Project Deliverable D - Detailed Design, Prototype 1, BOM, Peer Feedback and Team Dynamics

A2.2 - One-Handed Walker Steering

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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 often unable to steer with complete control, which poses a risk to her safety. She requires 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 and use. This deliverable focuses on our finalized detailed design that has been accordingly modified to the client feedback we received. With the finalized design ready, we were able to start prototyping and comparing the findings to the target specifications previously established. Finally, we produced an estimate of the price based on the different components we decided to use to produce this design and bring it to life.

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.

Furthermore, for people with similar mobility impairments to Janice, walkers should be easy to push and include a braking system that can be operated with only one hand. The goal of this deliverable is to develop a prototype of a one handed steering system that adapts to fit a variety of conventional two-handed walkers. This deliverable consists of analyzing and reflecting on client feedback to guide the design requirements of the first prototype, and the steps taken to design and test the first prototype of our one-handed steering device. This deliverable also includes our preliminary bill of materials, which has been largely based on the original concept design, but is tentative to change as we learn more about the project and advance to the next prototype.

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. Reflecting On Client Feedback

The second client meeting took place this, in which we presented our group idea for the design, and were able to discuss what our client liked and disliked. Her biggest concern was the braking system. She mentioned that some days she might be weaker than others, therefore, our braking system should be able to be activated using a minimal amount of force. This brought to light the issues that our client might face with our current braking system, as the braking system we currently have in our design may require more effort than our client can provide, nonetheless, we plan to reiterate this function since we aim to produce a design that will tackle any concerns our client might have. Another concern our client communicated was the ability to fold and transport the attachment, we were able to already take that into account beforehand with our group design and presented our idea to her. Although she was happy with our approach, we are planning to explore other approaches so that, even on her weakest days, she can use all aspects of the walker comfortably. On the other hand, she mentioned that she liked the compatibility of our design and the ease with which it can be installed. As this was ranked as one of our most important client needs, this confirmed that we are on the right track for this design and that we, as a group, have a good understanding of what is required of us. With a few added tweaks, we are confident that the design will make the walkers more accessible to our client.

3. Detailed Design

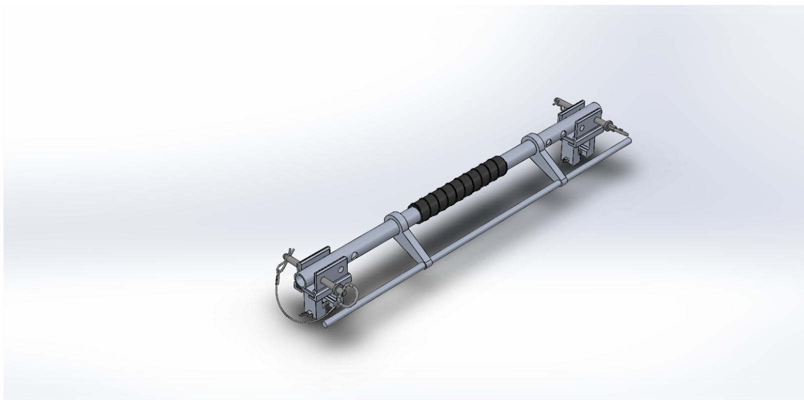

Figure 1

The initial concept design works as follows. The primary steering bar spans the width between the walker's handlebars. This allows the user to apply force to the walker in order to move it and alter its direction of motion, without requiring the use of both hands. The bar is secured to the walker through a 2-part fixture assembly. Two “teeth” which can tighten to the walker's handles via the help of a wingnut and threaded rod, secure the bar housing to the width of the walker. The steering bar is kept in place with the help of pins. These pins are easily removable to allow the user to manipulate the bar to access other functionalities of the walker (i.e., foldability, built in seating, etc.). The bar has holes placed near its ends to allow the user to adapt the system to different walkers with a different width between handlebars. The rubber grip in the center of the steering bar is used to provide grip for the user and allow them to utilize the product effectively given the variance in weather conditions. The braking mechanism consists of a hinge assembly and a braking bar. In the CAD model of the initial concept, shown above, the braking bar is the bar with the smaller outer diameter. This bar passes through the brake handles on either side of the walker and when it is pulled towards the steering bar by the user, it applies a force on the brakes and activates them. The brakes can be deactivated the same way. The hinges are fixed to the steering bar via bearings, which allows them their range of motion and ease of use.

4. Prototype Objectives

Prototype testing is an essential aspect of designing a new project, it allows for quick testing, risk reduction, and a prime learning opportunity to improve existing design ideas. A prototype is an early model of a product that is built with to test a concept with the goal of learning. Our goal for this prototype was to test out our approach for the clamps and other fixitations that might be involved in the foundation of our design, and then to receive client feedback on the design in our upcoming client meeting. This initial prototype testing will focus on verifying the versatility of our product, mainly whether it will be able to hold on to many different models of walkers and remain stable. In addition, the prototype testing will provide us with an understanding of what we will truly be able to achieve in this project, and what may be out of the scope of our design, as well as to evaluate the overall functionality of what we have created thus far.

The main objective of the first prototype testing is to test out the clamps on rods of different diameters to verify the compatibility of our design with many walker models. We also want to test out the sturdiness of our design, therefore, we also want to verify that the clamps will maintain a stable hold on the bar, and therefore not pose any safety risk for Janice. Additionally, the clamps will keep the bar in place when force is applied to push or pull the walker.

This prototype will also help us to gain a deeper understanding of SolidWorks and its functionality. As we have elected to create a low-medium fidelity prototype that will simply be able to demonstrate the ability of our clamps to increase and decrease in size, and therefore adjust to the proper width to attach to any walker. The possible results of our prototype will be very straight forward, as we will simply be verifying the range of walker handle sizes that our product can currently create a stable attachment with. Based on the results of the testing, we will be able to make adjustments to the upcoming prototyping if feel that our product requires more or less range in its adaptability. If the prototype is functional, then we will know that what we deemed as the most important concept for this design is be ready to be used in future prototypes and, eventually, in our final design.

5. Prototype I

5.1. Documentation

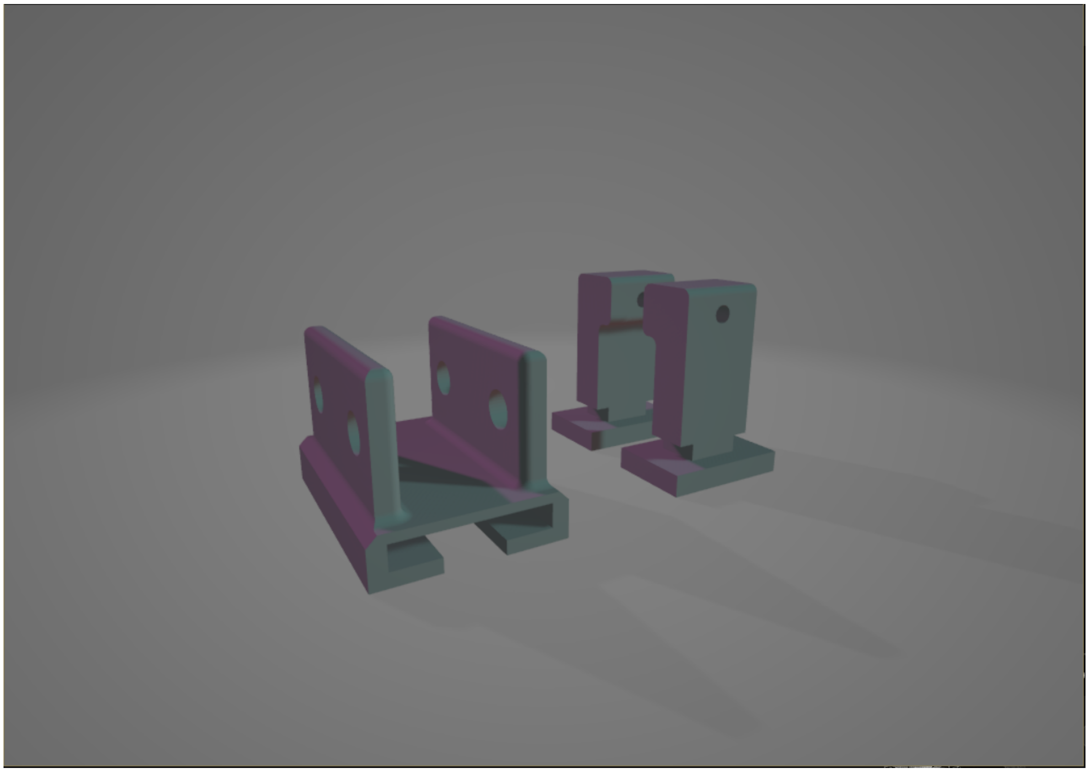

Figure 2: 3D Model of pinhold and fastening clamps

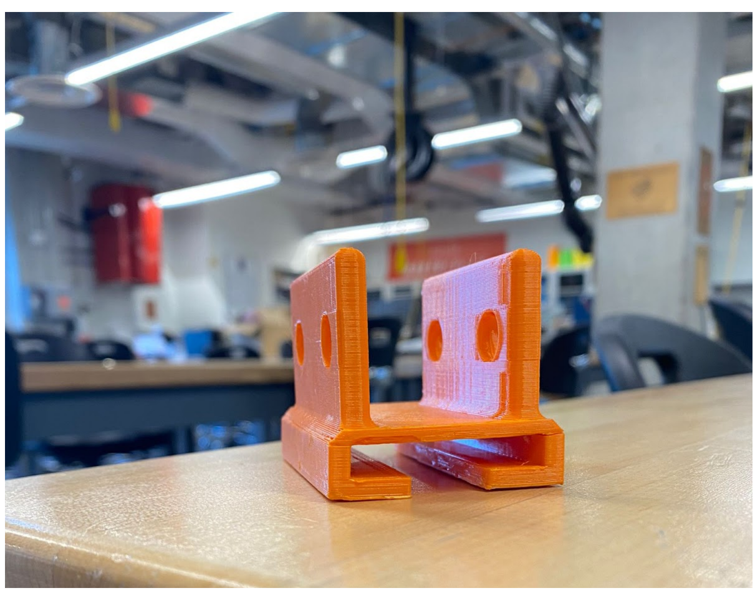

Figure 3: 3D print of the pinhold

Figure 4: 3D print of the fastening clamps

5.1. Testing

To test the prototype that we developed for this deliverable, we are going to test out specifications that aim to evaluate if the fixation system that we imagined would work.To do that, we need to test its structural integrity once assembled through a drop test and also test out its compatibility with rods of different sizes that aim to model walkers of different sizes.

For the drop test, we expected our product to be dropped from the average height that we evaluated to be around 165cm from the benchmarking data gathered in Deliverable B. So, up to that height we expect the attachement to keep its structural integrity.

As for the compatibility, we evaluated the average handle size of a walker to have a diameter that ranges from 2 to 3.5 cm, and our product must be very well clamped on rods of that size. We plan on evaluating the attachment strength by observing the behavior of the clamp when attached to rods of different diameters and subjected it to shaking.The strength of the attachment is going to be quantified by a scale from 1-5, with 1 being the case where the clamp is badly attached to the rod and is not stable at all, and 5 being the best case scenario where the clamp stays fully attached even when the rod is moved around.

5.2. Compare Findings To Target Specs

Drop Test:

Height dropped from (m)	Expected structural state	Observed
0.50	In one piece	In one piece
1	In one piece	In one piece
1.50	In one piece	In one piece
1.65	In one piece	Detached
2	Detached	Not tested (prototype broke)

What we noticed from the drop test is that the 3D printed version of the clamp did not withstand to be dropped from the height of an average size walker. This means that 3D printing the part with PDA filament is not an option for us.We plan on considering other types of filaments that might be stronger than PDA or choose a method of fabrication other than 3D printing.

Clamping Strength Test:

Diameter of the rod (cm)	Attachment strength (1-5)	Observed
1.5	1-2	1
2	5	2
2.5	5	2
3	5	3
3.5	5	4
4	3-4	4
5	1-2	2

Overall, we noticed that the design is not really adapted to circular handles. The actual clamps need to have a more rounded shape to fit the circular shape of the handles. Overall our design did not perform well on smaller diameters (less than 3cm), we think this is again due to the prototype not fitting correctly on to the circular handles. The performance, however, did greatly improve with bigger rods that allowed for more contact surface between the claws and the rod. We also noticed that our current design lacked adaptability, as the claws do not slide correctly inside the pinhole tray and this made it hard to fit the claw to the size of the rod. Our strategy to perfect the current design of our attachment is to, primarily, review the design of the claws to make them more circular. Also, we plan on adjusting the original sliding design by reviewing the dimensions of the claws so that they have have more freedom of movement inside the tray, while still being held in place.

6. Bill Of Materials

Bill of materials				
Item	Description	Quantity	Price ($C)	Amount ($C)
#1	Glarks 2 piece aluminum straight rod	1	$14.99	$14.99
#2	Aluminum 6061 Round Rod 2" Diameter X 24" Long	1	$48.72	$48.72
#4	ULINE Rubber tape	1	$12.50	$12.50
#5	Zinc Alloy wingnuts McMaster Carr (9986A230)	1	7.96	7.96
#6	Securing Pins McMaster Carr-(98412A211)	2	5.75	11.50
#7	Threaded Rod McMaster Carr 90575A570	1	2.97	2.97
			Total	$98.64

7. Critical product assumption

7.1. Availability of material needed

Regarding material availability, our product's end design does not require very complex machine parts or rare materials that would be subjected to shortages. In that sense, we do not expect the availability of the materials required for developpement to be a critical issue.

7.2. Critical functionalities and specifications

Due to the fact that our product is an add-on to a pre-existing device (our client's walker), one of the functionalities that is the most critical is the compatibility of our design with a wide range of walkers. If the product does not fit correctly on the current walker, or any of the future walkers, of our client, then it is going to be unusable. This means we need to pay particular attention in testing specifications such as the length of our device, its adaptability, and its fixations to the walker.

8. Conclusion

Upon testing our first prototype of the clamps and other fixations in our design concept by following the steps outlined above, we have recorded our results. With thorough testing, we concluded that our design for the adjustable clamps is feasible and will create the ability to maintain a stable attachment to any model of walker, so we will carry this concept through into the upcoming prototyping and design stages. We are now prepared to move forward with our next prototype and will be making changes based on Janice's feedback. Upon hearing from the client, she was impressed with the versatility of our design, but had some concerns with regards to the strength required to utilize the braking system. In the upcoming prototype we will be placing a focus on the braking system of our project, to ensure that the design works as it should, but also that it will require minimal strength so that it is easy to use even on Janice's weakest days. It is important that we reach all our goals for the upcoming prototype with regards to the braking system, as the following prototype and final design will rely on features that will be decided in prototype II. With respect to our budget, we have not yet made any purchases for our prototype or final project, as this prototype was of low fidelity and was designed using SolidWorks, which is a free software application for uOttawa students.

9. Works Cited

[1] "Aluminum 6061 Round Rod 2 Diameter x 24 Long - Etsy Canada." *Aluminum 6061 Round Rod 2 Diameter X 24 Long - Etsy Canada*, https://www.etsy.com/ca/listing/1094559563/aluminum-6061-round-rod-2-diameter-x-24?gpla=1&gao=1&&utm_source=google&utm_medium=cpc&utm_campaign=shopping_ca_en_ca_-non_domestic-not_ready_to_ship-craft_supplies_and_tools_a&utm_custom1=_k_CjwKCAjwv4SaBhBPEiwA9YzZvMuQRKfQ_7UguHp0alNbqSwzu8M_ZPxGgMOkAjYJI7KdIR5JvvX5QxoCtLEQAvD_BwE_k_&utm_content=go_18265483348_141454006296_620827864511_pla-1793329811020_c__1094559563enca_198213336&utm_custom2=18265483348&gclid=CjwKCAjwv4SaBhBPEiwA9YzZvMuQRKfQ_7UguHp0alNbqSwzu8M_ZPxGgMOkAjYJI7KdIR5JvvX5QxoCtLEQAvD_BwE.

[2] "Glarks 2Pcs 6mm x 356mm Aluminum Straight Metal Round Shaft Rod Bar for DIY RC Model Car, RC Helicopter Airplane, Model Ship (6MMX356)." *Amazon.ca: Industrial & Scientific*, https://www.amazon.ca/Glarks-Aluminum-Straight-Helicopter-Airplane/dp/B07KJ71T13/ref=sr_1_4_sspa?gclid=CjwKCAjwv4SaBhBPEiwA9YzZvOkCk15FfuuVaJxpZGfyK2l-W2VaxjaZSg3jxzlTEUAVISie9UlPGBoCUtYQAvD_BwE&hvadid=605573070411&hvdev=c&hvlocphy=9000668&hvnetw=g&hvqmt=e&hvrand=3680706516680983806&hvtargid=kwd-24087338066&hydadcr=29141_14628110&keywords=1%2Baluminum%2Brod&qid=1665265401&qu=eyJxc2MiOiIxLjUyIiwicXNhIjoiMC4wMCIsInFzcCI6IjAuMDAifQ%3D%3D&sr=8-4-spons&psc=1.

[3] "Ina." *KH12-PP INA • SP*, https://www.sp-spareparts.com/en/p/kh12-pp-ina?curr=usd&utm_source=adwords&utm_medium=ppc&utm_term=&utm_campaign=Smart%2B%7C%2BCA%2B%7C%2BOrganic&hsa_cam=18303538037&hsa_mt=&hsa_ver=3&hsa_src=x&hsa_ad=&hsa_net=adwords&hsa_tgt=&hsa_acc=6705635644&hsa_grp=&hsa_kw=&gclid=CjwKCAjwv4SaBhBPEiwA9YzZvNrBzytE-_Y0vVmjxGJoJYia7mdGzXJljpOxVQebXE3BlOaOsJMORhoCOmwQAvD_BwE.

[4] "Ruban Adhésif Isolant – 3/4 Po x 20 Vg, Noir S-5143." *Uline*, https://fr.uline.ca/Product/Detail/S-5143/Electrical-Tape/Electrical-Tape-3-4-x-20-yds-Black?pricode=YF912&gadtype=pla&id=S-5143fr&gclid=CjwKCAjwv4SaBhBPEiwA9YzZvCrvOeDt6yU8_BBmkok8vwD6wj6qABUtTOW3cueg1rLa4-NH4wG57RoCtGwQAvD_BwE.

10. Wrike Link

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