GNG 2101

Design Project User and Product Manual

ONE-HANDED WALKER

Submitted by:

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Table 1. Acronyms

Acronym	Definition
PVC	Polyvinyl chloride
BOM	Bill Of Materials
UPM	User and Product Manual
.stl	Standard Tessellation File format
S.T.I.N.G	Team and product name

Table 2. Glossary

Term	Acronym	Definition
UPM	User and Product Manual	The set of instructions that guides/instructs the user in how to properly operate the S.T.I.N.G effectively.

WHO IS DOING WHAT

Tasks	Person
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Using the Prototype/System	Sherry
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1 Introduction

This UPM provides the information necessary for the elderly and differently abled people to effectively use the one-handed walker for easy mobility and everyday use. It is also good for prototype documentation to keep records of what, why, when and how of our project. This information will enable the device to be easily replicated with ease. The information embedded in this document will be useful to other engineers in the field, startups and any organization concerned with accessibility projects. The unfair duplication of this document and this product is prohibited in accordance with the Copyright Act.[1]

[1] Copyright Act, Justice Law Website, Government of Canada, 1985. Accessed on: April 08, 2022. Available: Copyright Act (R.S.C., 1985, c. C-42)

2 Overview

The problem is designing and manufacturing a handle that will be attached to an existing walker that our client who suffers from Ehlers-Danlos syndrome, which causes weakness in her joints, can manipulate with one hand for her to move around easily. This project is important because our client currently struggles with moving her walker with both hands and being able to move it with one hand will make her life easier.

The client requires that the handle device be;

- The client is not supposed to lift over 5 pounds. Weight of walker – 5lbs arm max.
- The client's height – 5'7, a comfortable height range – is just below her chest.
- On a bad day, the client is very unstable and needs good support from the walker. The client uses a walker with bigger wheels. Her regular one uses small wheels.
- The client expects the timeframe of the walker to be 4-5 years.
- Expected folding time of walker – highest up to 5-7 minutes
- The client needs light at a wide angle to see left and right a couple of steps ahead.

Our incredible attention to detail separates our product from all others in the market for various reasons. Firstly, as designers, we were very considerate and empathetic in our design process for our client. Our choice of material was PVC pipe because of its durability and high tensile strength. We subjected the pipe to heavy loads, and it endured. We refrained from using metals like aluminum because, in a cold climate like ours, it will be very cold to touch and cause discomfort

to the client. Furthermore, we installed a flashlight holder to which the client could attach a flashlight to enabling her to see her surroundings in poorly lit areas.

Figure 1: Finished Prototype

Features of our device

Handle- A 15-inch PVC Pipe that will serve as the handle attached from one end of the walker to the other which the client will use to move the walker.

Two T-joint attachments: These will be attached at both ends of the pipe to connect it on the walker.

Flashlight holder- A clamp that will be used to hold the flashlight for use in dark or poorly lit areas.

Architecture of system

The handle, which is a PVC pipe, will have two T-joints connected to both ends with the use of an adhesive or by welding. These joints will be attached to both ends of the walker and it will be held securely in place. A clamp will be attached at the middle of the walker to place a flashlight on it if needed.

Bloc Diagram:

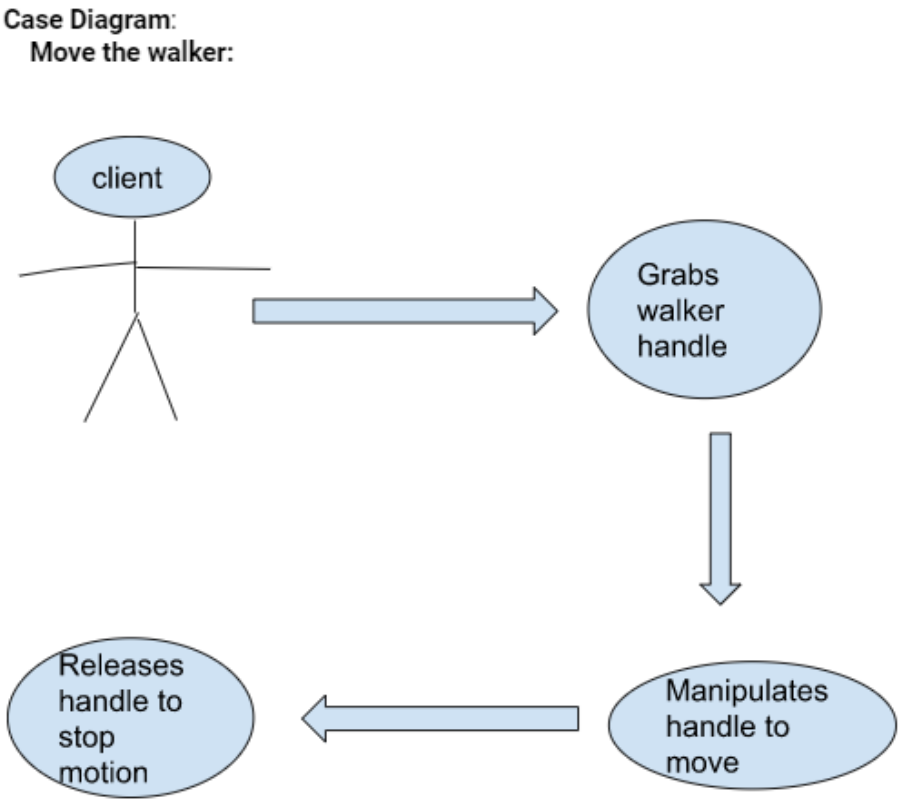

Figure 2: Use Case Diagram

Description: Figure 2 illustrates the process of using the one-handle walker steering. The client will grab the handle and move in the direction she wants. After getting to her destination or if she wishes to pause momentarily, she then releases

2.1 Cautions & Warnings

There are a few safety measures that should be kept in mind while using the one-handed walker;

- Applying too much pressure on one end of handle can cause handle to tip over
- T-joint attachments must be connected securely to both sides of the walker, or the handle will fall off with ease.
- Flashlight should be attached securely to the clamp to prevent damage
- All fittings and connections should be replaced at least every 2 years to avoid accidents due to wear and tear and loose joints.

Warning: Do not light fire close to the system. Store away from sunlight. In case of incidental damage, call support staff immediately.

3 Getting started

To begin, please verify that all required components are present and in working order. Start by examining your walker and ensuring its compatibility with our product. To determine compatibility, measure the distance between the two handles of the walker. The dimension should be around 15 inches, with a tolerance of +/- half an inch. If the walker dimension is within the tolerable range of our product, proceed by ensuring the walker is wholly unfolded to prevent any unwanted jerks of motion. Once the walker is ready, begin to examine our device. It is crucial to ensure all components are fully functional before use to protect the user's safety. It is the customer's responsibility only to attempt the operation of this accessory if it is safe to use.

3.1 Configuration Considerations

Before attempting the operation of our device, all components must be examined and checked for their safety. Begin a safety check of the device by examining each component one at a time. The first component to check is the PVC pipe, which should be straight and solid with no signs of stress or deformation. Next, ensure that the flashlight holder is present and is moving freely along the length of the pipe. In case of a malfunctioning or non-existent flashlight holder, discontinue using the walker after sunset. Finally, examine the two end pieces which grip the walker handles. Check for looseness in the connection to the pipe or any signs of cracking or excessive stretching. Refrain from forcing our product onto a walker with incorrect dimensions, as it can contribute to damaged end pieces; it should require low force to set up the system.

3.2 User Access Considerations

The purpose of the accessory is to be used by those requiring more effortless movement of their walker. This accessibility product allows users to move a walker by utilizing only one of their arms. S.T.I.N.G has designed this product to be as simple as possible to install and operate to increase walker accessibility to a broader range of people.

Please ask others for assistance if you find the installation or disassembly process too challenging. It can become difficult for certain people to detach our accessory, especially when it has a snug or tight fit with the walker handles.

3.3 Setting-up the System

Once you have confirmed the accessory is safe, you may attach our device to your walker. Refer to section 4.1.1 of this user manual for detailed instructions referring to the attachment of the system.

3.4 System Organization & Navigation

This system is broken down into 3 functions, with their respective subfunctions. For more information regarding this, please refer to section 4 where each function is explained in detail below.

3.5 Exiting the System

If you would like to remove the accessory from your walker, refer to section 4.1.2 of this user manual which discusses detaching our product from a walker. When storing the device, please keep it in a dry location away from direct sunlight.

4 Using the System

This system is broken down into 3 functions: attachment/detachment, movement, and the flashlight mount. The attachment/detachment section is tailored to give a detailed description of how to attach the system to the walker without any issues, along with how to take it off the walker properly. This document also lets the reader know the appropriate input for the required walker movement. Instructions regarding the proper usage of the flashlight mount are also provided, along with pictures for each process.

The following sub-sections provide detailed, step-by-step instructions on how to use the various functions or features of the S.T.I.N.G.

4.1 Attachment/Detachment

This system function provides details on how to secure the S.T.I.N.G to the walker in use. During the use of this device, one must make sure that the walker is in the “open” position, meaning that it is unfolded.

4.1.1 Attaching

When attaching the system to the walker, grab one side of the device and safely insert any one side of the walker in the cupping of the T-joint attachment, as seen in figure 3. Make sure the walker is partially unfolded.

Figure 3 Attaching the walker I

Once one side of the device is safely attached to the walker, attach the other side by gently putting the cupping of the other T-joint attachment, as shown in figure 4. It is important the device fits the walker; do not stretch the attachment before it is secured on to the walker.

Figure 4: Attaching the walker II

Once the attachment is secured onto the walker, unfold the walker completely. Some stretching may occur, as this device is supposed to fit a multitude of walkers.

4.1.2 Detaching

For detachment, reverse all steps followed during attachment, as in first make sure to fold the walker partially, then take off one side the attachment, followed by the other side and then safely store the device away from sunlight.

4.2 Movement

For movement of the walker using the S.T.I.N.G, only one hand is required. It does not matter which hand is used. This system is built for one-handed use, however, it can be used with two hands, if need be. Once the attachment is safely secured on the walker, as per the instructions provided in the previous section, put one hand on either side of the walker, preferably 5 cm away from the handles of the walker, and push in the required direction, as seen in figure 5.

Figure 5: Moving the walker

More movement tips and guides are available in the video manual, please watch it for a better understanding of how to use this attachment to move the walker.

4.2.1 Lateral Movement

For lateral movement, grab the attachment and apply force perpendicular to the attachment, i.e., push the walker away from the user.

4.2.2 Rotational Movement

For lateral movement, grab the attachment and apply force parallel to the attachment, i.e., push the walker away from the user while rotating the wrist at the desired angle.

4.3 Flashlight Mount

To appropriately use the flashlight mount, first move the flashlight module to the side that is not being used currently (this is not required). Tilt the head of the walker to be in the upright position (as seen in figure 7) from the normal resting position (as shown in figure 6).

Figure 6: Normal rest position of flashlight mount

Figure 7: Upright position of flashlight mount

Once the flashlight mount is upright, insert the back of the flashlight from the front of the attachment. Please note that an example of the flashlight mount in use is provided in figure 5.

Note: Do not move the flashlight mount with the flashlight still in place.

To remove the flashlight safely from the mount, gently push the back of the flashlight and grab the front head (**do not touch the reflector/bulb**). Once the flashlight is removed, tilt the mount away from the user.

5 Troubleshooting & Support

This section is broken down into 3 subsections: Error Messages or Behaviours, Maintenance, and support. Error messages or behaviours will bring your attention to the most likely failures with the product and how to avoid them. Maintenance will cover the recommended safety checks, servicing, and repair of the product. Support will outline the necessary steps to take to receive emergency assistance, report identified problems, and contact the support staff.

5.1 Error Messages or Behaviors

Parts of the product that are prone to breaking include:

- 3D printed t-joint attachments
- 3D printed flashlight securing apparatus

While all materials included in the prototype are strong and resilient, they are considerably weaker at the attachment points. Excessive downwards force on the PVC pipe can cause the t-joint attachments to deform past the limit of their elastic deformation (temporary deformation) and either plastically deform (permanent deformation) or break. The maximum force recommended to apply

on the product is 70lbs. This is to ensure the safety of the user and the functionality of the product. The 3D printed flashlight securing apparatus is in a position of much less stress than the t-joints but can still be prone to breaking if handled poorly. To maximize the lifetime of the flashlight apparatus, it is recommended to avoid inserting flashlights with a diameter greater than 1.4 inches. The internal diameter of the attachment is 1.3 inches, and while it will elastically deform to accommodate a flashlight with diameter slightly over 1.3 inches, too large a flashlight will likely result in the permanent deformation or fracture of the material.

The prototype is more likely to break if not handled carefully. It is important to avoid excessive forces acting on the product, especially when applied quickly. One example of this would be dropping the prototype. The materials used in this product are capable of absorbing large forces such as elastic deformation before plastically deforming. However, if the same force is applied too quickly, the material may not have enough time to elastically deform and fracture instead. Therefore, it is important to avoid actions like dropping the prototype to decrease the likelihood of cracks and chips and increase the longevity of the product.

5.2 Maintenance

To avoid failure of the product, regular maintenance is recommended. Before and/or after each use, be sure to:

- Wipe down the product with a wet towel to reduce the effects of weathering

- Inspect the product for any fractures or chips
- Check that the adhesive joining the t-joints to the PVC pipe still has a strong bond

This product is made from very durable, strong, and wear resistant materials. However, everything is subject to degradation over time, and it is important to perform regular, routine maintenance on the product to maximize its lifetime. Wiping the product down with a wet towel or cleaning wipe will ensure that the product does not experience any unnecessary corrosion or degradation from contaminants such as dirt, salt, etc. Inspecting the product before and/or after each use will serve to possibly avoid the propagation of cracks or chips. If any cracks or chips are discovered on the product, it is recommended to take corrective action as soon as possible to ensure the longevity of the prototype. It is best to repair the cracks or chips early as the become more difficult to repair as they increase in size. Recommended repairs include:

- Using a strong adhesive to bond the plastic back together (cracks)
- Submerging the damaged portion into hot water, mold the damaged area back together when the plastic has become malleable, then quickly submerge into cold water (cracks)
- Making a plastic slurry (cracks and chips)

Failure to repair the damaged parts will likely result in the fracture propagating and becoming increasingly difficult to repair before the part fails. Depending on the condition of the broken part, it may be possible to fix, however the repaired part will be much weaker than the original or even the part that was damaged but repaired before the severity of the damage increased.

5.3 Support

In the event you require emergency assistance regarding your product, it is important to follow these steps:

- Identify your problem
- If it is a problem outlined in sections 5.1 or 5.2, refer to those sections first
- If your issue is not outlined in sections 5.1 or 5.2, send an email to one of the support staff specifically describing your problem, along with images

If you do not receive a response within 48 hours, please reach out to another member of the support staff and bring your problem to their attention.

Support staff contact information:

Isaac Winsor: iwins019@uottawa.ca

Nina Blaney: nblan039@uottawa.ca

Gautam Mehta: gmeht084@uottawa.ca

Shehryar Ali Memon: smemo081@uottawa.ca

Oluwatamilore Ilupeju: oilup102@uottawa.ca

NOTE: Your email **must** have in the subject, “S.T.I.N.G. Customer Support”, to ensure the staff see it.

6 Product Documentation

When developing the product for the client, initially, a different idea was conceptualized that was vastly different from the final design. However, upon taking a step back and looking at the available resources, and what the design was ultimately bringing, a mutual decision was made to change directions and formulate a new concept, which ended up being the final prototype.

For the creation of the final prototype, since having to start back at the beginning, the team went back to look at the developed client needs. Here, upon looking at the client needs (as seen in section 2), it was decided to create a system that fell within those parameters, (for instance, how much the client could lift), as well as maintaining the main purpose of the attachment. With these important details in mind, the team created a new, simplistic design, with the main idea of keeping as simplistic as possible to give the client a device that they can comfortably utilize in their everyday life.

In the end, the prototype was made using three different parts/components. The two connectors situated at either side of the bar, the main body of the attachment, and a flashlight holder positioned on the bar, allowing for the client to move it around if need be. Bellow is a documentation of each element.

6.1 Main Bar

Ultimately, the main bar of the whole system is the most vital part of the attachment. This is because every other part of the prototype needs, at the very least, the diameter of the bar for the creation of them

6.1.1 BOM (Bill of Materials)

Table 3: Bill of Materials for Main Bar

	Part Name	Part Description	Quantity	Price	Link
1	*Carlon Schedule 1/2-inch 40 PVC Conduit*	PVC Pipe used for the main body of the prototype	1	$7.75	Pipe
2	*LePage Marine Epoxy, 25 ml*	Glue used to glue the connectors to the pip	1	$16.97	Glue
3	*Rust-Oleum Painter's Touch 2X Ultra Cover Multi-Purpose Paint And Primer in Flat Black, 340 G Aerosol Spray Paint*	Optional paint to colour the prototype to the desired colour	1	$13.87	Paint

When it came to choosing the main body of prototype, careful consideration was given to make sure that the material was lightweight, but also durable. This was the reasoning why it was decided to make the final prototype with the PVC pipe.

The PVC pipe being made from a combination of plastic and vinyl meant that the tensile strength, (σ), which is the maximum stress that a material can bear before failure, is quite high, (in this case, its around 350 lbs). Another benefit of choosing to use a PVC pipe is that it is light weight, falling well under the constraint of the whole prototype needing to be under 5 lbs.

6.1.2 Equipment list

The equipment needed for the creation of the main body is (baring the items listed in the BOM):

- measuring tape, (something that can be laid flat such as a measuring tape used for sewing)
- pens for marking the PVC pipe,
- a cutting device that can cut PVC pipe
- at least one of the two end connectors

6.1.3 Construction of the Main Bar

The steps to construct the main bar if as followed:

1. Measure the distance between the handles

Figure 88: Distance Between Handles

Description: Given above is an image depicting an example of where the measurement was taken from, with the final measurement in this case being approximately 18 inches.

2. After measuring the distance, take the PVC pipe and, choosing one end to be the reference edge, transfer the measurement onto the pipe, making sure to mark it with a pen.

Figure 99: PVC Pipe After Initial Measurement

Description: Above is an image depicting the PVC pipe, after it was measured.

3. Now, with one of the connectors, attach it to the reference end, and measure the distance from the ‘new end’ of the bar to the red mark.

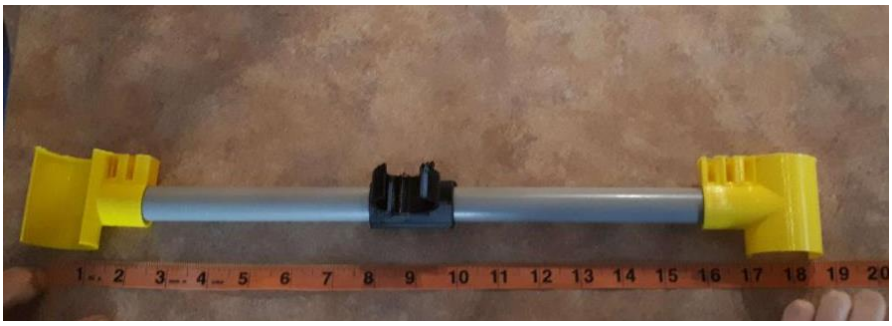

Figure 1010: Measurement of the PVC Pipe With the Connectors

Description: Above is an image depicting the PVC pipe, this time with the connectors attached, being measured

4. Using the new distance, do a simple calculation of the new distance – initial distance, to get the length that the attachments will be adding to the bar.
    a. Note: if using the exact measurements provided in the part drawings, then this distance should be 1.75”.
5. Cut the pipe to the needed length
6. Before attaching connects and flashlight holder, spray paint the part (if wanted).

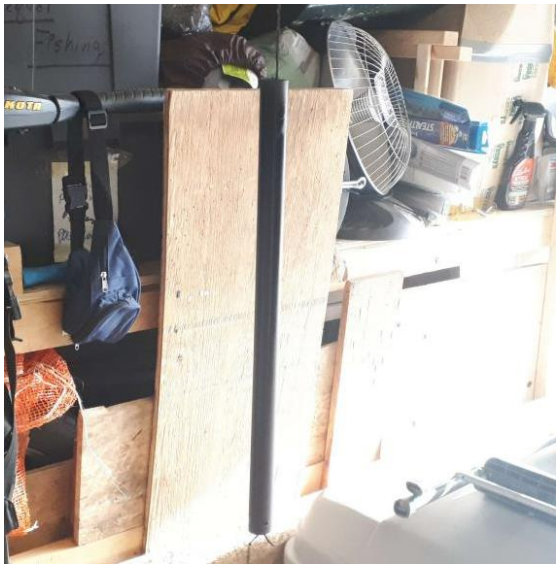

Figure 1111: PVC Pipe After Spray Painting

Description: Above is an image depicting the PVC pipe, just after it was spray painted, drying.

Figure 1212: All Parts After Paint Finished Drying

Description: Above is an image depicting the PVC pipe, connectors and flashlight holder after the paint has dried.

7. Slip on the flashlight holder.
8. Doing one at a time, with allowing time in between for each end to dry, attach the connectors with the glue.

Figure 1313: Fully Assembled Prototype

Description: Above is an image depicting the final prototype fully assembled. Painter's tape was used to help hold it in place while it dried.

6.2 Two Connectors

For the two connects, they were created using Solidworks 2021, with the idea in mind that they would be 3D printed using an Ultracura Machine. The reason why the connectors were 3D printed and metal was not used is because of the properties of plastic versus the properties of metal, specifically for their ductility.

When it comes to parts made from plastic in comparison to parts made from metals, plastic will allow for more elastic deformation to occur before failure. This means that the part could be made small than the circumference of walker handle, and still fit on it and allow for rotation or easy removal.

6.2.1 Equipment List

The equipment needed for the creation of the connectors:

- Measuring tape, (something that can be laid flat such as a measuring tape used for sewing)
- Solidworks (for this prototype, Solidworks 2021 was used, however any recent Solidworks version is fine).
- Ultracura 3D Printer (8mm nozzle)
- Ultracura Software

6.2.2 Creation of Two Connectors

The steps to create the two connectors are as follows:

SOLIDWORKS:

1. Measure the diameter, or the circumference of the PVC pipe and Walker Handle where the attachment is going. **Note:** for the PVC pipe, use the outer diameter. Also, if using the circumference, do not forget to convert it to the diameter.

2. With the measurements, open Solidworks and create a new part

3. Start by drawing a circle on the FRONT PLANE. This will be using the diameter of the walker handle as this is the part of the connector that gets attached to the handle. For this measurement, make sure it is at least 1/16” smaller than the measurement. Do not worry about it not fitting in the end, the idea is that it is a fraction smaller than the handle to make

sure its securely on, and with the connector being made from plastic it will allow for elastic deformation to occur.

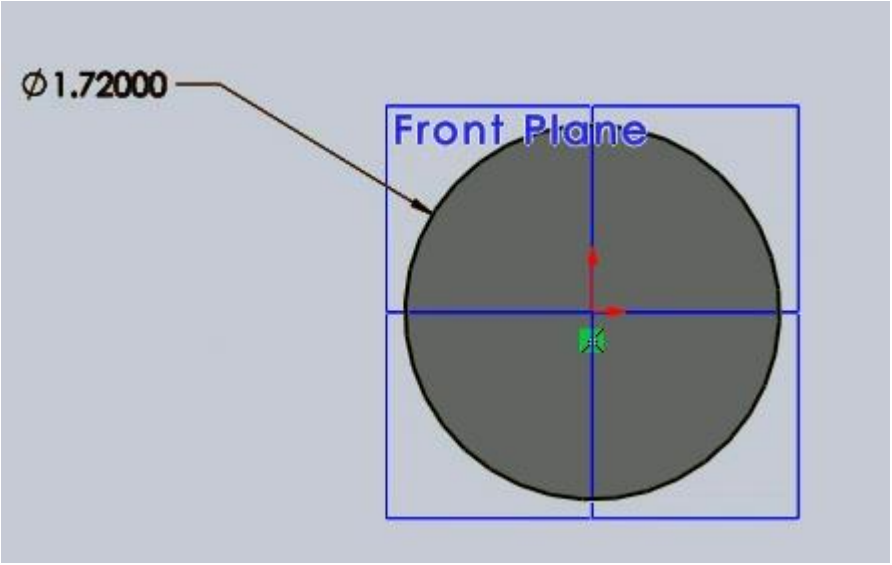

Figure 1414: Initial Circle Made

Description: Above is an image of the initial circle made in Solidworks. The dimensioned used for this part is the diameter of the walker handle.

4. Next, Boss-Extrude the piece, going in two directions, with each distance being 1.125”.

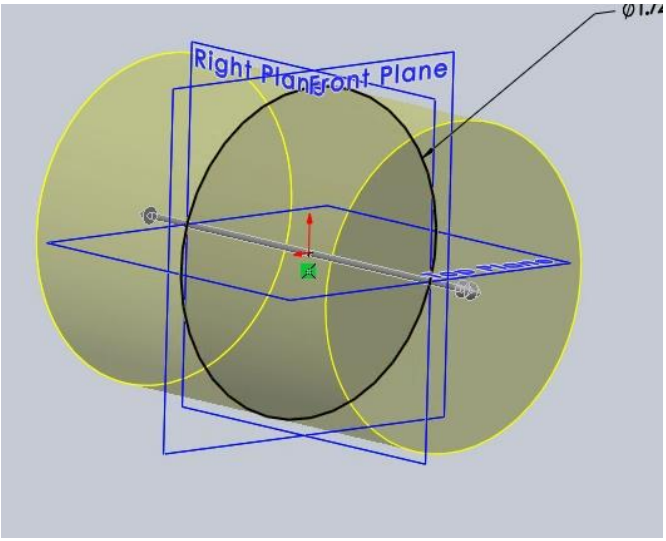

Figure 1515: Boss-Extrude of the Main Connection

Description: Above is an image of the Boss-Extrude of the initial circle made from step 3.

5. Now using the RIGHT PLANE, draw a circle using the diameter of the PVC pipe. This circle is 'attached' to the bottom of the Boss-Extrude part. **Note**: When using the diameter, add at least 1/16" to the measurement, at most 2/16" to the measurement. This is to make sure that it can snuggly fit on, with it not being too loose, or too tight.

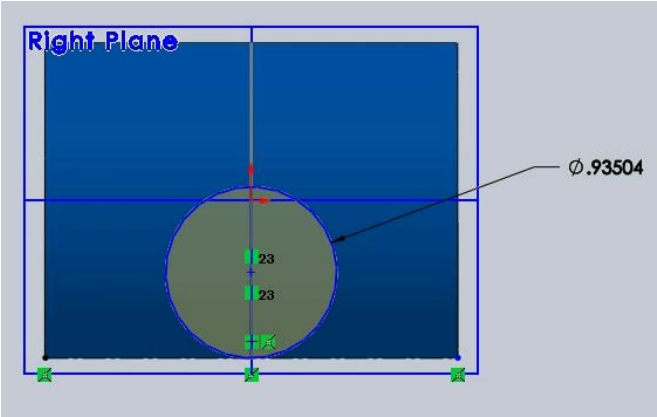

Figure 1616: Initial Circle for Connector to Pipe

Description: Above is an image of the circle drawn at the bottom of the Boss-Extrude, using the RIGHT PLANE.

6. Now Boss-Extrude this circle. Make sure its offset, by at least 1.85”. Then for Direction1, select up to surface, and select the outer surface of first Boss-Extrude.

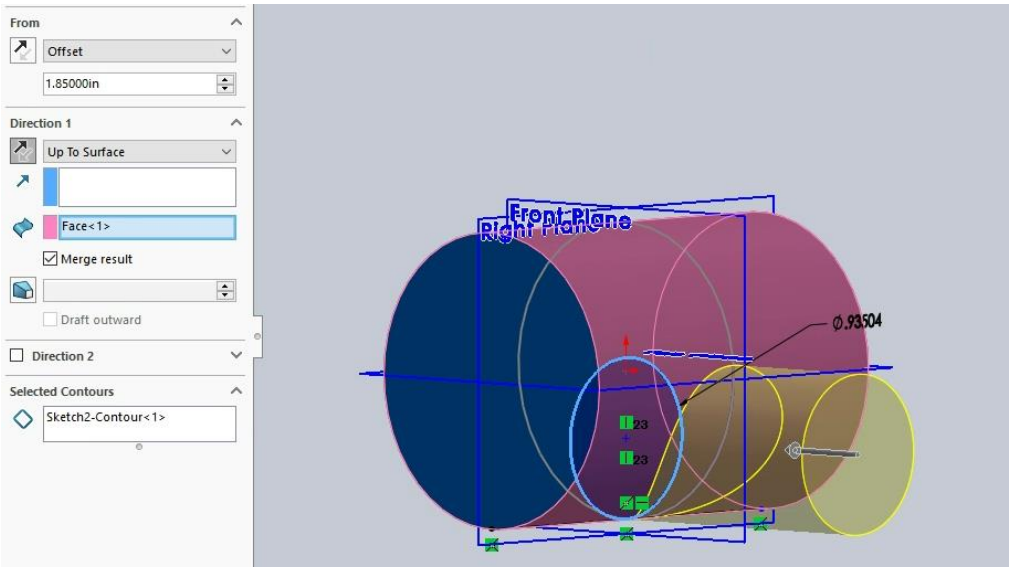

Figure 1717: Boss-Extrude of Attachment for PVC Pipe

Description: Above is an image of the second Boss-Extrude done, with the specifics shown to aid in creation of this section.

7. Now select the end of the first Boss-Extrude and draw on a circle (any end is fine). For this circle, the dimension should be the original diameter, but with at least 1/16” to 2/16” subtracted from it.

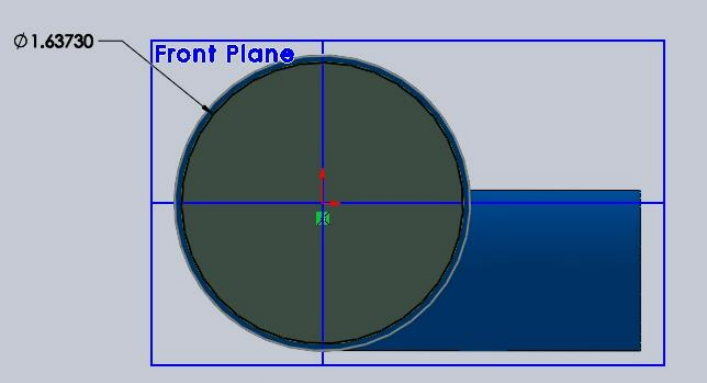

Figure 1818: Circle on One of the Edges of the First Boss-Extrude

Description: Above is an image of the circle drawn on one of the edges of the first Boss-Extrude with diameter given.

8. Now, Cut-Extrude the circle just drawn, selecting “Through All” for the main direction

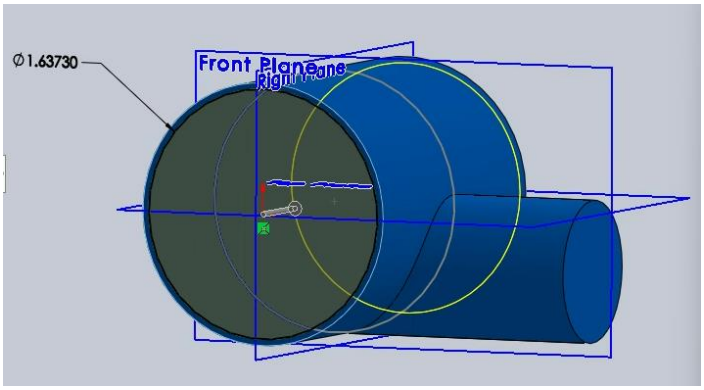

Figure 1919: Cut-Extrude of Circle Made from Previous Step

Description: Above is an image of the Cut-Extrude step of the circle made from the previous step.

9. Now move onto the second Boss-Extrude preformed. Select the end of that section, and draw a circle on it, following the same dimensioning information explained in Step 7. After making that, Extrude-Cut it. For Direction 1, select Blind, and make it go for a distance of at least 0.95”.

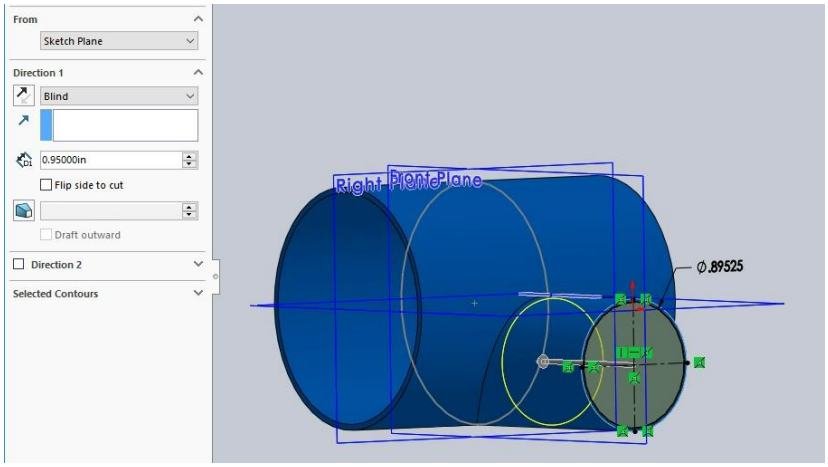

Figure 20: 20Dimension of Circle and Second Extrude-Cut

Description: Above is an image of the dimension and information of the second Extrude-Cut that needs to be made.

10. Move onto the first Boss-Extrude part of the design. Select on face and open a sketch. Now, approximately 0.41608” from the second Boss-Extrude, draw a line from the outer edge across. This line should be around 1.41196” if using the same dimensions. Then select the 3-Point-Arc sketching tool and make an arc connecting both ends of the line just drawn. After that, to make the drawing valid, dimension the radius of it.

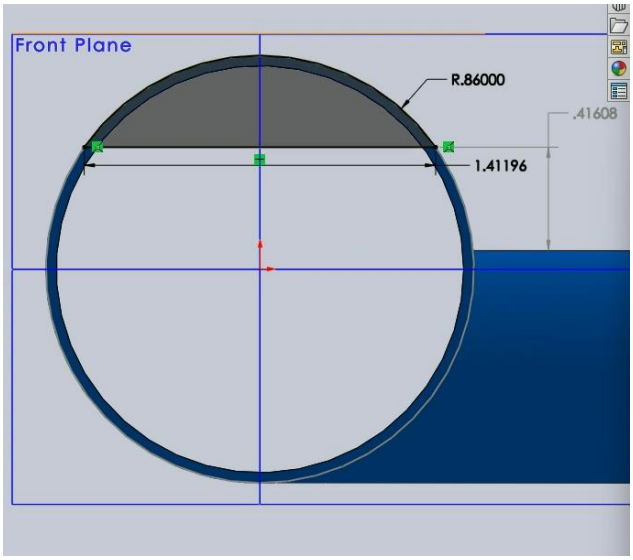

Figure 2121: Dimensioning of the Sketch

Description: Above is an image of the dimensioning needed for step 10. The light grey measurement is a Driven Dimension, where it has no effect on the final drawing as to not make it over-defined.

11. Using the sketch made step 10, Cut-Extrude it, selecting “Through All” for Direction 1.

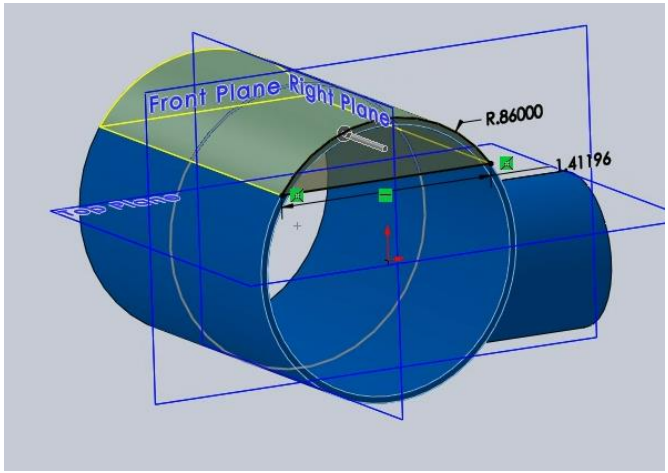

Figure 2222: Cut-Extrude of Sketch from Step 10

Description: Above is an image of the Cut-Extrude done in this step.

12. Now fillet specific edges (as see in Figure 18), with a radius of 0.05”

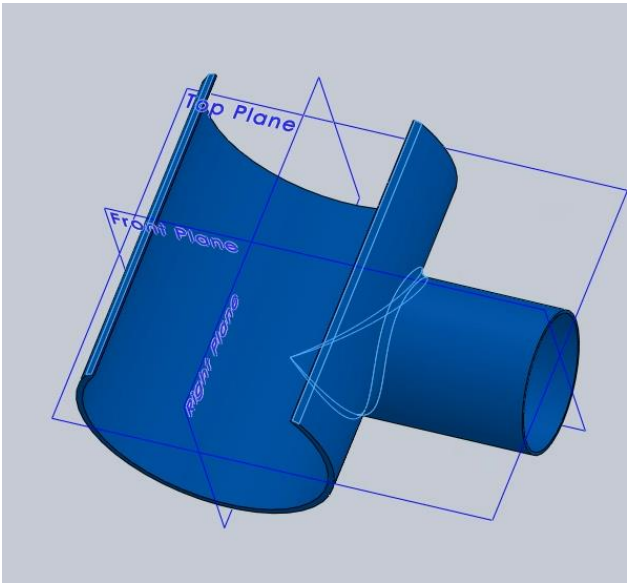

Figure 2323: Highlighted Edges That are Filleted

Description: Above is an image showing which edges need to be filleted with a radius of 0.05”.

13. Final step in solidworks is to save the file as a .stl file so it can be used with an Ultracura Machine.

PRINTING THE PART:

1. Open .stl file just saved on Ultimaker Cura

2. Optional: Add another part to the printing plate by right clicking the part and selecting “Multiply Selected”.

3. Make sure to select to add supports, (support placement should be “Touching Build plate”).

4. Add supports by selecting “Support Blocker”, (or the ‘E’ key). After putting the support inside the part that gets attach to the PVC pipe, resize to make sure it fits. This is to prevent supports from being made inside it.

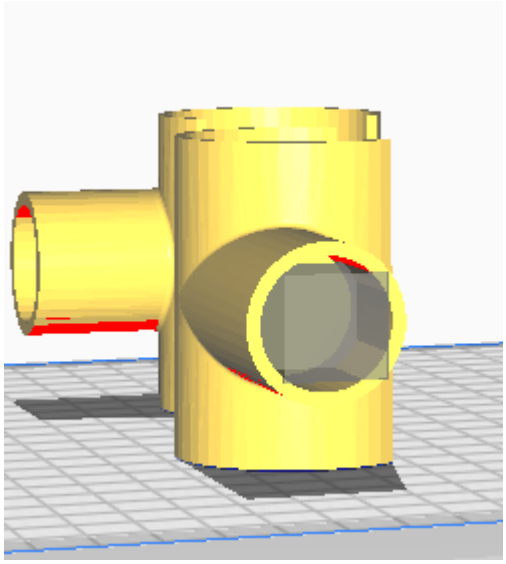

Figure 2424: Support Blocker in Place

Description: Above is an image showing where the support blocker is placed, with it resized to fit.

5. Once settings are set, (printing speed is 55.0 mm/s, with layer height being 0.25mm), start printing.

ATTACHING TO PIPE.

1. After pieces are printed, make sure to remove supports added during the printing process.
2. Just as in the creation of the main part, an optional step is to paint the part any desired colour.

Figure 2525: Painted Connection Parts

Description: Above is an image showing the painting connection parts, as well as the painted flashlight holder.

3. Following the steps in the creation of the main body, once paint is dried attach the Connectors to each end of the PVC pipe.

6.3 Flashlight Attachment

6.3.1 BOM (Bill of Materials)

For this part, no purchases were made, however, if one wishes to give a flashlight to the client, a flashlight that at least has a diameter of 1.30”.

6.3.2 Equipment

The equipment needed for the creation of the connectors:

- Measuring tape, (something that can be laid flat such as a measuring tape used for sewing)
- Solidworks (for this prototype, Solidworks 2021 was used, however any recent Solidworks version is fine).
- Ultimaker Cura 3D Printer (8mm nozzle)
- Ultimaker Cura Software
- Flashlight for reference measurements (if have one)

6.3.3 Creation of Flashlight Holder

The steps for the creation of the flashlight holder are:

SOLIDWORKS:

1. Start by drawing a circle with a diameter of 1.13” on the RIGHT PLANE. Then Boss-Extrude it going two directions, with the distance being 1.00”.

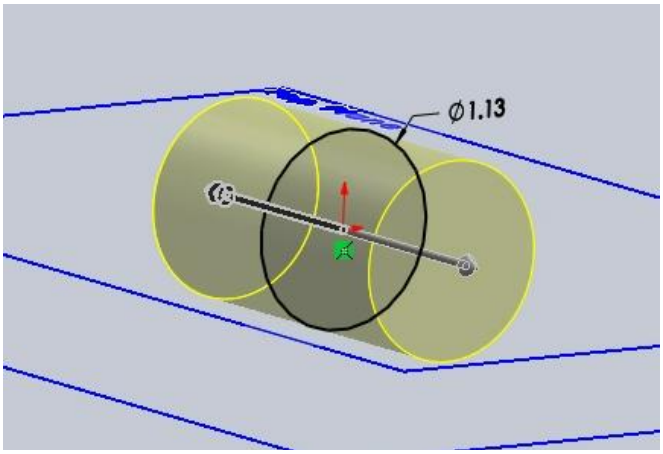

Figure 2626: Boss-Extrude of First Circle Made

Description: Above is an image showing the Boss-Extrude of the first circle drawn. For this Boss-Extrude, the Blind option is chosen.

2. Next select one of the ends of the Boss-Extrude and draw a circle on it with a diameter of 0.9”. After making the circle, Cut-Extrude it, with the option for Direction 1 being “Through All”. **Note:** This dimension should match the diameter of the PVC pipe, with a little bit added on to make a snug fit.

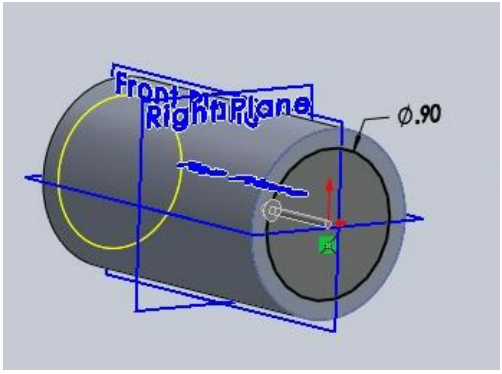

Figure 2727: Cut-Extrude of the Part

Description: Above is an image showing the Cut-Extrude of the part.

3. Using the RIGHT PLANE again, draw a rectangle-shape, that 0.5” wide and 0.75” long, with it being 0.42” from the center of the main extrusion.

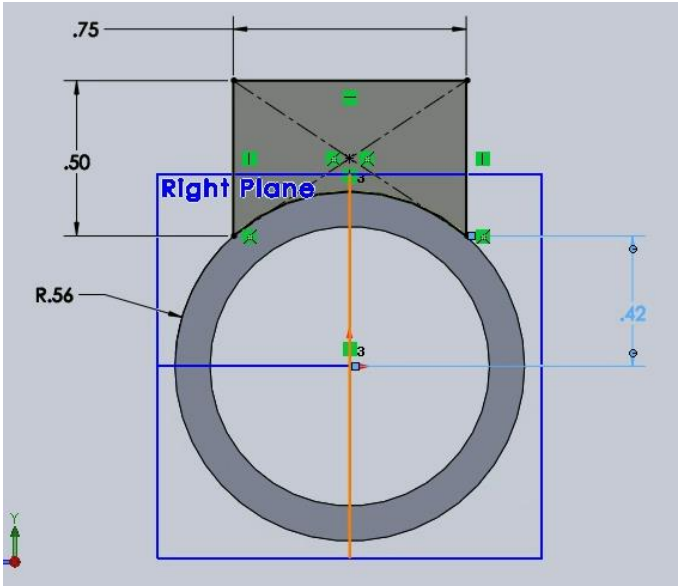

Figure 2828: Dimensions for Step 3

Description: Above is an image showing the specific dimensions needed for step 3.

4. After making the drawing, Boss-Extrude it, again going in two directions, with the distances being 0.375”. Just as in step 1, the option for both directions in Blind.

5. Using the FRONT PLANE, draw a circle with a diameter of 1.55”. Then Boss-Extrude this following the same information from previous steps, but this time the distance is 0.5” each way.

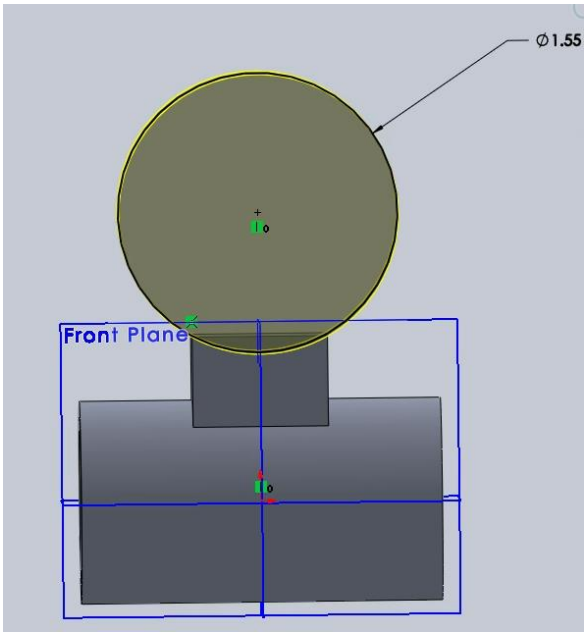

Figure 2929: Dimensioning for Step 5

Description: Above is an image showing the specific dimensions needed for step 5.

6. After Boss-Extruding, select one of the faces and draw the image seen in Figure 25 and Extrude-Cut it, with the direction being “Through All”. **Note:** the dimension of the circle, can be adjusted to match any diameter of the flashlight that is being used. This dimension can be made to be a little smaller than the diameter of the flashlight if desired, however, it does not need to be.

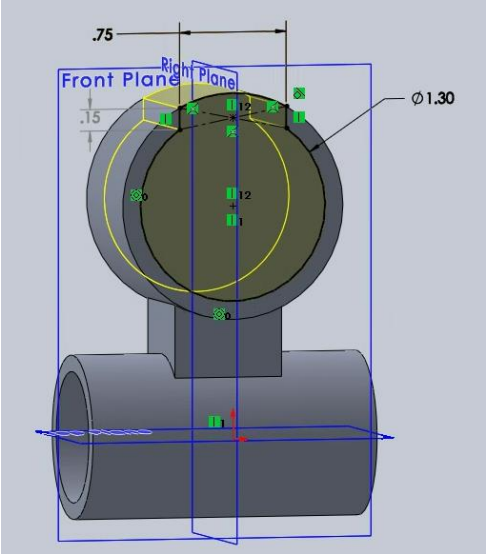

Figure 3030: Dimensioning for Step 6

Description: Above is an image showing the specific dimensions needed for step 6.

7. Fillet the edges connecting the top part with the bottom part. The radius for the fillet should at least be 0.1”.
8. After creation of part, make sure to save it as a .stl file to 3D print it.

PRINTING THE PART:

1. Open the .stl file on Ultimaker Cura.
2. The part should be oriented as seen in Figure 26. If not, make sure to adjust it to that orientation.

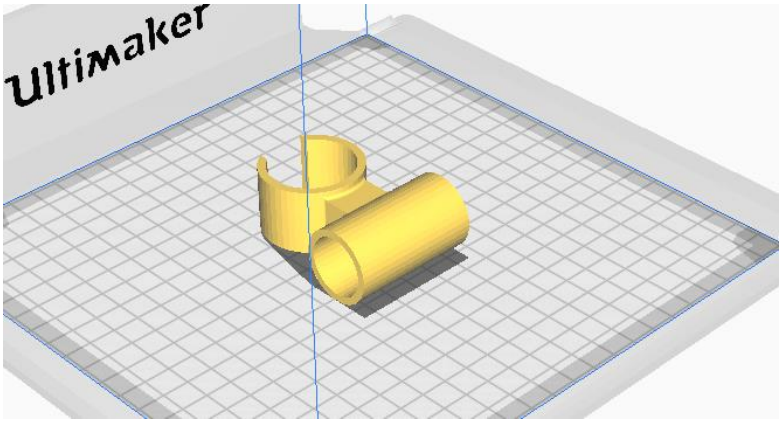

Figure 3131: Layout of Part in Ultimaker Cura

Description: Above is an image showing the arrangement of the part for step 2. This does not necessarily have to be set up this way, however, setting it up this way allows for no need of supports.

3. Using the same information for the printing of the two connectors, print the part.

ATTACHING TO PIPE:

1. Just as for the two attachments, once done printing it can be painted to any desired colour, as seen in figure 20.

2. Once done drying, all that's needed to attach it to the PVC pipe is to slide it on. There may be slight resistance, but it should fit. No glue needed to glue it in place, as the idea is that the client using the device can move the flashlight holder wherever it is needed to be moved. See figure 8 for fully assembled prototype.

6.4 Testing & Validation

When it came to the testing of the prototype, simple test was done. Firstly, an initial strength test was done, simply by different team members placing the PVC pipe on a corner of a table and applying our full weight on it to see if any permanent damage was done. After various test at different strengths, it was seen that no notable damage had occurred.

Another test done was using Solidworks 2021 to make a mock-up of the final prototype. This was done by making a mock pipe using the PVC pipes dimensions. This mock allowed to make any adjustments to the parts without needing to constantly 3D print each component.

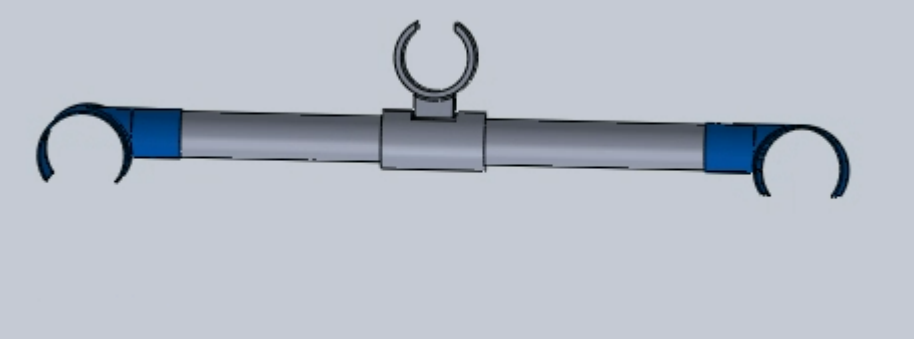

Figure 3232: Mockup of Final Prototype

Finally, the last testing done was making sure that every connected and that it could used with one hand. This was done after the creation of the final prototype and using an existing walker with dimensions like the clients.

7 Conclusions and Recommendations for Future Work

During the formation of this product, plenty of ideas had to be sidelined to achieve the primary goal of making the steering attachment fully functional. We are of the opinion that making the design collapsible by adding a twist-lock system to the middle of the bar would make the comprehensive design easier to carry and store. Other ideas, such as the addition of soft grips to the areas most likely to be touched, and the addition of soft rubber under the cuppings of the connectors to solve the problem of pinch points, are also a few other productive avenues for future work. Also, robotizing this project, though unlikely due to the project's budget, can be a step forward toward the commercialization of this design. The flashlight's mount is a flaw currently present in our design. Making sure that it does not tilt freely in the perpendicular direction while being able to move smoothly is key to making this design successful. This can be fixed by creating a channel in the main body of the handle, or if necessary, to incorporate more degrees of freedom, the grooving can be made 2D, like channels for a gear stick to allow for tilting of the flashlight mount.

There were a lot of lessons learned during the development and production process of this project; time management, awareness of responsibility, and humility toward others stood out as the most vital. Understanding time restrictions and budget limitations are necessary to avoid complications. These lessons must be implemented throughout the project, not only at the start, for moving the team in the right direction. Noting down ideas during the ideation phase, along with being nonjudgmental, benefits the team greatly, setting them up for success.

To conclude, use this manual to determine the best way to use this tool for yourself safely.

8 Bibliography

1. Copyright Act, Justice Law Website, Government of Canada, 1985. Accessed on: April 08, 2022. Available: Copyright Act (R.S.C., 1985, c. C-42)

APPENDICES

9 APPENDIX I: Design Files

See the MakerRepo repository for further details regarding this product; available: MakerRepo, published: Nov 23, 2022.

See the table below for details regarding this project's proposal. Also find updated links to relevant technical documentation.

Table 4. Referenced Documents

Document Name	Document Location and/or URL	Issuance Date
One-handed Walker Steering Project Proposal	Makerepo Project Proposal	August 16, 2022
Deliverables	Project Files	—