BARRIERS & DRAMA

FALL 2020

BLUE TEAM

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1 Problem Formulation

1.1 Introduction

Section 1 of the document provides a broad overview of the COVID-19 related project to keep performers safe and to reduce the spread of COVID-19, an objective statement, and a Black Box Model

1.2 Background

The Covid-19 pandemic forced educational institutions to adopt online learning as a method for teaching; and Six Rivers Charter High School is no exception and is looking for products to help ensure a more positive environment for their students who will adopt a hybrid curriculum of in person and online learning. Ron Perry, the principal of Six Rivers Charter High School, is seeking products to help facilitate the hybrid system for the upcoming 2021 year. The project seeks to make use of the "5 C's" from the school's vision statement which stand for communication, collaboration, creativity, critical thinking, and community. Doing so will better assist the students and faculty of Six Rivers Charter Highschool during this pandemic.

1.3 Objective Statement

The objective of this product is to provide a lightweight, portable, and reusable barrier for use on stage to help mitigate the spread of Covid-19 among students and faculty and help return students to an interactive and safe learning environment. The design will incorporate materials that abide by federal regulations and are safe for students to handle. The Plexi-Stand will be reusable and easily sanitized and will also allow students to maintain a high level of visibility to their viewers while following CDC guidelines to mitigate the transfer of COVID-19.The Plexi-Stand will also be cost efficient and easily replicable.

1.4 Blackbox Model

Figure 1: 1.4.1 Black Box

Input: Students need to
Be kept safe while performing

Output: The Plexi-Stand provides them a chance to do so

2 Problem Analysis

1. Introduction

The purpose of Section II Problem Analysis is to inform the reader about the specifications, considerations, criteria, usage and the potential production volume of The Plexi-Stand.

2. Criteria and Constraints

Criteria and constraints provide a set of standards along with their limitations that will be implemented in the design of The Plexi-Stand.

Criteria	Constraints
Under $30 a barrier	Barrier cannot exceed more than $30
Ease of production	Barrier must be easy to breakdown and move
Aesthetics	Must not detract from the play
Consistency	Able to function when needed
Portability	One average high schooler should be able to move it on their own
Transparency	The audience must be able to see the performers

Figure 2: 2.2.1 Criteria

3. Specifications and Considerations

The specifications and considerations for The Plexi-Stand are detailed below. The following list provides context for what attributes need to be implemented in the design as well as circumstances that have to be overcome.

3.1. Specifications

Specifications will describe exactly what the product will need to accomplish in terms of its design and functionality.

- Lightweight
- Transparency
- Collapsible
- Low Cost
- Non-permeable membrane
- Mobile

3.2. Considerations

Considerations are the instances that will have to be taken into account upon final design of the product.

- This product will be used by high school students
- This product must be carried upstairs to a stage.
- The barrier must abide by CDC guidelines
- The barrier must be quick to move
- The product must be as invisible as possible
- The product can amplify sound
- The barrier not only provides protection but has multiple uses
- If possible enough will be made for each individual student
- Withstand constant cleanings with chemicals

4. Usage and Production Volume

Usage and production will provide information on how the product is going to be utilized and how many are going to be produced.

4.1. Usage

Usage details of the product will be utilized by the client.

The barrier will be used as an additional resource to help mitigate the spread of Covid-19 by the performers of Melanie Zapper's play. It will be designed and built with the intention of blending in with the performers, so the audience barely notices the barrier during the play.

4.2. Production Volume

Production volume entails the quantity for the product produced and whether it will be replicated by other groups.

The production value for the product in question will be made for a cast of 8-30. If possible, it will be made for each individual student. Due to the costs and access to materials, the product must be reproducible by other parties. This extends naturally to Six Rivers Charter High School.

5. Literature Review

Below are some write ups about the research we did before designing and assembling our product.

2.5.1 Glass Barriers and COVID-19

UW Guidance for Barriers in the Workplace

(Univerity of Washington Environmental Health and Safety, 2020)

Since America has been hit with COVID-19, people have been utilizing different methods to try and stop the spread of the disease while hopefully continuing to go about everyday life. One of these methods is the use of glass barriers between people. A common example of this is when going to a store, the cashier will likely have a screen of plexiglass securely hanging in front of them, to help stop the spread of COVID. According to the CDC, the barrier must block the "breathing zone" for the people who will be using the barrier. This is a radius of 30 cm, starting from the center of your nose.

This article also discusses the importance of making sure that the barrier is kept at least 18 inches from the roof, so it doesn't interfere with the fire sprinkler system. Experts at the University of Washington suggest that the barrier must be at least 6 feet, or 72 inches, tall, so as to ensure that it aids in slowing the spread of microbes that might be carrying the disease. However, the barrier should be made with people over 6 feet tall in mind, so it can be used by anyone in the general population. It is also important to note that while the barrier is helpful in slowing the spread, it does not guarantee that its users will be immune to COVID-19. Users should still wear face-coverings and practice social distancing whenever they are able to.

2.5.2 Singing and COVID-19

High SARS-COV-2 Attack Rate Following Exposure at a Choir Practice-Skagit County Washington, March 2020

Hamner L, Dubbel P, Capron I, et al. High SARS-CoV-2 Attack Rate Following Exposure at a Choir Practice — Skagit County, Washington, March 2020. MMWR Morb Mortal Wkly Rep 2020;69:606–610. DOI: http://dx.doi.org/10.15585/mmwr.mm6919e6external icon.

In March 2020, there was an outbreak of COVID-19 in Skagit County, Washington. The outbreak resulted in 32 confirmed cases with 20 probable secondary cases as well as a result of this one incident. This led scientists to look into if singing has an impact on the passing on of COVID-19. It was discovered that aerosols containing COVID-19 can be projected out farther if the person spreading them is singing loudly. Aerosols are defined as small particles, or liquid droplets, that are dispersed through the air. For a time, this finding led to a ban on organized events that included singing, such as religious services, choirs, etc so that the spread could be slowed. These restrictions have been lifted in some places, but it is on a county by county basis.

2.5.3 COVID-19 and Kids

The Coronavirus mostly spares kids. Teens aren't so lucky.

https://www.nytimes.com/2020/09/28/health/coronavirus-children.html (Mandavilli, 2020)

According to this article, which is a breakdown of data released from the CDC, teenagers are twice as likely to be infected with COVID-19 than children under the age of ten. The article also states that both children and adolescents are more likely to be asymptomatic than adults and that this could be why infection rates are so low amongst the younger populations. They don't receive a test or any sort of treatment if they are not displaying symptoms. However, the article also suggests that we should consider teenagers ages 15 and up the same as adults, as their social circle is relatively the same as an adults giving the teenagers more opportunity to spread the disease should they contract it. Children under 10 seem to be a different situation. At this time, we know young children can and do contract the virus. Their infection rates appear to be lower than an adults, but we don't know if that is because their social circles are most likely much smaller and limited than a teenager or adults would be.

2.5.4 Schools, Theater and COVID-19

Pandemic 1918 by Catharine Arnold (Arnold, 2019)

School and Childcare Programs (Schools & Child Care Programs, 2020)

COVID-19 led to the shutdown of schools and forced students and teachers to adapt to distance learning. Now that some communities are at a point where they feel they can safely reopen their schools, they have begun to carry out that process. They follow the guidelines that are put out by the CDC by enforcing social distancing, masks, and barriers when appropriate. However, these students and faculty are still putting themselves at risk by participating in face-to-face classes and any in-face extracurricular activities they choose to be a part of. While the CDC website does a great job of providing resources for the public, it does not provide any specifications about how to conduct a theatrical performance during a pandemic. The book Pandemic 1918 written by Catharine Arnold goes into some activities people participated in during the Spanish Flu of 1918, but does not discuss any theater performances. All performers should do their best to follow CDC guidelines during the production, including wearing face coverings, social distancing and staying home when feeling sick to help prevent an outbreak taking place amongst the students. According to Melanie Zapper, drama teacher at Six Rivers Charter, the school has not received any guidelines they have to follow from the state or the district for how to conduct a play when school returns.

2.5.5 Plastic barriers

The purpose of plastic barriers is to mitigate the transmission of COVID-19 by trying to stop droplet transmission through the air. When physical distancing measures can not be enforced, plastic barriers can act as a last resort barrier to collect droplets. Pre-COVID, pharmaceutical companies would have plastic barriers in place to distance themselves from individuals picking up medicine that were recommended by the CDC and OSHA. Plastic barriers are easily cleanable and a cheaper alternative to glass. When using plastic barriers, It's important to keep in mind placement to effectively block the breathing areas from individuals.

Plastic Properties

Plastics are one of the most formable building materials on the planet. Due to their ability to be shaped when introduced to heat, plastics can form into as complex of a shape as one can think of. In terms of longevity, plastics are almost entirely weatherproof. However, under long periods of exposure to UV radiation this can ruin the integrity of the plastic over time. Plastics are also known to be minimally affected by salts and acids meaning that they can stand up to continuous exposure to sanitizing products. A large reason why plastics are utilized as a building material is that the relative weight to the strength of plastic is quite low.

Polymethyl Methacrylate (PMMA)

Polymethyl Methacrylate, also known as Plexiglas, was created in 1933 as a lightweight replacement to the glass used in cockpits on airplanes. Today PMMA is one of the most used plastics for construction. What makes it so popular is the high transparency rate. PMMA allows 92% of light to pass through a 3mm sheet, which is the best of all the rigid plastic materials currently available. PMMA is currently in use all over the county to maintain a barrier and promote social distancing. Because it is so lightweight, this is going to be considerably better than glass for when students must move the panels around. Due to the low budget of the drama class, PMMA is the cheaper alternative to other acrylics and glass which is important because being money conscious is a primary concern. The downside to PMMA is that large sheets will take up a large amount of space. The idea is to have something that can be easily collapsed and removed from stage without much effort. Depending on how large of a sheet of PMMA that is used, it might not be possible to disassemble in a timely manner.

Polyvinyl Chloride (PVC)

PVC is generally made out of a powder that is highly formable. PVC can be utilized in all facets of building due to its ability to be chemically bonded using joints and its low cost. PVC's ability to be easily bonded to other pieces make it a great product to form structural supports and frames out of. Another selling point for PVC is the low weight and how easy it is to move. PVC would end up working best with some type of plastic sheet as opposed to PMMA. Wood might potentially be considered as structural supports, but PVC is easier to set with cement and would require less engineering than wood to form a solid base.

California Department of Education Covid-19 Guidelines

As schools petition to reopen, several considerations for student safety must be implemented and a plan established prior to re-opening. The biggest priority for California schools is the safety of its students and to nix the spread of Covid-19. To accomplish this, protocols for distancing and protective equipment have been released by the California Department of Education (CDE) which references the recommendations from the Center for Disease Control (CDC). These are merely recommendations and as schools continue to re-open it will be up to each local educational agency to define what their protocols will be.

Face Coverings

For both students and staff, face coverings are recommended to decrease the air transmissibility of Covid-19. Face coverings include anything from face masks to face shields so long as the face shield implements a material covering the bottom exposed section of the mask and preferably tucked into a t-shirt. Face coverings should be worn in all aspects of school life. This includes moving around the room, moving to separate classrooms, entering and exiting campus, and in public transportation to school. If face coverings are required by the school, the school must be able to provide masks to students and faculty at their request.

Physical Distancing

The general rule for social distancing, is maintaining 6 feet of distance for all students and faculty. All rooms should be vetted for maximum occupancy while still being able to maintain 6 feet of distance. Attempts to minimize the number of students in a particular room should be incorporated to maximize the amount of space available to honor the 6 feet of separation recommended by the CDC.

Sanitation

Attempts should be made to avoid sharing items between students. Items that are in the highest traffic areas should be disinfected at least daily. Products should be selected that have minimal effects on individuals with asthma, which can be found on the EPA's website. Thorough cleanings should be allowed to air out afterwards prior to children arriving.

Mobility

Mobility is a topic that was specifically requested by the client. The object in question must be easy to move and preferably easier to carry with the individual actor. Thus, a good idea to implement for mobility would be the usage of small wheels; such a case could be a caster wheel or even a limited form of a dolly. The actor could move the object across the stage floor with ease if this were the case. It is clear that there have been other inventions before that have had some similar idea. So, it was essential to look into what others have done. There are multitudes more inventions that have used caster wheels. One can derive more information and inspiration from looking at past inventions and patents. It's unclear how this can be exactly represented but there is enough to show that it can make a difference.

2.5.6 COVID-19 and the Environment

The environment must be considered for dictating how and where the drama department will perform. According to the client, there is a likely possibility that the play they will perform will happen indoors. The most important aspect to consider about the environment whether it will be indoors or outdoors will be transmission. Since the goal is to prevent transmission of the virus from student to student, one must be aware of the limitations of grouping together. That itself is another issue since the client representative wishes to form small groups of actors to perform without risking exposure to the virus. More information is needed about Covid-19. Specifically, what is needed would be information about transmission and management of the virus.

According to Wiersinga et al (2020) transmission occurs by face to face interactions such as talking, coughing or sneezing being the most common. It is also stated that prolonged exposure within six feet elevates the risk of contracting the virus and aerosols can also lead to exposure. If the object can negate these limitations then the project will succeed. However, sanitation and cleanliness must be considered as the object can't contribute to the transmission as well. Management of the virus will keep its status in the environment in remission. From the same article, it can be broken down into three sections: Physical distancing, hygiene, and use of protective equipment. The barrier itself should act as a way to social distance and as a form of protective gear also. It should be noted that some measures may change as

more information about Covid-19 becomes more apparent. Nonetheless, the standards issued above should act as guidelines to the current situation.

2.5.7 Inventions during COVID-19

During this pandemic, people have made inventions to make life better. It is a result that comes from the inefficiencies and the challenges that come arise from COVID-19. Naturally this applies to the project at hand since there will be similar problems. Exercising caution along with maintaining proper sanitation procedures are some examples to consider.

There is a list of inventions out on a BBC article titled "The innovations inspired by a pandemic" about novel inventions. One in particular that may be of good usage would be the hands-free door handle. It may be applied to the product since it would adhere to the client's standards and it assists in sanitation efforts. The hands-free door handle as the name implies is a handle that opens a door without the need to use one's hands to open. It can be 3D printed and would save on costs which is another requirement from the client. The client representative has already stated that the product must be very cheap and easy to manufacture in surplus. Furthermore, it could be slightly augmented differently so that it may serve a different purpose.

One of the other inventions listed was about a virus killing snood. The company behind the snood claims to be able to kill the virus completely and disallow particles to enter the snood. Assuming the snood to be able to eradicate the airborne virus, it can also be implemented in some way to the product. As mentioned previously this snood can be reworked and augmented to fit a different purpose in the product. The snood prides itself on germ trap technology so there might be some competitor or fabric that can also assist in this matter.

Past Pandemics and What Others Have Done

It's essential to look back to how society has faced previous pandemics. One of the most recent outbreaks was that of the H1N1 outbreak, also known as the swine flu. There may possibly be some details documented which may help in designing the product in question. In the article titled "An Infection Control Program for a 2009 Influenza A H1N1 Outbreak in a University-Based Summer Camp" Tsalik et al detail their experience overseeing a university-based summer camp experiencing an outbreak.

Various baselines were established to ensure proper safety measures are taken. The first step was to identify possible cases for the influenza virus. CDC guidelines were taken into account for reporting individuals and an algorithm was created to deal with this regard. Therefore, the current guidelines as opposed to the ones that the authors (Tsalik et al, 2011) faced must also apply here.

Proper hygienic standards such as handwashing and applying hand sanitizer were stressed as well. The virus is airborne and can reach others within distance so making sure that the object adheres to CDC standards is essential. For public safety, it may be beneficial to establish perimeters to safeguard against the virus. It is challenging to implement any established protocol without seeing the campus just yet.

2.5.8 References

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Fischman, M. L, Beth, B. 2020. "COVID-19 Resource Center" COVID-19 Q&A Forum. Accessed October 3, 2020. https://acoem.org/COVID-19-Resource-Center/COVID-19-Q-A-Forum/Could-you-provide-guidance-on-the-use-of-plexiglass-barriers-for-workplaces-for-sneeze-guard%E2%80%9D-dropl

Hamner L, Dubbel P, Capron I, et al. High SARS-CoV-2 Attack Rate Following Exposure at a Choir Practice — Skagit County, Washington, March 2020. MMWR Morb Mortal Wkly Rep 2020;69:606–610. DOI: http://dx.doi.org/10.15585/mmwr.mm6919e6external icon.

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Wiersinga, W. J., Rhodes, A., Cheng, A. C., Peacock, S. J., and Prescott, H. C. (2020). "Pathophysiology, Transmission, Diagnosis, and Treatment of Coronavirus Disease 2019 (COVID-19)." *Jama*, 324(8), 782.

3 Alternative Solutions

3.1 Introduction

The Alternative Solutions section highlights the designs that are a byproduct of brainstorming sessions. Each following example was designed whilst having the criteria of the client in mind. Example pictures have been rendered and brief descriptions of the products are given below.

3.2 Design Ideas

During the initial design phase, two brainstorming sessions took place. These were conducted on Zoom to maintain social distancing recommendations. These Ideas were captured on paper and the results of these brainstorming sessions can be seen in Appendix A. These sessions were all “open forum” and started off with a central idea that we used to get deeper into the topic. Each brainstorming session took approximately 20 minutes. The following alternative solutions are the products of these brainstorming sessions.

3.2.1 COVID-Square

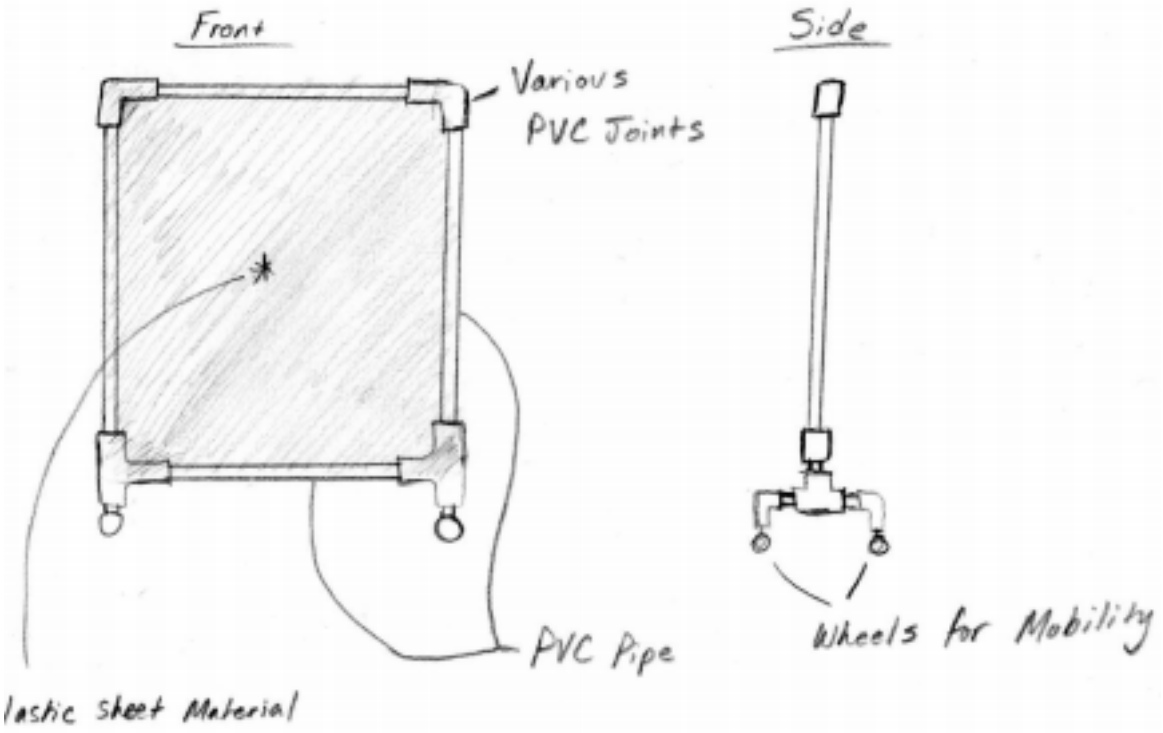

Figure 3: 3.2.1 COVID-square

The COVID-Square is a simple square constructed from PVC pipe to maintain a low price and weight. The dimensions would be approximately 7'x5'. Draped over the corners of the square would be a corresponding length of plastic sheet material that forms a bag and slips over the PVC pipe. To make the PVC pipe as invisible as possible it would be painted in a matte black paint. Various PVC joints and the pipes would all be fitted using an Epoxy or PVC cement. Attached at the bottom would be (4) wheels for easy maneuverability around the stage.

3.2.2 Plexi-stand

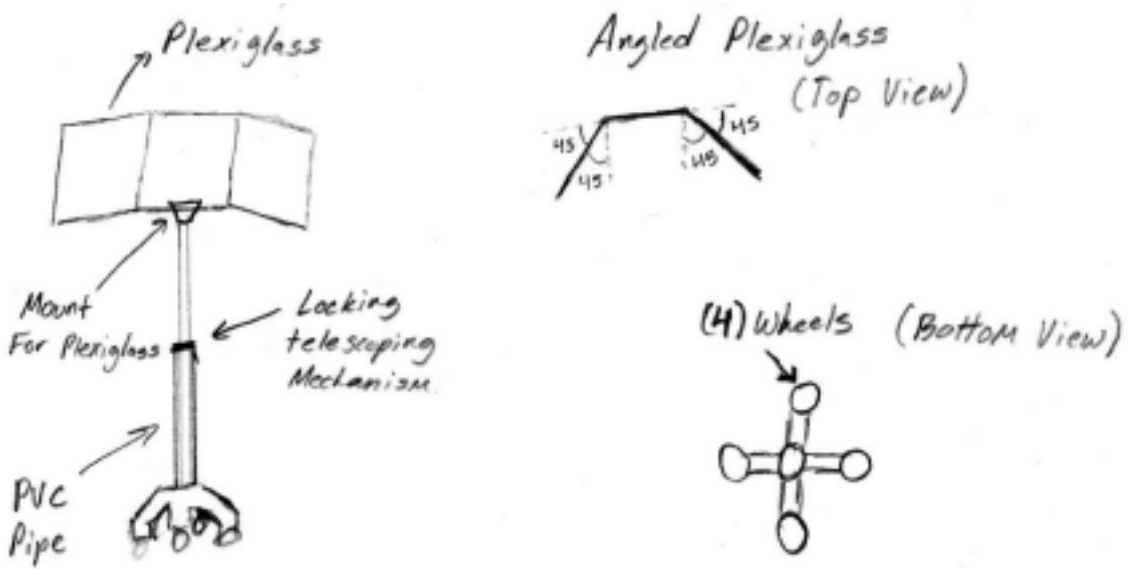

Figure 4: 3.2.2 Plexistand

The Plexi-stand is an alternative solution that tries to minimize the footprint of the plexiglass to allow the user to free themselves up as much as possible, while maintaining maximum protection around the face. The Plexi-stand is designed to have a locking telescoping arm to be set to the height of the user. The plexiglass portion is angled at 45° from the center piece. This design allows for minimum head adjustments to be made without having to completely move the stand, while still providing protection. (4) wheels have been attached to the bottom at 90° offsets from each other for mobility and stability. The stand will be made out of black PVC pipe to keep the weight low and the price minimal.

3.2.3 Plexi-Pack

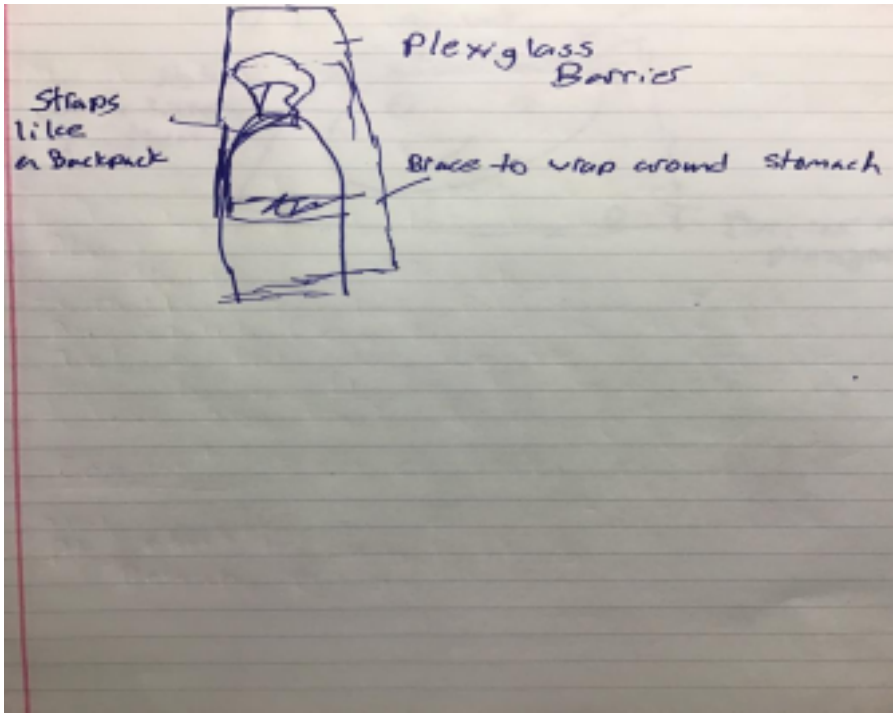

Figure 5: 3.2.3 Plexi-pack

This alternative solution would be a device that straps on to the back as if the wearer were wearing a backpack. There would be a brace involved that would support a plexiglass barrier that would wrap around the wearer and cover their entire torso at least. While this idea sounds reasonable in practice, it presents many challenges. There is a good chance that the weight distribution of the barrier could make it difficult for the wearer to be able to move comfortably and freely on stage. Cost is another issue in regard to this solution. We are supposed to keep the barrier as cheap as possible and buying and using that much plexiglass does not seem like a practical way to go about that. A final thing to consider with this solution is that it wouldn't leave much room for the performers to move and gesture with their arms, which at times is an important part of acting. Overall, this proposed solution sounds good in theory, but it is not very practical.

3.2.4 Plexi-Shield

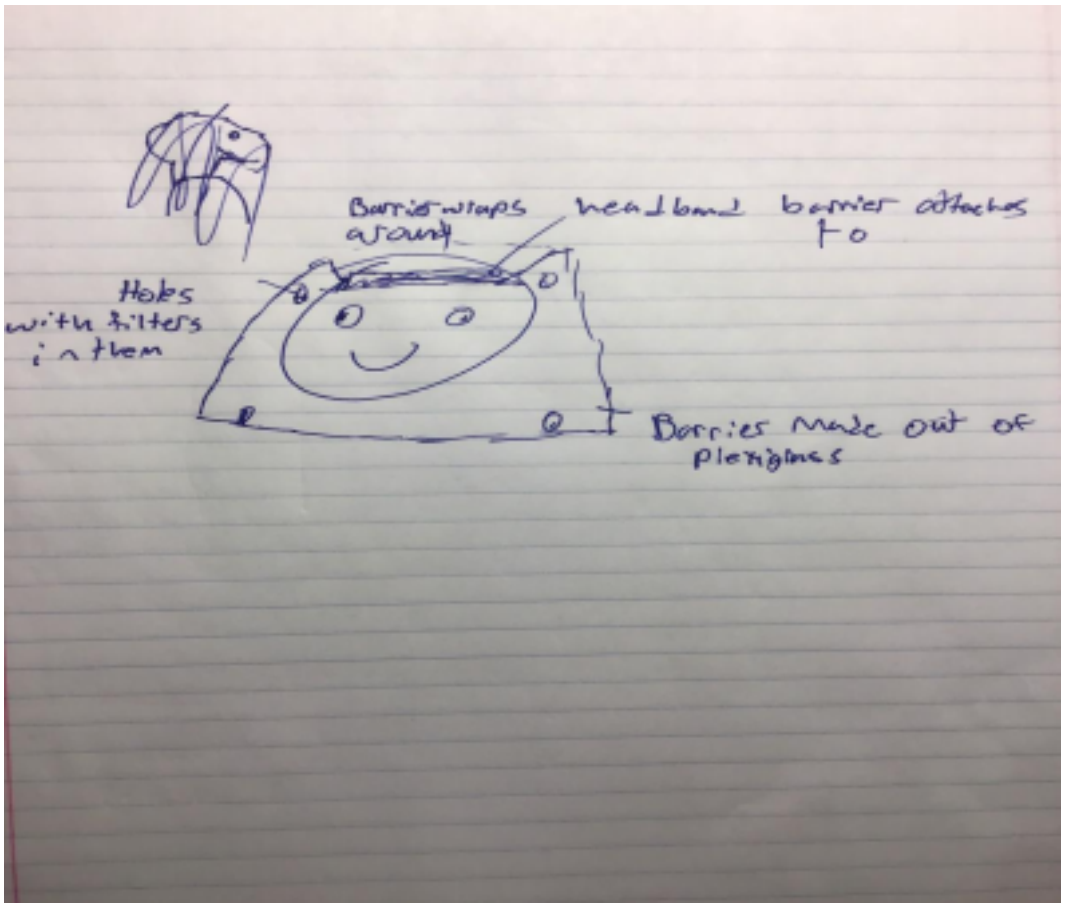

Figure 6: 3.2.4 Plexi-shield

This alternative solution works a lot like an actual face shield, but it would completely cover the head and would have MERV-13 filters over all of the airholes. The barrier would wrap around he head and would have cloth material at the bottom of it, that would tuck into the user's shirt. This barrier would not be too expensive to build initially, but the filters would have to be replaced on a consistent basis which could potentially drive up costs. Also, these barriers wouldn't be able to be repurposed into something else once the pandemic passes, meaning they would most likely end up getting tossed out after one use. Overall, this solution has the potential to be able to work, but it would only be used a couple of times before being thrown out and it could get expensive having to replace filters on a consistent basis.

3.2.5 Barrier Bag

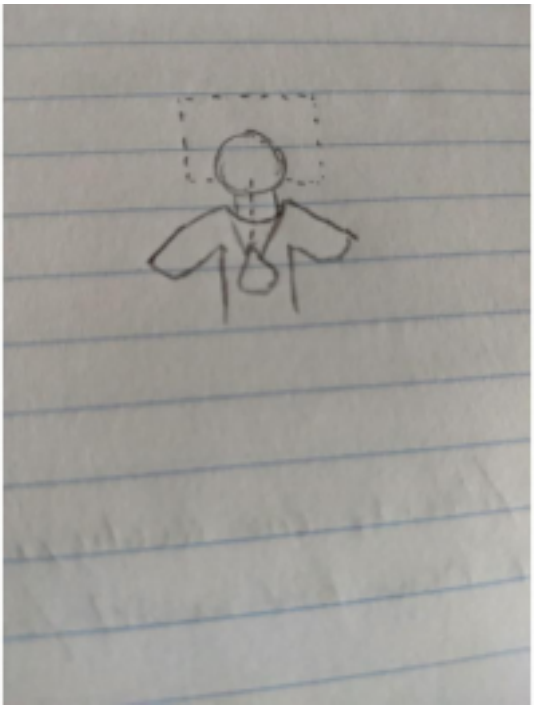

Figure 7: 3.2.5 Barrier Bag

The Barrier Bag would be an alternative solution that can be worn. Its design implements a hands-free approach to social distancing. While wearing the product, the barrier extends over the head of the wearer and protects them. It's a novel approach that allows the caster to perform while not having to worry about any possible entanglement with the actor's movement. The only caveat is that the actor would have to wear this as part of their play/performance. Another benefit would be how the barrier would cover the front of the actor. As the intent of the design is to practice distancing, it would allow particles to react to the barrier itself and not surround the user.

3.2.6 Selfie Barrier

Figure 8: 3.2.6 Selfie Barrier

The selfie barrier acts as a portable barrier where the user must hold the barrier. Just as people hold a selfie stick to take selfies, one can use the stick to provide their own protection. A con to this barrier would be that the actor would have to hold the stick to properly adjust the barrier. One pro of this would be that the barrier can be placed at the command of the user. It allows more flexibility which also allows for more mobility. The barrier itself can be made of various materials, one being Plexiglas. Since the stick can be adjusted, it can be properly adjusted to a point where a set length is adequate for distancing. It may take the user some time getting used to.

3.3 Appendix A Brainstorming

3.3.1 First Session

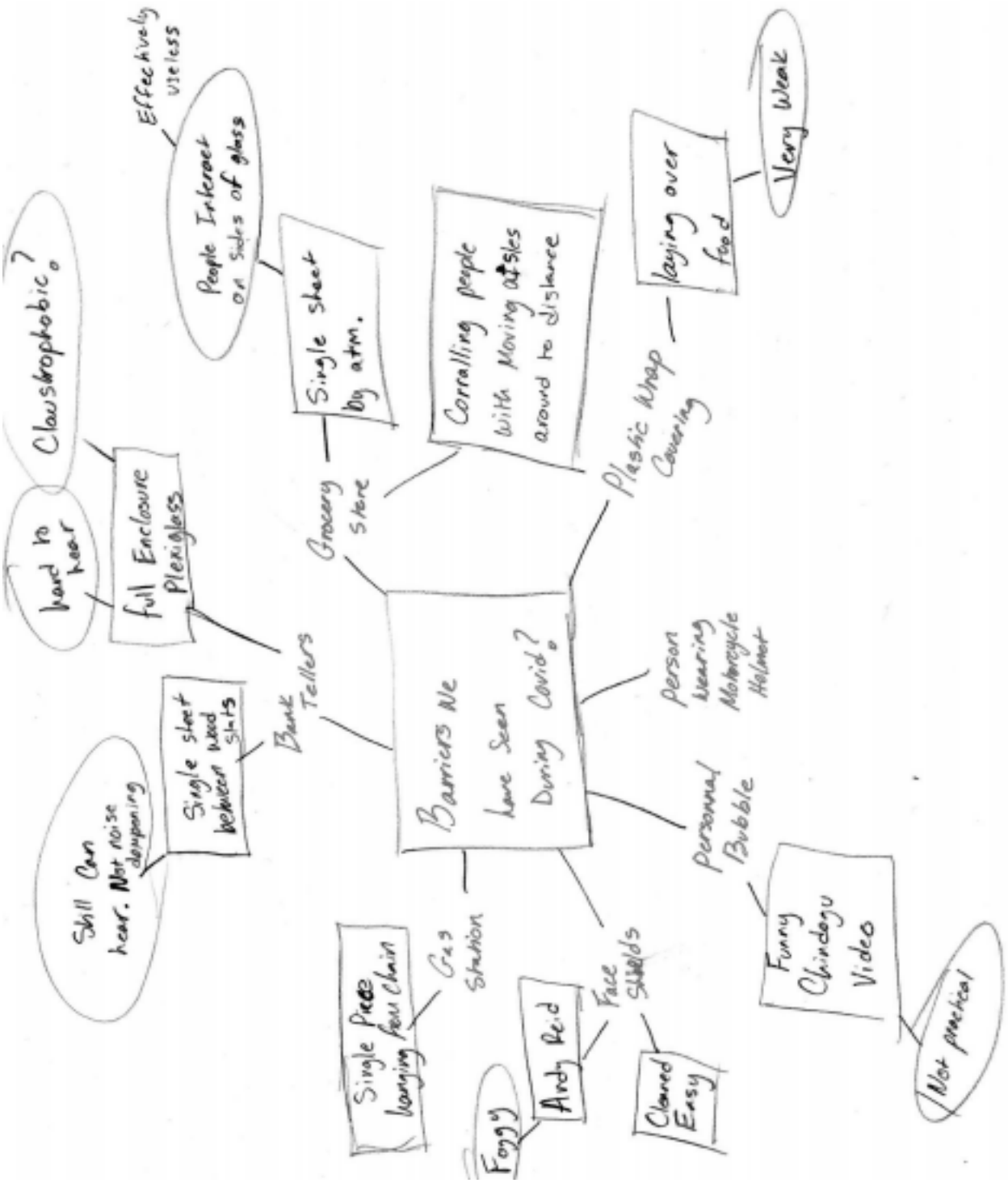

Figure 9: 3.3.1 Brainstorm

3.3.2 Second Session

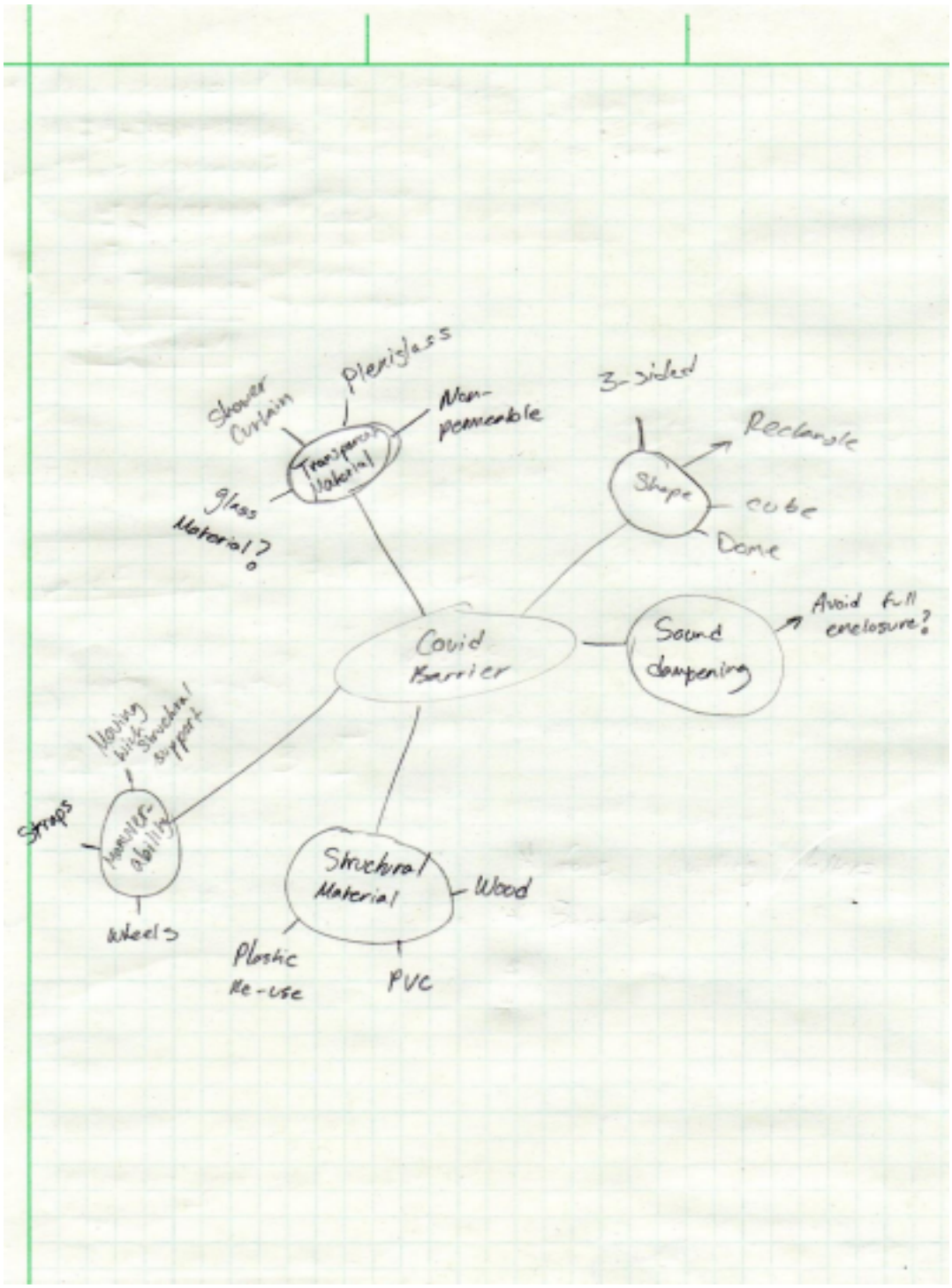

Figure 10: 3.3.2 Brainstorm pt 2

4 Decision Process

4.1 Introduction

The purpose of Section 4 of this document is to fully lay out the decision process of Blue Team. This section evaluates the alternative solutions from a previous section and it will also delve into the Delphi Method. The Delphi Method is a method weighs the criterion in order of most important to least important.

4.2 Criteria

Listed below are the team's criteria and their corresponding definitions. These are the criterion used in the final decision on the design of the product.

Cost- Our client specified that the barrier had to at least be under $100 per barrier. The team decided to try and make the barrier so it will only cost $30 per barrier. In other words, as cheap as possible.

Reproducibility- Since this barrier is to be used during a theater production, it is important that is can be assembled and disassembled quickly and with ease.

Obscure Face- The client does not want the barrier to obscure the performers face too much.

Mobility- It is important that the actors can perform and move the barrier when needed.

Storage- This criterion takes into account how easily the barrier can be stored.

Adjustability- The performers will need to be able to adjust the barrier at will.

Safety- The barrier must help mitigate the spread of Covid-19. The performers must also be able to use the barrier without putting themselves in any danger.

Sound Integrity- The barrier must not interfere with the audio quality.

4.3 Alternative Solutions

The following are our alternative designs that are detailed in Section 3.

- COVID-Square
- Plexi-Stand
- Plexi-Pack
- Plexi-Shield
- Barrier Bag

- Selfie-Barrier

4.4 Decision Process

The primary tool Blue Team used when making their final decision is referred to as the Delphi Method. In order to begin the Delphi Method, Team Blue selected a few different criteria and then met with their client and arranged them in order of most important to least important. After that meeting, all the team members then met and discussed which they felt was most important and listed off their reasons why. After much deliberation, the group came to a final conclusion and assigned weights to all of the criterion. The Delphi Chart can be found below.

4.5 Final Decision

The Delphi Method said that Blue Team should use the Plexi-stand design after going through the criterion. After much deliberation, Blue Team agreed and decided once and for all on the Plexi-stand idea. The design is very ergonomic and user friendly. The Plexi-stand design is also cheap to produce and the team can easily build as many as their client requests.

Weight	Alternative Solutions(0-50high)											
(0-10high)	Covid-Square		Plexi-stand		Plexi-pack		Plexi-shield		Barrier Bag		Selfie-barrier	
1	25		50		10		50		40		50	
		25		**50**		**0**		**50**		**40**		**50**
5	10		50		0		50		25		50	
		50		**250**		**0**		**250**		**125**		**250**
7	45		40		0		25		40		40	
		315		**280**		**0**		**175**		**280**		**280**
8	50		50		5		40		30		25	
		400		**400**		**40**		**320**		**240**		**200**
8	40		40		25		40		35		40	
		320		**320**		**200**		**320**		**280**		**320**
9	35		40		50		50		40		50	
		315		**360**		**450**		**450**		**360**		**450**
9	50		50		45		40		50		30	
		450		**450**		**405**		**360**		**450**		**270**
10	40		40		50		50		40		50	
	1875		**2110**		**1095**		**1925**		**1775**		**1820**	

Figure 11: 4.5.1 Delphi Table

5 Specification of Solution

5.1 Introduction

Section 5 of this document goes over the final design process chosen in the previous section in much greater detail. In this section you will find a detailed breakdown of the cost to build the barrier and a table indicating how many man hours went into developing this design. This section will also include step by step instructions on how to safely implement and use the model.

5.2 Description of Solution

The Plexi-Stand is made up of an IV stand with wheels at the base so the performers can move the about the stage with their barrier as they please. At the top of the IV stand is one 18x18 piece of plexiglass with two 6x18 pieces of plexiglass attached at the sides to form a barrier around the performers face. The barrier is lightweight and easy to hold onto making it easy for the performers to practice with it and get used to using it.

Figure 12: 5.2.1 Final Product

5.2.1 The Plexiglass

We purchased three sheets of 18x18 pieces of plexiglass and cut down two sheets so they would fit on the sides like we needed them to in order to create a barrier around the user's face.

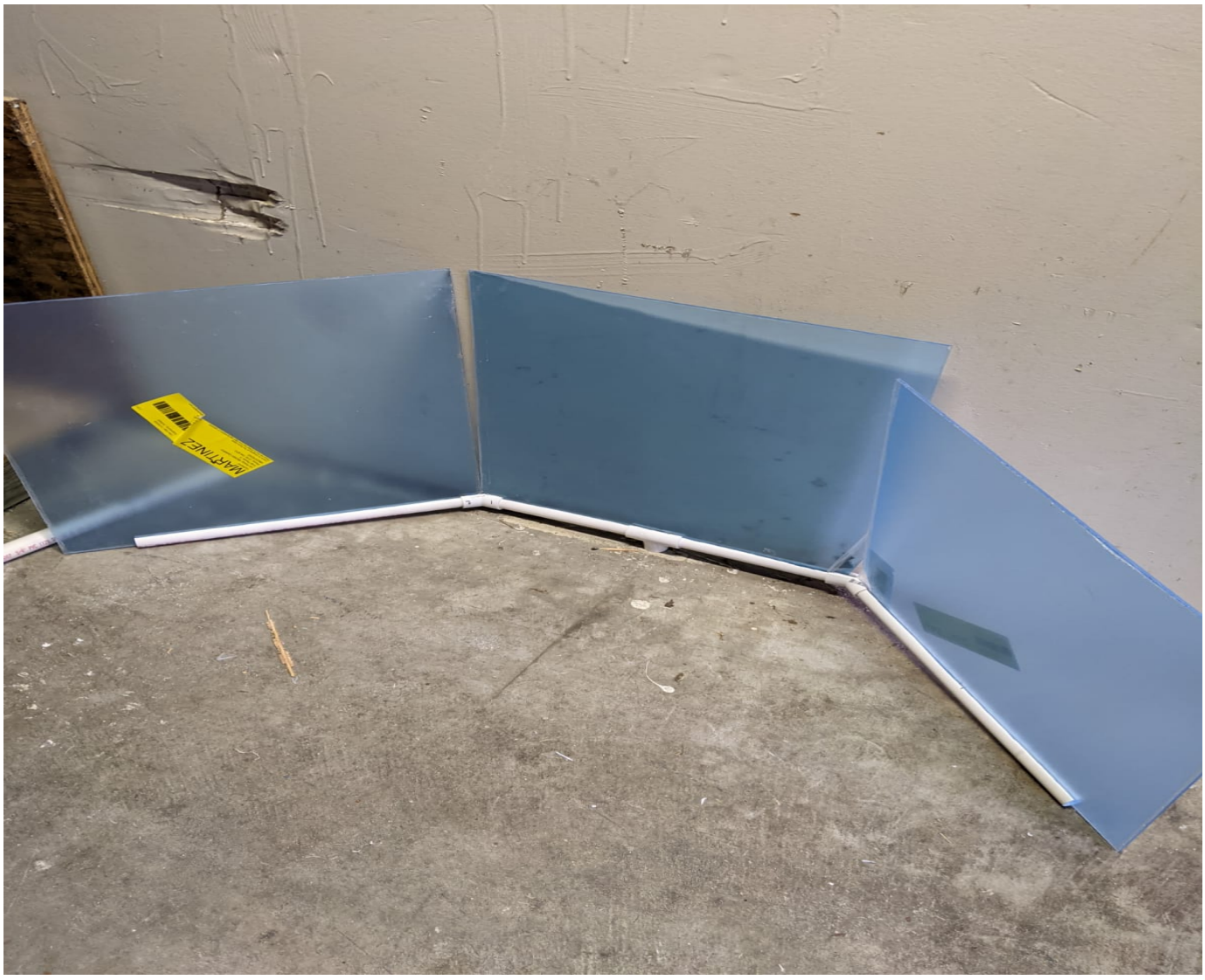

Figure 13: 5.2.1 Plexiglass

5.2.2 The IV stand

Taking the advice of their instructor, Blue Team bought an IV stand and repurposed it so it would be able to hold Plexiglass at the top.

Figure 14: 5.2.2 making progress

5.3 Cost Analysis

Section 5.3 is broken down into three sub-sections; design costs, cost of materials, and maintenance costs

5.3.1 Design Costs

The design costs paint a picture of how many man-hours Blue Team put into the project throughout the semester. In total, Blue Team spent 156.5 total man-hours on this project. Below is a pie chart breaking down how the teams time was distributed.

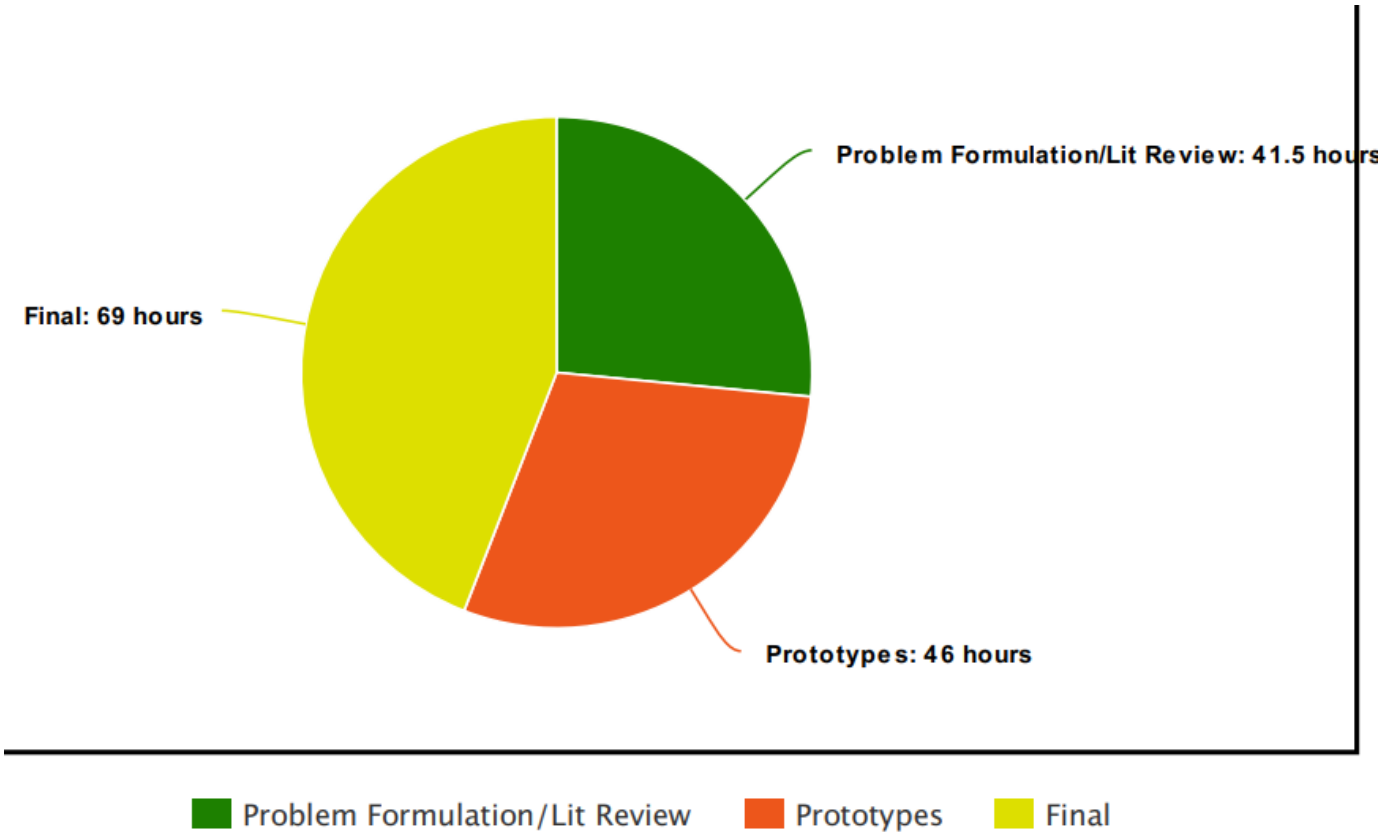

Figure 15: 5.3.1 Time pie chart

5.3.2 Cost of Materials

In total, the Plexi-Stand cost $140.18 to produce. Below is a table breaking down the costs and how the money was distributed:

Receipt Source	Receipt Date	Receipt Total	Receipt notes
Amazon	Oct. 31st	$29.19	IV stand
Home Depot	Nov. 17th	$44.34	18 x 18 Plexi
Ace Hardware	Oct. 22nd	$18.48	PVC pieces
Ace Hardware	Nov. 17th	$5.98	More PVC for top mounts
Harbor Freight	Nov. 14th	$6.93	PVC Cutter
Ace Hardware	Nov. 18th	$8.59	PVC Primer/Cement
Harbor Freight	Nov. 17th	$26.67	3-Inch Cutter/ Cutting wheels
Total: $140.18			

Figure 16: 5.3.2 Costs

5.3.3 Maintenance Costs

The Plexi-stand is built to last for years and years with little maintenance required. Assuming the students follow the instructions on how to use it, and its stored properly, there shouldn't be any need for the user to spend money on upkeep apart from buying some towels and disinfectant spray to wipe down the plexiglass after each use.

5.4 Implementation & How to Build

One of the main benefits of the Plexi-stand is that it is self-explanatory on how in how it is supposed to be used. The performer moves the stand around with them as they would a microphone stand in order to keep the barrier in front of their face.

5.4.1 How to build

1. Create a center mount. 3/4" PVC extension must contain a drilled in retaining screw. The neck must also be drilled in with the same screw. A 1/2" thread is secured to the T connector. A ring surrounds the mount which will be looped in by two zip ties. The T connector must be slotted and one piece of PVC that must hold the length og the 18x18 must be slotted too. PVC cement and primer must also be added to better join the pieces of PVC. This forms the center mount.

2. Cut the sheets of plexi to form a "18x18" and two "6x18" pieces. Slot four elbow pieces and two PVC pipes; This will join the two "6x18" pieces. Add PVC cement and primer to join the PVC pieces to the center mount.

3. Add the sheets of plexi to the pieces of PVC and the center mount. Add two elbow pieces to join the joints of the top sheets.

4. Apply super glue to crevices in the PVC. Add clear sealant to the edges of the sheets

5.5 Performance

The prototype is fully functional and it provides a safe way for students to be able to perform their craft while also being fully visible to the audience. Blue Team only built one stand, but the Plexi-stand can be replicated with relative ease for however many performers a play might require.

Figure 17: 5.5.1 Final Product