Deliverable C - Conceptual Design and Project Plan

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B2.1

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# 1 Introduction

In the previous deliverable, we identified the clients’ needs, created a problem statement, identified the metrics, found similar products to benchmark against, and identified the target specifications. Now the team has moved onto the ideation phase where the conceptual designs will be created and decided upon.

# 2 Required Product Functions

|  |  |  |  |
| --- | --- | --- | --- |
| **Number** | **Client Need** | **Product Function** | **Need Shorthand** |
| **1** | The Product should alleviate or mitigate the force on the client’s upper back when the wheelchair is reclined. | Product supports client’s upper and lower back. | Support |
| **2** | The Product must be comfortable to use for several hours a day. | Product molds to client’s back. | Comfort |
| **3** | The Product should maintain the width of padding on the lower back of the chair. | Product maintains shape after prolonged use. | Durability |
| **4** | The product must be able to strap to the chair. | Product straps on to the chair | Modularity |
| **5** | The Product should fit on the chair | Product is measured to fit on the chair. | Fit |
| **6** | The Product should be easy to manufacture (no equipment necessary) or cheap to ship (light, compact), as the client is not local. | Product is lightweight and easily compactable. | Weight |
| **7** | The Product should match the aesthetic of the rest of the chair. | N/A | Aesthetic |
| **8** | The Product should remain within cost constraints (< $100 CAD) | N/A | Cost |

Table 1

# 3 Functional Decomposition

Text, letter

Description automatically generated

Figure 1

# 4. Concepts

## 4.1 Andrew’s Concepts

### 4.1.1 Concept 1

The first concept is a cushion that is made by modifying the current cushion that the client uses. The product will be modified by removing the lower part of the cushion and leaving only the top half. Then new straps would be added to attach it to the headrest.

### 4.1.2 Concept 2

The second concept is a cushion that is specially produced. It will be a medium firm foam cushion that is all custom designed by the project team. The cushion would be shaped to support the clients back and Velcro straps would attach it to the back of the wheelchair.

### 4.1.3 Concept 3

The third concept is that a cushion that is filled with air is used. The cushion with air will be able to inflate to have support but still deflated enough the hold the client up comfortably. Because the cushion is filled with air it will not flatten like foam does.

## 4.2 Justin’s Concepts

### 4.2.1 Concept 1

The first concept is a cushion with shredded memory foam inside. It is moldable so the client can adjust it to their needs, however it is firm enough to maintain its shape. It can be attached to the headrest of the wheelchair.

### 4.2.2 Concept 2

The second concept is a gel cushion with a high viscosity and a low specific heat, allowing for the cushion to maintain a comfortable temperature hour after hour. The cushion will also always mold to support the clients back in the most comfortable orientation.

### 4.2.3 Concept 3

The third concept is a pad with spring supports, which dynamically adjusts as the wheelchair is jostled. The springs will have a high enough rigidity to support the back, yet remain flexible enough to absorb the impacts of small obstacles

## 4.3 Amy’s Concepts

### 4.3.1 Concept 1

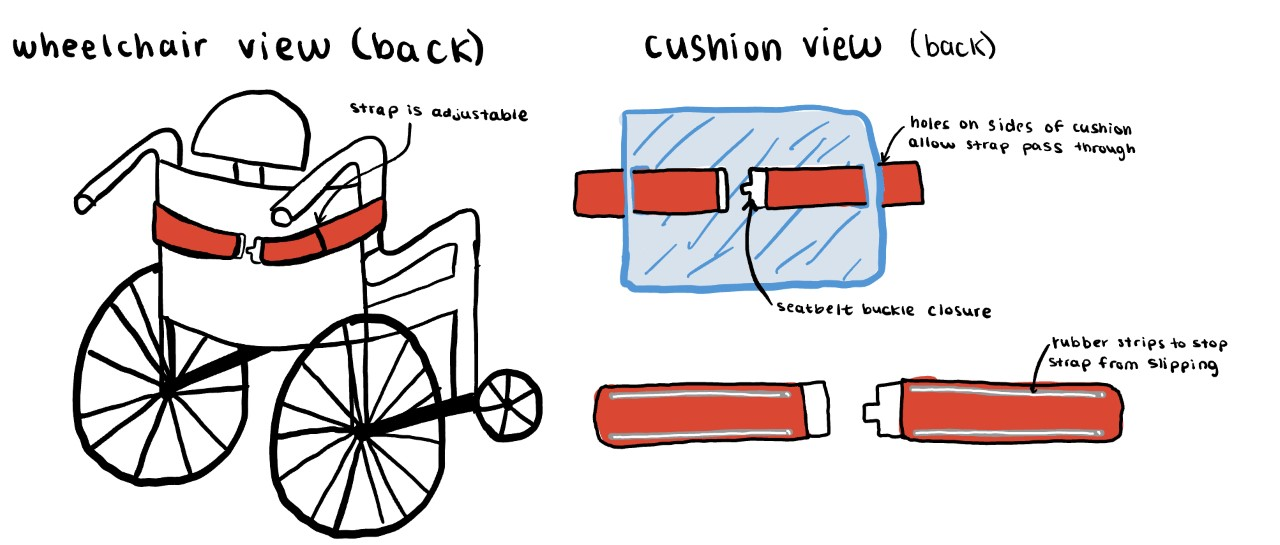


Figure 2

This concept uses an adjustable seatbelt strap to attach the cushion to the wheelchair. There’s a hole on each side of the cushion to let the strap pass through. There are thin rubber strips on both sides of the strap to stop the strap from slipping up or down the back of the wheelchair. This concept does not require any modifications to the wheelchair.

### 4.3.2 Concept 2

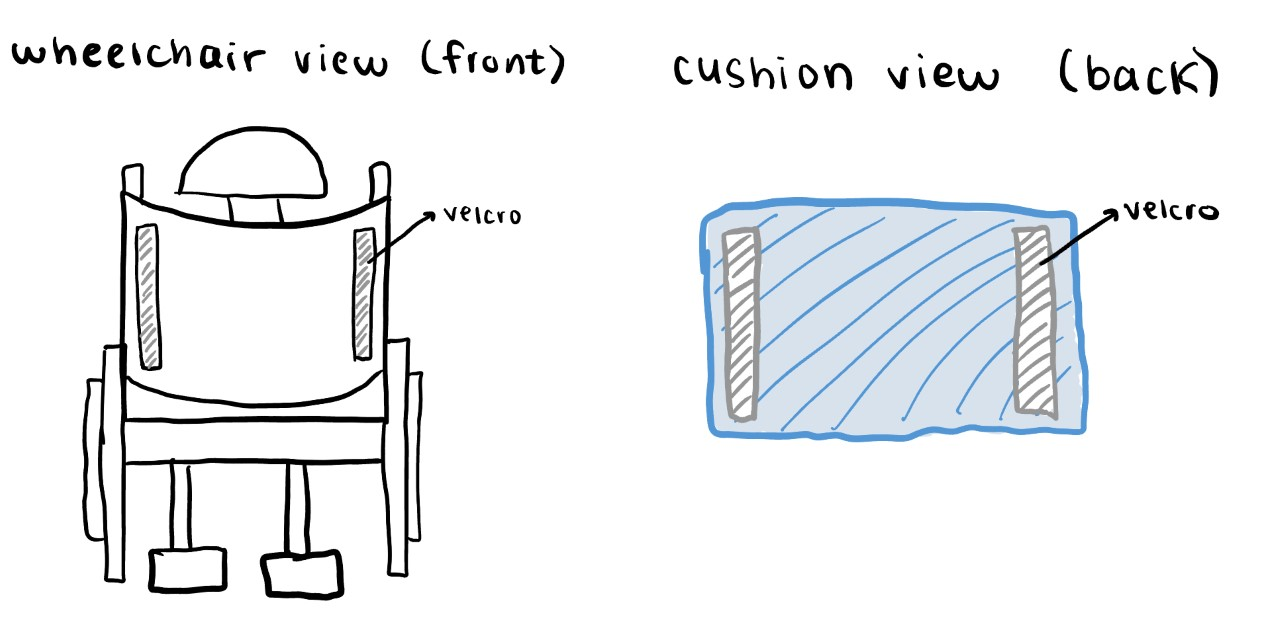


Figure 3

This concept uses strips of Velcro on both sides of the cushion and the back of the chair. The cushion attaches directly to the Velcro on the chair, in a position specific to the client. This concept requires one small modification to the wheelchair, Velcro would be attached to the back of the chair and would also need to be replaced frequently.

### 4.3.3 Concept 3

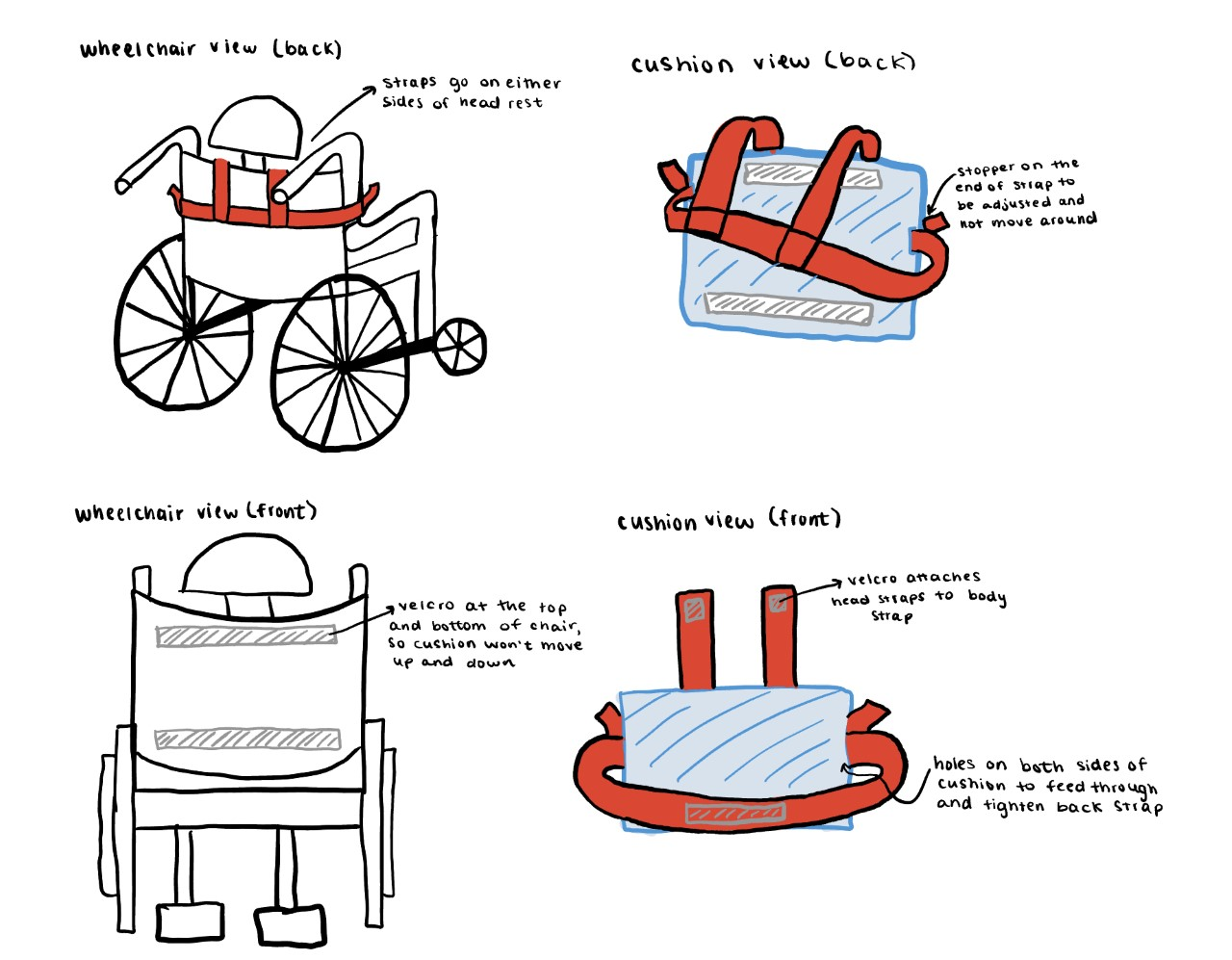


Figure 4

This concept is a combination of the two above. The cushion attaches to the wheelchair with Velcro at the client’s desired position. There are straps on the top and sides of the cushion, the length of the strap attached through the side of the cushion is adjustable. The top straps stop the cushion from sliding down the wheelchair and are secured with Velcro to the other strap.

## 4.4 Meg’s Concepts

### 4.4.1 Concept 1

The first concept is a cushion made from memory foam. It will be made to cover the entire back of the seat, including the area that the clients shoulder bumps. The memory foam will conform to the shape of the clients back.

### 4.4.2 Concept 2

The second concept is a cushion that contains a plastic piece that has already been made to match the user’s specific back. Then, there is foam placed over to ensure that it is comfortable for the clients to use every day.

### 4.4.3 Concept 3

The third concept is a wire backing where there are many layers of mesh placed over the back of the wheelchair. The wire backing will match the shape of the user’s specific back and the mesh will be layered on top, so the seat is comfortable.

## 4.5 Elhadj’s concept

4.5.1 Concept 1  
According to the information we were able to collect, the client has a personalized wheelchair. By assuming that she has a chair that was designed for her height and body type, perhaps the equipment and the dimensions chosen are based upon her members length etc. So, we can assume that if a cushion is just put behind her back that could be a problem as it will take away some comfort if the wheelchair fittings or dimensions had been made to fit her members length in such a way that a cushion could not be added behind the client's back. For example, if there is an equipment that has been put in the wheelchair for her feet to rest comfortably and that process has been done by measuring the length of her legs, putting a cushion behind her back could make her difficult to put her feet in that equipment and that would decrease her comfort.

So, the idea of the first concept is to create an opening and put the cushion in the back of the wheelchair after removing the material that is there afterwards. The cushion has a memory foam so it automatically takes the shape of the back and that will provide an excellent back support and relieve common symptoms that result from body weight pressing on the lower back area.

Also, for her safety against an obstacle the idea is to install on the wheelchair a belt which during collision will stabilize her against collisions coming from the ground (pushing her up) but also collisions that happens when circulating (that could push her out of the wheelchair) and for that it needs a belt that keeps her down but also backwards as shown in green in the figure below by the force diagram. This seat belt is pretty much the same as the ones that are put in the seats of commercial airplanes.

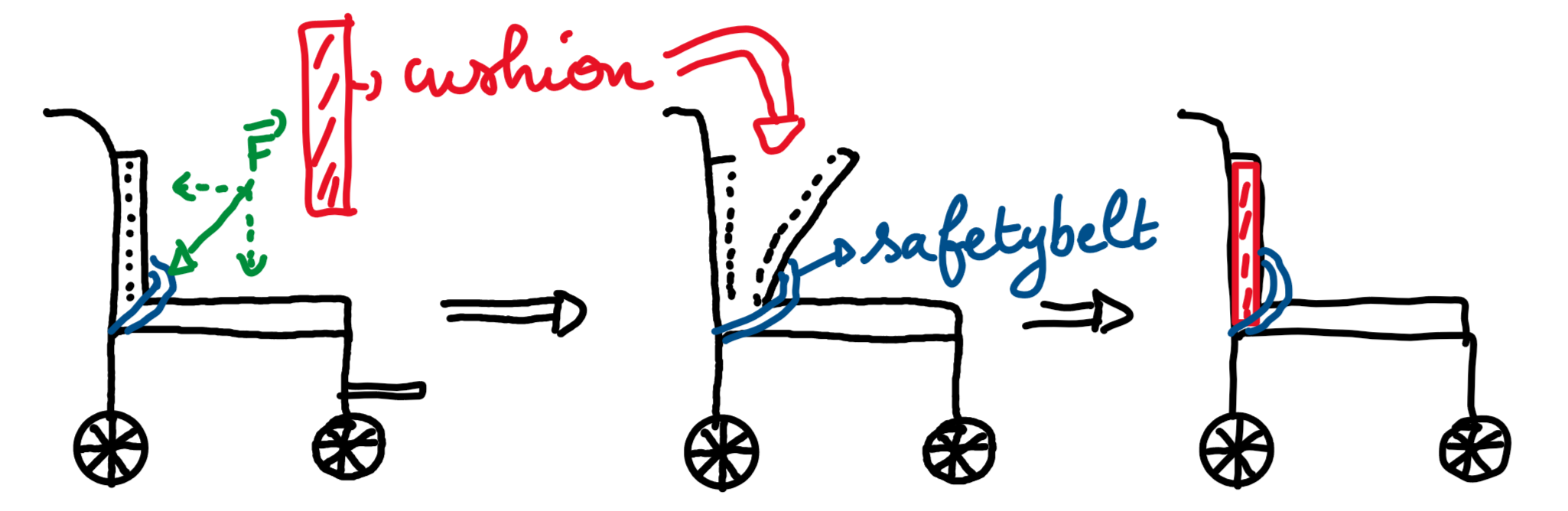


Figure 5

Figure for concept 1

### **4.5.2** Concept 2

For the second concept if we found out that it is possible for us to put the cushion behind her back without causing a decrease of comfort or safety for her, we can just measure the length of her back and then put a memory foam cushion and adjustable straps to keep the cushion in place in the wheelchair. Just like the first concept the safety belt will be put in the wheelchair

### **4.5.3** Concept 3

The third concept is a high-density foam cushion that encapsulates a viscous gel that conforms to the body’s natural contour and adjustable straps to keep the cushion in place in the wheelchair. Just like the first and second concept the safety belt will be put in the wheelchair.

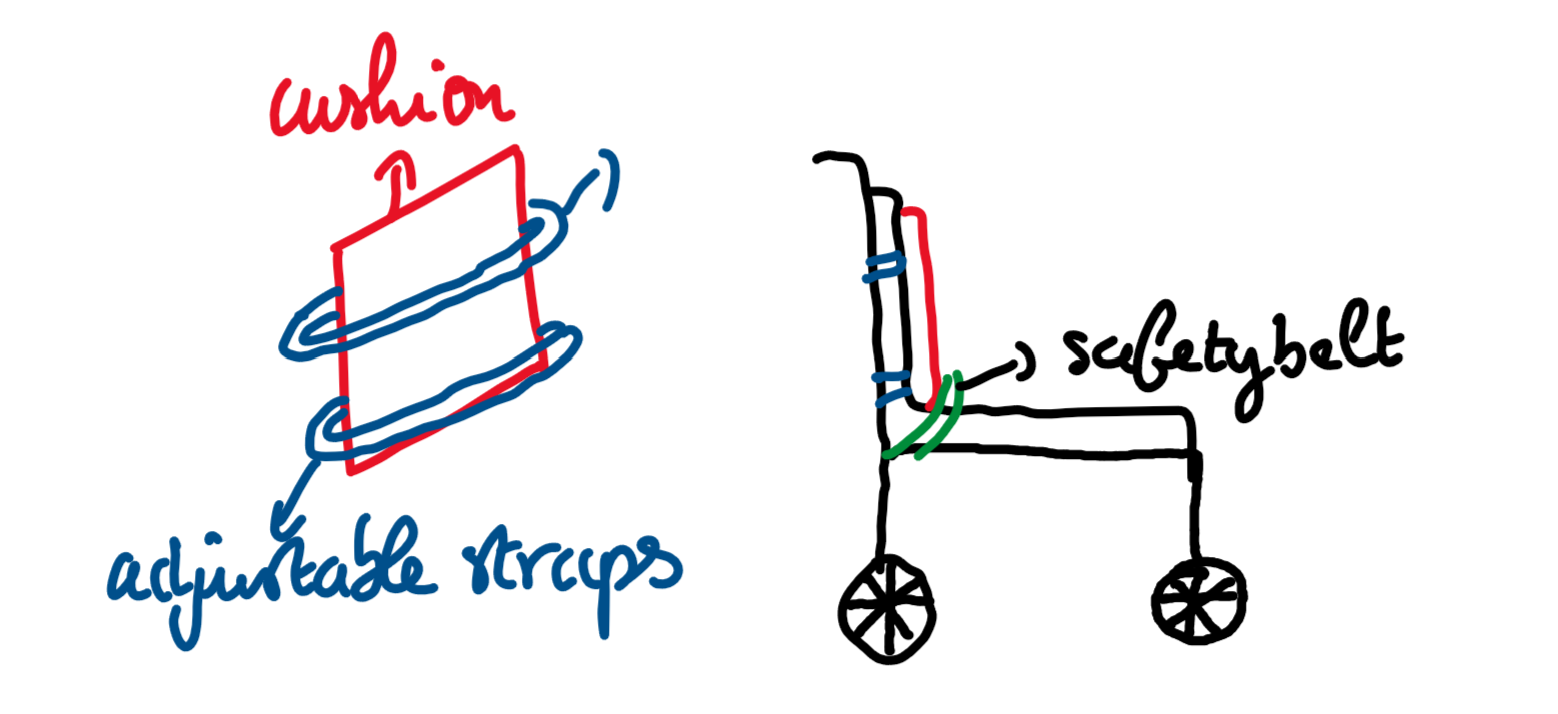


Figure 6

Figure for concept 2 and 3

**4.7 Concept Analysis**

## ****4.6****

Table 2

## 4.8 Promising Solutions

Based on the above decision matrix, the 5 ideas that scored highest according to our needs list were Concepts 7, 11, 4, 2, and 3.

# ****5 Group Design Concept****

## 5.1 Concept Explanation

The group concept will be a concept made from multiple components from the promising concepts. Velcro will be used to hold the cushion to the back of the wheelchair. The process of attaching the Velcro to the chair will be minimally invasive and not damage the chair to the extent that it will void the warranty. A drawback to the Velcro is that the Velcro will eventually need replaced. This part will be shown to the client and if this is unable to be done straps will be used. A piece of plastic that is medium soft will be shaped to the clients back, this plastic piece will be a backing for the cushion. It will have slots for fabric straps that hold the Velcro to the chair. This plastic backing will be used as a base for various cushions that will be prototyped and tested. The various cushions will include a shredded memory foam cushion that compresses to the clients back shape, a medium firm cushion that is shaped to the clients back, and the last variation will be an air-filled cushion that inflates to desired firmness. Drawbacks from the cushions is that the cushion will flatten over time. These variations will be held to the plastic backing by a fabric liner that wraps around the plastic backing. This fabric liner will help to make it easier to replace cushions.

## 5.2 Visual Representation

A picture containing icon

Description automatically generated

Fabric to hold cushions to plastic backing.

Various cushions.

Green is shredded memory foam. Red is medium firm foam. Yellow is an air cushion.

Velcrow sewn to the back of the chair

Plastic backing with slots for straps

Figure 7

# 6 Client Meeting 2 Preperations

## 6.1 Client Meeting Questions

Questions:

1. Can you provide measurements of the wheelchair?
   1. Height of backrest (getting measurements copy)
   2. Width of the backrest (ditto)
2. How thick is the current cushion you are using? Are there any thicknesses that you think would work better? 5 inches
3. Is there a difference between desired support on your left and right side? Uniform across the back mainly right but uniform is best
4. Introducing Group Concept
5. Are you comfortable with attaching Velcro to the back of your wheelchair? Special foam so we cant sew Velcro on I think we will go with the headrest.
6. Would you be able to provide photos of you sitting in your wheelchair? Bucket seat
7. Do you like the idea that we’ve come up with so far? Is there anything you would change?

Long term and versatile so that we can swap to multiple chair variationts

7Wrike

<https://www.wrike.com/frontend/ganttchart/index.html?snapshotId=nfFSLGHIo1nBj0yfqAbMSrG3S6uXRpCk%7CIE2DSNZVHA2DELSTGIYA>

# 8 Conclusion

In this deliverable, each member of the team created and shared their concepts. Each concept was then given a score for how well it matched the needs of the client. Based on the scores, the best solutions were deemed to be concepts 2, 3, 4, 7, and 11. The concept that was chosen was a cushion that uses Velcro to attach to the chair and a plastic backing. A visual representation was created for this. Throughout this deliverable, we learned that everyone has valuable insight and opinions and that often, many different ideas can be combined to get the best possible solution. The most productive avenue for future work is the method that was taken in this deliverable, where everyone adds their own ideas and the one with the highest score is selected.