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Sound Glove: A Development in Collaboration

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SOUND GLOVE: A DEVELOPMENT IN COLLABORATION

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Abstract

Through design and technical work, the collaboration between the areas of Sound and Costume Design have been minimal. When these areas interact, it is usually for the small notes, like the shoes are too loud, or the jewelry is too much. However, in the following chapters I will propose a way to deepen the collaborative relationship between Sound and Costume through a prototype named the Sound Glove.

The Sound Glove has been developed through researching previous products, researching for materials, constructing a budget, developing applications of the Sound glove and then creating a prototype. With these steps, the following chapters will show the areas of collaboration that Sound and Costume Design can begin to develop or be created.

Introduction

Through experiences that I have had as a costume designer and technician on productions, it is very rare for a direct collaboration between a costume and sound designer to happen within a production. This separation is apparent, but it did not cross my mind until I was part of a production named *Gloria* by Branden Jacob Jenkins.

As costume designer, I communicated the story, the plot, and the environment of the characters with the costumes I designed inspired by the vision of the director. The sound design, by Shannon Marie O'Neal, was excellent and demanded considerable work. However, the director would have several notes for the sound designer during the technical process. For example, the story of *Gloria* takes place in an office, and the director believed that there were not enough office sounds, such has fax machines, printers printing, computer starting up, happening within the production. With the number of notes accumulating for the sound designer, it caused a strain in the sound team with the amount of hours of research and work that had to be done last minute.

As this all unfolded and I sat watching, I had a few thoughts. What can I do, as a fellow designer, to help sound with design? Is there some tool I can use in costume design that might help the sound designer and their team of sound engineers? Is there a link that I am not seeing?

The final conclusion I am came to in this situation was that there was nothing as a costume designer I could do to help to assist the sound design. While the conclusion of this scenario was disappointing, I left the experience with a new challenge. What would a more supportive collaboration between sound and costumes design look like?

What could be created to cement a collaboration between the tangible and intangible designs of a production?

With this new mission and support of colleagues and fellow artists, I set off into a new world of collaboration and reflection. In the coming months after this challenge arose, I conducted more research in on development in technology and possible application for a union of costume and sound design. Through the research that was conducted, I developed a project to create a new product to combine costume and sound technology for live performances. Not only would the product combine technologies, but also it would deepen the relationship between the costume and sound designer.

I am proposing to create a wearable finger triggered audio system that will produce sound in a small scale or large-scale theatre, called Sound Gloves. These gloves will create ambient environmental sounds that will develop the world of the performer and will act as a platform for storytelling. Throughout the thesis, I will be covering different aspects that led up to the construction of the prototype including the research into products that have come before, discussing further what the product is, and the application of the product for those who could use it.

While previous products are similar, I will show how the Sound Gloves I have developed will use these previous products as a base to develop the technology with new functionality. Most products that have come before are musically based and tell a story through instruments, musical keys and notes. The product I am proposing is environmental-based and will tell the story by creating the world of the performer with

these environmental sounds, such as a rustling forest, busy cityscapes and the calming beach.

With the ability to customize the Sound Glove, the application of the storytelling platform is inexhaustible. Additionally, I will be covering the use of the Sound Glove with applications extending beyond performers to audience members. For performers, the product can help create the world of the production for the performer or the audience they are performing to. For audience members, the product could give them an opportunity to participate in a production like never before.

Also, within this section, I will discuss the role of the designer to the relationship of the Sound Glove. It will highlight the roles of the costume designer and the sound designer. The costume designer focuses on the structure of the product. The sound designer focuses on coding the software and programing the sound effects of the product.

Following the application of the prototype, I will discuss the purpose of the Sound Gloves, materials I used to make the product and the budget developed for them. With the information gathered from previous products, I chose an affordable option for theatres and a material that will be simple to replace if it were to be broken. With the affordable material, the product becomes more customizable based on the production or story that is being portrayed. Also, with accessible software to program the Sound Gloves, the sounds are in line with the custom ability of the structure of the glove. With the combination of attainable hardware and software, it is possible for most regional theatres to have access to this new platform of storytelling.

Finally, I will cover the process of creating the prototype of the product, what I learned throughout the process, and the outcomes I gathered from building the prototype. By creating the prototype, the process of the costume and sound designer would become clear by me performing the tasks of both sound designer and costume designer as I perform the tasks for both the sound designer and costume designer. Other theatre companies could take this process and create or modify the product to suit their production’s needs. Others can also develop their own product from the research, application and process of construction

The process of the Sound Glove could be one way to deepen the relationship between the costume design and the sound design and establish an avenue to create a new form of storytelling.

History

As stated in the introduction, products of similar use to the Sound Glove already exist in the entertainment world. The previous products do entertain audiences and performers alike. The previous products can also tell stories. However, products found within the research are musically based. The gloves are used by musicians to create more movements that are restricted by traditional instruments.

This chapter will explore the various artists who have created the previous products and discuss what these products are. The chapter will also consider the varying materials that each product is made from. With this information it can lead to a deliberate choice of what the proposed product will be made from and how it will be made.

In the first product, they found a solution to untether the body from instruments and speakers in order for musicians to create movement with their music. Imogen Heap is a United Kingdom based musician who has many talents and a few different albums out. Heap also is accredited for her song “Hide and Seek” that was “reimagined for the Broadway play, Harry Potter and the Cursed Child” (Boilen).

Included within Heap’s talents, Heap is a “world-class audio engineer” and performer for her audiences (Pallister). Constantly, Heap found that the movements to create beautiful affects for her music were lacking an energizing movement. To just dial or press a key was not the same and not very performative for the audience. Heap was looking “to be able to reach inside into the software [she] love inside the computer but without having to stand next to it…” (Boilen). With more exploration, Heap and her team developed the Mi.Mu Gloves.

The Mi.Mu Gloves makes sounds through sensor technology and tracking the movement of a performer's hands. Through the software programming, called Glover, that comes with Mi.Mu gloves, a performer can change the pitch by lowering or raising the hand (Mi.Mu). The performer can also change the key to the gloves by moving their hands side to side. Performers can also program a certain key or note or effect to happen based on the hand gesture they do. Sounds produced by the gloves are similar to a keyboard or a synthesizer.

Heap's Mi.Mu Gloves are made out of a stretch fabric with sensors sewn throughout the gloves. These sensors inside the gloves track the movement of the hands including bends of the fingers and positioning of the performer's hands. How the Mi.Mu Gloves originally were able to connect to a sound network, or the Glover software, was with wires that were connected to a computer the main sound system and then eventually various amps.

However, the most current model of the Mi.Mu Gloves works through Wi-Fi connection to a computer connected to the main sound system in a performance space. Heap's Mi.Mu Gloves can be played to a small or large audience.

While the Mi.Mu Gloves are an incredible leap forward in the music industry, they are not entirely accessible to most people. Heap does explain that software is "open sourced and so is the hardware" and does encourage the exploration of her product (Pallister). However, this process does require time and plenty of knowledge in audio engineering. The Mi.Mu Gloves are currently for sale online for £2,500.00, or $3,344.83, for a pair as of 2020 (Mi.Mu). Mi.Mu gloves are also not available to be

made and shipped in a quick fashion. Once the gloves are ordered, it takes a couple of months before the product is on site and ready for use (Mi.Mu).

With the next product, the Remidi T8, the creators made a similar glove but it was more affordable and more accessible to the general public. The Remidi Team is a collection of musicians and audio engineers who are “inspiring and empowering creators while producing in the studio, performing live, and moving their first steps into the world of music creation” (Remidi). Remidi Team have created various platforms for artists to share their progress with their art, songs they have created with the Remidi product and showcase their process with the Remidi product.

Another way Remidi has worked towards achieving this goal is by creating the Remidi T8. Remidi T8 is a pair of gloves with sound technology throughout the construction of the gloves. The Remidi Team describes the Remidi T8 as the “world's first wearable device to record, play, and perform infinite combinations of notes and sounds” (Remidi). The Remidi T8 can make any surface into an instruments, or a performer can play an instrument in the air.

Similar to the Mi.Mu Gloves, the Remidi T8 can be programmed to make certain sounds, keys, notes, and effects based on hand movements that are tracked by the gloves. In addition, the programming software that Remidi has, named ReRoute, can be adaptable to any program that records music or sound, such as Garage Band, Amazon Live, or Logic (Remidi). Remidi T8 can also connect to the mobile app they created named ReMix. ReMix is used “to remix songs from the Remidi Contributors community” (Remidi).

Similar to Mi.Mu Gloves, Remidi T8 is made of stretch fabric with sensor technology. The sensors in the gloves are found at each one of the fingertips~~,~~ and three sensors in the palm (Remidi). Another tool that the Remidi T8 has in its hardware is a dial to change the instrument the gloves are playing. The Remidi T8 are also wireless, connecting to devices through Bluetooth technology, so there is no restriction of movement for the performer (Remidi).

Not only did Remidi build an accessible community of musicians looking toward exploration, but they make Remidi T8 more affordable for all musicians. For a single Remidi T8, it costs $349.00 as of 2020 (Remidi). This price is significantly less than the before mentioned Mi.Mu Gloves.

For performances using the Remidi T8, the best audience size is a small audience or recorded performances for later audiences to see and hear. Since the Bluetooth technology has not proven reliable yet in mainstage sound system, it is considered quite difficult to perform to a large-scale audience and have it be reliable.

The final product, that led to the development of the Sound Glove, is Onyx Ashanti's Kinetic Modular Exoskeleton (TED Archive). Ashanti is a jazz musician from Mississippi that is trained to play the saxophone (TEDx Talks). However, Ashanti felt that the saxophone made him too stationary and he wanted to be able to move with the music has he played it (TEDx Talks). Ashanti stated that when developing this new technology, he wanted his knowledge of his "culture" come from his mind "then [through the] technology coming out of [his] hands" (TEDx Talks).

Through research, Ashanti discovered the idea of developing the software through open-source forums on the internet and creating the hardware with a 3D printer

(TEDx Talks). To produce the hardware, Ashanti used a RepRap 3D Printer, a 3D printer that was invented by various collaborators around the world, that he built for about £500, or $693, then printed the hardware from the RepRap printer (TEDx Talks) (RepRap contributors). Ashanti developed head gear to go over his head with a mouthpiece attachment, like a saxophone, and developed two hand pieces with triggers to act as the valves on a saxophone (TEDx Talks). To create these pieces, it cost Ashanti £70, or $97.02 (TEDx Talks).

Ashanti's Kinetic Modular Exoskeleton uses sensors, similar to Mi.Mu Gloves and Remidi, in all the pieces to track the movement of the hardware into the software, that Ashanti developed, and will change the key to the triggers when they are pressed (TEDx Talks). The mouthpiece attachment also changes the pitch and the longevity of the synthesized music in the software when it is blown into (TEDx Talks). Ashanti's product can be used for both intimate performance spaces, and large-scale performance spaces by being connected to his software through a computer, to a main sound system and then to various amps in the performance space (TEDx Talks).

When developing the Sound Glove, I looked heavily at Ashanti's Kinetic Modular Exoskeleton for the hardware of my product and how I could grow from the Kinetic Modular Exoskeleton to create the Sound Glove and its unique qualities.

The products above focus on musicians and their connection to music. The Sound Glove would focus on performers and audience members and their connection to the production and their movements. With the Sound Glove, it is hopeful to combine the qualities of these products above, make these qualities more available and affordable, and create a product that can be used in theatres.

Application

Within this chapter it will cover who will use this product in the theatre industry. To be clear, the product can be used for others outside the theatre industry. In the future, one could produce the Sound Glove, or a different product following the methods that I perform in the prototype chapter, for various applications, not just performance of theatre productions. That will not be covered within this chapter. I will focus on performers, such as dancers and actors, as well as the audience members that come and see the production, and the designers who develop the production. The chapter will focus on the various ways these active members could use the product.

The chapter will include how performers can communicate the story of the production through performance. Performers can use movement and the product to affect the story and the environment of the production. It will include how the audience members can be a part of a production and affect the story of the production. The audience members can use the product to affect the environment of the performer and become a vital part of the production.

The final member of the theatre industry that will be covered in this chapter will be the designers of the production. The structure of the product can be designed to be part of the story of the production, which the costume designer could develop into the overall costume of a character. Also, the sound that the product can make can also be designed to affectively enhance the environment of the production, which the sound designer could focus on and develop the sounds of the environment of this production.

While each one of the roles above are a part of the theatre industry and focus on the story of the production, each one will have different functions with the

product. Within the next few sections, it will become clearer what those functions and devices could be with the product.

The performer can develop many parts of the production with the use of the Sound Glove and cues. One such example is the environment of the production. The performer can establish and develop the environment with the product.

With the product, that means that it will require fewer establishing factors, such as set pieces, light cues, or sound cues, to establish the environment of the production. This would include set pieces and prop pieces. This is beneficial especially on a low budget production, or a production with a limited amount of space, like in a black box theatre. Performers already work in conditions like this and use silent pantomime to establish the environment of the production. Now with the Sound Glove, performers can move their performances to the next level.

With the press of a button, the performer can be transported into a new environment. They could be placed into a city with traffic whizzing by. To establish the city, the next button is the sound of the wind blowing through the streets. The next button could be people chatting on the sidewalk. With the help of the performer and the use of the product, the production has now transported into a city.

To also help establish a new environment and add to the story of the production, the performer can also use body language and movement with the product. The performer can react to the environment that they have created. For example, how does a performer react to rain? Based on the character the performer is portraying, this reaction could go various ways. The performer could dance in the rain to portray joy of the character. The performer could run in the rain, which could show a range of

emotions including fear, anger, and desperation. The performer could also run for shelter, and the product can establish the shelter the performer is using to shelter from the rain.

Another example would be how a character react if in a meadow? What is in the meadow? What kind of creatures are in in the meadow? Are they friendly creatures, or dangerous creatures? Based on the sounds that the product can produce, such as insect noises, chirping from birds, and growling from creatures, and the movements and body language of the performer can answer these questions and more.

Using the Sound Glove, the audience is no longer a passive member in a production. The audience is an active member in the production and will not only affect the ways that performers will be reacting to, but also will establish a new experience that a production can bring to its audience members. Within this section, it will discuss on how the Sound Glove will change the participation that the audience can contribute to a production.

With the Sound Glove that is used by the audience, each audience member will have a unique experience. A unique experience can be an excellent addition for a production, and it is not the initial time that the theatre industry has given a unique experience for each audience member. Inspiration for this function of the product comes from a production in New York named *Sleep No More* (The McKittrick Hotel).

Sleep No More is a reimagining of the production of Macbeth "through a film noir lens" (The McKittrick Hotel). In this production which it takes place in a 5-story warehouse, where audience members are instructed to remain silent throughout the experience and to wear the mask they received at the beginning of the production. The

audience is then dropped off from of an elevator on various floors. Each floor has their own set of performers portraying various characters from Macbeth. The audience then is free to explore the space and free to follow any performer to follow their story through the space. Once audience members have decided who they are following, they have determined the path the production is going to take for them. Each performer will go to different locations, at different times, at different speeds to tell different stories. A performer could also determine to do a one-on-one experience with an audience member or completely ignore the mass of audience members following them through the warehouse (The McKittrick Hotel).

Since there is no way for audience members to experience the same production as the next the audience member, this causes each audience member to experience their own unique production of Macbeth. The appeal of this unique experience gives incentive for audiences to come back to *Sleep No More* to experience another aspect of the show that they had missed the first time.

Another show that is interactive for audiences' members, no matter the age, is Rania Ajami's *Pip's Island* (Elstein). Ajami is "a filmmaker and children's media director and the show's chief creative officer" who wanted to develop a show that would "make playtime better for kids and their parents" (Elstein). With the use of interactive technology, wearable technology and live and interactive performances, Ajami vision came true. *Pip's Island* is a "hour-long interactive journey" that allows children freedom "to move around from room to room as they join performers, puppets, and animated characters in a series of challenges that help the story unfold" (Pip's Island). The following is a description of *Pip's Island* from Aaron Elstein's article.

"*Pip's Island*, aimed at children 4 to 10, uses animation, video, music, puppetry and other media to tell the story of a boy and his friends rescuing a magical island from the evil Joules Volter and his moles. Children are encouraged to take part in challenges to earn 'sparks' on their light-up wristband. The show is spread through nine rooms, and as many as 50 people can see it at once" (Elstein).

The wearable technology that the children wear during their adventures in *Pip's Island* is "The Spark Badge", that was developed by Rosco DiSanti, the Projection Designer of *Pip's Island* (Pip's Island). DiSanti came up with this concept by being inspired by Disney's *Glow with the Show* Mickey Mouse ears, that follow the colors of the fountain show in Disney's California Adventure, that uses infrared receivers to change the colors of the Mickey Mouse Ears (Pip's Island). DiSanti wanted to achieve this magic of Disney within the badges, but instead of using infrared receivers, DiSanti decided to use esp8266 Wi-Fi module chip in the badges (Pip's Island). Similar to smart technology in homes, "The Spark Badges" uses routers, triggers, and Raspberry Pi Blynk Server to change the colors on the badges when the children earn their sparks from completing the challenges in the various rooms of *Pip's Island* (Pip's Island).

Taking from *Sleep No More* and *Pip's Island* and what they bring to their audience members, how can the theatre world create more experiences with audience participation? How can the audience participation be even more enhanced within a production? Finally, how can an audience member affect the production more than just their physical presence in the room? To answer all these questions, the Sound Glove is the solution.

With the Sound Gloves, audience members can now affect the environment of the performers with their own set of the product. Each audience member could be given a set of the product if the production schedule allows it. While it may be expensive for a

larger audience, for a smaller audience it can be quite affordable. For example, to create 20 Sound Gloves, or 20 sets of the gloves or 40 individual gloves, it would be $2,000, without the purchase of a 3D printer. Compared to the Mi.Mu Products, that were discussed in the history chapter that costs £2,500, or $3,464.96, for one pair of gloves, this is quite an affordable option (Mi.Mu).

When creating these gloves, they can be made with general sizes. With the general sizes, the Sound Glove can then be used by most audience members. The costume designer can decide what these general sizes are, and how the Sound Glove looks on the audience members hands. The designer can also decide if all the audience members' glove the look the same, creating a unifying look for all the audience members, or make the gloves with only a few different colors, creating groups among the audience members, or make the Sound gloves all unique and making them all different. Any of the choices the costume designer makes, with collaboration of the sound designer, would create an unique experience for audience members participating in a production.

The sound effect will then be heard from the audience's glove and a performer, whoever is closest to the audience member, can react to the sound effect. The sounds programmed into the Sound Glove can also vary. Each Sound Glove could be programmed differently with various environmental sounds. If each product is programmed differently by the sound designer, it would create a more unique experience for audience members. This is all based on what the needs of the production and the time allotted to the production.

On the other side of the spectrum, all of the Sound Gloves could be programmed the same. While the sounds could be programmed the same, each member of the audience will have different experiences in a production. This is due to the fact that performers could react differently to different stimuli.

Once the audience member introduces a new aspect of the environment, it is the responsibility of the performer to react to it with improvised reactions, or reactions achieved through rehearsal with the sound effects. The performer can react to the stimuli like the way discussed earlier in the chapter but will react to stimuli when it is presented to them by an audience member. Of course, if there could be a lot of stimuli produced by many audience members, there are ways to limit the reactions. Some suggestions would be to have a director give each performer a certain sound to react to. With this direction, a performer would be able to tune out other stimuli and only listen for a few different sounds, or one particular sound.

Let's examine the rain example once again. A performer hears torrential rain from an audience member. The audience members are now having an effect on the production. Once again, the performer will react to the stimuli with various reactions including dancing, running, trying to keep dry, embracing the rain and so on. Once the performer reacts to the stimulus, it is now part of the environment of the product.

As performers react to the stimulus with their own different improvisation or direction from a director, they are creating a unique experience for the production and for the audience member. Similar to *Sleep No More*, the product and the performer are creating a reason for audience members to come to another production. The product and the audience member are also creating a unique experience for the performer to

perform various reactions from various cues. The product is creating a new section of the production with each production run for both performers and the final cast members, the audience.

With such an interaction between performers and audience members, it is important to set up accepted boundaries[1] and accepted trust [2]among the performers and the audience members. By establishing the boundaries and trusts, it will help avoid injury to, and cruelty from, performers and audience members. I will not be covering in detail how to establish these boundaries and trusts and what these boundaries and trusts should be. Each production, company, crew and company will need to establish boundaries and trusts based on the needs of the script, production, cast and crew. However, I will offer this example.

When a person participates in a haunted house, whether they're a performer or a haunt house participant, the basic understanding is that one will get scared inside the haunted house. To avoid injury or too much cruelty in the haunted house, the haunted house creates a boundary between the performers and the participants by creating the rule of no touching. The performers cannot touch the participants and vice versa. By setting this boundary, it also creates a trust between performers and participants to trust that they will not touch to prevent injury and putting anyone's safety at risk.

The product not only affects the performance of a production, but also all areas of design. Scenic design does not need to be as detailed with a black box set and using

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[1] "In psychotherapy there is a need for rules and expectations to be discussed and agreed upon in order for the relationship to be acceptable and successful for all parties" (Barnett and Hynes).

[2] "In an ongoing relationship, future actions or deeds may not be specified; rather, there is a mutual attitude of goodwill. Such relationships involve 'accepted vulnerability to another's possible but not expected ill will' (Baier, 1986, p. 236)" (Tschannen-Moran and Wayne 557).

blocks as furniture and shelter. Props can also now be represented through the sound that the Sound Glove can be produce, such as a doorbell, a phone ringing and more. Lighting could eventually be incorporated into the design of the product with more technology added to the product to create more of a spectacle. The last prospect is the product could also not only control sound, but also control lights and projections.

However, I will be focusing on the two areas of design. In the two areas of design, I will focus on the collaboration of their design and their individual designs. In this section it will focus on the costume design and the sound design.

While both will develop designs to further the story of a production through the product, each will be developing the product in various ways. The costume design will further the story of the production with designing the structure of the product with focusing on who will be wearing the glove, the symbolisms in the story and what the designer wants to represent. The sound design will further the production by focusing on the programming of the product and determining the sounds that the product would produce. With the collaboration of the costume designer and sound designer, the development of the product is fulfilled and can move the production further.

To begin the costume design process with the product, first is to consider who would be wearing the product. Based on who will be wearing the product, which could be a performer or an audience member, will change the design of the product. The costume designer can use measurements of the hand to create the glove that will fit the performer. For the measurements that can be used for the glove would be the diameter of the fingers, the wrist measurement, and many more. The full set of measurements I used can be found in the Prototype chapter. The costume designer can also create

various shapes that the design requires in Tinker CAD, a free online drafting software, to create the pattern of the glove and add to the design of the glove (Autodesk). How I used Tinker CAD can be found in the Prototype chapter. Also, the costume designer can determine the color and structure of the product by choosing the plastic filament and the color of the filament. In collaboration with the sound designer, the costume designer can also determine the location of the hardware of the sound unit on the glove, that will be covered in the next chapter.

For the sound design process, the sound designer will focus on the software and programming of the software on the Sound Glove. The sound effects that the designer decides to implement can move the plot forward and enrich the story with this new technology. To connect the components, the designer can decide on the type of connection of the hardware and how to showcase the wires that make this connection with the collaboration of the costume designer.

The suggested steps above for collaboration do not need to be the only collaborative steps. Collaboration between designers should be done each step of the way, even though tasks can be done separately. Within in the Prototype chapter, I will be going through the tasks I developed for each designer. Normally the tasks that I undertook would have been done by two separate designers, but I decided to work on the project on my own and do the tasks of both designers.

The Sound Glove

In this chapter, I will cover the main purpose of the product. The section will also cover how the product will achieve the purpose that it is sought out to be. It will also cover how the purpose will be beneficial to the theatre community.

Next, I will cover what exactly the Sound Glove is. It will discuss what choices were made to create the product. While similar to other products from the previous chapter, the new product will combine the success of the gloves before and create a more customizable and affordable option.

Finally, I will look at the materials that will be used in the creation of the Sound Glove. The section will also focus on the benefits of these materials. Mostly to focus on the accessibility of the materials, the affordability of the materials and the customizations that can be done with the materials. With all these aspects investigated, it will clear the way for discussions on how to make the product and who this product will be for.

There has been discussion of wearable technology in the theatre industry that is for storytelling for productions, performers and audience members. The main purpose of this product is have wearable technology that produces sound effects on cue. The Sound Glove will use buttons, hardware, and software on a self-contained system to create environmental sounds to reflect the environment of the production to performers and audience members.

The options are endless to help develop the environment of the production. Using the Sound Glove, a performer can be transported to any environment. While scenery can also support the environment, the product can support richer environments with limited scenery pieces.

The performer will be able to work their own sound board in the glove to enhance the sound design of the production. The performer can also seamlessly transition from scene to scene to new environment without running crew moving set and prop pieces to the proper place.

For the product structures, the Sound Glove will be similar to the products that have come before. The Sound Gloves will have buttons on the fingertips that will trigger environmental effects. The buttons will be connected to a Micro: Bit, “a pocket sized computer”, with Alligator Clips in the Ground port, GND, Pin 1 port, and Pin 2 port (Micro: Bit). The buttons will then be connected to the Mini.MU Speaker, a small Sewable speaker sold by Mi.Mu company, with another set of Alligator Clips with the same ports (Amazon). Once the buttons are triggered with a push, the Micro:Bit will send a message through the buttons to the Mini.MU Speaker and then it will produce sounds that is programmed into the Micro:Bit.

Within the prototype chapter, I will discuss how I connected the hardware, the software and the structure, with images of the construction.

Alligators Clips may not be a long-term secure connection for a final product of the Sound Glove. However, for the prototype of the Sound Glove, the Alligators Clips are easier to experiment with and can always be changed at a future time. The Micro: Bit is then connected to a Mini.MU Sewable Speaker that then produces the sounds of the environment.

All the products that are stated above are easily available. With availability to all these products, it will be simple to produce this product for a single performer, or an audience.

The Sound Gloves also are incredibly affordable compared to the other products on the market. With limited purchases, the product will rely on a one-time purchase of a 3D printer, roll of plastic, the hardware and software, it costs less than $1000. The Sound Glove could be created less than the previous products, such as the Mi.Mu gloves at £2500, or $3464.96 (Mi.Mu).

In Table 2.1, the table supplies the materials needed for the product, the price of the product, quantity of the product and the source of the product. To discuss the accessibility of the materials, all of materials can be purchase over the internet. Most materials can be purchase through Amazon as well. Open to all and fairly easy to find with a simple search on Amazon. For a couple of the materials, one would have to look at other places. The buttons for the product can be found on Yahboom, a technology-based website (Yahboom).

Table 2.1. Materials for 1 Glove.

Name of Material	Price of Material	Quantity of the Material	Source
Sunlu Pla 3D Printer Filament, PLA Filament 1.75 mm Dimesional Accuracy +/-0.02 mm, 1 kg Spool, PLA	$23.99	2	Amazon
micro:bit BBC2546862 go, Original Version	$19.50	1	Amazon
Pimoroni Mini.MU Speaker	$11.99	1	Amazon
WGGE WG-026 10 Pieces and 5 colors Test Lead Set & Alligator Clips, 20.5 inches (1 PACK)	$5.99	2	Amazon
Yahboom button module compatible with alligator clib/DuPont line/ PH2.0 cable	$2.99	3	Yahboom

List of materials for 1 glove of the product. The total for 1 glove in the product is $100.42.

Another tool that is needed for the product is the 3D printer for the structure of the glove. The structure of the Sound Glove will be created out of Thermoplastic

polyurethane filament, TPU filament, a Flex material that “is a very strong and elastic material” that can make it easy for the wearer to bend their fingers, and move their hands (Prusa 59).

There are a variety of 3D printers on the market. The one used to create the prototype is the Original Prusa i3 MK3S. However, this unit costs $749.99 for the build your own kit (Prusa Research).

For an available and affordable option, there is a unit named RepRap 3D Designer. The RepRap Printer is a 3D printer that was invented by various collaborators around the world. On their website, they supply a free blueprint on how to create the RepRap 3D printer. To purchase the supplies for the RepRap 3D printer, it will cost about £500, or $693, and the time to create the printer (RepRap contributors). Once the printer is created, it can be used for the product and many more projects in the future. The printer can then also be used in the many ways to customize the product.

The Sound Glove can be customized with all the materials that are listed in table 1. For the 3D printing, the product can be designed through 3D printer software, such as Tinker CAD. Tinker CAD is a free internet software through Autodesk and accessible through the internet (Autodesk). With this software, the product can be designed with various patterns, that could hold motifs, symbols and much more. The design can also be customized based off of a performer’s hands. This will give the performer comfort while performing in front of audiences. Also, with the TPU filament’s flexibility it adds to the comfort and flexibility on the performers’ hands.

Once the product is ready to be printed, the product can be printed in various colors. The product could combine a number of colors to create a pattern or symbolic

design or have a solid foundation of one color to unify the look of the product. The product could be printed with colors that match the costumes of the character the performer is portraying. The product could also match the skin tone of the performer to have it blended into the performer. The only limit to this customization is the availability of the materials on the internet and the flexibility of the materials that one would want in the product.

For the software of the product, it is just as customizable. The Micro: Bit can then be programed with various sounds effects that correspond with sensors when pressed. The signal is then transferred to the speaker and the product produces a sound.

As Table 2.1 represents, each item does not have a large price tag. No item, other than the 3D printer, has a price tag higher than $25.00. To create the whole product, the estimate for 1 glove is $100.42. Compared to previous products that have come before, this costs 28.77% of the cost of the cheapest product. At this price, the product makes the technology accessible to most performers, companies and more.

With exploring the cost of the Sound Glove, what the Sound Glove is, and the purpose of the Sound Glove, it is clear what the steps will be to create the prototype. In the next chapter, I will discuss my journey through creating the prototype of the Sound Glove.

Prototype

With all the knowledge that was gathered from the other chapters, the ground plan was laid out and could now be built for a prototype. As a prototype, it is not perfect, and it will not be the final product. The prototype is to act as the first step on the many step process for future artists to explore and develop further.

A software that was extremely effective and helpful with the whole process was OneNote. With OneNote, I could develop a digital journal to record all aspects of this document including meetings with advisors, questions I developed through the process and resources I found to help with the product. To record each day, I used the software OneNote to document my notes, images, and videos of my progress.

The way the chapter will be set up is based on the days of working on the project and what was accomplished on those days. For the full process, it took about 30 days to create the prototype. Each day there were successes and failures. When a hypothesis was successful, I moved forward with the project. When a hypothesis failed, I would learn from it and revisit it the next day. Again, this is so future artists, designers and technicians can learn from my process and develop their own action plan to create a product that will strengthen the bond between sound and costume design.

To begin the process on Day 1, I experimented with the Micro: Bit to develop more knowledge about this “pocket-sized computer” (Micro: Bit). I began the process with the Micro:Bit because I knew I would need more time to understand the software section of the product rather than the hardware of the product. I opened the package and found inside there was the Micro:Bit, the battery pack, a USB connector,

and 2 AAA batteries. Once I plugged in the Micro:Bit, it had me play games to make sure that the Micro:Bit worked. It did work so I moved onto the next step.

The next step was to go to the official website of Micro: Bit (Micro: Bit). Once visiting the site, it gave me options of programs to program the Micro: Bit with.
The options were MakeCode, Python, and Scratch. MakeCode is a program that Micro: Bit developed for students with “colour-coded blocks” (Micro: Bit). Scratch is a similar coding system used by both students and professionals to code the Micro: Bit again with color-coded blocks (Micro: Bit).

Figure 5. 1. The Back of the Micro: Bit.

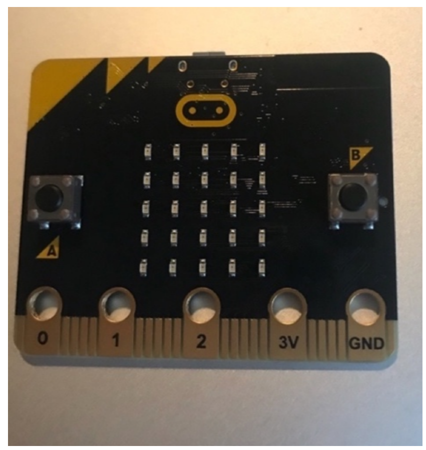

Figure 5. 2. The Front of the Micro: Bit.

After reading the options, I found the best program for me was Python. “Python is a text-based language used widely in education, and by professional programmers in areas like data science and machine learning” (Micro: Bit). The reason I did choose this option is how widely it is “supported by a huge community of educators and computing experts” because it was “designed with teachers and learners in mind” and how it is used “by professional programmers in areas like data science and machine learning” (Micro: Bit). With choosing Python, it also made me hopeful that another artist with a

higher skill set in computer programming could use Python and make the product more customizable for their personal or professional use.

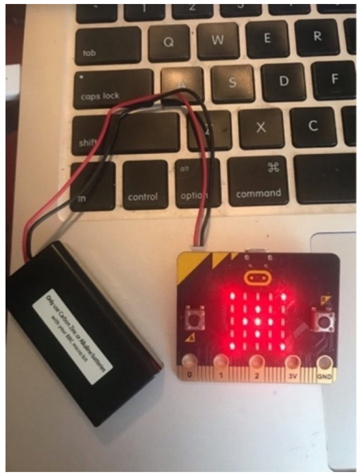

Figure 5. 3. Micro: Bit with Battery Pack doing the Snowflake Program.

Once I decided on the programming system, I continued with the tutorial of the Micro: Bit. The tutorial had me program the Micro: Bit to scroll “Hello World!” across the display. After that programming, I did one more tutorial I found on YouTube to have it tell the temperature of the room. If it got too cold, the Micro: Bit displayed snowflakes on to the dashboard of 25 LED lights (Hackster.io).

I conducted more research into the Micro:Bit and found that there was reference guide on how to program various actions, including games, lights, and sounds, onto the Micro:Bit using Python (Micro: Bit). The reference guide is called the BBC Micro:Bit Micro Python (Micro: Bit). With all the information gathered for the Micro:Bit on Day 1, I felt comfortable moving forward in designing the structure of the product on Day 2.

To start my Day 2, I had started my software and gathered supplies I would need to develop the structure of the product. The software I used to develop the structure was Tinker CAD, a free software system to design various structures (Autodesk).

Before I started building any structure though, I took in depth measurements of my left hand. Table 5.1 has all the measurements of my left hand in inches.

Table 5.1. Hand Measurements in Inches.			
Wrist	7	Pointer Finger to Mid Thumb Arch	4 ½
Duck	9	Thumb to Mid Thumb Arch	3
Back Arch of Hand	5	Thumb Arch Total	7 ½
Palm Arch of Hand	4	Knuckle Diameter	8
Middle Finger to Wrist	7	Space between Thumb and Pointer	2
Pointer Finer to Wrist	6 ½	Space between Pointer and Middle Finger	½
Ring Finger to Wrist	6 ½	Space between Middle and Ring Finger	½
Thumb to Wrist	5	Space between Ring to Pinkie Finger	½
Pinky to Wrist	5	Diameter of base of Pinkie Finger	2
Middle Finger Length	3	Diameter of base of Ringer Finger	2 ½
Pointer Finger Length	3	Diameter of base of Middle Finger	2 ½
Thumb Length	2 ½	Diameter of base of Pointer Finger	2 ¾
Ringer Finger Length	2 ¾	Diameter of base of Thumb	2 ¾
Pinkie Finger Length	2 ¼		

List of measurements used in the digital flat patterning[3] of the Sound Glove.

Once I took all the measurements, I developed the pattern pieces of the product. The product will be put together with pegs through holes int the seam of the plastic pattern pieces. The product will go together similar to a garment. The pattern pieces would include pinkie finger pattern, ring finger pattern, middle finger pattern, pointer finger pattern, thumb pattern, wrist pattern, battery pack pattern, and Micro:Bit pattern. Each pattern will need to print twice, once at the original size of the digital flat pattern, and then printed again at 10% larger than the original.

[3] "A system of making flat, 2 dimensional patterns that when sewn together create a desired fit" (Isn't that Sew, LLC)

When I started to develop the pattern pieces in Tinker CAD, I changed the settings of the grid to inches from millimeters in Edit Grid (Autodesk). I then created the main structure of the shape using a combination of squares, rectangles, circles and triangles. With Tinker CAD, shapes can be inserted onto the Workplane as solid shapes or as holes to easily modify the structure of the available stock shapes in the Tinker CAD Gallery (Autodesk).

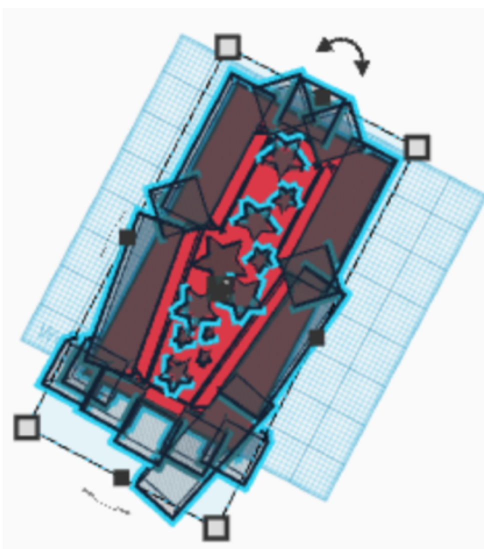

Figure 5. 4. Version 1 of the Ring Finger Pattern Ungrouped in Tinker CAD.

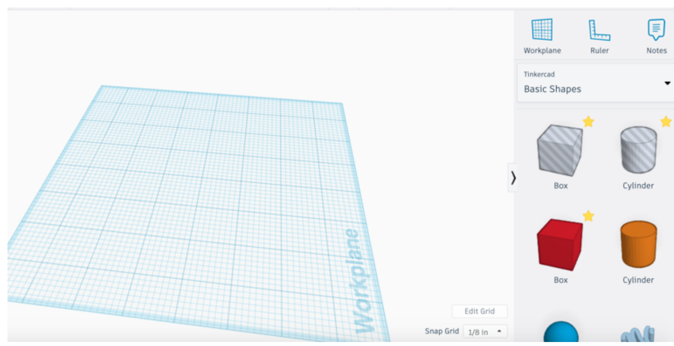

Figure 5. 5. Tinker CAD Workplane.

To create these patterns, it was a lot of trial and error. However, I did develop a method that worked the best over time. First, I create a base layer that would hold the entire pattern. For example, the middle finger would be 1 1/2 inches wide and 7 inches long, so the base has to be 3 inches wide and 8 inches long to hold the quarter inch seam allowance on each side of the pattern piece as well as the pattern piece itself. I then made the thickness of the base at 1 ⁄ 8 inch.

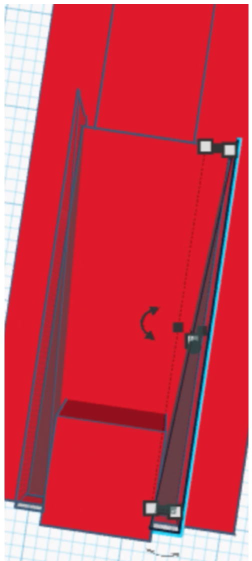

Figure 5. 7. Above View of Pinkie Finger Pattern to Create the Bottom Edge of Pattern in Step 4.

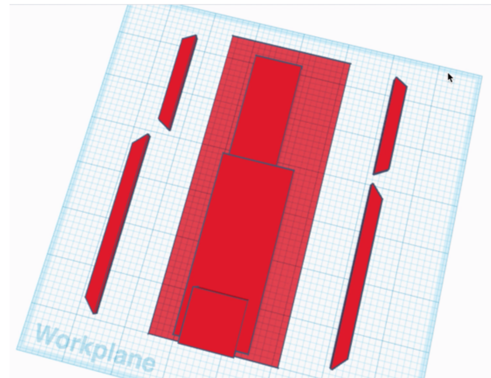

Figure 5. 6. Base, Rectangles and Seam Allowances of Pinkie Finger Pattern for Steps 1, 2, and 3.

Second, I lay 2 rectangles on top of the base. I make the first rectangle the length of the finger and the width is half of the diameter of the finger, and 1⁄4 inch high. To determine the length of the second rectangle I take the length of the finger to the wrist minus the length of finger. The width is 1 inch wider than the finger with a 1/ 4 inch on both sides of the finger, and an 1⁄4 inch high. For example, here are the dimesons of the middle finger pattern. The first rectangle dimension is 3 inches in length, 1 1⁄4 inches in width, and 1⁄4 inches high. The second rectangle dimension is 4 inches in length (7 inches minus 3 inches), 2 1/4 inches wide (1 1/4 inches plus 1 inch), and 1/4 inch high. The rectangles are then stacked on top of each other, and it is time to move on to the next step.

Third, I created the seam allowance on the sides of the rectangle. For the seam allowance dimensions, they are the length of the previous 2 rectangles and 1/4 inch wide. There should be seam allowance on each side of the rectangles. I wanted to create a trapezoid shape from the rectangles, so I used the square hole, an easily

accessible shape in the Tinker CAD Gallery, shape in the to create 45-degree angle cuts. The reason I chose this shape for the seam allowances to create foldable wings to be able to connect the patterns together.

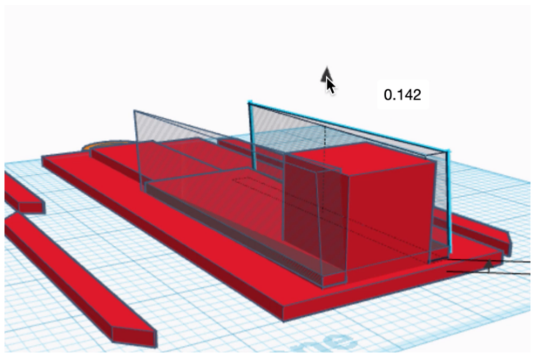

Figure 5. 8. Side View of Pinkie Finger Pattern to Create the Bottom Edge of Pattern in Step 4.

For my fourth step I restructured the bottom of the pattern to fit the wrist and create more of a trapezoid shape. The width of the pattern at the bottom edge depended on the pattern piece. I had to make sure all the pieces added up to the wrist measurement. For the middle finger pattern piece, I made it an inch. To make this shape, I had to use a wedge hole to make the bottom edge 1 inch and meet up with the top edge of the second rectangle. I made sure the wedge hole does not go through the 1⁄8 inch base so the main pattern piece could be connected to the seam allowances. Then I grouped the shapes together, and Tinker CAD cuts away the excess rectangle. I then created a seam allowance for the bottom edge in the same process as before.

For my fifth step I moved the seam allowances to the edges of the rectangles and changed the angles so the seam allowances were right next to the edges developed edges.

For my sixth step, I reshaped the top of the finger with multiple square holes by changing the angles to create a rounded top. Similar to the last hole, I made sure that the square holes don’t go through the base. I then grouped these boxes together to create the round shape on the top finger. I also developed a seam allowance for the top of the finger. To create this seam allowance, I took the ring shape and then used a square hole to cut it in half. I shaped the ring to fit on top of the finger.

After I created this shape, I grouped all the parts together. I then had an entire block all put together and it could be moved and resized as one piece.

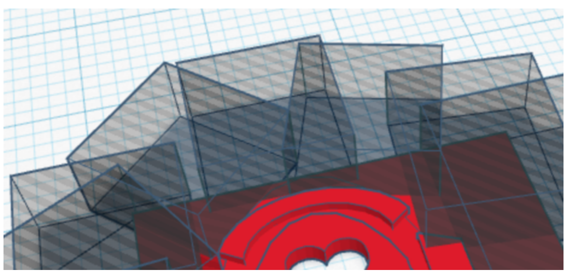

Figure 5. 9. Square Shape Hole to Create the Rounded Top of the Pattern discussed in Step 6.

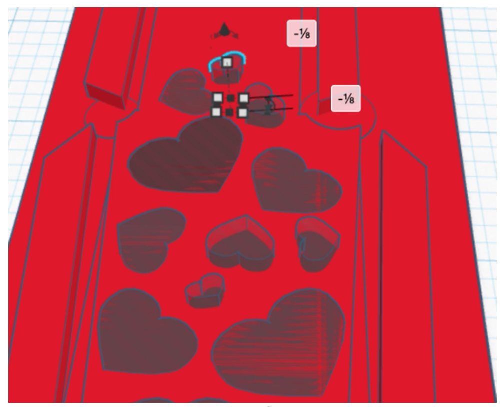

Figure 5. 10. Heart Shaped Holes Cut into the Pinkie Finger Pattern as discussed in Step 7.

The seventh step was to cut away the excess with similar methods that were used before. However, now these shapes could go through the base so it will cut away the rest of the base. During this time, I also added my shapes to the pattern pieces. These are all custom and unique to each pattern piece. I then grouped the holes to the shapes, and it produced the final pattern piece. Each pattern piece may have small deviants from these steps above, but to create the shapes of these patterns, this is the main method I followed.

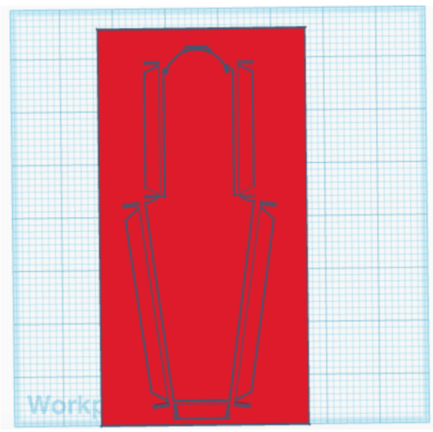

Figure 5. 11. Middle Finger Pattern's Base in Tinker CAD.

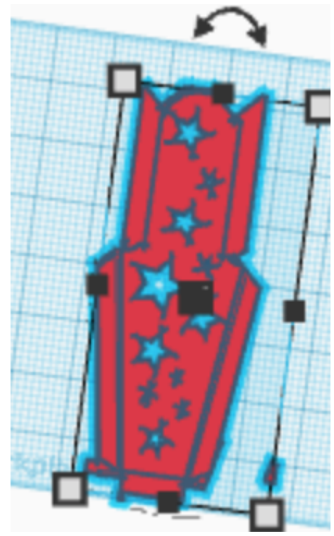

Figure 5. 12. Version 1 of Ring Finger Grouped in Tinker CAD.

To create the initial Middle Finger Pattern, it took about 3 hours to develop. It is because it took a while to develop the shape through the measurements that were taken before, working with the Tinker CAD software, and perfecting the shapes of the product.

To create the Middle Finger Pattern, I spread the 3 hours through Day 2 and Day 3 due to eye strain from staring at the computer too long without eye protection. The best eye protection I have found that helps is the blue light glasses. The blue light glasses protect eyes from the blue light that is produced by screens of electronics. Without this protection, blue light affects sleep, and “research shows that it may contribute to the causation of cancer, diabetes, heart disease, and obesity” (Harvard Health Letter). In my case, it caused eye strain and then migraines.

To continue my journey, I found protection for my eyes and continued on Day 4. From developing the Middle Finger Pattern, I developed a patternmaking method that was as efficient as possible to create all the solid pieces first before putting holes into the pattern piece. I found that it was difficult to go back and fix the solid parts of the

pattern once it had holes in it. With this new information I moved onto the next pattern piece, the Pointer Finger Pattern.

However, it seemed like the Tinker CAD system wanted me to take another minute to think about the pattern because the Tinker CAD system crashed for about a half an hour. With the extra time, I thought about the shape of the pattern and realized this pattern would look different then the Middle Finger Pattern due to the connection to the thumb at the thumb arch.

Finally, Tinker CAD finished updating, and I was able to continue to build the pointer finger section. The process for the Pointer Finger took about 2 hours to complete. After the pointer finger section was finished, I started the ring finger. The process of the ring finger was similar to the design of the middle finger. To create the pattern, it took less than an hour.

With each pattern it appeared I was going faster and faster. Two patterns, the pointer and ring finger pattern, were created in 1 day compared to 1 pattern, the middle finger pattern, created over 2 days. As each day passed, the faster I would get.

On Day 5, I took a break from developing the structure in the software and focused on the hardware of the structure. As stated in previous chapters, the product is created out of TPU flexible plastic filament. These pattern pieces would be printed on “The Original Prusa i3 MK3S+ 3D Printer” (Prusa Printer Information).

Before I was allowed to operate the printer, I had to consult with the Professional in Residence - Properties Designer/Mentor, John Eddy of the Louisiana State University on using the 3D Printer and make sure the 3D printer was working functionally. I scheduled a meeting for a later date to be working with the 3D printer. To

be prepared to work with the 3D printer, Eddy printed out and gave the manual of the printer to me to read about using the 3D printer properly. Eddy also informed me that the best way to transfer information to the 3D printer is through an 8GB SD Card. Eddy suggested I would find out how to transfer this information from my MacBook Pro to the SD card. Luckily, my MacBook Pro was one of the last models to have a SD card slot for the SD card to be easily inputted into the laptop.

I took the time during this day to read the manual. While reading the manual, I found out more background information about the printer and the basic parts of the printer. It also covers the safety instructions when using the 3D printer.

The background information was to learn more about the author of the manual and inventor of the Prusa Printer. The author of the manual and the inventor of the Prusa Printer is Josef Prusa (Prusa 3). Josef is “one of the leading developers of Adrien Bowyer’s international, open-source, RepRap Project”, which was discussed in earlier chapters (Prusa 3). Prusa’s main goal of the 3D printer to “make the technology more accessible and understandable to all users” (Prusa 3). Prusa has an ambitious goal developed with the 3D printer.

“In his own words, he imagines 3D printers will be available in every home in the not-too-distant future. ‘If anything is needed, you can simply print it. In this field, you just push the boundaries every day” (Prusa 3).

Next, the manual describes the parts of the printer and offers a glossary. Glossary is as follows:

“*Bed, Heat Bed, Print bed*- The commonly used term for the printing pad – a heated area of the 3D printer where 3D objects are printed.

Extruder- The printing head also known as an extruder, is a part of a printer consisting of a nozzle, hobbed pulley, idler, and a nozzle fan.

Filament- The term for plastic provided on a spool. It's used throughout this handbook as well as in the LCD menu on the printer.

Heater, Hotend- Other names for a printing nozzle.

1.75- 3D printers use two different diameters (thickness) of filament: 2.85 mm (commonly called as 3 mm) and 1.75 mm. Worldwide, the 1.75 mm version is used more, although there is no difference in printing quality" (Prusa 7).

The safety instructions of the printer covers important points. Some the important safety instructions that stuck out to me were to not touch the nozzle or heat bed when the printer is printing or warming up, to not leave the printer unattended while it's still on, and "plastic is being melted during printing which produces odors" so make sure to "[s]et up the printer in a well-ventilated place" (Prusa 8).

With this information, I felt confident about working with the 3D printer at the meeting I would have with Eddy. However, I needed to prepare more by developing the rest of the patterns for the product.

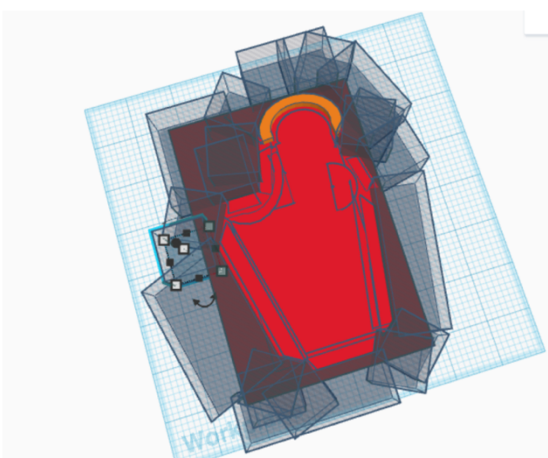

Figure 5. 13. Thumb Base in Tinker CAD.

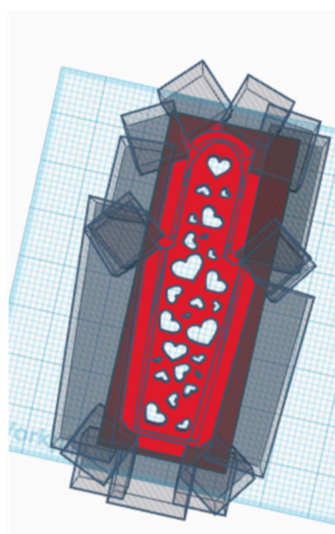

Figure 5. 14. Pinkie Finger Pattern in Tinker CAD.

For Day 6, I finished developing the patterns for the product. The patterns include the pinkie finger pattern, thumb pattern, and the wrist pattern. To create the pattern pieces, it was similar to the other pattern pieces. Each piece took about 45 minutes to create.

With the patterns developed, once the 3D printer was set up, the patterns could be created immediately. However, I would discover that to set up the printer would be harder than expected.

To begin my first day with the 3D printer on Day 7, I downloaded the software, Prusa Slicer (Prusa Research). Prusa Slicer is a software developed by the Prusa 3D Printing company for their printers. The software transfers the information from a computer to an SD Memory Card and then to the printer.

This is how the product would be transferred from Tinker CAD to the printer. In order to transfer the information from Tinker CAD to the Prusa Slicer, I had to download the pattern pieces to my computer as an STL. file[4], or an OBJ. file[5]. While starting the printer, Eddy decided to calibrate the printer since it had been a while since the printer had been used. When doing the calibration of the machine, the printer detected issues with the amount of power coming into the printer. The printer needs at least " 90-135 VAC[6], 3.6 A / 180-264 VAC, 1.8 A (50-60 Hz[7])" for it to work (Prusa 7). We changed the location of the printer and plugged the printer into a different outlet. Now with enough power, we moved forward with the calibration.

[4] STL File stands for Stereolithography File (Pacyga 60).
[5] OBJ File is open format file created by Wavefront Technologies (Jones and Nevile 62).
[6] VAC stands for "volts-alternating current" (Gutschick and Kay 1126)
[7] Hz stands for "Hertz, unit of frequency" (Ode 10).

Even with enough power, we still ran into errors in the XYZ calibration[8] while trying to do the First Layer Calibration[9]. With a lot of research on the Prusa forums, we found it could be the PINDA probe[10] being too close to the heating bed (Prusa Research). This still did not solve the problem, and Eddy and I ran out of time. We were going to meet the next day and were hoping to have help from the support center. Although nothing was printed during this day, I did learn more about the printer. For example, I learned how to move the axis of the printer so I can move the printer's extruder and arm to clean the printer properly[11]. I also learned how to clean the printer[12]. While learning this new information, I could say at the time I was discouraged in my ability to print the product myself.

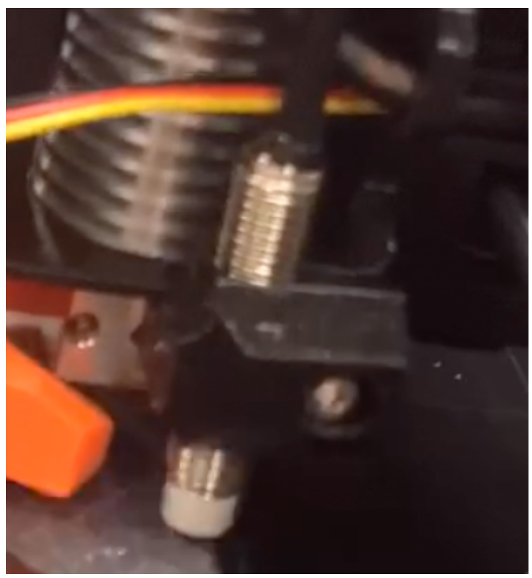

Figure 5. 15. PINDA probe on Prusa Printer.

[8] XYZ calibration is a "routine" to "measure the skew of the X/Y/Z axes" on the printer and "to find the position of the 4 calibration points on the print bed for proper bed leveling" (Prusa 19).
[9] First layer calibration is used to "calibrate the distance between the tip of the nozzle and the probe" (Prusa 26).
[10] PINDA stands for "Prusa Induction Autoleveling" (Prusa 19). PINDA probe senses the Heatbed through magnetics and temperature to make sure the extruder does not touch and scratch the Heatbed (Prusa Research).
[11] To move the arm of the printer, go to the main home screen. Select Settings. Select Move Axis. Select XYZ. Then use the dial to move the arm of the printer (Prusa 69).
[12] To clean the Heatbed, use isopropyl alcohol (Prusa 15). To clean the extruder, "use a wire brush to clean the nozzle from the outside" and "[h]eat the nozzle before…" (Prusa 69).

To continue my process on Day 8, I did find a new solution in case the 3D printer that I had access to would not work. On the Louisiana State University campus there is a CxC Design Lab[13] that has their own 3D Printers. If I make an appointment with the CxC Design Lab, I can email them my patterns as a stl. file or obj. file and they can print them off for me (Louisiana State University). The benefit to doing this procedure would be I would not have to print the structure myself. I would have more time to focus on other aspects of the prototype, and there would be a guarantee that the prototype would be printed. The con of using the facilities is that it does cost money to print with the CxC Design Lab (Louisiana State University).

I did decide to schedule a meeting with the CxC design lab to print the prototype. To start the process, I had to register for an account with the CxC design lab. I had to create an account with them so I could prove that I was a student at Louisiana State University and could use their facility (LSU CxC).

After creating the account, the process was quite simple. The webpage took me to a calendar with hour time slots to schedule a time, even though the printing would be happening asynchronously from the meeting time. Once the time and date were supplied, the website gave information on what hardware it would be using, the type of file they needed, the process of the print, the price, and an estimate on the amount of time it would take for the print.

I then answered questions that the CxC Design Lab asked. Some of the questions that they asked were if "this appointment was related to a course

[13] CxC, "Communication across the Curriculum", "…is a multimodal, multifaceted program that works to improve the writing, speaking, visual and technological communication skills…" (Louisiana State University).

assignment?", what was the "purpose" of the appointment, and what would be the "[d]ate and time the assignment is due" (LSU CxC).

Once all the questions were answered, I submitted some of the patterns and an initial informational page since I would not be meeting with a person face to face to go over what I expected from this print.

The patterns that I submitted were the pinkie finger pattern and the thumb pattern through the form. I would submit the rest of the patterns, middle finger pattern, pointer finger pattern, and ring finger pattern, through an email to the design lab. The CxC design lab sent me a confirmation email at the end of the form to verify that I had signed up for the appointment.

What I found from this experience was the CxC Design Lab uses the same printer that I have access to, the Prusa i3 MK3S (LSU CxC). This gave me hope for the printer I have access to because maybe I could contact someone on Louisiana State University campus to help troubleshoot the 3D printer that I have access to.

I also found that the CxC Design Lab uses a PLA filament[14]. PLA filament is a strong plastic that holds its structure well and is very resistant to the elements (Prusa 56). While PLA filament is a strong filament, it is not as flexible as a TPU filament or flex filament (Prusa 59). This flexibility is essential for the product and the prototype. With both the pro and con of using the facility, the printer and the filament, I would continue to work with the 3D printer I had access to try and make it work.

On Day 9, I received emails between Eddy and the customer service agent of Prusa. Within the emails, Eddy explained the issues that we were experiencing and

[14] PLA stands for Polylactic Acid filament. PLA filament "is the most commonly used material for 3D printing" (Prusa 56).

asking the agent to help troubleshoot the issues. The agent noticed that the issues arose after we had updated the firmware on the printer. The agent suggested that we downgrade the firmware to an older version and see if that solves the problem. Eddy and I planned to meet in a couple days and try to work with the printer again.

For Day 10, I emailed the CxC Design Lab with questions about the print. I took a day to be prepared to work with the 3D printer the next day and wait for a reply from the CxC Design Lab. I also ran into transportation issues with my car not starting so I could not go to the building that had the 3D printer I had access to. Luckily, my car was fixed within the day, so I could go to the building the next day.

On to Day 11, I met with Eddy to work with the 3D printer. Before we worked together, Eddy had downgraded the printer. We moved onto the calibration of the printer again. The XYZ calibration went off without an issue and we moved onto the first layer calibration.

In the first layer calibration, we ran into more issues. The filament appeared to not to be sticking to the Heat Bed. The ABS filament[16] we were working with was not the proper filament to work with in the first layer calibration. The reason being that the ABS requires high heat for the ABS filament and more precision than the first calibration requires (Prusa 72). We then changed the filament to

[16] ABS stands for Acrylonitrile Butadiene Styrene (Prusa 58). ABS filament "is a strong and versatile material" (Prusa 58). It is more resistant than PLA and can be used for objects that are going outside (Prusa 58).

a PET filament[17]. PET filament was sticking to the Heat Bed, but the filament was still sloppy looking and not making right angle corners.

However, the calibration did work, so we moved on and tried a test print. The Prusa company has a test print file on their program of a 1/8 in thick rectangle with their name in the center. After the 2 layers of plastic were laid, the print would stick to the extruder and move along the heat bed. This continued with 2 other test prints.

Once again, we ran out of time to work with the 3D printer. Within this day we had gotten further than we had ever before. Eddy also took the information we gathered today and was going to send another email to the customer service agent and see what else we needed to do to get it to work. After today, I was more hopeful with printing the prototype myself with the printer I have access to.

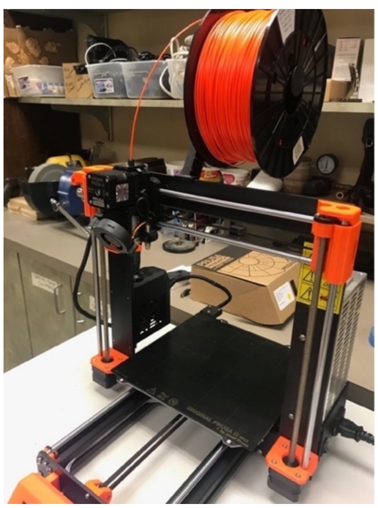

Figure 5. 22. The Original Prusa i3 MKS3 Printer with PET filament.

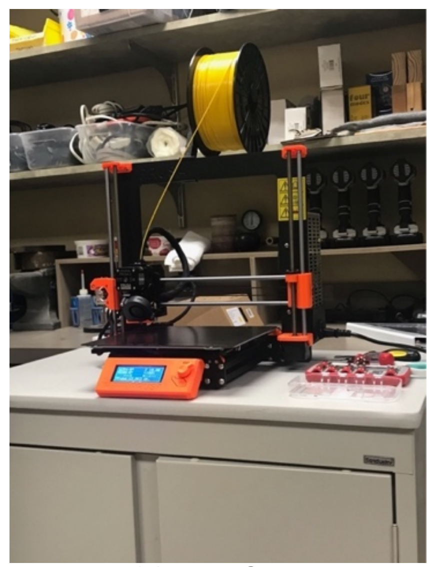

Figure 5. 21. The Original Prusa i3 MK3S Printer with ABS filament.

[17] PET stands for Polyethylene Terephthalate (Prusa 57). PET filament "is another commonly used material" (Prusa 57). It is "more ductile" and "less brittle", which is why it is suitable for mechanical components (Prusa 57). Parts of the Original Prusa i3 MKS3 Printer is made with PET filament (Prusa 57).

Later this day, I received an email from the CxC Design Lab. They explained how much it would cost for the pinkie and thumb pattern, which would be $31.95. They also explained how it was during a Thanksgiving Break that the print would take longer. Finally, they asked if I had a color preference to my print. I explained that it would be fine if it would take longer and that I did not have a preference on the color.

To start my next day on Day 12, I received more emails from the CxC Design Lab. They did explain to me that my informational page about printing a second batch to print that would be 10% bigger than the original size was not clear enough. It makes sense because I did not supply exact measurements for the larger ones. I emailed them back telling them I would create a new appointment to print off the larger ones when I had those fully designed.

However, I did think about the progress that was made the day before and I was very hopeful that I could print off the pieces myself in a couple days. The resident prop master gave me permission to work with the printer by myself over the Thanksgiving Break to see if I could get it to work. However, first I focused on working with the Micro:Bit and constructing pads for the glove.

To start the process, I gathered all the supplies I needed. The supplies that were needed were the Micro: Bit, USB adapter for the Micro:Bit, Battery Pack for the Micro:Bit, 2 AAA batteries, Alligator Clips, Tin Foil, E6000 Glue, Cardboard, and the Mini.Mu Speaker. Once I gathered all the supplies, I began to build the finger pads.

In my original plan, the finger pads were going to be buttons from Yahboom (Yahboom). However, as more time went on and the more money I spent, I

lost the budget to purchase this item. I found on the Micro:Bit website an instructional program of creating a guitar out of cardboard and tinfoil (Micro: Bit). I found this to be an affordable solution and a unique one as well. The tinfoil will act as a conductor for the finger pad and will be connected to the Micro:Bit and the Mini.Mu Speaker with Alligator clips.

In order for the connection between the Micro:Bit and the Mini.Mu Speaker to be complete, the GND (Thumb finger pad) must be touched and one of the pins, Pin 1 (Pointer Finger Pad) and Pin 2 (Middle Finger Pad) must also be touched. With these being touched, it completes the circuit and the Micro:Bit is able to communicate with the Mini.Mu Speaker and be able to produce the sound effect.

I created a finger pad by tracing my middle finger, pointer finger and thumb on a piece of cardboard. I then added a seam allowance around the finger pads, about 1/4 inch all the way around. I then drew a long post with a circle at the top, as if it is a pole. I also added seam allowance around the pole and the circle. The pole and the circle will connect the top of the finger to the pad of the fingertip.

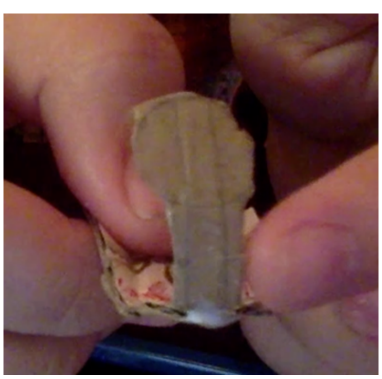
Figure 5. 23. The Middle Finger Pad Top.


Figure 5. 24. The Middle Finger Pad Bottom.

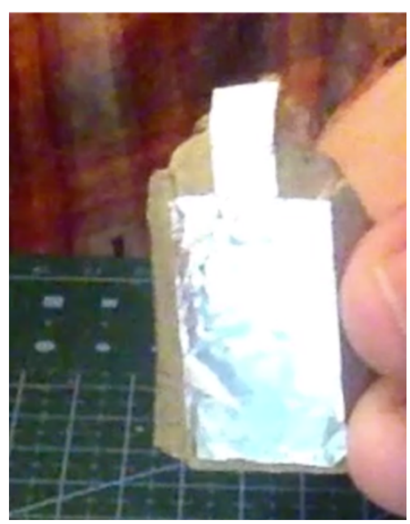
Figure 5. 25. Tinfoil on the Finger Pad.

Then, I created 2 marks in the middle of the poles, 4 marks around the circle, and 2 marks at the top of the finger pad. These were created to help with the flexibility of the cardboard to make sure the finger pad would be able to wrap around the tip of the finger.

After all of the patterns were created, I then cut out the pieces from the cardboard. I then cut the small marks around the pattern. The small cuts helped make the finger pad more flexible and be able to go over the curve of the finger.

Once all the pieces were cut out and bent to go over the finger, I moved on to the tinfoil. I cut the tinfoil into a rectangular square that would go from the top of the circle to the bottom of the finger pad. I made sure the tinfoil would not rip when the finger pad was bent. Then I glued the tinfoil to the finger pads using toothpicks to spread the glue around on the cardboard. I chose the E6000 glue because it is a strong glue that can handle delicate objects like tinfoil.

After the middle finger section was completed, I repeated these steps for the ring finger and thumb pad. The finger pads were now complete.

Figure 5. 26. The Whole Middle Finger Pad.

I then moved onto coding my Micro:Bit for the sounds. I started by plugging in my Micro:Bit into the computer using the USB adapter. I decided to do a test run of the sounds on the Micro:Bit with an already established code with Guitar Code 1 (Micro:

Bit). With the test, I wanted to make sure the Micro: Bit and the Mini.MU Speaker were working.

However, as I tried to download this program on the Micro: Bit as a HEX file[18], the file would not download onto the Micro: Bit. I tried ejecting the Micro: Bit and plugging back in. I tried using a different program. I tried resetting the Micro: Bit with the button on the back of the Micro: Bit. None of these things worked.

After troubleshooting even further, I believe that why it was not working was because I was trying to download a HEX file on the Micro: Bit with another HEX file on it. With this information, I developed a game plan for the next time I work with the Micro: Bit, which was to reset the Micro: Bit to factory settings with a code found on the Python editor (Micro: Bit). I stopped working with the Micro: Bit for the day and rested to work with the 3D printer the next day.

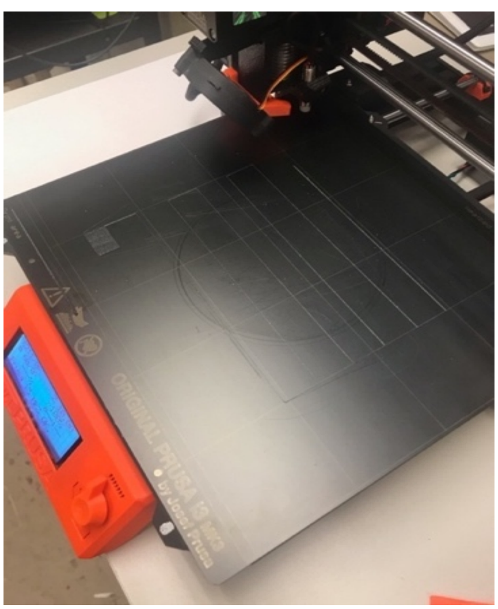

Figure 5. 28. First Layer Calibration.

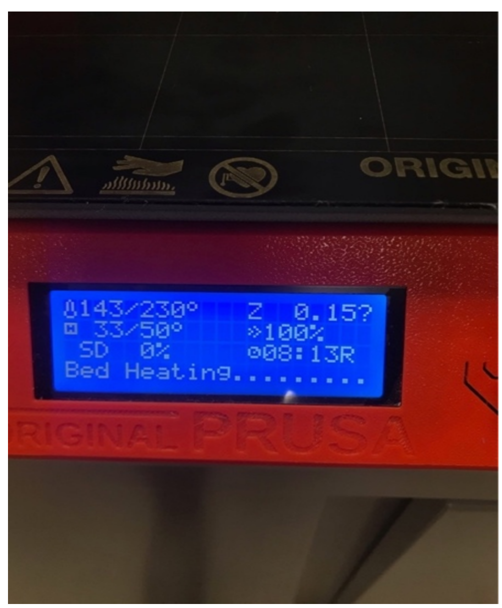

Figure 5. 28. LCD Panel.

[18] HEX File stands for intel-hex format. “Intel hex consists of records of data, with the address in memory to store the data at the start” (Micro:bit Educational Foundation).

For the start of Day 13, I began working with the 3D printer by myself by changing the filament from the PET to PLA. I figured if the CxC Design Lab works with it, it must be a reliable filament to work with (LSU CxC).

Before I worked with the 3D Printer, I looked through the manual again. I noticed there was a step that both Eddy and I missed in the first layer calibration. There is an option in the first layer calibration named the Live Z Adjust[19] (Prusa 26). The manual says that you must set the Live Z Adjust during the first layer calibration and it could change when moving the printer (Prusa 26). An example the manual gives is they set their Live Z Adjust to -0.65, but it could be different on all machines (Prusa 26). The highest the Live Z Adjust can be without changing the PINDA Sensor is -2.000 (Prusa 27).

With this knowledge in mind, I did another first layer calibration test with the new PLA filament and changed the value of the Live Adjust Z to various increments to find the best value. The more I increased the value, the crisper the edges would get and be less sloppy. The final value I found for the printer to work efficiently and be best quality was -0.6500.

[19] Live Z Adjust is adjusting the arm of the Original Prusa i3 MKS3 Printer to "adjust the nozzle height until the extruded plastic sticks nicely to the bed and … can see that it is being slightly squished" (Prusa 26).

Now that the printer was set up correctly, I moved onto a test print. Instead of the Prusa test print, I made my own test by creating a 1/8 in thick Key chain with my name on it. I developed this pattern also in Tinker CAD and imported the pattern into Prusa Slicer as a stl. file. I set up the settings in the Prusa Slicer to work in the Speed Setting (.15 mm), with Fillamentum PLA 1.75 filament on the Original Prusa i3 MK3S.

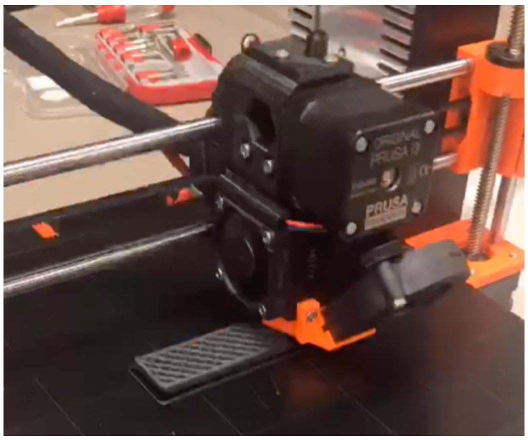

Figure 5. 29. Extruder printing PLA filament to Heatbed for Key Chain.

Figure 5. 30. Key Chain Made with PLA filament.

Once all settings and design were set, I took the SD Memory Card from the printer, and plugged it into my MacBook Pro's SD Memory Card slot. I then exported the pattern as a Gcode file[20] to the SD Card Memory. The G-code file is the only file type that the printer will read. The file loaded onto the upload correctly, so I ejected the SD Memory Card from my MacBook Pro and plugged it into the printer. I then went to the option on the printer "Print from SD". Found the name of the file, "Emma Key Chain" and hit print. After 50 minutes of printing, I then had a complete keychain with my name on it.

Now that I know that the printer was working with the PLA filament, I wanted to test the flexible filament for the structure of the glove. However, I found right when I

[20] G-code file is the file type that 3D printers can read and produce a print (RepRap contributors).

wanted to test the filament, I did not have TPU flexible filament. The filament I had purchased before was a PLA filament.

I did have enough in my budget to purchase another roll of the filament, so I planned on purchasing a new roll. Before I found one though, I looked through the settings on the Prusa Slicer and saw what flexible filaments the Prusa Slicer already has in their settings. I found a filament named SainSmart TPU filament. I chose them because the only filaments that they have in the slicer were flexible filaments and I read positive reviews online. After doing research on Amazon, I purchased a roll of SainSmart TPU 1.75 filament in a pastel purple. A 250 mm roll of this was $29.99. I would have to wait till the TPU filament came in the mail and was delivered.

While I was waiting for the filament, I was contacted by the CxC Design Lab. In this email, they wanted to set up a time to pick up the pattern pieces and the final price of the prints at $51.99. They also informed me that they only take the currency on campus, TigerCASH[21]. I replied with a thank you for their help, and that I would pick them up in a few days at 1 pm and I would have their payment for them.

[21] "TigerCASH is a debit card system using [a] Tiger Card (LSU ID) to provide a fast, safe and convenient way to make purchases on and off [LSU] campus" (Louisiana State University).

A couple of days had pasted since Day 13, but I continued with the process and began Day 14 when the TPU filament came in. I started with the first layer calibration to make sure the filament would work, and it did. I finally did a test of the TPU with a heart keychain that I developed in Tinker CAD. I followed the similar process of the first test with PLA, except I changed the filament setting from Fillamentum PLA filament to SainSmart TPU filament. I changed the filament settings because each filament has to have a certain temperature to print correctly, and by changing it in the Prusa Slicer, the printer will be able to be set at the correct temperature. After a half an hour, I had a heart keychain.

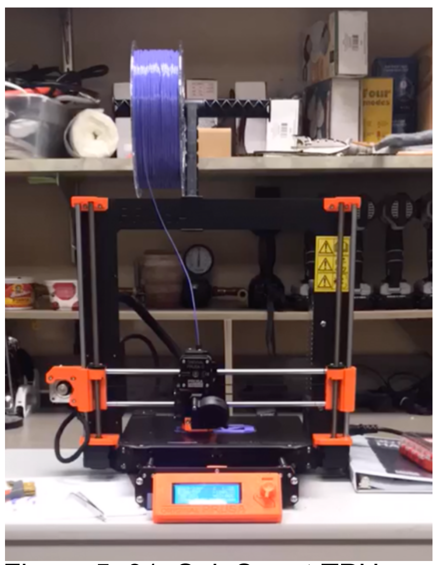

Figure 5. 31. SainSmart TPU Filament in the Original Prusa i3 MKS3 Printer.

I then moved on to printing the first part of the prototype, the wrist pattern. To print only one side of the wrist, it took 2 hours and 44 minutes. I determined in order to get a lot of the printing done, I had to come in over the weekend and stay a majority of the day to get some of the structures printed.

Day 15 was the day that the prints from the CxC Design Lab were finished. I picked up the 5 pattern pieces from the lab in a plastic baggie and paid for them. The design lab printed them in red which I think looked great. When I received them, they had plastic strings going through holes and looked kind of messy as well. As stated before, the CxC Design Lab uses the PLA filament to print these pieces so I will not be using them for the structure. However, I am happy I still printed them because I learned many things about the designs that I made in Tinker CAD, I didn't have to use my filament to find out the errors, and I didn't have to lose time to my errors.

Figure 5. 32. Pattern Pieces Printed at CxC Design Lab.

With the PLA model, I went into Day 16 ready to print and fix the errors of the model. After receiving the models, I noticed how thick the pattern pieces were. I had them set at ¼ inches thick for all the pattern pieces. ¼ inches thickness was entirely too thick. I went into Tinker CAD and changed the thickness to 1/8 inches. I then looked back at all the patterns and determined that the wrist and pinkie finger patterns were ready to be printed after resizing. I laid out 2 wrist patterns, and 2 pinkie finger patterns on the Prusa Slicer program and downloaded the file onto the SD Memory Card. Once starting the print on the printer, it said it would take 8 hours and 13 minutes.

While these patterns were printing, I went back to the patterns that needed work.

For the thumb, it was an easy fix by getting rid of an extra layer that was added by an added cylinder. Once that was eliminated, the thumb pattern would be an even surface. Another easy fix that needed to happen was to add seam allowance to the top and bottom of the ring finger. I added those to the pattern using the same method used in the process.

Next one that needed to be fixed was the pointer finger pattern piece. The way it was shaped, it would not work with the thumb pattern or the middle finger pattern. Also, the shape that the pattern had did not look good in the print. I decided to create a new pointer finger pattern following the process as stated as before. For the new shape on the pointer finger, I got to showcase the ability to use text as shapes for the product.

Figure 5. 33. Wrist and Pinkie Finger Pattern on Heatbed of the Original Prusa i3 MKS3 Printer.

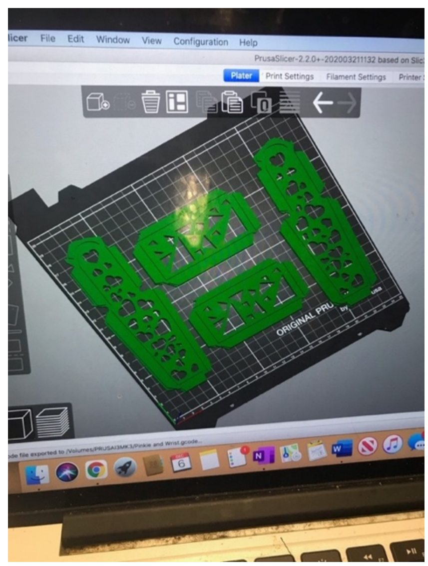

Figure 5. 34. Wrist and Pinkie Finger Pattern on Prusa Slicer.

Similar to the pointer finger, the middle finger was not correct with its seam allowance being 1/8 inch wide instead of 1/4 inch wide. Also, I thought that the pattern was quite sloppy looking. I decided to redo this pattern piece as well.

By the end of the day on Day 16, the wrist and pinkie finger patterns were finished printing. The print was a success and it made me hopeful for the rest of the printing.

Day 17 I printed 2 of the Pointer Finger Patterns and 2 of the Ring Finger Patterns. It took 14 hours to print all of the pattern pieces. I ended the day with starting the print of the 2 Middle Finger Patterns. It took 8 hours and 13 minutes to print.

To start Day 18, I started the printing of the 2 Thumb pattern pieces and 9 pegs. The pattern would take 3 and half hours to make. I had developed the pegs through connecting the pinkie finger patterns together and the finger of the Pointer finger patterns together.

The best way for me to develop connections between the patterns was to cut holes into the patterns. After marking the holes with a sharpie, I used a Leather Hole Puncher at its 1/8 inch setting to cut the holes in the seam allowance. The reason that I added the holes later instead of within the design of the pattern was so if the holes did not match, I did not have to re print the whole design. If I had to re print the patterns, it could take hours to replace.

Once the holes were created in the pointer and pinkie finger patterns, I tried different methods to put the pattern pieces together. I tried putting the patterns flat against each other and tied with string. This method pinched my fingers. I then tried wires stacked on top of each other. It was closer to what I wanted, but it still pinched the top of the fingers.

Next, I noticed I needed more flexibility with the patterns. To fix the patterns, I used a box cutter to cut through the pattern slightly to add more flexibility to the

patterns. I cut 6 small slashes at the top, middle and bottom of the finger sections and I cut 4 long cuts along the seam allowances, that can be seen in Figure 5.35. These cuts improved the flexibility and stopped most of the pinching in the fingers.

After making the cuts, I tried the final method of using toothpicks as pegs and sticking through the holes of the patterns while they were stacked. The method caused more depth in the fingers and reduced pinching in the fingertips.

Now that I had determined pegs were the best method to connect the pieces, I developed the pegs using Tinker CAD. Within Tinker CAD they have an option to print a toothpick. I resized the toothpick to an 1/2 inch in length. I also produced caps for the pegs that were 1/4 inch length, 1/4 inch wide, and 1/4 inch high.

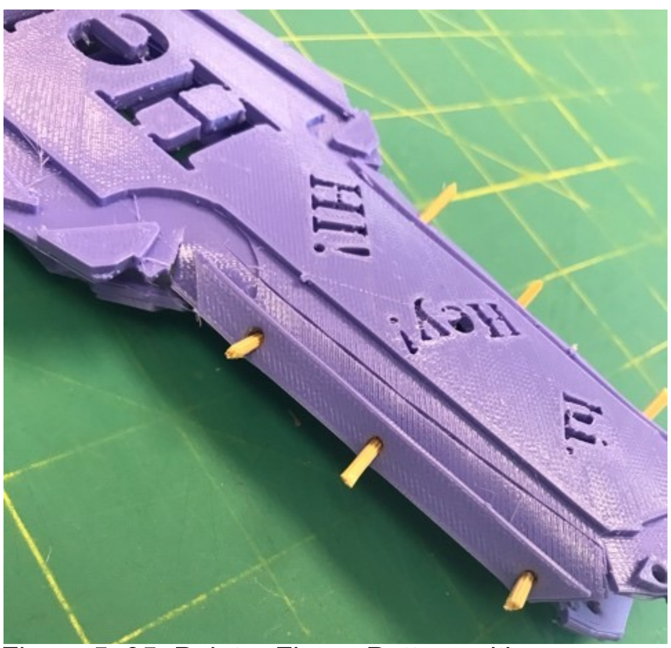

Figure 5. 35. Pointer Finger Pattern with Toothpicks as Pegs to Hold the Finger Section Together.

Figure 5. 36. Pegs for the Sound Glove.

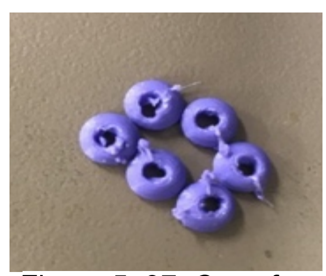

Figure 5. 37. Caps for the Pegs.

On Day 19, I finished marking and cutting the holes and creating small cuts in the plastic in the rest of the patterns. With all the holes cut, I counted, and I needed

to print 100 pegs to print to connect the whole glove together. I started the print of the 100 pegs and went back to the Micro: Bit to work on programing it.

To begin my programing of the Micro: Bit, I went back into the Python Editor. Once in there, the Python Editor already had a program on it named "HELLO WORLD!"

Figure 5. 38. Police Siren Code in Online Python Editor.

(Micro: Bit). I plugged in my Micro: Bit and connected it to the Python Editor and downloaded the HEX File. The Micro: Bit took the HEX File and now was scrolling "HELLO WORLD!" with a heart at the end. With this code downloaded, I knew the Micro: Bit was fixed and now could be programed for sound effects and music.

To begin the coding process, I referred to the reference guide for Python Editor. Under the music section of the reference guide, there is a section labeled Sound Effects (Micro: Bit). In the Sound Effects sections, it gives information on how to create a police siren sound effect with the use of frequencies (Micro: Bit). The Micro: Bit can register notes of sound with frequencies as numerical values (Micro: Bit). The example given in the reference guide is "the frequency of 440 is the same as a concert A used to tune a symphony orchestra (MicroPython contributors). Coding the police siren, there is a function with Python coding called "range" (MicroPython contributors). With range, it

creates a “range of numeric values” with various “step size[s]” between a “start value” and an “end value (MicroPython contributors). The example given in the reference guide is in Figure 5.38. With this example, the Micro: Bit produces a police siren when connected to a speaker on an endless loop until it turns off.

To test this code, I disconnected the Micro: Bit from my MacBook and started to connect the Micro: Bit to the essential hardware for the code to work. I plugged the battery pack into the Micro: Bit. The battery pack turns on the Micro: Bit. Next, I connected the Micro: Bit to the Mini.MU Speaker with 3 alligator Clips. 1 alligator clip is connected to the 0 Pin, 1 clip is connected to 3V pin, and 1 clip is connected to GND[22] pin on both Micro: Bit and Mini.MU Speaker.

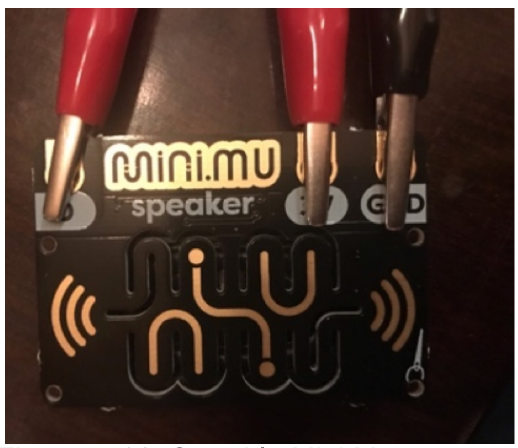

Figure 5. 39. Sewable Mini.Mu Speaker.

Once all these clips were connected, the Mini.MU Speaker began to make a siren sound and proved that my coding worked.

Next, it was time to find out how to code the Finger Pads that I constructed before. I went back to the Guitar Chords Instructions on the Micro: Bit website to find out how to code the Micro: Bit to activate sound effects when touching the finger pads

[22] GND stands for Ground.

(Micro: Bit Guitar Chord 2). With my research, I found a way make the pins active with the Micro: Bit was to add the condition to the code named “if pin[number of pin]_is_touched():” followed by the desired sound effect code or music (Micro:Bit Guitar Chord 2). For pin 1, I decided to put the police siren code. For pin 2, I decided to use a preset music effect within the Micro:Bit library called “JUMP_UP” (Reference Guide Music). The code to set the condition to play the music effect is “music.play(music.JUMP_UP)” (Reference Guide Music). Figure 20 is the code I used with the glove.

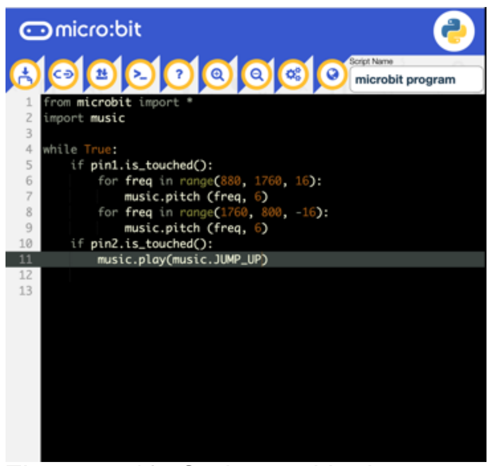

Figure 5. 40. Code used in the Micro: Bit for Prototype.

Once I wrote the code, I connected the Micro:Bit to the Python Editor with the USB Micro:Bit Adapter and downloaded the HEX. File. After a successful download, I ejected the Micro:Bit. Once I plugged the battery pack into the Micro:Bit, I started the connection between the Micro:Bit, the 3 Finger Pads, and the Mini.Mu Speaker.

To connect all of these ports, I used 6 alligator clips. Similar to the police siren test, 2 of the alligator clips connect the Micro:Bit to the Mini.Mu Speaker at the pin 0 and the pin 3V. 1 alligator clip is connected to the Micro:Bit and to Finger Pad 1 through pin 1. Another alligator clip is connected similarly, but through pin 2 and connected to

Finger Pad 2. The final connection to make the Micro:Bit, Mini.Mu Speaker and finger pad function is 1 alligator clip connected to the Micro:Bit to the Finger Pad GND through the pin GND and the final alligator clip connecting the Finger Pad GND to the pin GND on the Mini.Mu Speaker. Once all these alligator clips are connected, the Micro:Bit lights up and is ready to be tested.

For the sound to come out of the Mini. Mu Speaker, either Finger Pad 1 or 2 needs to be touched and the Finger Pad GND also needs to be touched. Once both are touched, the sound programed in the Micro:Bit will be produced in Mini.Mu Speaker. I also made a discovery that if the Finger Pad GND touches either Finger Pad 1 or 2, the Mini.Mu Speaker will produce the sound programmed in the Micro:Bit. The reason this worked is because when the tinfoil of the Finger Pad GND touches the tinfoil of the Finger Pad 1 or 2 it completes the circuit of the program. After attaching all the alligator clips to their various pads and ports, I then taped the clips in place with electrical tape.

Now with the Mini.Mu Speaker producing sound successfully, I felt confident to

Figure 5. 43. Micro: Bit Connected to the Finger Pad.

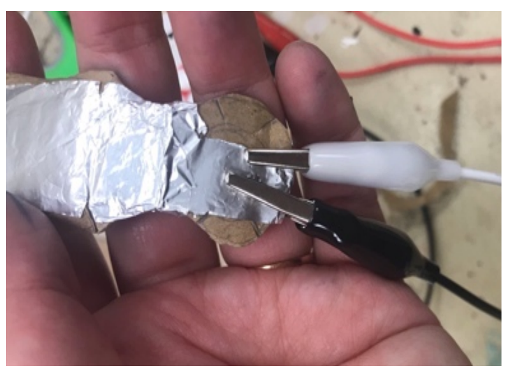

Figure 5. 43. GND Finger Pad Connected to Micro: Bit and Mini.Mu Speaker with Alligator Clips.

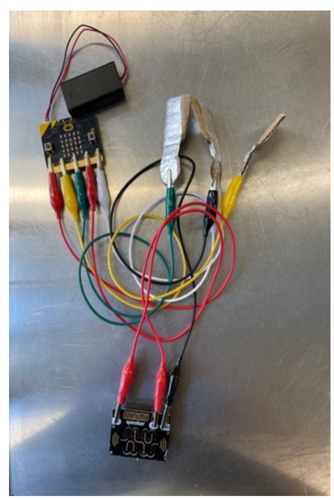

Figure 5. 43. Complete Sound Unit.

move back to the structure of the glove on Day 20. Now that I had all 100 pegs and plugs printed, I started to punch holes into the plugs with the Leather Hole Puncher. The holes will allow the tip of the peg through the plug. After making 30 plugs with holes, I started to put the pattern pieces together at the seams. I first prepped the holes on the pattern by taking tweezers and stretching the holes for the pegs. Then I took a toothpick with E6000 glue on the tip and ran the toothpick through the holes on both seams. With the holes fully coated, I took the pegs and ran them through the holes. With the help of clips, I then held the seams together and took a heat gun to the seam to heat the plastic to reinforce the adhesive. Once the seam and pegs were cool and dried, I then added more E6000 to the tips of the pegs with a toothpick and then added the plugs on the tips of the pegs. I then took the heat gun to the plugs. This method I used for most of the structure. It did take trial and error to achieve this method, but this was the best way to make the structure with efficiency and speed.

Figure 5. 46. Thumb and Pointer Finger Pattern Connected with Pegs, Caps, and E6000 Glue.

Figure 5. 46. All Pieces Connected and Drying in Front of Fan.

Figure 5. 46. Sound Glove Connected and Drying with Clips.

However, this method took a few days to construct the gloves still. I would still spend Day 21, Day 22, Day 23 and Day 24 building the structure.

Once the structure was created, I then clipped the glove in various positions over night to create more elasticity into the glove. By the end of creating more elasticity, the glove started to resemble a baseball mitt. I also started to notice that my pinkie finger could not reach the slot of the pinkie finger, and my ring finger could barely reach the ring finger slot. However, as I was running out of time to construct the glove, I decided to move on and focus on the combining the two units together.

To combine the two units, I used Velcro to connect the sound unit to the glove. The reason I chose Velcro was so the sound unit, the battery pack, Micro: Bit, Mini.Mu Speaker, and finger pads. could separate from the glove easily. Velcro is also easy to hide from audience members from stage.

My process to put Velcro on the sound unit and glove is as

Figure 5. 48. Top of the Sound Glove.

Figure 5. 48. Bottom of Sound Glove

follows. First, I covered the Micro:Bit and the Mini.Mu speaker with electric tape so important ports, like the Micro: Bit's battery pack, USB adapter port, and Mini.Mu's speaker, would not get glue inside.

I then used industrial strength spray glue to spray the back of the Micro: Bit's battery pack, the Micro: Bit, the Mini.Mu Speaker, the loose wires that were combined with electric tape and the bottom of all of the finger pads. I applied the glue to 8 Velcro pads and then stuck one side of the Velcro pads to the sound unit system, as shown in Figure 5.50.

Figure 5. 49. Mini.Mu Speaker with Electric Tape Covering Alligator Clips, Battery of Mini.Mu and Any Openings on Mini.Mu Speaker.

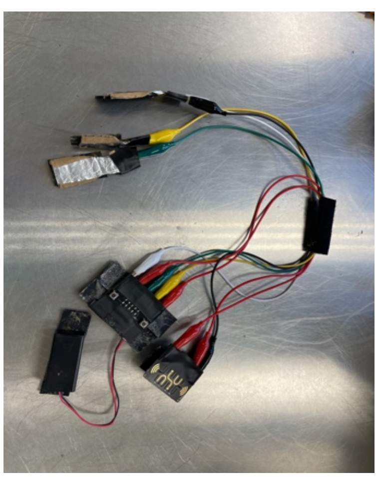

Figure 5. 51. Sound Unit with Velcro Pads.

Figure 5. 51. Sound Glove with Velcro Pads.

Next, I sprayed the glove with industrial strength glue on the top of the hand, the wrist piece and the thumb, pointer finger, and middle finger pads. I then used the same

method as the sound unit Velcro. I used the other half of the Velcro and attached 8 strips of Velcro. Now with both of the units have their Velcro, they can be combined to create the full prototype.

After completing the prototype, I changed the batteries in the battery pack, and tested the prototype. While there was still stiffness in the fingers of the gloves, the prototype produced sound successfully and moved successfully. The final prototype can be shown in Figures 5.52, 5.53, 5.54, and 5.55.

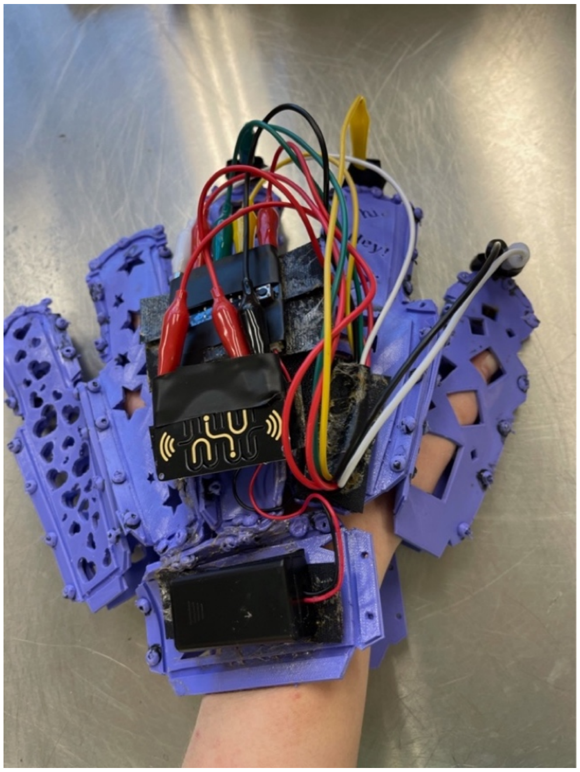

Figure 5. 52. Front of Sound Glove.

Figure 5. 53. Back of Sound Glove.

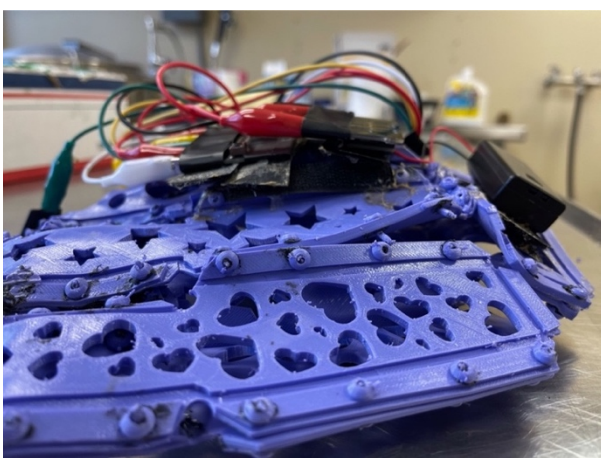

Figure 5. 54. Side View of Sound Glove.

Figure 5. 55. Finger Pads Touching to Produce Sound on Sound Glove.

While each step was not successful, and I would have changed some aspects of the glove, which I will cover in the conclusion, I learned many new skills along the way. I developed new computer programming skills, such as Tinker CAD, Python Editor, and Prusa Slicer. I also developed new skills in costume technology with developing new patterning skills.

As stated before, this is not a final product. I wanted to showcase the development for a relationship between a costume and sound design with the prototype. I also wanted to showcase the steps I developed for artist, programmers, engineers and more so they can move the product forward and develop a final product. As I was successful in conveying both of these objectives, I would consider this prototype as a success.

Conclusion

Throughout the process of research, possible applications and construction of the prototype, I have made discoveries in various areas. The areas of discoveries are within the prototype, within my own capabilities, and within the development of collaboration of sound and costume design.

Discoveries made within the prototype were found within the structure of the prototype and the construction of the prototype. The discoveries I made can be used the next time I, or another artist or designer, design and construct another prototype to be more efficient and more successful than the current prototype.

Within my own capabilities, I developed new skills in various areas. My skills grew in software programming skills, digital drafting and physical construction. To highlight these developments is important not only for my growth, but also for other artists and designers to use my method to strengthen their skills in these areas as well.

Finally, the development of collaboration between sound and costume design were discovered through this process. It is important to highlight where the collaboration between the two areas of design began, where the collaboration is now because of the prototype, and where the collaboration can go into the future of sound and costume design.

As stated before, discoveries were made when creating the prototype. Some of the main discoveries made while creating the prototype was within the structure of the prototype. Within the structure of the prototype, I made a discovery about the pattern pieces. I found that my finger pattern pieces were not flexible enough as one structure connecting the finger and the back of the hand section. If I were to construct another

prototype, I would separate the two sections so the finger section would be one pattern piece, and the back of the hand section would be another. I would even suggest breaking the finger pattern piece into more sections to allow flexibility for bending at the knuckles of fingers.

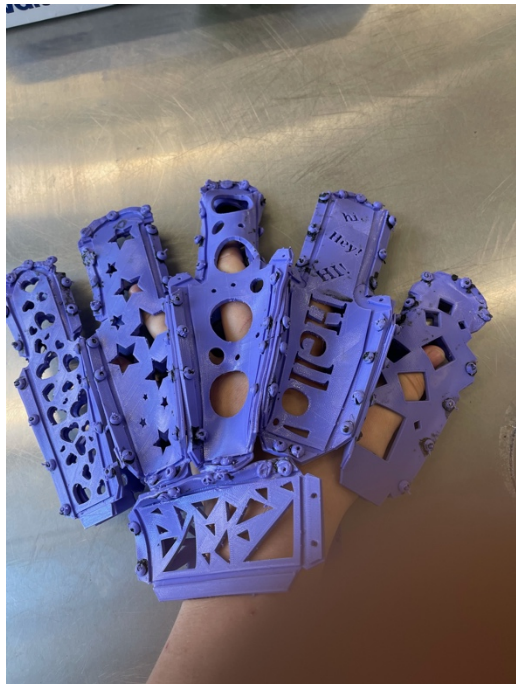

Figure 6. 1. My Hand in the Prototype.

Within the addition of pattern pieces, I also discover some sections that I would eliminate from the prototype. I would eliminate the pinkie finger pattern piece and the ring finger pattern piece as well. With these two pattern pieces, the glove was too wide, and my fingers could barely reach into the two sections. The pinkie finger pattern piece and the ring finger pattern piece were also two of the fingers that did not have finger pads to create sound of effects. Since the two do create sound effects, they can be easily eliminated from the prototype.

Not only were there discoveries in the structure of the prototype, but there were discoveries in the construction of the prototype as well. To construct the next prototype, I would focus less on using glue to construct the prototype. The E6000 glue took too

long to dry for an efficient build. The E6000 glue would take at least a day to fully dry. If the glue would not fully dry, the pegs would not stay in their holes and would not connect the sections. Even with the caps, the pegs would not stay.

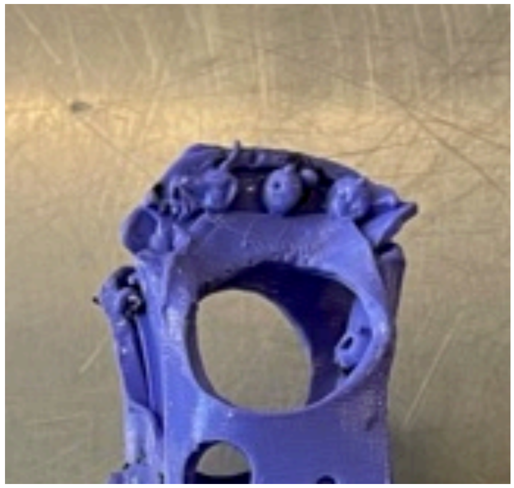

Figure 6. 2. Top of the Middle Finger Pattern.

However, I did find a solution halfway through construction that worked the best. With a suggestion from the costume shop manager, I started to use a heat gun to create more flexibility in the glove. A byproduct of this process was the plastic would melt and then would meld to each other and have a stronger connection. The melting would also solidify the pegs in their holes and were less likely to fall out of place. The next time I work with a plastic filament, or create another prototype, I would focus more on using heat from either a heat gun or blow dry to connect the pattern pieces. Also, I believe it is important to emphasize the importance of working in a well-ventilated area when working with items that can give off hazardous odors, such as plastics, that can lead to lifelong complications. When I was working with the melted plastic, I was working in a place with a vent and a fan to create a well-ventilated area.

These discoveries in the structure and construction can help artists and designers not only make the next prototype more successful and more efficient, but also

can use these insights to build another structure, not necessarily the sound glove, with more efficiency and success.

Another area of discoveries that can benefit future artist and designers is in the development of skills. Within my capabilities, I noticed growth in my software programming skills, digital drafting skills, and 3D printing skills.

To help with the development of my software programming skills, the software within the Micro: Bit, Python Editor, helped the most. In order for me to program the Micro: Bit, I had to learn text-based computer programming in order to have the Micro: Bit send a message to the Mini.Mu Speaker to create sound effects. I can take the information I learned for Python Editor to create new programs for the Micro: Bit, or future computer programming on another device.

I also notice development in my digital drafting skills. The tools that helped with this development was Tinker CAD and the Prusa Slicer. In order for me to create the pattern pieces of the prototype, I had to develop a method to create pattern pieces in Tinker CAD. I can use the same method to create various structures and future pattern pieces.

Another tool that was beneficial to develop my capability in digital drafting was the Prusa Slicer. Prusa Slicer helped me develop spaces between pattern pieces on the 3D printer, and then also helped with transferring information from the digital space into the physical one. Information I learned from the Prusa Slicer could be used in the future to learn more about various filaments and try different settings for different structures or a future prototype.

Finally, the last development I made in my capabilities was in 3D printing. My new knowledge in 3D printing can be used on other Prusa printers to trouble shoot issues with the printers, be able to understand the capabilities of the 3D printer and can be used to create different structures with various filaments.

I believe it is important to highlight these developments because artists and designers could use the methods, I developed to strengthen their skills in software programming, digital drafting, and 3D printing. They can use these methods not only to create another sound glove prototype, but also a structure, a new design, or a new computer program.

The final development, which possibly could be one of the most important developments that came from this process was the development of collaboration between sound and costume design. At the beginning of the process, there was not much collaboration, or even many discussions, between sound and costume design areas. The discussions were limited. The discussions would focus on foley sounds*, such as the sounds of shoes, fabrics or other articles of clothing. Focusing on the clicking of shoes on stage, focusing on the sound of fabric as an actor makes movements in a garment, or focusing on the sound that jewelry is creating on stage can only lead to a finite number of discussions with a few solutions.

However, with developing the Sound Glove, there are now new avenues of collaboration between the two design areas. The collaboration that is developed because of the Sound glove can include developing a structure that can accompany the sound unit and the actor's hand. It can include developing sounds on the glove to add to the identity of the character. It can be developing aesthetic of the glove to develop the

identity of the character, including the color of the glove, the shapes in the glove, and the lines the structure. These are just a few examples of collaboration that the product can lead to between sound and costume design.

The avenues of collaboration that are opened from the prototype are endless. Many more collaborations between the two areas can come from future products that could create sound too. What other costume pieces can be created that can manipulate sounds? Could a hat be created to make sounds when a gesture is executed? Could there be a dress that could create a song? Could we create innovated masks that can create sound efficiently with sound effects and voice boxes? The new products create new ways to develop characters, productions and collaborations for sound and costume designers in the future.

The options of collaboration in these possible projects have no limit. The discoveries found in the prototype's structure and construction, in the development of my capabilities, and in the development in collaboration can be used to create these new projects. With these new products will come new developments that will initiate many varieties of products. These discoveries can also help others find their method of research for their product, the application of their product, their method of constructing their product, and developing their own areas of collaboration between various areas of design.

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Vita

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