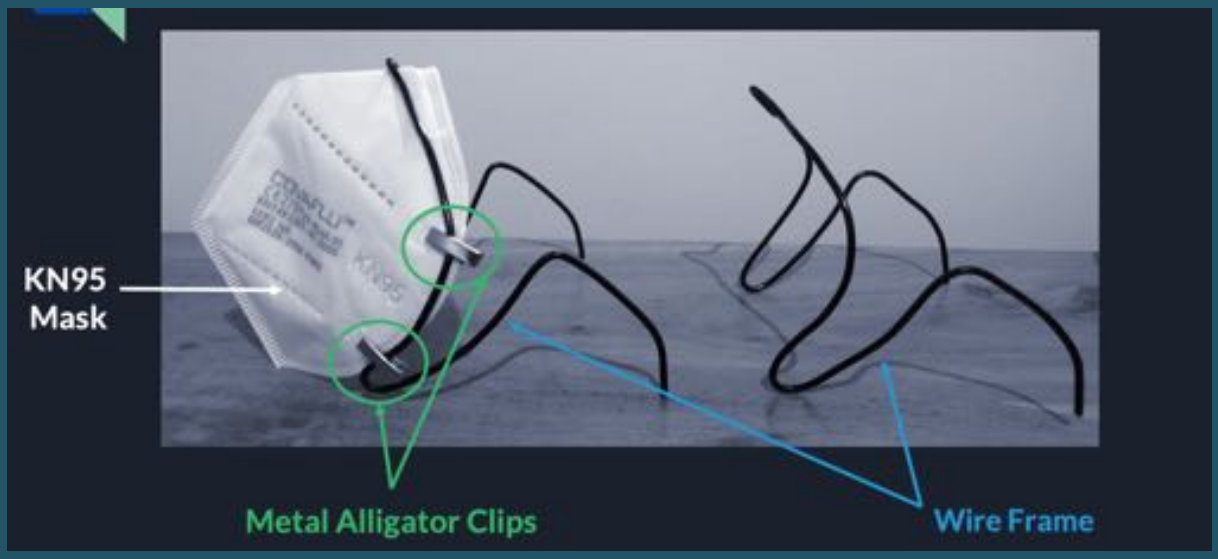
Status: Completed

Members:

Andreas Petrides, Kelvin Ma, Yiwen Ma, Teng Zhang, Zach Neveu, Connor Rog

Client:

Jim Wice



The Need

Quadriplegia is paralysis caused by illness or injury that results in the partial or total loss of use of all four limbs and torso. Due to the COVID-19 pandemic, there is an unmet need for quadriplegic individuals to put on a mask. The direct need is a device that assists in mask application and removal. The client has quadriplegia and uses a power wheelchair and splints to assist in accessibility. He is unable to loop a mask over his ears, but he can put on and remove his reading glasses.

The Solution

The design uses a thicker coated wiring to create a more substantial support structure. The coated wire allows a user to bend the frame slightly so that the mask rests flush along their skin. This functionality is similar to the metal nose-bridge found in common disposable masks. It is important that the mask can remain tight to our client's face as this is an integral function of masks with classic ear loops. We use metal alligator clips, these clips hold the mask in place along the frame, while allowing easy changeability of masks. Finally, we chose to use a KN95 mask as these are medically protective and our client Jim currently uses an N95 mask, while the design could be adapted to work well with any mask the client uses.

VOICE CONTROLLED REMOTE

Overview: A TV remote control for a client having Cerebral Palsy and minimal speaking.

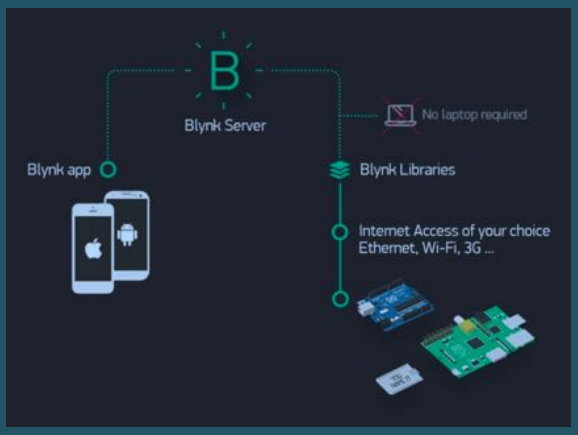
Status: Complete

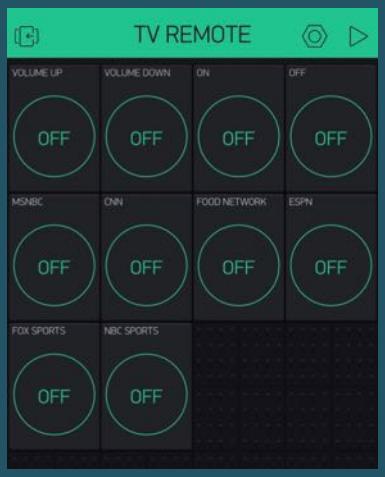
Members:

Mohamed Al Kooheji, Eeswar Adluru, Nikki Gharachorloo, Ryan Milligan

Client:

Max Plansky





The Need

The client's father needs to assist the client in operating a TV. The client would like to be able to operate the TV independently, including changing channels and adjusting the volume. The need is to enable the client to use a remote with commands with the use of his head switch.

The Solution

The voice controlled remote will allow the client to turn on/off the TV, go back and forth between the channels, increase/decrease the volume, and check the schedule of the shows on each channel at his convenience. The design includes an IOS app that allows communication between a head switch and TV and integrates the use of a head switch with an iPad to prioritize the client's comfort while using the remote. The TV remote interface is simple and accessible for the head switch.

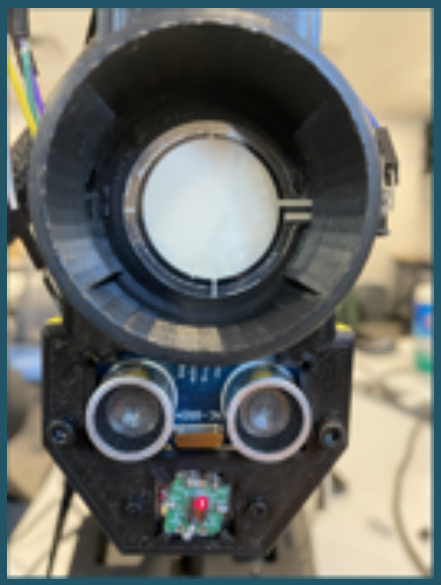
ATHELAS

Overview: An autonomous vitals measuring robotic arm device that assists nursing home populations.

Status: Completed

Members:

John Allen, Akhil Bagul, Kaylin Devchand, Christian Hardy, Unnas Hussain



The Need

The goal of this project was to alleviate the time, effort, and risk required of assisted living home staff during routine vitals assessments of residents. In nursing homes, common vitals tests check the respiration rate, heart rate, blood oxidation, and body temperature of patients that are particularly at risk. These tests are taken weekly or monthly and are usually done by a designated nurse. However, in the climate of the Coronavirus pandemic, these tests are recommended by the CDC to be done three times a day, thereby taking up the bandwidth of multiple healthcare professionals. These nursing home professionals are taking care of one of the most at-risk populations in the world. But with limited time and resources, it becomes difficult to maintain these vital assessments to the necessary degrees recommended by the CDC.

The Solution

Athelas robotic arm design allows for the biological measurements of a patient without the need for them to move or adjust very much. If the patient is sitting upright in front of the table, and their arms are already on a rest (for example, if the patient is in a wheelchair), the robotic arm can accommodate their position utilizing the patient tracking system and algorithm. The robotic arm allows the sensors to come to the patient, align with the patient's body, then gather the biological measurements. The robotic arm has five degrees of freedom allowing for complete 3D articulation. The sensor data is collected and displayed on the web interface. The arm's web interface displays the live information and allows for the user to command the arm's movements. The different sensors give the patient an overview of things they may need to check regularly such as blood pressure, body temperature, heart rate, blood oxygen, heart, and lung audio.

PUPPET SHOWPLACE THEATER

Overview: Develop an adapted rod puppet to assist puppeteers with disabilities minimizing their ability to control a puppet with the arms, wrists, and fingers.

Status: Completed

Members:

Alice Tsai,
Sarah Dunbar

Client:

Roxie Myhrum, Heidi Rugg, Daniel DeLoma
Brookline Puppet Showplace Theater

The Need

Puppet Showplace Theater is New England's center for puppetry arts. The theater is dedicated to presenting outstanding professional puppetry to diverse audiences through performances, workshops, and community outreach activities. It envisions a vibrant, welcoming, and culturally responsive puppetry center that inspires creativity and invites participation by people of all ages, backgrounds, and abilities. Some puppeteers have disabilities minimizing their ability to control a puppet with the arms, wrists, and fingers. The Puppet Showplace Theater has asked us to develop an adapted rod puppet to assist these puppeteers.

The Solution

We have developed a solution for puppet operation that reduces the strain for operating the puppets. The mechanism incorporates a rod puppet that can move the arms and mouth of the puppet with less strain on the user's arms, hands, and fingers. It is removable and usable on a variety of rod puppets. In the rod puppet mechanism, the 3D printed buttons drive the movement of both the arms and mouth. There is a 3D printed base to accommodate the movement and length of buttons. The 3D printed arms facilitate movement by buttons as strings are connected on the back of the arm from inside the rod. The 3D printed jaw has strings connected at back and rubber band in front.

RFID/BLE ATTACHMENT

Overview: The power to spontaneously explore new places for blind people

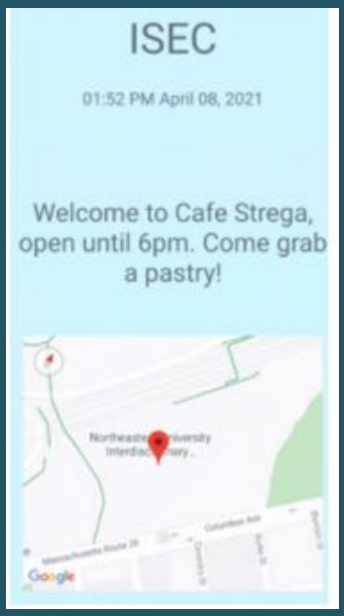
Status: Completed

Members:

Joshua Alter, Nick Craffey, Daniel Peluso, Nithila Raman, Neil Resnik, & Katharine Welch

Client:

Professor Mona Minkara



The Need

It is estimated that there are 285 million visually impaired people in the world who have been independently living and navigating in a world designed for seeing people. Despite modern technological advancement, there have not been great advancements for the visually impaired culture. Currently, there is no good option to read medium-range information such as billboards or hours on a storefront.

The Solution

Our product is a cane attachment that reads information off of markers placed around cities. The device can be used independently or it can be paired with a smartphone to offer more features. Static RFID tags are used for storing information that doesn't change often, like a room number, a street sign, or the name of a building. Bluetooth beacons are used to store richer, more rapidly changing information, like a restaurant and its menu or the T and its arrival times. An application is provided to update this frequently-changing information on the Bluetooth beacons. The user device reads from both the static RFID tags and the dynamic Bluetooth beacons and output this information over audio.

VIBRATING WRIST BAND

Overview: A sleek vibrating device indicating a person with hearing loss that someone is trying to speak.

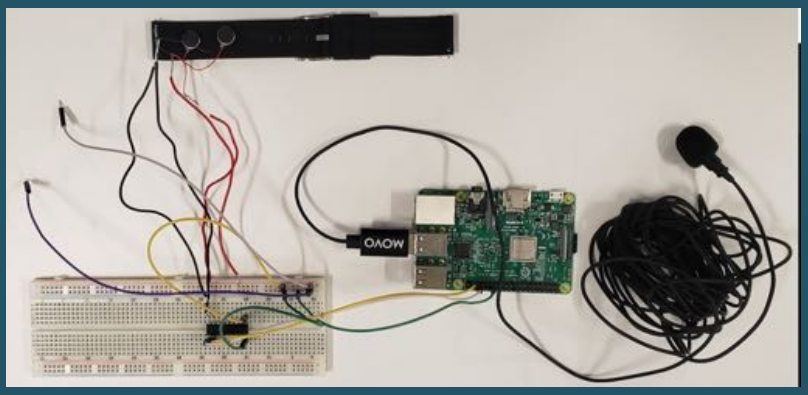
Status: Completed

Members:

Mahitha Appasani, Karizma Kishnani, Mohammedali Roowala

Client:

Erin Rosenfeld



The Need

People who are deaf or hard of hearing typically lose hearing sensitivity in one or both ears, and this hearing loss can be anywhere from mild to severe. While there are many devices to help people of this population communicate easily, if a person who is hard of hearing does not use any amplifiers, they typically cannot hear someone speaking to them when they are facing away from them. Additionally, it can be difficult to see people's hearing aids if they are concealed by head coverings or long hair. Therefore, our goal is to build a convenient and sleek vibrating device that can indicate to a person with hearing loss that someone is trying to speak with them would be a great solution to this issue.

The Solution

This product is affordable, convenient, and useful. It is wearable with a stylish wristband that contains a microphone along with a sensor and can vibrate when a human voice is sensed nearby. With this device, people who are deaf or hard of hearing can be notified if someone is talking to them. There is a frequency sensor inside the wristband that can detect the human voice, so frequencies between 200 Hertz and 10,000 Hertz. Along with the frequency bandpass filter, there is a volume meter to detect how close the sound is to the person. This can eliminate conversations that are farther away from the person so that the person isn't notified of irrelevant information. There is a button that the user can press to indicate that they are now aware of the sound and are engaging in conversation.

TEACHING TOOLS FOR VISUALLY IMPAIRED

Overview: Large US puzzle to facilitate learning in the classroom for visually impaired

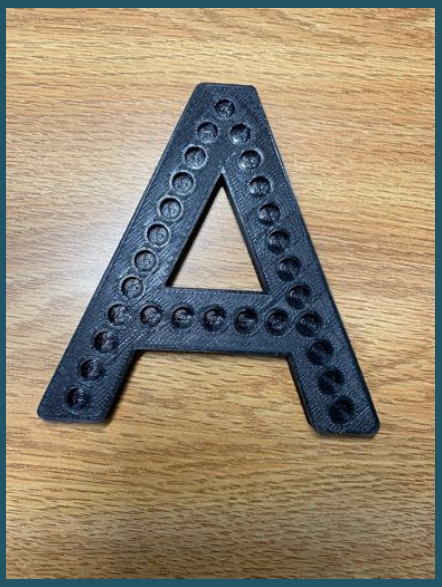
Status: In Progress

Members:

Kelsey Dupont, Tarak Bakhda

Client:

Diane Poirier



The Need

Students with visual impairments require special teaching tools to facilitate learning in the classroom. While learning United States geography, students need to understand the shape and size of states. Physical models of each of the states would allow students to hold and feel the outline of the state. Having the pieces come together like a puzzle would help students to learn where states are concerning one another. In addition to geography, students also learn how to read and write in the classroom. Physical models of letters would be a useful tool for students to learn what each of the letters looks like and to trace them with their fingers.

The Solution

Working on designing and building a large puzzle of the United States (approx. 5' by 5'), with each state its piece and true to shape. The pieces will be solid black with a bright red outline to accommodate students with CVI. A knob will be placed in the center of each piece for easy grabbing. Additionally, each puzzle piece will have a magnet to allow the pieces to stay in place while in the puzzle backboard. We will design and build five sets of alphabet letters (upper and lower case) in pompadour font. Upper case letters will be approx. 4" tall and lower-case letters will be approx. 3" tall. All letters will be solid black with a red outline. Letters will have raised bumps along with them for tactile tracing.

MULTITAP ACCESSIBILITY KEYPAD

Overview: A device for blind and/or limited dexterity individuals in their hand movements to communicate with a mobile device.

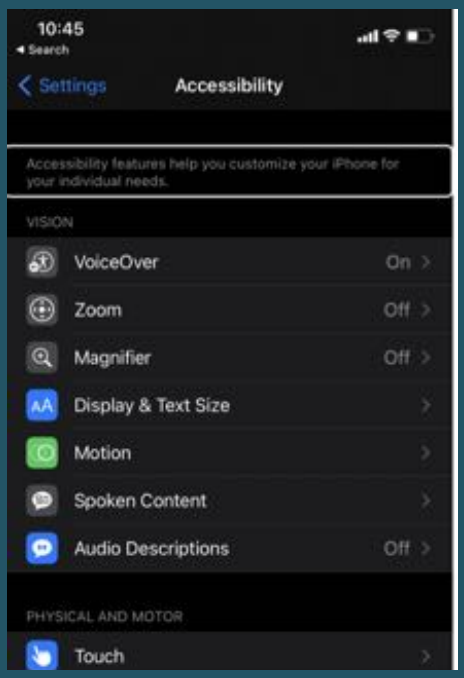
Status: In Progress

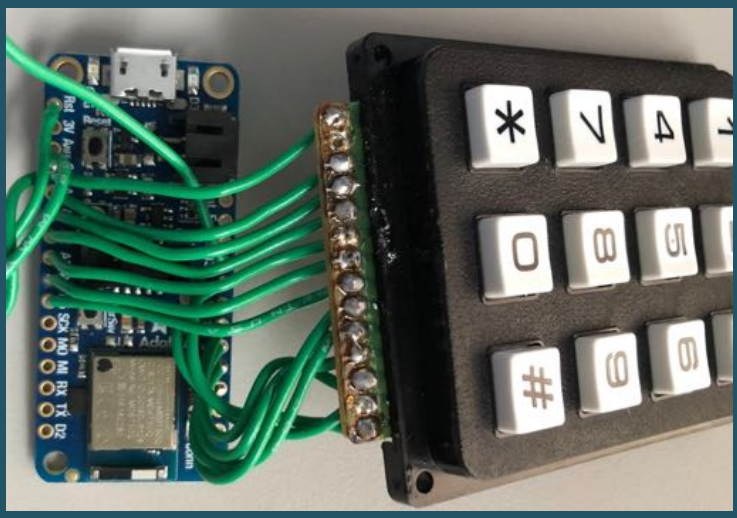
Members:

Jeffrey Zhou, Ethan Axelowitz, Evangelos Barous

Client:

Sina Bahram





The Need

The client is a blind man in his twenties with nerve damage that limits his motor function within his fingers, and an inability to speak in volumes above the whisper level. His left hand is completely non-functional and he can only use his thumb on his right hand in a non-swiping motion. Thus, he is unable to use any speech recognition as input; he must use a screen-reader and voiceover to know what is displayed on his device, and any input to his device goes through that right thumb. All current means of communication do not meet every one of Logan's specific needs.

The Solution

The MultiTap Accessibility Device is a wireless, keypad-based communication device that assists individuals that are blind and/or have limited dexterity in their hand movements in communicating with a mobile device. The Bluetooth device will utilize a 12-key, 4-row-by-3-column numeric keypad (as found on many fixed lines or older mobile phones) to facilitate both text input and OS navigation via VoiceOver. The device also features a speaker to provide audio feedback for normal operation (power on, BlueTooth connected, etc.).

ADAPTIVE GUITAR VERSION 2

Overview: Build a custom guitar that will help an individual with restricted motor skills play guitar

Status: Completed

Members:
Aman Choudhary
Fraser Shaw
Kerri Lehmann

Clients:
Brenda and Brian Manning

The Need

The client has limited use of the left side of his body but wishes to play the acoustic guitar. We have been tasked with creating an apparatus that allows the one-handed usage of an acoustic guitar. The design would be able to press chords and allow the client to strum at the same time with his right hand.

The Solution

Our solution is to make an apparatus that has a foot pedal, so the client is free to hold the chords down with his hands. The new structure includes making an attachment that holds the pick and can move up and down the guitar. The previous solution had the structure attached to a motor controlled by a foot pedal. It was an electro-mechanical system. The client had issues with the electrical part. Hence, our new solution is a structure attached to a purely mechanical system operated by the foot pedal and the bike brake wire. Although this does not allow for individual strings to be plucked, it allows for chords to be played easily.

X-MAX GAME CONTROLLER

Overview: Develop an alternative Xbox experience for a client with cerebral palsy

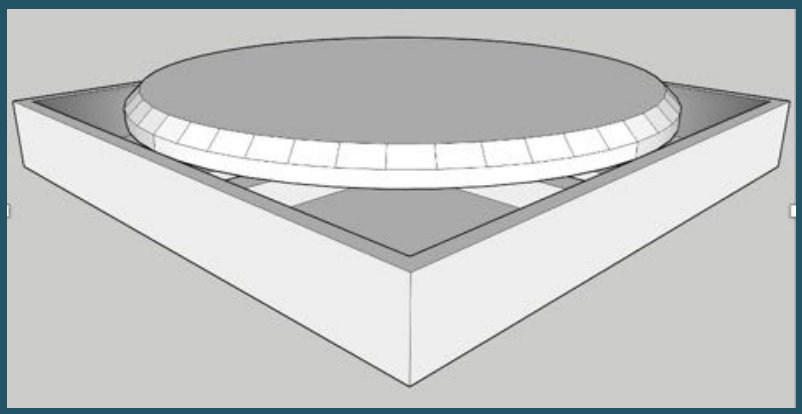
Status: In Progress

Members:

Sebastian Ardila, Matthew Luongo, Thomas Davie

Client:

Max Planksy



The Need

Our client who really enjoys playing video games has cerebral palsy. This inhibits his motor skills to the point where it is impossible for him to play video games. More specifically Xbox, using traditional control systems. Our controller aims to enable him to play XBox with minimal external assistance.

The Solution

Our current solution is an array of mechanical switches suspended around Max's head which allow him to control 4 of the 10 buttons on a traditional Xbox controller. The switches are covered with large foam pads to enable comfortable head operation. The recent update includes an inline companion controller so that an occupational therapist or friend can play the game with Max and aid him as he learns to use the device.

SENSORY WALL

Overview: To design a portable sensory wall for individuals with sensory impairments such as tactile and visual to strengthen motor and visual skills.

Status: In Progress

Members:

Arianna Ranalli, Alison Rogers, Jillian Lombardi, Teertihiveen Parsicha

Client:

LifeStream

The Need

Adults with sensory impairments require therapies to strengthen their motor and visual skills and sensory wall can be used to cater to this need. The sensory wall should serve as a mode to strengthen motor and visual skills that is conveniently portable. The items fixed to the wall will incorporate aspects of touch, sound, and sight with the intent of creating a stimulating device that will promote interaction with the environment for the users.

The Solution

The wall is composed of 3 panels and has dimensions of 50.4 inches in height, and a total width of 106.5 inches, with each panel having a width of 35.43 inches. The design is portable to be used in all patient care rooms, which was done by attaching wheels to the base of the board structure. Lifestream has requested that it demonstrate daily task skills such as light switches, doorknobs, locks, belts, and buckles. Additionally, sensory stimulation devices displaying and verbalizing commands to complete certain tasks will further exercise visual, auditory, and tactile sensory responses. These components will be completed using Arduino software and coding techniques by building off of existing Arduino projects currently available.

BLIND NAVIGATION MAP

Overview: Creating an 3D map of the Museum for visually impaired.

Status: In progress

Members:

Irfhan Shaw
Meher Sukhija

Client:

Ronit Minchom
Museum of Fine Arts

The Need

Individuals with visual impairments have been traditionally limited in their interactions with visual art museums. This project is focused on creating a 3D printed map of the layout of the Museum of Fine Art to enable individuals with visual impairments to independently orient themselves around the MFA.

The Solution

The primary objective is to enhance the MFA way-finding experience for individuals with visual impairments via a portable, tactile map by extruding the digital copy of the map to develop a physical 3D print. The map is easily transportable, tactile, and comprehensible. For transportability, we developed a 3D printed map booklet of the four levels combined by binder rings. While the booklet will be tactile regardless, we want to ensure that the tactile experience is comfortable and discernible. Lastly, to ensure the map is comprehensible, we plan on experimenting with various sizes, extrusion heights and symbol markers. We have completed the prototype of the first floor map and working towards designing the remaining floors of the museum.

YOU'RE WITH US! MENTORSHIP

Overview: *Increase social inclusion for individuals with disabilities via integration into project teams*

Status: Active

Member:

Brendan McManus

Collaborator:

You're With Us!

Overview

There is a huge need for social inclusion among individuals with disabilities. To ensure we actively engage with the populations we serve, we've partnered with You're With Us. You're With Us! is a non-profit 501(c)(3) organization and a Department of Developmental Services (DDS) service provider that creates inclusion opportunities for young adults with disabilities. The program identifies and trains college clubs, groups, and teams to welcome individuals with disabilities into their groups as they are. You're With Us! believes that a meaningful life includes a home, a job, family, friends and social opportunities with their peers - able and otherwise.

We've recently welcomed Brendan McManus, a member of You're with Us, into the Enabling Engineering family. Brendan has joined 2 project teams, Ponytail Helper (pictured above left) and Pedaling Music (above right). Brendan has a special interest in mechanical engineering and has supported both teams in assembling prototypes, determining dimensions, and brainstorming prototype improvements.

THANK YOU

Enabling Engineering wants to thank all of those that have made it possible for us to continue to scale our impact. We want to express gratitude to our collaborators for offering professional and technical expertise, our clients for providing essential feedback, and our donors for ensuring we have the resources needed to operate.

Enabling Engineering particularly thanks our major donors, without whom our work would not be possible:

Lanes Family
Richard J. Scranton Fund
Timothy Moore