Project Deliverable C

Conceptual Design and Project Plan

A2.2 - One-Handed Walker Steering

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Table of Contents

List of tables

List of Figures

Abstract

Our client, Janice, is an individual with a variety of health issues leading to mobility impairment, including hypermobility syndrome, myopathy, and epilepsy. This combination has left Janice dependent on a walker, but due to frequent dislocations of both her shoulders and spine, as well as other appendages, this fix alone is insufficient as she is frequently unable to steer with complete control, which poses a risk to her safety. She needs a system that will allow her to steer the walker efficiently with only one arm, that is transferable to be used with either arm, and is easy to install, operate, and maintain. The goal of this deliverable was to both create a conceptual design and prepare for the next client meeting. For the conceptual design, the group was required to break down the required product functions into smaller basic sub-functions to clarify the core functionality of the product. Each team member was then required to create a minimum of three product concepts, either for a specific subsystem or the entire system. The concepts were then analyzed using the target specifications from Deliverable B, in order to choose three main promising design concepts. These three concepts were then modified and integrated with one another to create one final group concept, which was represented in a CAD model. With respect to the upcoming client meeting, a list of questions was created to be asked to Janice in order to gain some more information with respect to our metrics and any other subjects that required clarity. The overall goal of the deliverable was to create a strong group concept of what our one-handed steering device would look like and how it would function, to present to Janice at the upcoming client meeting. Upon creating this design concept, we reflected on what information may still be required to create the optimal prototype and compiled a list of questions for Janice, whose answers will provide us with clarity as we proceed to the next deliverable.

1. Introduction

Our client, Janice, is unable to properly utilize the two-handed steering mechanism on her walker due to a hypermobility syndrome that causes her shoulders to frequently dislocate throughout the day and consistently leaves her with one arm in a sling. She has expressed a desire for a device that will allow her to steer her walker with one hand and can be temporarily attached to any basic model. Her end goal is to be able to safely direct her walker with either hand individually, requiring it to be a versatile design that can primarily be used with either hand, as well as be easily added to and removed from any walker, as she often changes between models and brands due to their short lifespan, without requiring any permanent alterations to the walker. Within the accessibility field, devices for those with partial mobility impairments has remained quite stagnant over the years, therefore leaving a great need for products, for Janice and others with similar mobility impairments, that provide additional accessibility assistance.

In order to achieve this goal, we have proposed a one-handed steering device that can be used with any model of walker. It will consist of two bars, one for gripping and steering the walker, and one bar underneath to be used for braking. This product will be highly adjustable, able to tighten around any size of existing handle and also able to extend to cover the distance between the two existing handles, on any model of walker. The lower bar will hook underneath the existing walker brakes, and due to its rigid nature, when pressure is applied to the braking bar, it will also apply pressure to the existing brakes to bring the walker to a stop. The device will also not require any permanent modifications to the walker, but will be easily removable and adjustable, so that the user is still able to fold up their walker and utilize the walker seat. In addition, we have created an integrated lighting system that will consist of a simple bike light that can be attached to the main steering bar, and can be easily aimed at the ground ahead.

The development of this product will not only benefit Janice and those with a similar combination of mobility impairments, but also those around them. It will allow Janice and many like her to complete tasks that many others take for granted with more ease, like taking her kid to the park or going grocery shopping independently. This one-handed steering device will be the next step in innovation that the accessibility industry can take to create equality between everyone, no matter their physical state.

Another vital aspect of any engineering design project is proper planning. In this deliverable, a detailed schedule is proposed, as seen in the Wrike chart, for the completion of the design project as we move on to the prototyping stages of our design. It is important to break down each task within the deliverables into more manageable subtasks in order to ensure that the group remains on task and is able to complete each step of the project with great attention to detail. Each task has been roughly broken down and assigned to a group member, with an estimated completion time. The schedule is tentative to change as the project progresses and we gain more information, but it provides a strong structure to ensure project completion.

2. Functional Decomposition

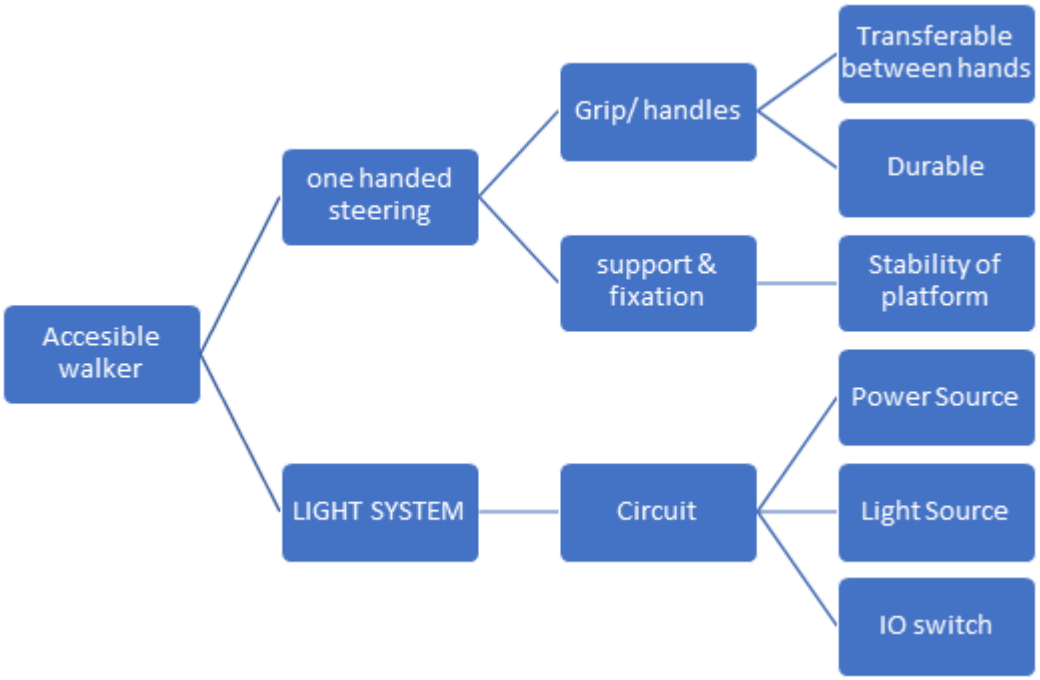


Figure 1 - Functional Decomposition

2.1. System boundaries

First, we identified the main function of the device we are developing. Starting with the reason for this device, we determined that the main function of the steering device was to make existing walkers more accessible. Our design hopes to achieve that through two main functions as shown in the figure above (*Figure 1).*

2.1.1. One handed steering:

The first function we decided on is to make the walker more accessible was personally requested by our client and it was the one-handed steering function. Further sub functions of this function shown in the figure illustrate what concepts we decided to use to achieve this function.

2.1.2. Lighting :

This second function incorporated into the design focuses on making it more useable during the night. We decided that an integrated lighting system would be best to achieve this. We plan to incorporate this system into our design through 3 sub functions shown in (*Figure 1).*

3. Product Concepts

3.1. Shahd's Concepts

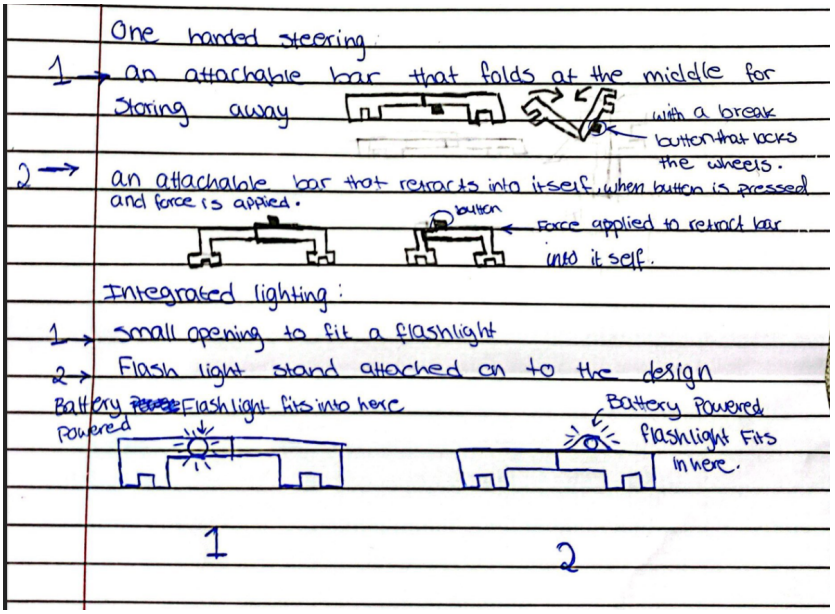


Figure 2

3.2 Mark's Concepts

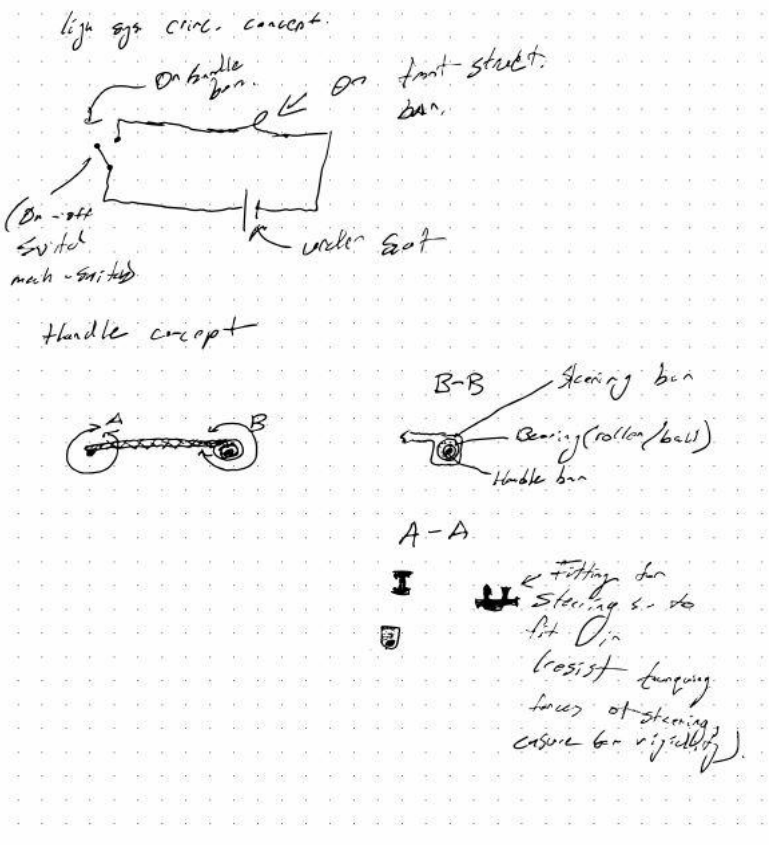


Figure 3

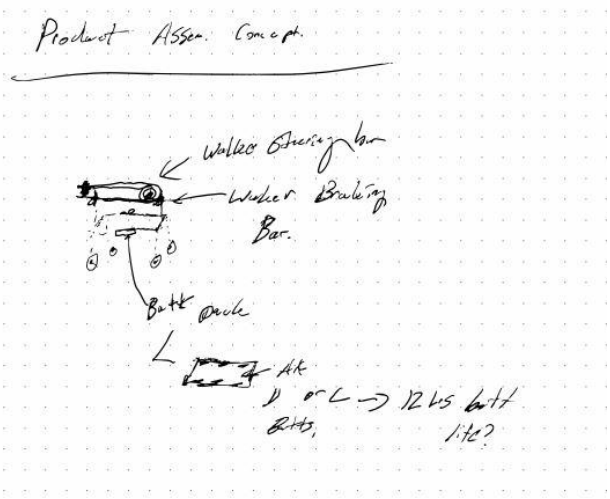


Figure 4

3.3. Sydney's Concepts

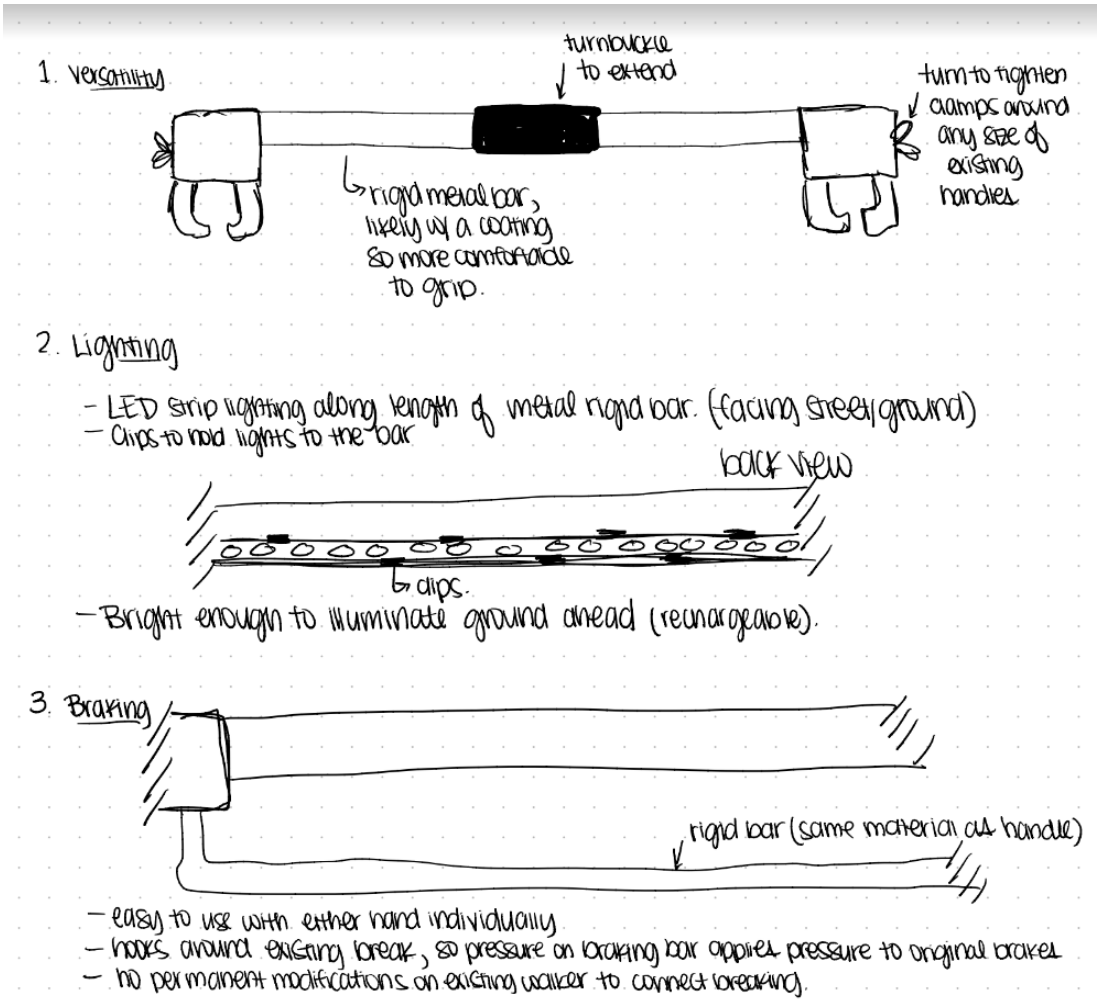


Figure 5

3.4. Mehdi's Concepts

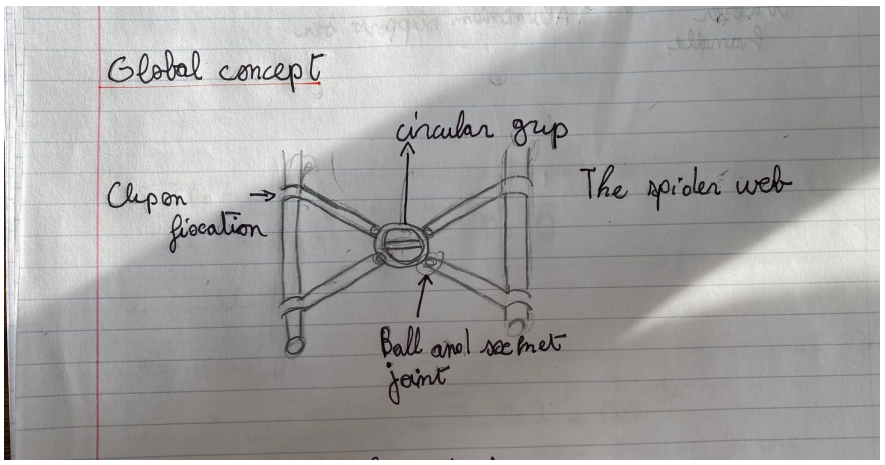


Figure 6

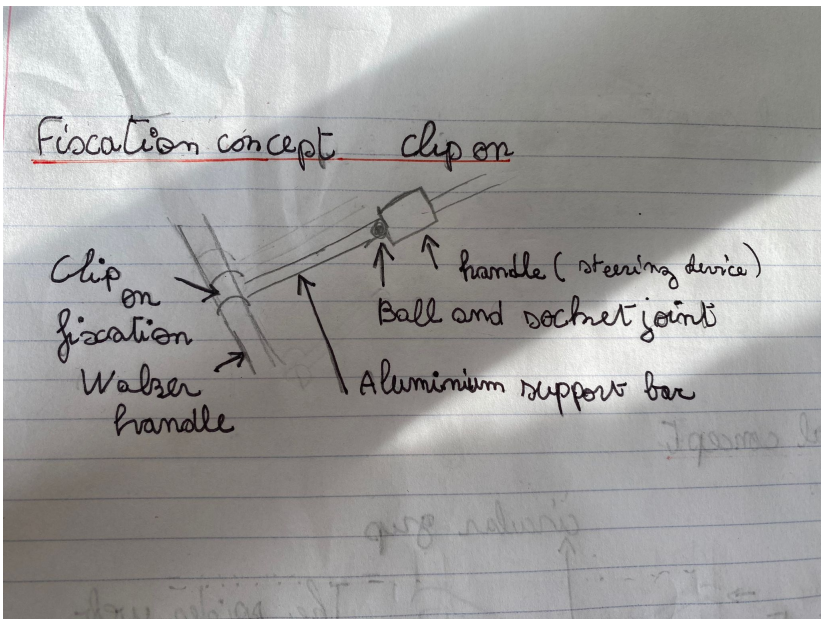


Figure 7

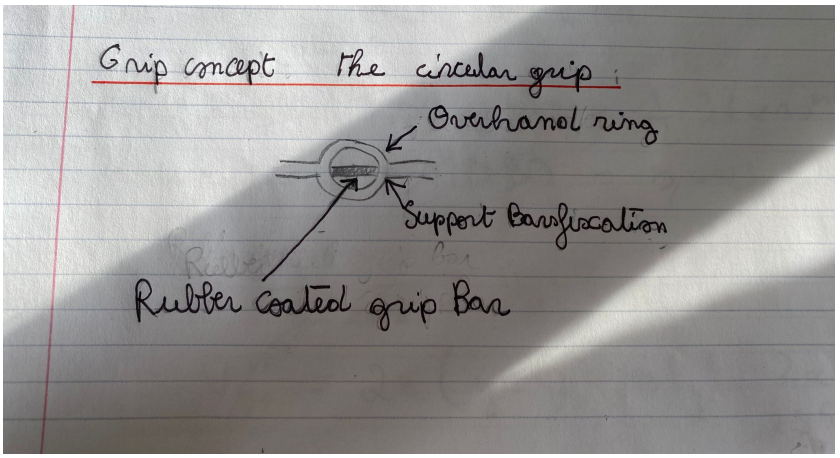


Figure 8

3.5. Rayane's Concepts

3.5.1. Handle System:

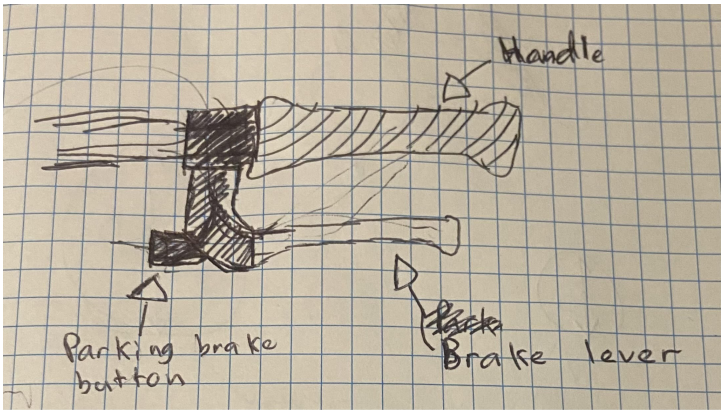


Figure 9

The handle system is composed of the handle, brake lever and parking brake. The handle is made of plastic material with a rugged surface. The brake lever uses a wire which connects to both rear wheels for stopping them if needed. The parking brake button is connected to the same system of the brake lever and is used to permanently block the rear wheels (for parking the wheelers).

3.5.2. Light System:

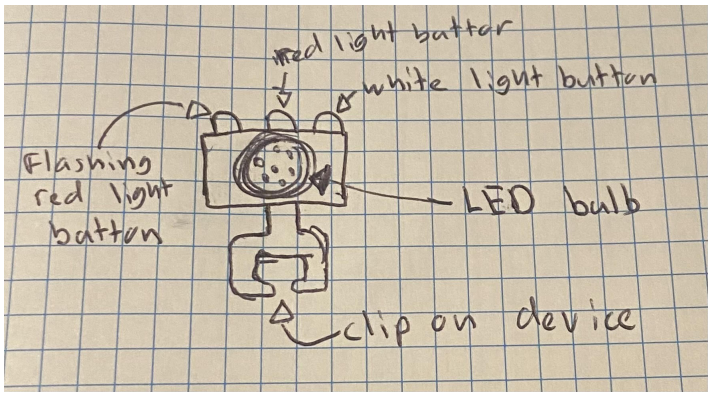


Figure 10

The light system is a battery-operated LED system with three switches and a clasp on the device. One white light for illumination, the second for the red light in case of a problem and the third one for flashing red light to indicate an emergency.

3.5.3. Steering System:

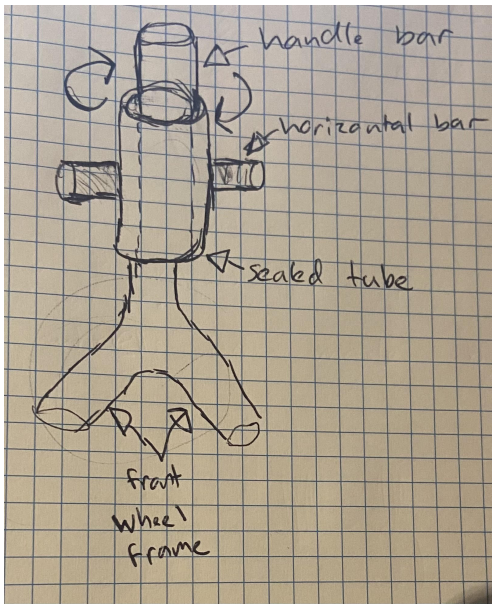


Figure 11

The steering system is composed of a sealed short tube in which the handlebar is inserted and connected to the front wheels. The short tube is connected to the rear wheel system using a horizontal bar. The sealed short tube is lubricated so that the handlebar can be rotated left or right easily.

4. Analyzing and Evaluating Concepts

Metrics		Concepts provided by each team member (grading :1-5)				
		shahd	Mark	Sydney	Mehdi	Rayane
1	Stability	Foldable Aluminium/zinc bar 3	Non foldable Hinge design aluminum pipe 4	Non foldable Metal bar 4	Non foldable Multiple fixations aluminum	Plastic Non foldable 4
2	Elevation	Elevated from the walker 5	No elevation 1	Slightly elevated (1-3 cm) 4	No elevation 1	No elevation 1
3	Price	High end (50$+) 1	Mid range (30-40) 5	Mid range (30-40) 5	Mid range (30-40) 5	High end 1
4	Weight	Medium weight 3	Light weight 5	Medium weight 3	Heavy due to more support bars 1	Lightweight 5
5	Lighting type	Incandescent 1	(Light emitting diode) LED 5	LED 5	N/A	LED 5
6	Length (adaptable or not)	Non adaptable length 2	Non adaptable 2	Adaptable length 4	Non adaptable 4	Non adaptable 4
7	Durability	Durable -simple folding mechanism 4	Very Durable -anti corrosion coating -simple mechanism (not a lot of wear and tear) 5	Mildly durable -mechanism for the fixations that might decay after extensive use 3	Not very durable due to excessive stress on the fixation (torque) 2	Mildly durable -Complex mechanism that is connect to the front wheel that might decay after extensive use 3

8	Grip (material used for the hand/ device interface)	same as the fixation bars 1	same as the fixation bars 1	Rubber coating 5	Rubber coating 5	Rugged plastic 4

Table 1 -Concept Evaluation

4.1. Process and methods :

4.1.1. Grading scheme:

The grading system used ranges from 1 to 5, with 1 being the worst. The maximum grade attained regarding particular metrics is also a way for us to recognize how important this metric is going to be for the development of the final design.

4.1.2. Stability :

To evaluate and assess the stability of each concept, we based our analysis on the material used for the handle and its design. The analysis showed that concepts using hard metals (aluminum or zinc) would be able to withstand more sheer force than those using plastic. Similarly for the designs, those that incorporated more moving parts such as hinges or locks, can result in a less sturdy handle.

4.1.2. Elevation:

Regarding elevation, our estimations were based on the nature of the design and how it would be mounted as visualized in the sketches. Through that, we were able to perform a quick estimation of the elevation in each design. In the target specifications previously established in deliverable B, we aimed for an ideal elevation of 5 cm (about 1.97 in) from the walker, therefore, all designs were compared to this metric.

4.1.4. Pricing :

Pricing was evaluated through analyzing the complexity of each design in addition to the materials used. The more complex the design and the more expensive the materials used were, the lower the grade assigned for that metric.

4.1.5. Weight :

Weight was approximated by looking at the scale of each design and the materials used. We aim for our product to be as lightweight as possible while still being sturdy enough to withstand the weight of our client, each concept was graded accordingly.

4.1.6. Lighting system:

The lighting system was evaluated in a binary fashion (5 if LEDs were the main light source, 1 if they were not). Since our client mentioned she uses LED lights regularly as they

are the most adapted to her condition (epileptic seizures). The use of incandescent light being a potential issue, concepts incorporating that were graded accordingly.

4.1.7.Durability :

Durability was evaluated regarding the number of moving parts in each concept. Concepts using multiple mechanical systems were deemed not as durable due to the possible effects of wear and tear that could impede the device's function in the long run.

5. Design Solutions

5.1. Design 1

The first design consists of a bar with clamps on either end to clamp onto the existing handles of the walker, as shown in *Figure 5*. There is a small handle on either side that is turned to tighten the clamps as desired, hence, making them compatible with any kind of handle. The user uses this bar to push and steer the walker using either hand, which was one of the most important needs interpreted. For the Braking, it was important to incorporate something that substituted the existing brakes as they are left and right-handed and hence do not allow for one-handed braking. This design includes an overhanging bar that when pulled up would press on the handle brakes. Additionally, the installed bar can be pushed away to the side to allow the user to use the seat in cases of certain models, and for storing the walker away. This idea was incorporated from concept 3.2. There is a fastening pin and once this pin is unfastened by untwisting, the bar disconnects from one side and falls to one side clearing the way for the seat and the walker can be stored away if needed. Finally, for the integrated lighting system, the design includes a battery-powered LED attached to the front of the handle.

5.2. Design 2

The second design uses a similar approach to the first design. Similarly, it consists of a bar that can be clamped onto the handles and a battery-powered LED attached to the bar, though it uses a different approach for the store away aspect and the braking system. Firstly, instead of a bar that hangs from the steering bar and presses both hand brakes, there is a button that activates the brakes as shown in *Figure 2*. This idea was incorporated from concept 3.1, a brake button does result in a more time-consuming installation though as the button needs to be set up with the brakes to activate them. For storing away, this product also uses a pin mechanism but instead of the bar disconnecting from one side and falling to the side, unfastening this pin allows the bar to fold down the middle once the walker is folded. The pin is unfastened by pulling it from its place, which then unlocks the folding mechanism once this is done, simply pushing the handles of the walker together to fold it will also cause the bar to fold. This can bring up the issue of the mechanism accidentally catching on the skin of the user.

5.3. Design 3

The third and final design discussed is based on concept 3.4. As visualized in *Figure 6*, rather than simply having a bar that settles onto the existing handles and is used to control the walker like in designs 1 and 2, this design uses a spider web-like design. It consists of 4 bars that meet in the middle to form a circular grip. Along with this, we incorporated the brake button from concept 3.1. However, the circular hand grip would require more torque to steer the walker, therefore, making it less accessible than the other two designs since it requires a certain amount of force which cannot be easily applied using one hand. As illustrated in *Figure 8* this circular handle does allow for a better grip since it is surrounded by rubber. For the braking, the brake button would be located on the side of the circular handle and once pressed activates the handle brakes installed on the walker halting it to a stop, as previously mentioned this method of braking would increase the installation time. Finally, for the integrated lighting system, this design uses a bike light that would be attached to the handle. Since bike lights are already made for the outdoors, this guarantees the functionality of the light system even in extreme conditions and would require less testing of that certain aspect as it is a well-trusted design used on bikes and other products.

6. Group Design

6.1. The Final Design Concept

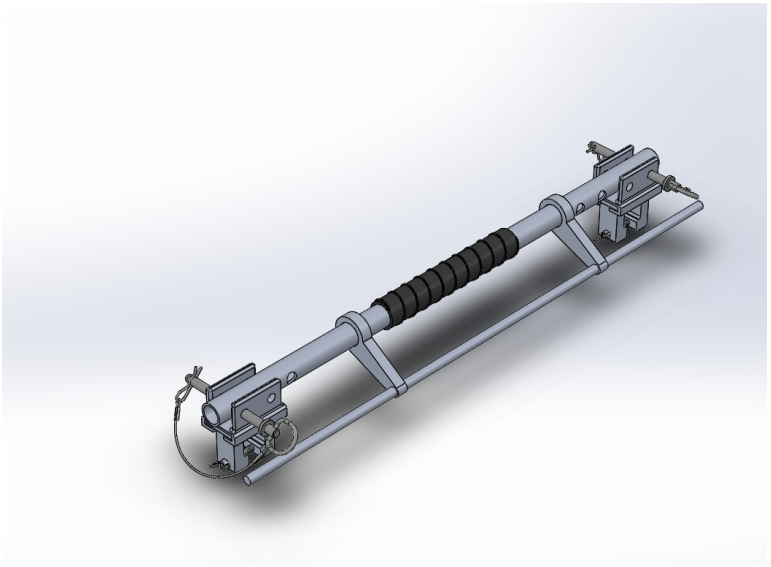


Figure 12

The final design achieved was a combination of various aspects of the three discussed designs. It includes a bar with clamps on either side that can be tightened to fit onto any handle through screws on one side as shown in *Figure 5* from design 1. This design was the most favorable as it was the most compatible since the tightness of the clamps could be adjusted and it does result in a complicated installation process. The bar design was chosen rather than the

spider web design due to the fact that the spider web design would require a torque not easily produced by one hand. Additionally, the braking system from the same design was chosen for our final design. The brake is activated through a bar that hangs under the handlebar and can be pulled on to press both handle brakes, in turn activating the brakes as shown in the figure above. For the integrated lighting, we landed on the system in design 3 as it proved to be the most reliable and easy to install, moreover there are many options on the market allowing for freedom of finding a product that does not interfere with the client's epilepsy. Lastly, a new concept was introduced in recent discussions that allowed the design to be more compatible. The bar length can be adjustable by leaving a few excess inches (1-2) on either side of the handle so that the clamps can be moved to the side to extend the length for larger models. This was based on the benchmarking done in Deliverable B which showed how models varied in size.

6.2. Advantages and Possible Drawbacks of This Design

When producing a final design, we tried our best to satisfy all the needs, starting with the more important ones, one of which was compatibility. Since our design does not require any installation of the actual mechanism of the walker, this makes it quite easy to install and does not require any prior knowledge of the walker to be installed. Furthermore, the clamps and extending bar allow for this design to be incorporated into any walker, considering the larger models. Finally, the rubber band on the middle of the handle betters the grip for all kinds of weather conditions.

On the other hand, a drawback of the design is regarding the store away mechanism. Although the chosen design for this concept is one that helps tackle another issue, the useability of the seat, considering the fact that the bar is expected to be rugged enough to hold the weight of the user, it will drop down rapidly and could possibly collide with the user's lower body. Through iterative testing and prototyping, we hope to produce a design that makes this scenario highly unlikely.

6.3. Relating to Target Specifications

During the analysis stage, we graded favorably the designs that were the closest to the marginal values previously decided on in deliverable B. Those designs (or parts of them) were then combined to form multiple solutions which led us to our final design. This resulted in a final design for which all the subsystem concepts were deemed the closest to the target specs compared to their counterparts.

7. Conclusion

Upon analyzing the technical specifications and client needs of Deliverable B, our group has created three overall design concepts and assessed their potential success in fulfilling client needs. We have developed a strong group concept, based on a combination of factors from each of the potential designs, with which we will continue the design process. The design includes the best options for each broken down criterion and is feasible for us to complete within our budget, while also going beyond the distinct client needs. This design concept has given us a clear image of what our final project will look like and how it will function, using many concepts learned in previous classes. We have also created a concise plan for completing this project based on the design planning processes learned in class, which is outlined in our Wrike Gantt chart. In the upcoming deliverables, following a client meeting to be held on October 5, we will begin work on our first prototype and expect to have a draft of our final project to present to our client and receive essential feedback in the near future.

8. Client Meet 2 Prep

8.1. Questions for the client:

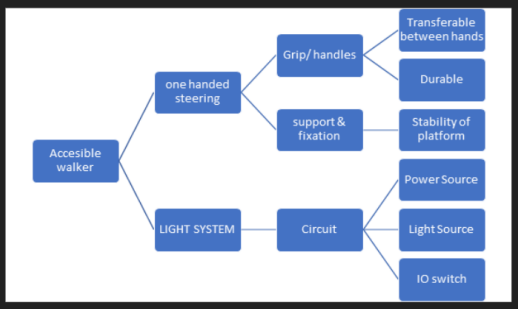
1. What do you think of the current state of the project so far ?
2. What would you say differs between the needs identification that we performed and the reality ?
3. What are the functions that this object must fulfill ? What differs from the functional decomposition that we did and your view ?
4. From what we presented, which characteristics would you like to see the most in the end product ?

8.2. Client meet slideshow :

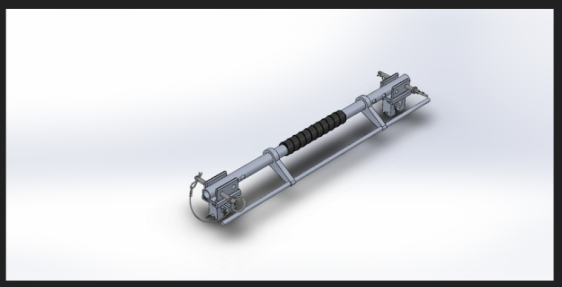
Identified needs

#	Translated Needs	imp (1 least - 5most)
1	Solution should be versatile, and applicable to different kinds of walkers.	5
2	The walker can be used during winter.	3
3	Walker can be used in the dark.	2
4	Handle has a good grip.	3
5	Easily foldable.	4
6	The handle height is adjustable.	3
7	The steering device should not take up a lot of space on the walker.	2
8	The walker is low cost.	2
9	Walker needs to be easy to steer.	4
10	Handle can be used by either hand.	5
11	Wheels can be bigger in the front.	3

Functional decomposition



Current state of the design



What's next

Prototyping :

- Walker attachement
- Bar
- Rubber coating

Testing :

- extensive testing of each part to see if it meets the target specs , testing safety of use.

9. Wrike Link

https://www.wrike.com/open.htm?id=963685589