Project Deliverable I – User Manual

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1 Introduction

Our client suffers with EDS, which causes symptoms of frequent joint dislocation. Every time our client goes over a bump in their wheelchair, their back and shoulders dislocate. We have designed a wheelchair cushion that has attempted to solve this problem.

The purpose of this user manual is to ensure that our users clearly understand how to use our product. We will go over the cautions and warnings surrounding the creation of our prototype, how the user can create their own prototype, the setup process of our product, the maintenance of our product, and some of the modifications and improvements that could be added to our product. After reviewing this manual, you will have all necessary information to employ and re-create our product.

2 List of Acronyms and Glossary

Table 1: Acronyms

Acronym	Definition
EDS	Ehlers-Danlos Syndrome
BOM	Bill of Materials
CAD	Canadian Dollars

Table 2: Terms

Term	Acronym	Definition
Laser Cutter	N/A	Machine which uses lasers to cut pieces of material.
Ehlers-Danlos Syndrome	N/A	Connective tissue disorder that causes joint dislocation.

3 Overview

The problem our client suffers with is ongoing and evidently very painful. The products that are currently on the market do not cater directly to the needs of our client or provide the support that is needed. Solving this problem is important because it could significantly improve our client's quality of life.

The fundamental needs of the user include relieving the force on the client's upper back, providing support for several hours a day, the capability of attaching to the wheelchair, maintains the width of the lower back of the chair, easy to put together, and lightweight. Our product has been designed to fit these needs, with the main priority being mitigating the force on the client's upper back.

Figure 1: Front View of Prototype

Figure 2: Back View of Prototype

Our product consists of the following: An acrylic backing with small holes for the snaps and slits for the strap, a cushion cover containing shredded foam, a compression sleeves with snaps that attach to the backing, and an adjustable strap. If the user wishes to change the amount of support the cushion provides, they can access the inside of the cushion cover to add, remove or replace foam.

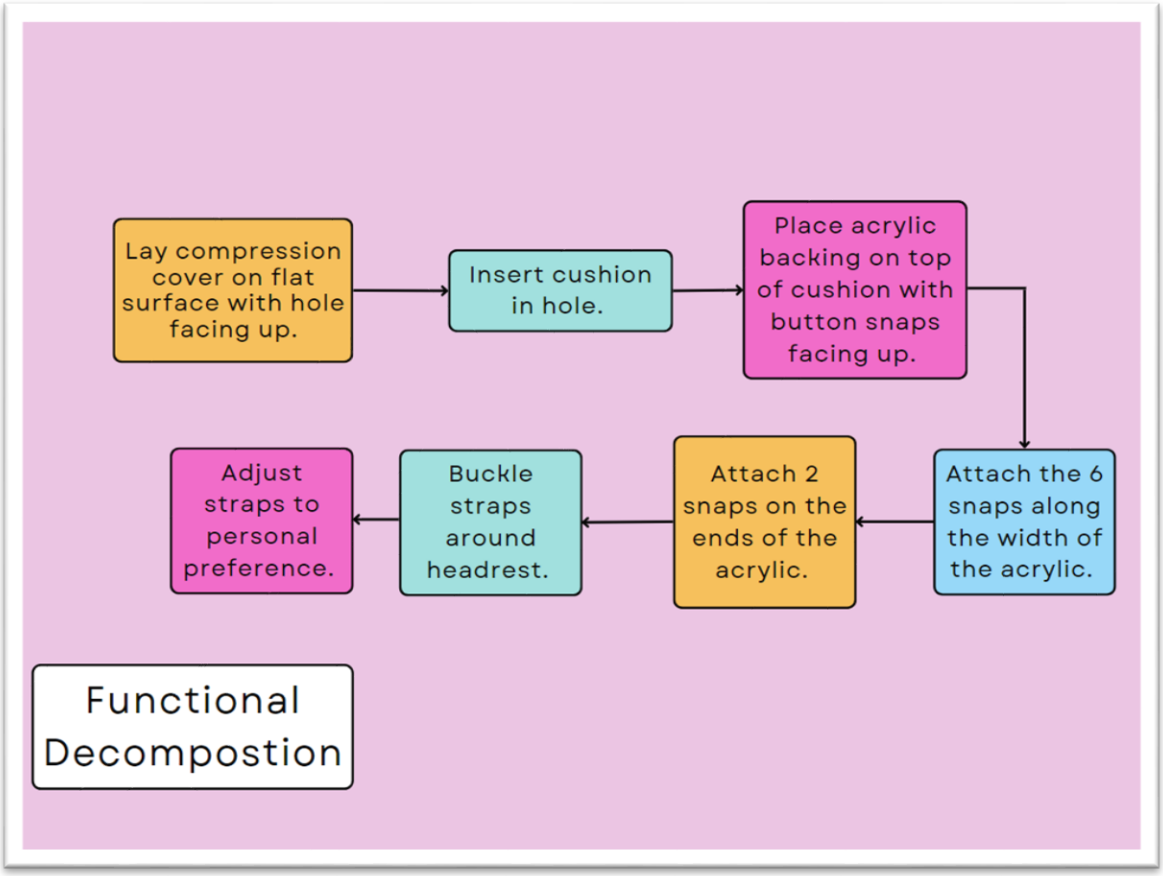

Figure 3: Functional Decomposition

Above is a functional decomposition explaining how the user can put the product together.

3.1 Cautions and Warnings

Users of our product must know how to properly use a wheelchair. If the wheelchair is not electric, the user should know their limitations when it comes to powering the wheelchair themselves. The strap on our cushion should only be used to wrap around the headrest or back of the wheelchair, it should never go around the user's neck. The corners of the acrylic backing have been chamfered to avoid sharp edges; however, the user should still be cautious of any sharp corners on the product. When attaching the snaps, the user should be cautious to not snap themselves or their clothing with the acrylic backing.

4 Product Documentation

4.1 Acrylic Backing

The acrylic backing was used as a support for the cushion, and it has slots in it so that the straps can be fed through the backing and the case has snaps to hold the cushion against the backing.

4.1.1 Materials

To make the acrylic backing, there are three fundamental materials:

- 24x12 1/8” piece of acrylic
- 8 Pairs of heavy-duty snap fasteners
- 3’ of ¾’ wide nylon strap with buckles

4.1.2 Steps to Make

The first step in this process is preparing the acrylic backing. The acrylic backing must be laser cut from the 24x12 1/8” thick piece of acrylic. The full dimensions are shown in the figure below. see full dimensions

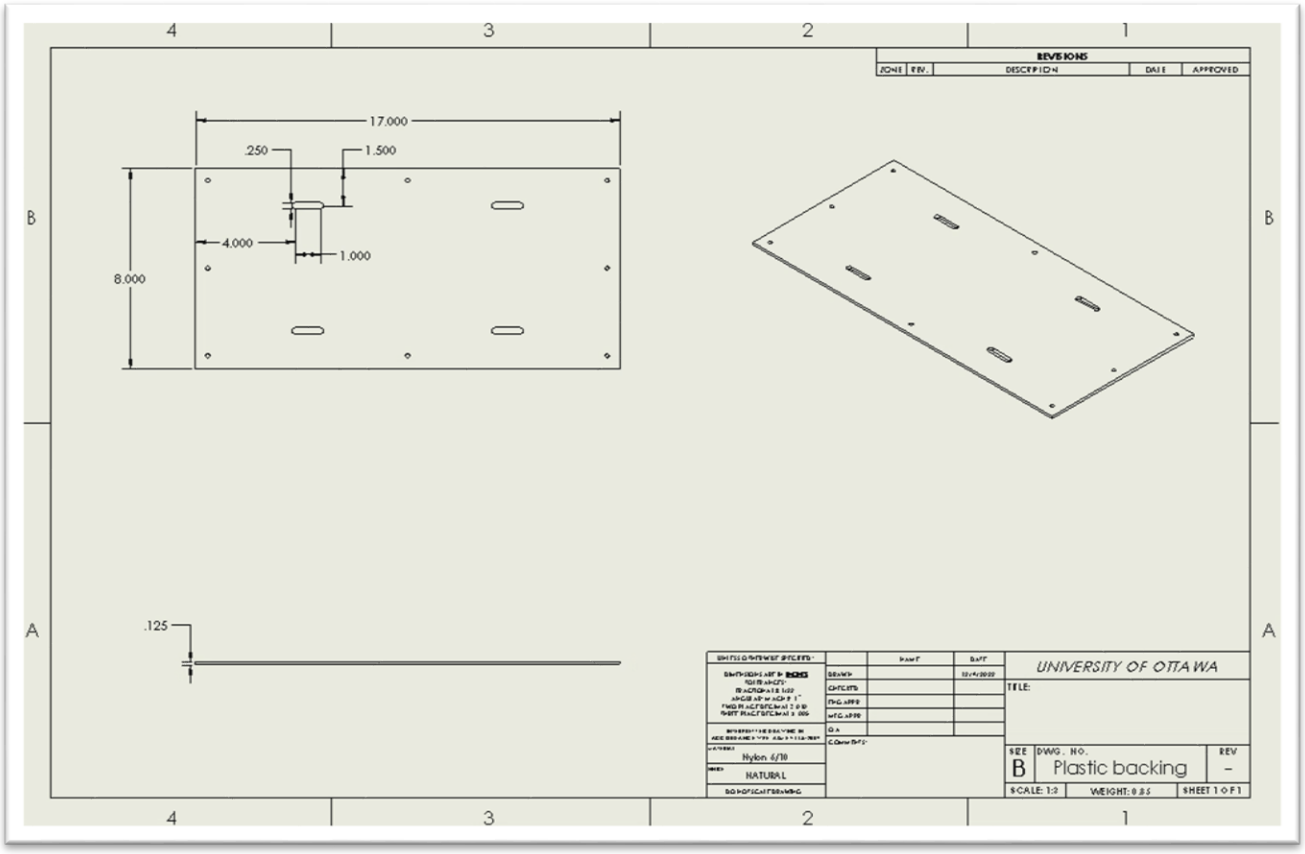

Figure 4: Sketch of Acrylic Backing

4.2 Cushion

The cushion portion of our product is what will provide comfort to the client.

4.2.1 Materials

To make the cushion, the team needed to acquire shredded foam. To stay compliant with the company values, the foam must be repurposed from another source to ensure that the product is sustainable. You will need a standard size cotton pillowcase for the fabric portion. If you do not have a pillowcase, you can use any cotton and sew around the edges. You will also need a pencil and a sewing machine or needle and thread depending on whether you choose to sew manually or not.

4.2.2 Steps to Make

Take your cotton pillowcase and measure 13'' from the width of the case, mark it with a pencil. Make two marks on both sides and connect them with a straight line. Cut along the straight line. You should now have a 20'' x 13'' piece of fabric that looks like a bag with an opening at the top. You're now going to measure 1'' down from the opening of the ''bag'' and mark it with a pencil. Do the same on the other side and connect it with a straight line. Now you're going to sew along the line by hand or with a sewing machine. Stop sewing 2.5'' before reaching the end of the fabric. On the remaining 2.5'', sew two buttons approximately 1'' apart. Cut holes that match up with buttons so the case can be fully closed. After the buttons are installed, you can start working with the foam. Take your piece of foam and cut it into chunks. The size of the foam chunks depends on personal preference. Insert as much foam as you would like into the case. Once the appropriate amount of foam is added, close the cushion with the two buttons. The cushion is now complete, there is a reference photo below showing what it should look like.

Figure 5: Cushion

4.3 Compression Sleeve

The compression sleeve will compress the foam inside the cushion and attach the cushion to the acrylic backing.

4.3.1 Materials

To make the compression sleeve, you will need a 25'' x 30'' piece of fabric, 8 fabric snaps, a pencil, and a sewing machine or needle and thread. It is strongly recommended to use a sewing machine for this portion because it requires a lot of stitches.

4.3.2 Steps to Make

To begin, take your piece of fabric and lay it on a flat surface. Draw straight lines 1'' from the edges of the fabric. Fold the edges to the line and pin in place, sew the fold. This will create a 0.5'' seam on the edge of the sleeve making the final product look cleaner. Draw a line

in pencil on each of the edges indicating the centre on the length and width. Place the cushion in the centre of the fabric first, then put the acrylic backing on top of it. Fold the edges of the fabric to the acrylic backing, measure the distance from the edge of the fabric to the backing. Take the cushion and backing of the fabric and draw a line in the middle connecting the measurements on both short ends of the fabric. Take the corners and fold them to this line, pin them in place. Sew along the folds you created. Repeat this process on the other side of the sleeve. After the corners are folded, make a once in fold and pin into place. Sew along the edge to give the ends a cleaner finish. Now place the cushion and backing in the sleeve, use a pencil to mark where the snaps will go. Install the snaps, and the compression sleeve is now capable of attaching to the backing. There is a reference photo below showing what the complete compression sleeve should look like.

Figure 6: Compression Sleeve

4.4 Strap

The strap will attach our product to the client's wheelchair, it wraps around the headrest and can be adjusted to sit at the ideal height.

4.4.1 Materials

To make the strap you will need at least 2 yards of nylon webbing band, a buckle for the band, a needle and thread, a good pair of scissors, and a lighter. It’s not recommended to use a sewing machine for this step as the nylon band is too thick for most sewing machine needles.

4.4.2 Steps to Make

Measure 2 yards of the nylon band and cut it. Burn the end with the lighter to prevent it from fraying. Insert the end through the buckle hole and make a 2’’ fold, pin in place. Carefully hand sew this fold to keep the buckle in place. Thread the end of the strap through the slits in the acrylic backing. The strap is now completed and attached to the backing. Below is a reference photo showing how the strap should look.

Figure 7: Adjustable Strap

4.5 Bill of Materials

The bill of materials is shown the figure below. The bill of materials provides a breakdown of where expenses associated with the process of making the prototype.

Table 3: BOM

Item Number	Part Name	Quantity	Unit Cost	Extended Cost
1	Fabric	1	$10.00/yard	$14.97
2	Sewing Kit	1	$0	$0
3	Foam Cushion	1	$0	$0
4	Strap	1	$2.00/yard	$20.00
5	Snaps	10	$1.20/snap	$12.00
6	Acrylic Backing	1	$13.00	$13.00
				Total $59.97

In the BOM, there are a few important points to highlight. The first point to raise is that no money was spent on foam. This was because the foam that was used was repurposed from other sources. This is more beneficial for the business as less money is spent on manufacturing while making sure the product is sustainable. By doing this, the company's values aren't compromised.

5 How to Setup Prototype

5.1 List of Components

There were many components that were used in the creation of this product. The materials required to make the prototype are sustainably sourced shredded foam, two different types of fabric, an acrylic backing, snaps, and straps. There were also different manufacturing processes that had to be learned for this project, such as using a sewing machine and a laser cutter.

5.2 Setup Process

The process to set up the prototype consists of six steps. The first step was positioning the compression cover such that the cover is placed on a flat and level surface. The hole of the cover must be facing away from the table and towards the client. After this, the client places the cushion into the hole. Ensure that all parts of the cushion are tucked into the cover. The next step is to attach the acrylic backing. To do this, the acrylic backing must be placed on the top side of the cushion. The snaps must be facing upwards to ensure the next step is completed properly. The next step is to attach six individual snaps to the product. The position that the snaps are meant to be attached at is along the ends of the backing. The final step in assembling the product is attaching the straps to the rest of the product. To accomplish this, the straps need to be buckled around the headrest.

6 How to Maintain Prototype

There are buttons on the cushion which will allow for the user to change how much foam is in the product and allow the user to replenish the foam when it becomes flattened down. The cushion casing and the compression cover are also washer and dryer safe so it can be cleaned very easily. The plastic backing should be checked monthly for plastic deformation and any surface cracks that may have started or spread.

7 Modifications and Improvements

One of the modifications that could be made to our product is the design of the compression sleeve. Currently, the compression sleeve is fully functional, however, it does not look clean. When all the snaps are attached to the backing, the corners on the sleeve stick out. To change this, I would connect the corners and then attach the snaps in the appropriate location.

There are also some modifications that could be made to the acrylic backing. While laser cutting the holes for the snaps, we had to do it a couple of times to ensure that we made the perfect size hole. Because of this, there are a couple unnecessary holes in the backing which came from the trial-and-error process of installing the snaps. We also had a small surface crack form after installing one of the snaps with too much force. This crack will not propagate. Although these things do not affect the overall functionality of the backing, we were hoping to send our client a prototype in better condition. Purchasing more acrylic and creating a new backing is a potential modification that would improve the condition of our product.

8 Conclusion and Recommendations for Future Work

In conclusion, this manual equips you with knowledge on how to construct and assemble our product. We recommend scaling this product to fit a variety of back injuries. It is a very versatile product with a large market presence of similar products, so scaling either customer pool or product offshoots. There are many students, office workers, artists, and people suffering from various disabilities who are all potential customers of a successful anti-fatigue, anti-distress cushion. Any parties that can adapt our product to fit this niche is in a prime position to thrive. If we were to run through our testing phase again, we would focus more on analytical testing and less on physical testing. This way, we can suit the product more exactly to our client.