GNG 2101

Design Project User and Product Manual

Seatbelt Guide

Submitted by:

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Table 1. Acronyms

Acronym	Definition
BOM	Bill of Material

1 Introduction

This User and Product Manual (UPM) provides the information necessary for users with limited ability to buckle their seatbelt to use the “seatbelt guide” and for prototype documentation.

Safety Sergeants were presented with a problem with creating a seatbelt-guiding device that allows a six-year-old child with Arthrogryposis to buckle her seatbelt independently, at the beginning of the Fall 2022 semester. Arthrogryposis is a term used to describe a variety of conditions involving multiple joint contractures or stiffness. This condition would limit one’s mobility of their limbs and can prohibit their abilities to do many daily activities, such as buckling their seatbelts. For the user of our product, she often found it difficult to reach for her seatbelt, causing her to need assistance from her parents to complete such a task. As the user’s goal was to be able to complete the task of buckling seat belt independently, her parents were looking for a safety belt accessory so that it could decrease the difficulty of the task for their daughter. The assumptions were made that the safety of the seat belt should not be affected by our product while ensuring easier access to the seat belt. The overall development of the product is available through the MakerRepo website for Safety Sergeants linked in Appendix I.

The purpose of this document is to give the user an understanding of the background of the final prototype delivered to our client, as well as introductions on how to use it. Throughout this report, the problem presented by our client will be discussed in more depth and an overview will be provided in addition to the proposed solution. Instructions on how to set up the final prototype, how to operate it as well as its maintenance. Moreover, the manual will outline a more in-depth look into the functionality of each individual subsystem and feature included in the rack along

with troubleshooting and support information. Lastly, background information on the development process in the form of the product documentation will be described throughout the UPM.

For the purpose of this UPM, the reader is assumed to be our client while the user is assumed to be our client's daughter. While this UPM will be accessible electronically, using the provided pdf format, this document ensures the security and privacy of the user. All links available throughout this document are guaranteed to be safe and will provide no connection to the user's information.

2 Overview

The problem that we were tasked with solving is that there are people who have limited mobility/strength, this fact means that it may be difficult to operate the tradition seatbelt on their own. Many people who are in this situation would like to be able to do things on their own to give them a higher sense of individuality as they do not have to rely on someone else to help them. Our design will be a broad product that can be used by many, but we are being tasked with designing this item by a father whose daughter has a condition called arthrogryposis, causing her to have limited mobility in her elbows and shoulders.

What the user needs is a device that makes it easier for the user to fasten the seatbelt on their own. Firstly, the guide needs to be able to be operable by only one hand. Secondly, it cannot impede the safety of the seatbelt. Next, it must be easy to install. As well as have a long-life span. It must also not impede upon the comfort of the person who is sitting in the seat with the guide installed. It must also come at a reasonable price, and as per requested by the client it should be pink/purple, as those are the colours his daughter likes.

When first meeting the client, he told us about other groups attempt at making this product, from that interaction we were able to find out that the main problem with the other groups attempt was that the guide did not slide well on the belt. For our design we spent a lot of time focusing on how to make the guide slide well on the belt. To solve this, we decided on ball bearings, this solution works very well as our guide has no problems sliding along the seatbelt. Our product also has a nice handle on the rope of the guide that allows for a more comfortable and easier grip on the guide. We also have a stabilizer for the female end of the seatbelt, so the user doesn't need to reach don't and

grab the female end as it is held up by our stabilizer. Our 3D-printed design has filleted corners to give the guide smoothness.

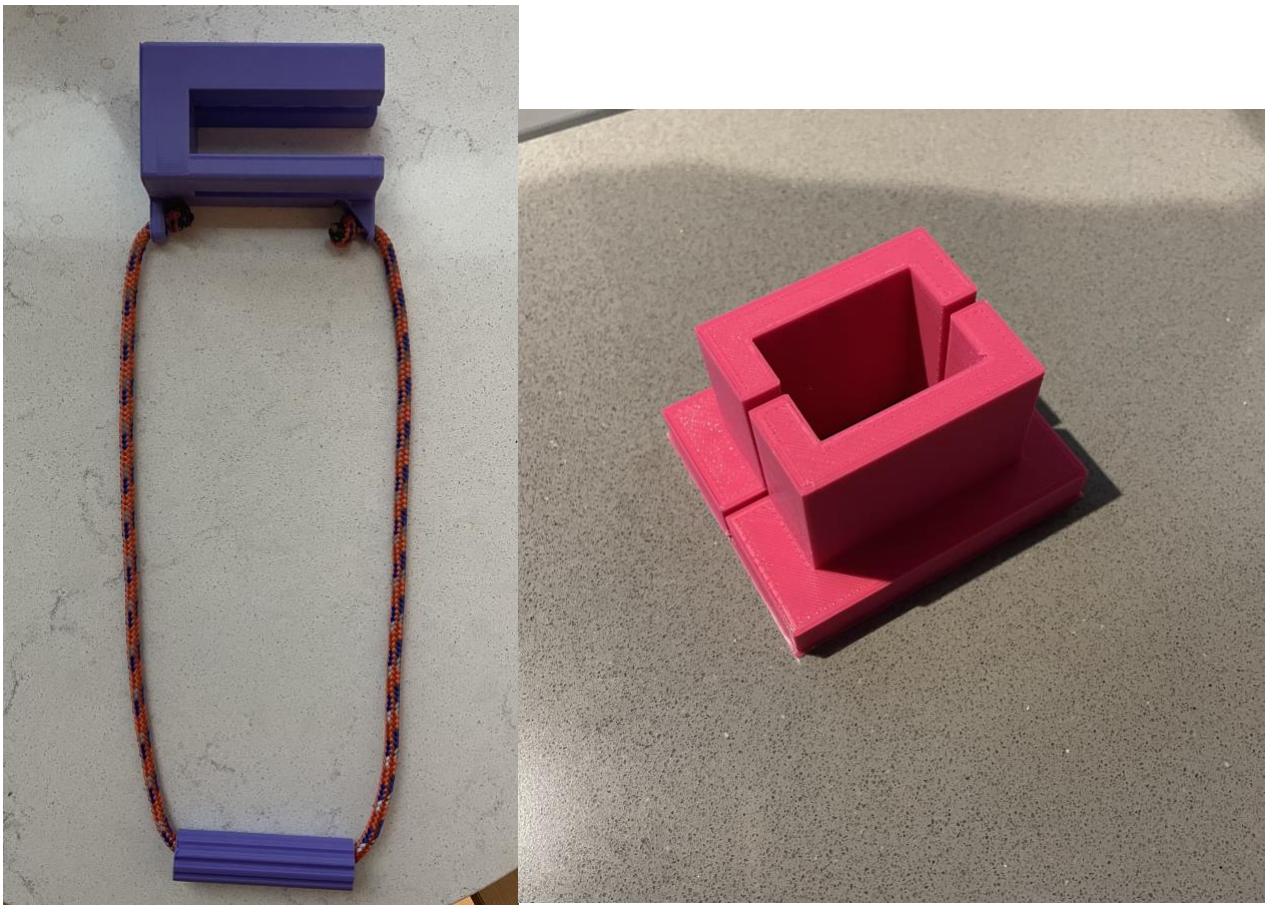


Figure 1 - Final Prototype Photos

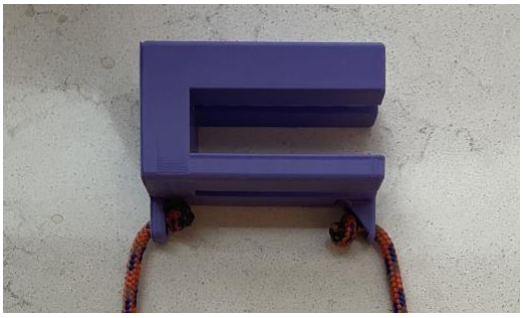
The purple piece is the guide itself, it slides onto the male end of the seatbelt, and the handle hangs below it, ready to be grabbed. The pink pieces go around the female end of the seatbelt, to hold it in place, thus the user will not have to grab onto it. The guide has bearings inside of it to allow for less friction against the seatbelt while being operated. The length of the rope can be adjusted by simply tying new knots. The guide and stabilizer can be easily removed from a vehicle, by simply sliding the guide off the belt, and by taking the ring off the stabilizer.

2.1 Cautions & Warnings

Do not stick any fingers into the guide as there are moving parts with can cause injury. Try to keep hair and clothing way from bearing when operating the guide.

3 Getting started /Setting-up the System

When starting to set up the device, you will notice that there are four parts, the 3 parts of the stabilizers and the guide itself. To set up the device, you would simply slide in the buckle and the belt through the guide and it will easily secure in place. Next you must take the stabilizers and put it around the male part of the seat belt and have it securely in place with the rectangular ring.



Seatbelt guide

Seatbelt guide after in place with the buckle

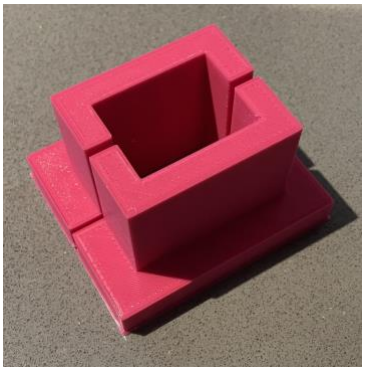
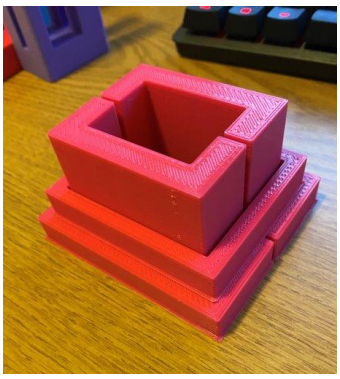


Image of the Male Stabilizer



Male end stabilizer with security ring

Figure 2 Product Images for References

3.1 Configuration Considerations

The device setup requires no external tools or devices.

3.2 User Access Considerations

This device is for people of all ages but beware of children sticking any fingers into the guide as there are moving parts with can cause injury.

3.3 Exiting the System

To remove the device simply slide it out of the buckle and remove the stabilizers from the male end of the seat belt and store in place. This device does not need to be removed after each time of use and is designed to be kept in place after each use.

4 Using the System

The following sub-sections provide detailed, step-by-step instructions on how to use the various functions or features of the seatbelt guiding device.

4.1 Main Function

The main function of our seatbelt guide was to simply to be attached to the male part of the seatbelt and provides an extension which is the rope for the user to reach for. For the required inputs, the user will have to grab the handle on the rope which would hang below his or her chest and pulls it downward until the male part of the seatbelt is within the user's reach. The user can then grab onto the male part of the seatbelt with both hands and insert it into the stabilized receiving end. No output is produced from the system.

Figure 3 Guide Installed on Seatbelt

4.1.1 Sub-Function

We also have another component which is installed around the receiving end of the seatbelt to stabilize it and make the process of attaching the two ends of the seatbelt easier for the user since the user might want to use both hands.

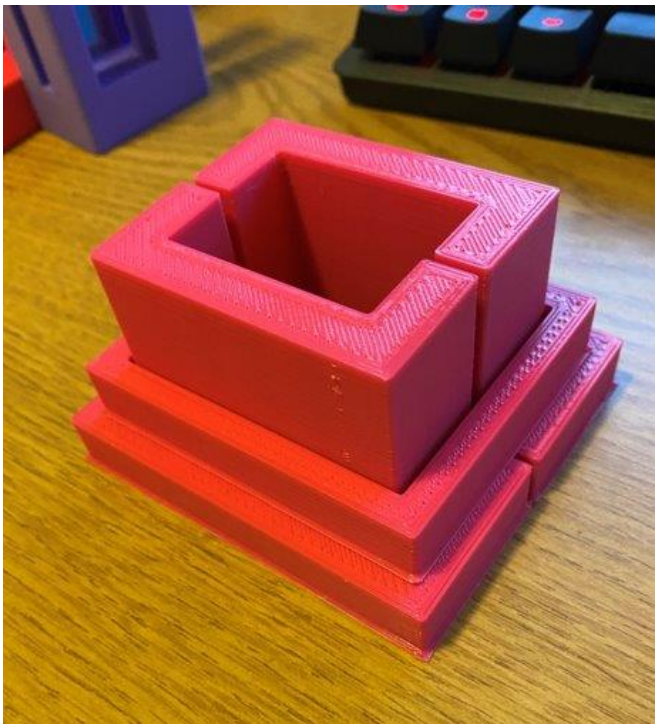


Figure 4 Female-End Stabilizer

5 Troubleshooting & Support

5.1 Error Behaviors

A common error that may happen is one of the bearings in the guide breaking, in such a case, you must remove the guide from the seatbelt, so that the broken bearing does not damage the seatbelt or the guide.

5.2 Maintenance

No maintenance is required to keep the product functioning.

5.3 Support

If support is needed to do not hesitate to contact Oliver Burpee at the email: oburp095@uottawa.ca. There we will help you with errors pertaining to our product. To make it easier for us to help you, please include a photo and describe of the part of the product that is not functioning / broken. Please include your full name and contact information in the email too. From here we will open a case file and determine how to repair or replace your seatbelt guide.

6 Product Documentation

This prototype began with measurements. A seatbelt from a 2021 Honda Civic was measured to get approximate values for the customers seatbelt. Then following our original concept a 3D model was created to match these dimensions.

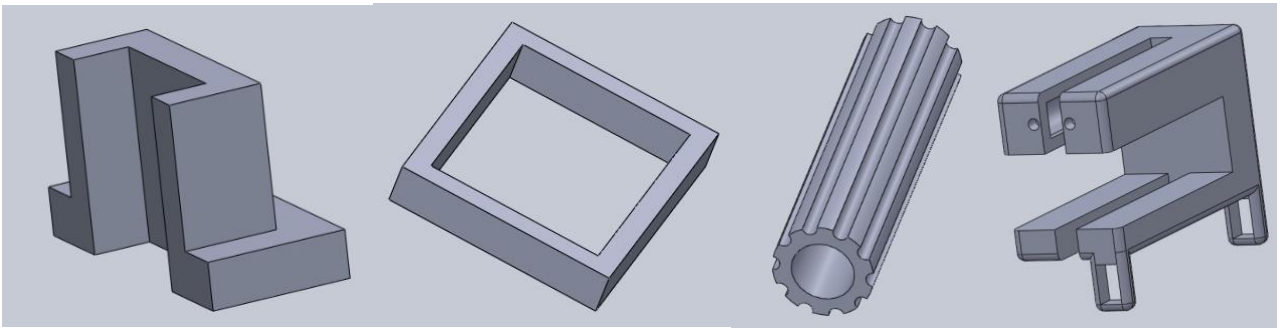


Figure 5: Prototype 3D Model

This model can they be 3D printed, the settings used in the 3D printer were the standard settings, this includes 20% grid infill and 3mm walls. The file titled SeatbeltBase.stl must be printed twice.

6.1.1 BOM (Bill of Materials)

Material	# of Units Needed	Cost per Unit	Total Cost	Reference for Cost
Ball Bearings	10 ~ 20	$12.99 for 20 items	$12.99	https://www.amazon.ca/Bearings-Double-Shielded-Miniature-Skateboard/dp/B0B2X6CY8K?qu=eyJxc2MiOiI2LjI1IiwicXNhIjoiNS4xNyIsInFzcCI6IjQuNjUifQ%3D%3D&sourceid=Mozilla-search&psc=1

Metal Rods (3 ~ 5 mm)	2 segments of 10 ~ 15 cm	$14.99 for 35.6cm	$14.99	https://www.amazon.ca/Glarks-Aluminum-Straight-Helicopter-Airplane/dp/B07KJ71T13?qu=eyJxc2MiOiIyLjcxIiwicXNhIjoiMS45MiIsInFzcCI6IjEuMDAifQ%3D%3D&psc=1
3D Printing Filament	1	$15.00	$15.00	https://makerepo.com/job_orders/new
Industrial Adhesive	1	$0.01	$2.57	https://www.homedepot.com/p/Liquid-Nails-10-oz-Heavy-Duty-Construction-Adhesive-LN-901/202203994
Rope	< 2m / < 7ft	15ft for $18.88	$18.88	https://www.amazon.ca/IIT-48780-Flagline-White-Color/dp/B005CKPPU8/ref=sr_1_2?crid=3DXSYAZBHE1O4&keywords=rope&qid=1667935780&qu=eyJxc2MiOiI2LjgxIiwicXNhIjoiNi40NSIsInFzcCI6IjYuMjEifQ%3D%3D&refinements=p_85%3A5690392011&rnid=5690384011&rps=1&sprefix=rop%2Caps%2C359&sr=8-2
Total Cost				$51.89

Table 2 BOM For Guide

6.1.2 Equipment list

1. Ultimaker 2^+ 3D printer
2. Needle nose pliers
3. Toothpick
4. Metal Saw
5. Scissors
6. Lighter

6.1.2 Instructions

1. Begin by 3D printing ClampHolder.stl and Handle.stl.
2. Cut two steel rods to exactly 3 inches in length, we never tested a different metal though it may be easier to cut a different softer metal, such as aluminum.
3. Insert the rods in the parallel slots on the ClampHolder.stl piece halfway in.
4. While the rods are only halfway inserted use the needle nose pliers to place the bearings on the rods on the inside of the piece. Place 5 bearings on each side.
5. Dip a toothpick in a very small amount of adhesive, place the adhesive on the end of the rod which sits inside the piece. Repeat with the other rod.
6. Slowly insert the rods in fully and allow for the adhesive to cure.
7. Once cured, using a toothpick and more adhesive, secure the bearings.
8. Using scissors cut a piece of rope to be 20 inches long. It should be noted that this can be adjusted to the length desired by the user.

9. Thread this piece of rope threw the Handle piece, insert the ends of the rope through the two holes at the bottom of the Clamp Holder piece. Tie knots and heat them with a lighter so they do not come undone (See Figure 6).

Figure 6: Knots

6.2 Base Holder

6.2.1 BOM (Bill of Materials)

Material	# of Units Needed	Cost per Unit	Total Cost	Reference for Cost
3D Printing Filament	1	$6	$6	https://makerepo.com/job_orders/new
Total Cost				$6

Table 3 BOM For Base Holder

6.2.2 Equipment list

1. Ultimaker 2^+ 3D printer

6.2.3 Instructions

1. 3D prints the following files SeatbeltBase.stl (print this one twice), and BaseClamp.stl.

6.3 Testing & Validation

Target Specification	Unit	Target	Prototype	Explanation
Does not Impede the safety of the seatbelt	Yes/No	Yes	Yes	This does not change any functionality of the seatbelt once fastened.
Operable by one person	Yes/No	Yes	Yes	It can be used by one person only.
Operable by one hand	Yes/No	Yes	Yes	It can be used by only one hand.
Lifetime	Years	>5	>5	This is durable plastic it will be durable and should not require replacing in less than 5 years.
Allows user to reach the seatbelt more easily	Yes/No	Yes	Yes	The rope handle allows for easy access to the seatbelt.
Comfort of the user	Subjective	Not Intrusive	Yes	Does not affect comfort.
Cost	CAD	<50	$50 approximately	Very cheap as it is almost 100% plastic.
Time to install	Seconds	<25	<25	Slide onto seatbelt very easily and quickly.
Appearance	Colour	Pink/Purple	Purple	N/A
Compatibility with vehicle (size)	inches	Female: 1.7x1.4 inches Male: Slit for belt >0.2 inches	Fits	Slides onto any common seatbelt.

Table 4 Testing

7 Conclusions and Recommendations for Future Work

In conclusion, our final prototype was an overall success, it functioned properly on a standard seatbelt, and we received much positive feedbacks from our client and the judges.

One lesson we learned from this project is to plan better and ensure that our components have the right dimensions before assembling our physical prototype. While polishing our final prototype, we noticed that the metal rods are slightly too long, a small part of the rod are outside of the prototype. We could not use equipment's from the lab or a proper saw because the rod and the bell bearings are already glued and are stuck to the body of our prototype. In the end, we had to spend a lot more effort to remove the exposed ends of the rods. For any other groups that wishes to continue and improve our work, we recommend improving the design of the main body in a way to prevent hairs from getting stuck in the bearings and rods inside. If we had a few more months to work on the project, we would try to implement the said improvement and make our product looks nicer.

APPENDICES

8 APPENDIX I: Design Files

Table 5. Referenced Documents

Document Name	Document Location and/or URL	Issuance Date
BaseClamp.stl CAD File	Located in the Maker Repo	12/11/2022
ClampHolder.stl CAD File	Located in the Maker Repo	12/11/2022
Handle.stl CAD File	Located in the Maker Repo	12/11/2022
SeatbeltBase.stl	Located in the Maker Repo	12/11/2022