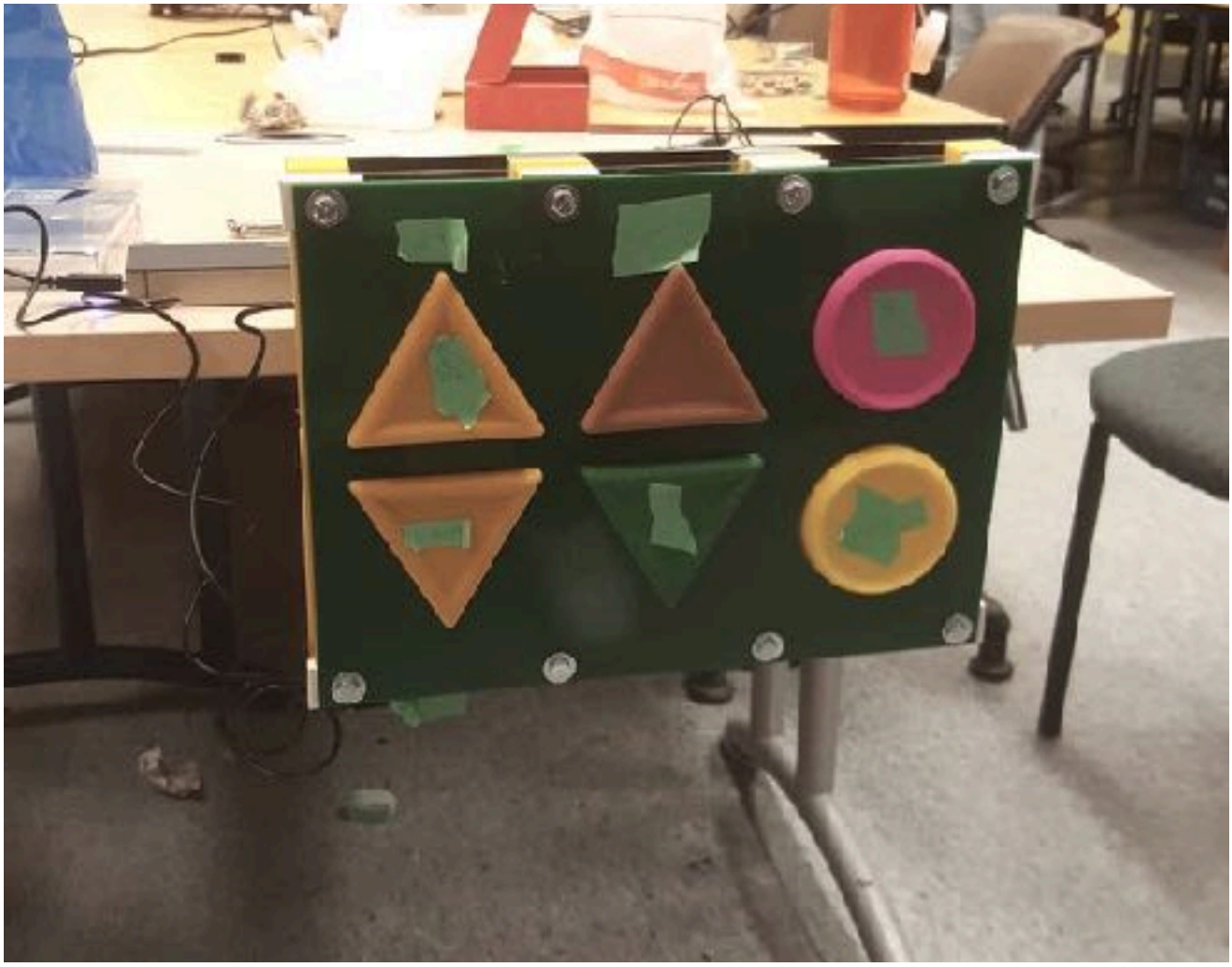

Foot Controlled TV Remote

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ABSTRACT

Objective

Our main objective through this project was to provide our client, Jorge, with a foot controlled television remote that would enhance his quality of life.

Solution

We created an oversized remote that would better fit his use, which incorporated his input on size, and how the device itself was mounted, along with other criteria.

Project Outline

By utilizing the tools given to us, we were able to create a working television remote for our client to be able to use with his foot. Throughout the semester, we have gone from basic brainstorming to a working prototype in a matter of months. By following the design process, such as establishing metrics, design and creation of a first prototype, to an economics report and a full fledged working prototype. Our group has created a product that we ourselves are proud to give to Jorge.

Our strategy to tackle this problem was to emphasize with Jorge as much as possible so that we could understand his problems. We had client meetings with Jorge to gather as much information as we could on his conditions and needs. This allowed us ideate possible design ideas for a TV remote. In this process we took into account benchmarking, costs, and measurements to ensure we could come up with feasible solutions. Once we selected an idea we began to enter the prototyping phase. The first prototype involved a simple model of our product. The prototype was meant to explain to Jorge what the remote would look like so that we could get his feedback. With Jorge's input we began the construction our second prototype.

When Jorge tested out our working prototype, he was able to operate it with ease. The buttons were big enough for his feet to use, which delighted him. Although we encountered many different obstacles, we were able to overcome many of them. One thing we would do differently is a better job of organization of documents, pictures and schematics keeping them all in one place would provide easier access and reference for the team.

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INTRODUCTION

Throughout our days, we do many activities starting with things like brushing your teeth, to eating food and using computers, to writing letters and watching TV. Now, imagine trying to do these things without the use of your hands. You instantly realize that it is almost impossible to do basic activities like these without the use of your hands. Cerebral Palsy is a result of a brain injury or abnormal growth of the brain during pregnancy which, "[…] affects body movement, muscle control, muscle coordination, muscle tone, reflex, posture and balance. It can also impact fine motor skills, gross motor skills and oral motor functioning" (1). For people with this condition, doing basic activities like these can lead to a frustration and depression due to fact that they cannot perform this activities like other people.

For our final project, we decided to work with a company named ComputerWise, to help a person name Jorge who has cerebral palsy (Fig.1). Jorge can't use his hands and has a lack of mobility in his legs. He is also not able to speak properly and has to use a computer aided software to communicate with others. When we read about the project, it told us that Jorge wanted to help design a foot operated TV remote alongside us, which he can use and wouldn't require the help of others.

When we met Jorge for the first time, we were able to empathize with him and also understand what his needs are for the foot operated TV remote. Jorge told us that he gets very upset and depressed when using his current remote because he isn't able to push the buttons easily. Since the buttons are small and meant to be used by a hand, Jorge ends up hitting multiple buttons at once and accidentally switching channels or turning off the TV.

Figure 1: Picture of our client Jorge in a wheelchair

Jorge told us that he wants a TV remote which can be attached to the side of a table and has buttons big enough to be pushed with his feet. These were his most important needs because currently he is using a normal TV remote taped to the side of his table and pressing the buttons with his foot (Appendix 1). After meeting with Jorge, we noticed how he operates his wheelchair with his left leg and realized that he crosses it over his right leg to push buttons and move the joystick around. This let us know the positioning of the remote. He requires that the remote be accessible by his left foot, but on the right side of his body. The remote needs to be operated at table height, and mounted perpendicular to the table, as the current one is

now. Another need that we discovered from the meeting was how he would interact with the remote. Jorge needs to be able to drive up to the remote easily while in his wheelchair, and position himself without a problem. It is required that he is able to see the remote past his tablet, which is positioned right in front of him, along with utilizing non-slip materials for due to him wearing socks.

As of now, Jorge is still using the small remote meant to be used by hands, with his foot. When we considered alternatives that have been made for people that have this type of condition, we surprisingly couldn't find any. This led us to further understand Jorge's pain because he probably felt like no one cared about him and didn't want to help him to do the things he loves like watching TV. Since there are no real foot operated remotes available as of now, our project will be a one of a kind in this regard.

RESEARCH & BENCHMARKING

During our research, 3 conceptual designs that stood out to us as being products that would rival ours are the three listed. While not exactly a match with our design, they did have the same intention in mind for the user, and for that reason we chose to benchmark with them.

Joystick remote

Although there was not much documentation for this design, it was intended to ease the strain on your hand in order to be able to use a television with greater ease. The goal itself was in line with our own, and as we researched this led us slightly further into ergonomics, but the remote was meant for use with hands, not feet, although foot operation was possible. This remote itself fell in line with the reasons in which we were creating a remote so we utilized it as a reminder that the end user should be always be first priority.

Hands free remote

The hands free remote involves a plethora of function buttons, which can control multiple devices. The function buttons provided on the casing are adapted for use by a foot of a user (2). This was potentially the closest to our actual functioning prototype, although we did not implement many of the design characteristics which they discussed in their patent, but pushed more so for a simpler design that would provide a easier user experience.

Foot operated controller

The foot operated controller is a practical control device having up to eight independent channels of communication for simultaneously operating a plurality of electromechanical devices or for simultaneously performing a plurality of independent functions on an electromechanical device, such as a prosthetic hand, includes a foot-operated controller and a microprocessor (3). Although the device sounds quite similar to our prototype, it is in fact quite different. The foot operated controller was a flat pad used under the foot, and used electromechanical buttons.

USER REQUIREMENTS

Our customer for which we are creating our project for is named Jorge, who is a disabled man, with limited use of his hands, along with not being able to speak. We are working with Computer Wise, which is a technology company which aims to provide independence to people with multiple disabilities.

Jorge operates a motorized wheelchair, and uses a joystick and two buttons connected to tablet with special software in order to communicate with others.

The largest need that he has is that he requires a larger remote than the one that he currently has. At the moment, he is using a normal television remote, taped perpendicular to a table, and pushing the buttons with his foot. Breaking this need down into 3 larger categories, we came away with positioning, how he interacts with the remote, along with the specifications of the remote itself.

Specifications that Jorge outlined for us were that it was required that we use buttons for him to be able to push, for the remote to be stationary (secured to the table) along with it to be plugged into the wall instead of battery operated. He needs large enough buttons for him to be able to push with his foot, along with separate buttons for each function.

PROBLEM STATEMENT

The main problem presented is that George cannot use his current television remote due to it being too small. He needs to be able to watch TV without being frustrated with his situation. The product that we are designing needs to be able to operate as a basic remote on George's current television as well as he has to be able to drive up to it and utilize it in his wheelchair. George must be able to see the remote past his tablet which is attached to the wheelchair, along with being able to reach the remote with his left foot (must be in his range of movement), and the remote has to be operated by foot. The product has to be evaluated by George due to him being the primary user.

POTENTIAL DESIGN SOLUTIONS

MAIN REMOTE DESIGN

Our team produced two different conceptual designs, in order to provide the most range of ideas to our proposal for Jorge when we presented the first prototype. Both concepts utilized 6 buttons, in order to match with the remote layout that he currently has (Appendix 2). We contemplated creating a keypad for Jorge's remote, but we wanted to create a functional prototype first that addressed his, before creating things that go above and beyond his expectations. Both designs also involved using an infrared Arduino kit to transmit signal to the television. Our team decided that the layout and size of the

button would be the same regardless of which design we chose, so designs concepts were a question of which mounting methods would be used.

MOUNTING SYSTEM DESIGN

Concept 1: Clamps

The first solution generated was that of a remote mounted onto a table, by the use of a vice-grip style clamp, and a mounting bracket to attach the mount and remote (Appendix 3). This involved a bracket similar to that of a Smith machine, to mount the remote (Appendix 4). The table mount would consist of 2 clamps welded to a faceplate in order to give a flat surface to mount the remote on. The clamps would be welded together to increase the structural stability of the remote.

This design is meant to be adaptable to any table that Jorge chooses to mount the remote on. The adjustable clamps make it so that the user is able to properly attach the remote to any surface the user chooses, regardless of its thickness.

Concept 2: Stand-alone Structure

The second concept we generated involved a stand-alone structure to support the remote, which was be based off of the design of a 4 legged chair (Appendix 5). The remote would be mounted vertically, and would allow Jorge to drive up to the device and use it accordingly. This would use the same remote that was explained earlier. The remote would be mounted on the structure using rails, in order to allow for vertical mobility.

Chosen Concept

We preferred these two solutions because we felt that they addressed Jorge's needs most accurately. By limiting the number of buttons, we are able to create bigger buttons than the current remote, enabling him to push them with ease which is the most important need in this project. We were aware that the Jorge's biggest cause of frustration was the lack of size of each of his buttons. If we minimized the size of the buttons for the sake of having a full keypad, it may prevent Jorge from pressing the buttons properly. However, future variations of this design could involve integrating a keypad while at the same time optimizing the button sizes for the user.

Both mounting devices were feasible, although solution 1 would need to have something to be mounted on, versus solution 2 is able to stand on its own. The biggest factor in choosing which solution

we were going to select depended on the exact placement that Jorge would be using the device, and the amount of freedom he wanted to have with being able to move the remote. We wanted to make the remote to be adaptable to Jorge's needs. If Jorge was to get a new table, or change the layout of his living room then he needed a remote that could adapt to the new changes and surroundings.

DESIGN CRITERIA

Some of the design criteria we used were:

- Performance
- Environment
- Aesthetics
- Safety
- Cost
- Ergonomics
- Maintenance and repair
- Usability

We wanted our product to performance up to the typical standards of regular TV remotes, as it is not ideal to have a remote that only works 50% of the time. An unreliable product would only frustrate the client more and defeats the purpose of this product. It is ideal to create the product out of recyclable materials if the product shall ever need disposal. Environmental friendliness is not the most important design criteria, but it was still put into consideration. We wanted a product that is aesthetically pleasing since the client shall use the remote on a regular basis having an ugly product may cause the client to not to want to use the product or even prevent them from purchasing it. Safety is considered a key design criteria an unsafe product warrants an injured client and also more frustration while using the remote if it is not designed with safety. We wanted a cheap cost effective product so the customer gets value for their dollar. An ergonomic product ties into safety an unergonomic product can potentially cause injuries to the users of the product. A product that requires minimal maintenance is both ideal and beneficial for the client and us as well. Minimal maintenance will drive the over money put into the product down though it may increase the initial cost. The most essential design criteria would be performance and safety, without these key design factors we would not be able to build a viable product for our client.

Customer Needs

#	Component	Description of Need	Importance (Scale 1-5)
1	Case, Size (Buttons)	Larger Remote	5
2	Structure, Position	Needs to be able to reach buttons with foot	5
3	Connection	Needs to be TV Compatible (IR)	5
4	Labeling	Needs to be able to see buttons and their functionality	4
5	Material	Needs to be able to push buttons without any hassle	3
6	Operable	Remote needs to function properly as a TV remote	5

Establishing Metrics

#	Need #	Metric	Units
1	1, 2	Dimension	Feet
2	3	Frequency/ Force	N
3	4	Length	cm
4	5	Density	g/cm^3
5	6	Frustration	N/A

Marginal & Ideal Value

Metric #	Metric	Units	Marginal Value	Ideal Value
1	Dimension	Feet	0.2’ x 0.2’ - 2’ x 2’	1’ x 1’
2	Frequency/Force	N	0	0
3	Length	cm	10-100	60
4	Density	g/cm^3	0.9 - 1.6	1.05
5	Frustration	N/A	N/A	N/A

DESIGN SOLUTION

Out of our design concepts, we chose to produce the foot remote clamp design as its adaptability was crucial for our client. The remote is a 38.9cm x 29.1cm x 4.5cm with 6 basic buttons on it: power, mute, volume up, volume down, channel up, channel down (Appendix 6).

The majority of the case was created using 3D printing plastic. Firstly the buttons were the most crucial pieces of our remote. They were big enough for a human toe to push as well as spaced out enough so that a user wouldn't press a wrong button by mistake. Additionally each button had a small indentation in it so that the user's foot would be guided to press the button (Appendix 7). The buttons were printed in such a way that springs could easily slide inside them.Each button was parallel to a base connected with a spring. (Appendix 8) Once the user pushed down on the button face with enough force, the button face would make contact with the push button underneath. The springs would then push the button pack up to prevent it from being constantly pressed. We used C-clamps for the mounting system, along with 2 sheet metal strips with holes so the remote can be adjusted for height. (Appendix 9) The C-clamps were very crucial in our design as they allow for the remote to be mounted on any table surface. If Jorge decides to change the table he mounts the remote onto, then it can be done so with ease. Eight nuts and bolts are used to hold the remote in one piece. This was done so that remote would be firmly fixed together. Our client Jorge has strong kick when he operates the remote with his feet. Therefore the collection of these nuts and bolts would ensure that remote wouldn't fall apart. To program the remote we used an IR receiver to pull the codes for a particular TV, then used an IR transmitter controlled by 6 buttons to send a particular command to the TV (Appendix 10).

CONSTRAINTS

Our foot operated TV remote was created specifically based on Jorge's needs and it was made using our own ideas. However, even though we came up with this idea ourselves, there are still mechanisms and parts of it which have their own patents and copyrights. After doing a search online for similar concepts we came across a few patents which related to our product and some of the mechanisms related to it.

The first patent that we found was titled, Foot operated controller and it was for a product which could control electromechanical devices. This product is meant to be a “practical control device having up to eight independent channels of communication for simultaneously operating a plurality of electromechanical devices” (3). The product mentioned in this patent is essentially a prosthetic foot which has 8 pressure sensors mounted at specific spots for user input and are connected to a micro controller. This patent is like our product in the sense that it is controlled by the user's foot and it sends a signal to an electronic device. Our product however is not based on pressure sensitivity, it has physical buttons that need to pushed for a signal to be sent and there are only 6 buttons. Also, the product that is patented sends a signal to devices by using a micro controller and a wire whereas our product uses an Arduino and an infrared L.E.D. The foot operated remote is also meant to be used by people who full control of their feet whereas our remote is meant for people who can’t fully control their feet.

The second patent we found was tilted “Hands Free Remote Control”. This remote can control a variety of functions. Similarly, to the remote we created, it is foot operated and meant for users who cannot use their hands. The remote also includes transmitters, sensors and an infrared emitter. The operation of the remote doesn’t require the manual use of fingers making it ideal for our client. This patent is very similar to our product in the sense that it is desired for a customer with a hands disability. Also, it's meant to be used with feet (similarly to Jorge’s remote). The functions of this remote closely match that of Jorge’s. For example: the remote has a casing with buttons with several functions, similarly to how our remote has buttons with functions such as: power, volume, and channel.

The third patent that we found was for something called Ergonomic television remote control. This patent was for a joystick approach to solving the problem of not being able to use your hands. The joystick had set commands for motion such as, pushing the stick up/down to change channels and pushing it left/right to change the volume . It however, does have smaller buttons to the side of the joystick which control the power the and other options. This remote is similar to our concept in the sense that it is meant to be used by your feet and also control a TV. It also works in the same way as our remote by using an Infrared LED to emit the IR signal to the TV. However, the key differences between the designs is that this uses a joystick instead actual buttons and it also puts more stress on the foot and requires more accuracy to make sure the joystick doesn’t turn while pushing it.

When looking at all these different patents, one can see that there are characteristics from each design that are similar and different to our Foot Controlled TV Remote. After doing our online search we were able to identify certain aspects that related to our product. For example, in the first patent the foot operated remote was meant to be used by people who were in full control of their feet whereas our product is meant for people who can’t fully control their feet. The second patent had almost the exact

same idea as our product in terms of customer needs and design. The only difference was that our product was more specific on the functions of the buttons. The third patent Ergonomic Television Remote control took a very different approach from the first two as it used a joystick to control a remote. However, this idea is very similar to Jorge's method of communication as he controls his tablet with a joystick. All in all, this research proves that there are a variety of solutions and methods that can be used to approach a problem.

PROTOTYPING STRATEGY & RESULTS

Our group had the chance to meet with Jorge only 3 times, so we had a limited amount of prototyping phases with him. The objective of the first prototype was to simply give Jorge an idea of what our product would like. Our strategy was to show him a non-working model of our remote and ask for Jorge's feedback.

Prototype 1

The first prototype that we made was made of basic household supplies because we just needed it to help Jorge understand what we were planning on making (Appendix 11). The prototype was broken into 2 main parts: the mounting system and the actual remote itself. The remote itself was designed to have only the 6 necessary buttons on it which are the power, mute, channel up/down, and volume up/down**.** The buttons were also different shapes based on their functions like the channel up/down and volume up/down buttons were triangles and the power & mute buttons were circles. Our team came up with three different sizes for the buttons (Appendix 12). After our 2nd client meeting with Jorge, he preferred the largest of the button size. The second portion of the prototype was the mounting system and this was made of a broomstick, some clips, and zip ties (Appendix 13). The mounting system attaches to the side of the table and also allows for some adjustability. The mounting system is easy to use and requires no maintenance once setup. After our meeting with Jorge, he said he was satisfied with the model of the mounting system of the remote.

Prototype 2

By our second prototyping phase our group had built a working prototype. This was the stage where our client would test out the remote. During the Design Day demonstration, Jorge had the opportunity to operate the remote and determine whether or not his needs were met. Thankfully the remote worked successfully for him, as Jorge was able to press each button and control the tv function with ease. Most importantly, the remote buttons were in fact big enough for Jorge's toes to press.

CONCLUSIONS

In summary we learned a lot about ourselves as individuals and team members, one key lesson that it is crucial to communicate and not only communicate but do so effectively. Planning is an essential part to stay productive and setting standards and goals well understood by everyone is a great place to begin. It's also important to recognize your strengths and weaknesses and use them to your advantage while benefitting the team's objectives.

We created a TV remote but on a larger scale, using an IR transmitter to complete the basic functions of a TV remote. The remote can be broken down into 2 components the remote itself and a mounting system. The remote is primarily 3-D printed and was originally modelled in SolidWorks, we also used acrylic along with the laser cutter for the remotes case and dividers. Sheet metal and C-clamps we used for the mounting system.

RECOMMENDATIONS

Some recommendations are that for future prototypes one should consider the precision of the 3-D printers while modelling the remotes components. Another consideration would be to create a more compact design ensure a lighter remote. Changing the method at which the button's click is another consideration to prevent jamming and having a smoother pushing motion.

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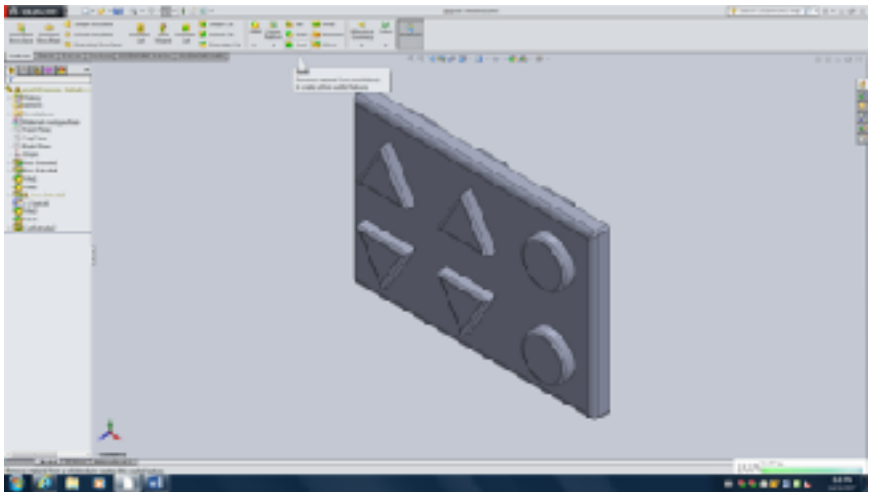
Appendix 1

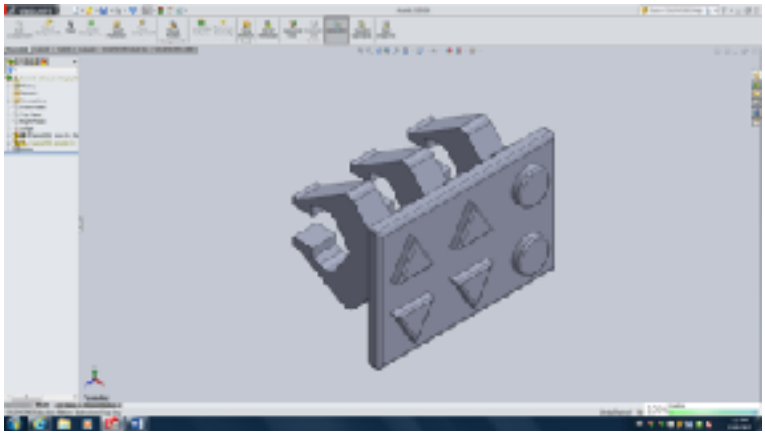
Jorge's Current Remote

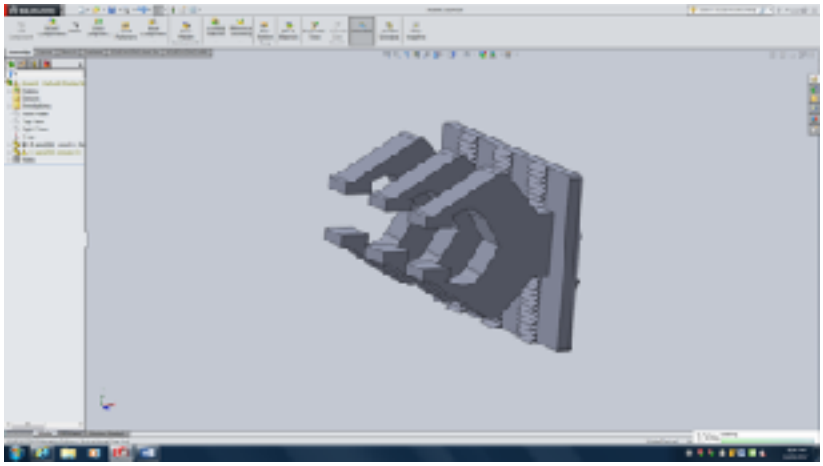
Appendix 2



STL Model of Remote

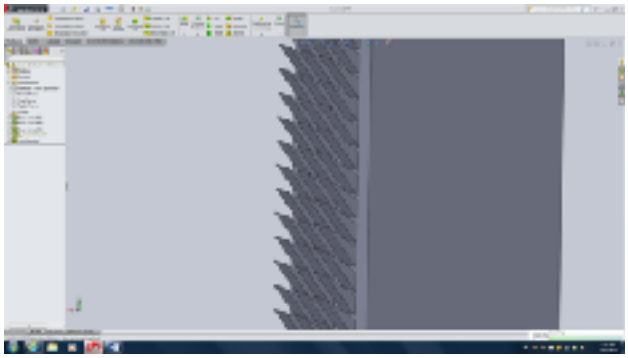
Appendix 3





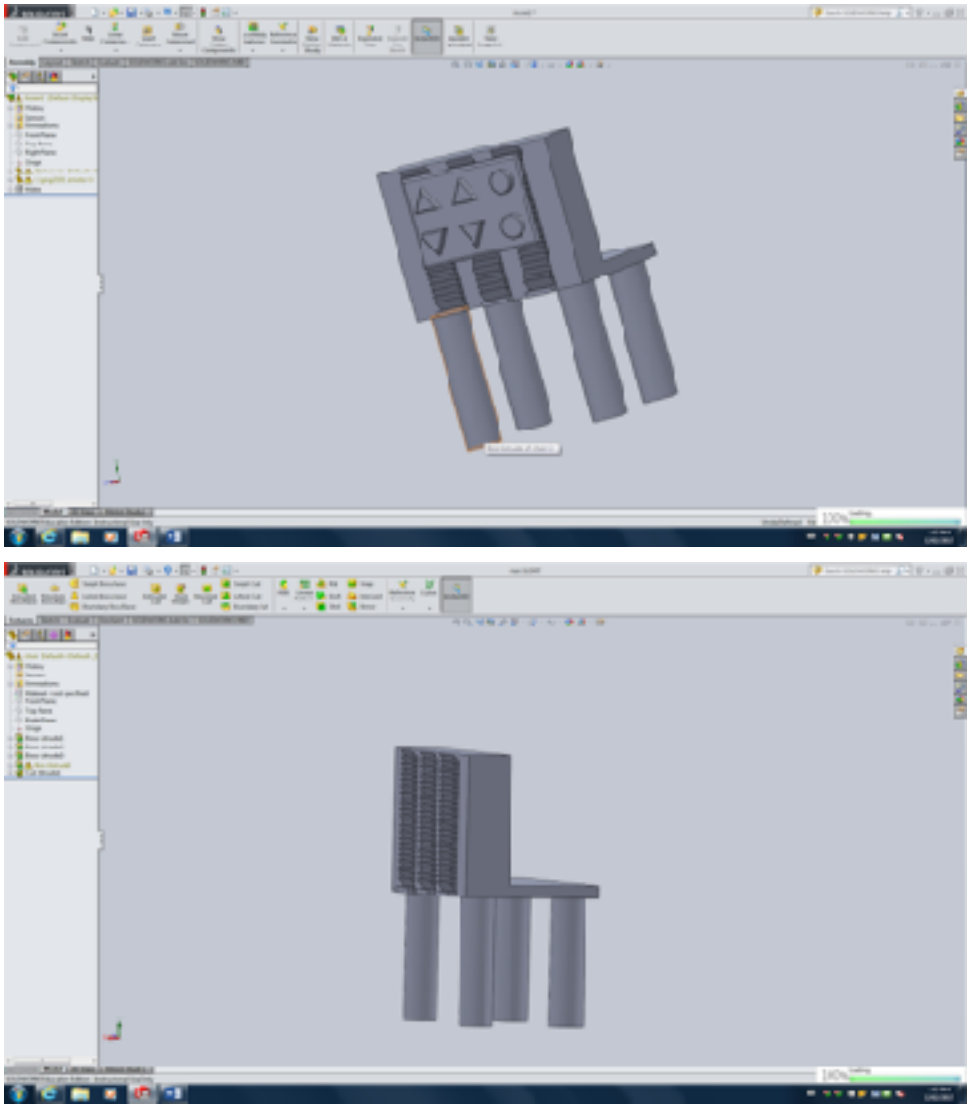
STL Models of the Clamp Mounting System

Appendix 4



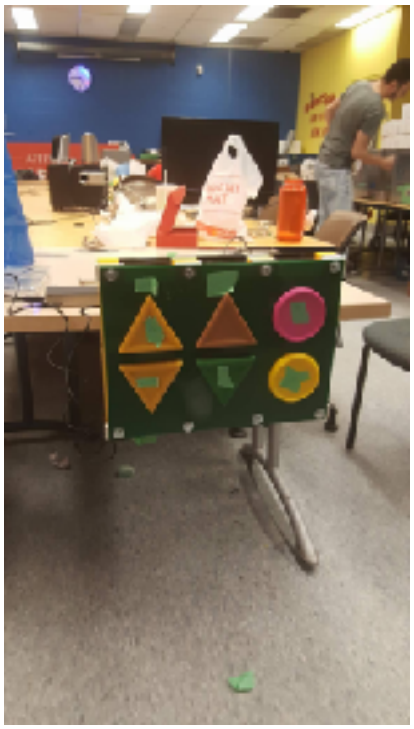
STL Model of mounting system

Appendix 5



STL Model of Stand-alone structure

Appendix 6

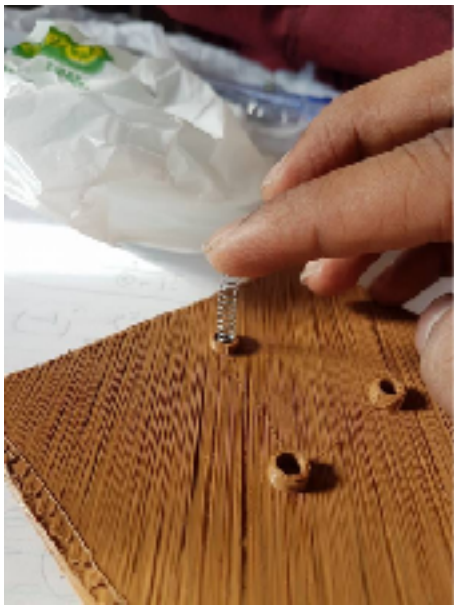


Picture of finished Remote

Appendix 7

Picture of a 3D printed button

Appendix 8



Picture of springs underneath of buttons

Appendix 9

Picture of the C-Clamp mounting system

Appendix 10

Picture of Arduino set up

Appendix 11

Prototype 1

Appendix 12

Picture of different button sizes

Appendix 13

Mounting System for Prototype 1

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