FOr Project Deliverable F - Prototype 2

A2.2 - One-Handed Walker Steering

Submitted by

[Shahd Al-Zuhaika , 300227606]

[Mark Uchanski , 300229193]

[Rayane Laouadi, 300250220]

[Sydney Ceolin, 300197739]

[Mehdi Ezzine 300268811]

Due date: 2022-11-6

University of Ottawa

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 reflection on our last meeting with the client and our second prototype. We tested two different materials for the bar and compared their findings to the target specs for a clear view of the functionality of our product before moving onto the final stage and bringing our design to life.

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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.

Our group is developing a second prototype of a one handed steering system that adapts to fit a variety of conventional two-handed walkers, this deliverable will place a focus on the optimal materials for the main handlebar. This will ensure that our product will be able to withstand enough force so that, if Janice's legs give out and it is required to withstand her entire weight, it will be able to do so. This deliverable consists of analyzing and reflecting on client feedback of the first prototype in order to develop our second prototype, and the steps taken to design and test the second prototype of our one-handed steering device. This deliverable will also thoroughly explain our testing plan for prototype II, including the reasoning behind the tests, the objectives of the testing, a description of the current prototype, and the expected and desired results of the tests, as well as a measuring system for the results.

2. Reflecting on Client Feedback

The third and final client meeting took place this week, we were able to update our client on the progress we have made and the results of our second prototype. In addition, we were able to ask her some last-minute questions in order to finalize our design. During our second client meeting, we discussed the possibility of a different approach regarding the foldability of our design and hence the group came together and brainstormed a few different ideas which we were able to discuss with our client during this third meeting. We presented two ideas to our client; one where the handle folds to one side by sliding out a pin, while the second one consisted of removing the bar from the handles completely and storing it away in a provided designated bag. Our client pointed out that she would rather have the handle fold away to one side rather than removing and storing it away as she might forget it in a cab or bus, therefore, we will be proceeding with the pin design that allows for the handlebar to detach from one side. Furthermore, she reiterated the need for our design to be able to carry her weight as some days, her lower body might be feeling weaker, and she would need to rest a good portion of her weight on it. This brought to light another issue that we decided to address in the testing of our second prototype. We were planning to use the material PVC for our handlebar which our client especially liked due to the fact that it would not rust or corrode increasing its life span and making it more weather resistant. After the meeting, however, our team was able to get hold of the PVC bar and after analyzing it we became concerned with the ability of this material to hold our client's weight. Hence, we decided to test out a bar made of a metal alloy that we were able to retrieve from the lab. We compared both these materials and chose the one that works best for our design based on our findings and the predetermined target specifications. Our client also gave us an extremely helpful piece of advice that we will be incorporating into our testing for this prototype and future designs. She mentioned that if we were not able to function this walker one-handed, then she would not be able to either and so we will be completing our testing of the functionality one-handed to get a good idea of how our client would feel when using our design.

3. Prototype Objectives

For this second prototype , we are going to be testing two handle bar design currently considered for the final product.The first design consist of a pvc tube with a 2cm diameter , the middle section is going to be wrapped with vinyl tape for better grip.The second one consist of metal alloy tube with a spring mechanism inside of it allowing to expand and collapse (similar to shower curtain rods) , which is also being rubber coated in the middle for additional grip. This rudimentary design is meant to emulate the type of handle that our client would be using to test the overall user experience , but also to find out the material best fitted to our needs.

In that sense we are going to be testing the grip of each handle with and without the rubber coated middle section in different use cases qualitatively to see if it is really necessary depending on the material we choose.One another key aspect that we need to test for each design is the sheer pressure withstandable and the deflection resulting from it.These metrics are going to be tested by attaching masses of known weight to the middle section of each bar.

4. Prototype II

4.1. Prototype documentation

Figure 1: Physical protorype of the PVC handlebar with the rubber coated middle section

Figure 2: Physical prototype of the metal alloy handlebar with the rubber coated middle section

Figure 3: Testing installation to measure the deflection under weight of each bar

4.2. Testing

For the grip test, we are going to be evaluating the grip of the design in different case scenarios by replicating movements that our user would usually perform to steer and maintain herself on the walker. The grip level is going to be evaluated qualitatively by grading with the following qualification: poor, moderate, good, or excellent.

To measure deflection, a mass of known weight is attached to the middle section of each handlebar which is supported at its ends. Deflection is found by taking the height of the support on which the bars are resting as a baseline and measuring the lowest point reached by each. Target deflection was chosen based on testing, we tested what rate of deflection would feel safe while using a walker and we found that a maximum deflection of 1 cm is what feels safe to the user. Deflection above that whilst still being safe do not give the user confidence to normally use their device (Ie lean on it completely and maneuver it swiftly). We divided the acceptable value by two for the metal alloy handlebar due to its price, it is twice as expensive as the PVC, so the benefit of choosing it must be likewise.

4.3. Comparing findings to target specs

Table 1: Deflection Test Data

Mass attached (kg)	PVC		METAL ALLOY	
	Target deflection rate (cm)	Observed (cm)	Target deflection rate(cm)	Observed (cm)
5	<1	2	<0.5	0
10	<1	3	<0.5	0

15	<1	5	<0.5	0

Results from testing show that PVC failed to meet the targeted maximum deflection. We also noticed that the user would not feel very safe using this handlebar due to its excessive bending. The metal bar exceeded our expectations, it met the targeted deflection rate for every test. In addition, during testing the bar felt sturdy even when used one handed and resting all our weight on it.

Table 2: Grip Test Data

Use case	PVC		METAL ALLOY	
	Expected level of grip	Observed	Expected level of grip	Observed
No rubber coating	Good	Good	Moderate	poor
Rubber coating on	Excellent	Excellent	Good	Excellent
Rubber coating on with gloves	Good	Excellent	Moderate	Excellent
No rubber coating with gloves	Moderate	Excellent	Poor	Moderate

The testing showed that for the PVC handlebar, the rubber coating was not necessary. The grip, with or without winter gloves, is strong enough so that it does not slip out of the user's hand while testing. On the other hand, for the metal alloy bar, the rubber coating proved to be required. From a user's standpoint, it also enhanced the in hand feel of the handlebar by acting as an insulator.

4.4. Assumptions and Analyzing Results

While performing the testing of both handlebars, we were able to roughly analyze some of the crucial mechanical properties of each material. This analysis was based purely on what we saw during testing and not on numerical data since we do not have the proper equipment for testing the mechanical properties and furthermore, that kind of analysis has already been done before and the data can be found online if needed to decrease any existing uncertainty. From the start we were able to see that the PVC had a lower elastic modulus, meaning it did not resist elastic deformation as well as the metal alloy did. This was clear as the metal alloy did not bend or elastically deform at all while undergoing testing, as shown in table 1, while the PVC did. We analyzed this property because the bar was expected to hold the weight of our client without bending and remain sturdy to keep our client balanced. We could also see that with bending, the PVC slightly plastically deformed, not enough to hinder its functionality but enough for us to notice. The metal alloy on the other hand, corresponding to the same amount of weight, did not plastically deform, this makes sense as from table 1 we can see that the metal alloy did not even enter the elastic region which is what comes before plastic deformation. This illustrates that the metal alloy has a greater yield strength than the PVC (as yield strength corresponds to the resistance to plastic deformation) which is the most crucial mechanical property of our design since our customer stressed the need for our design to withhold her weight which relates to the yield strength. The last mechanical property we discussed while testing was the ductility. We were not able to compare the ductility as we did not have enough material to fracture our prototypes, however, we were able to make assumptions based on our engineering knowledge. We know that plastic is known to be significantly ductile, more than metals. After further discussing this amongst each other, we reached the conclusion that although we do require ductility for our product as an instantaneous fracture could lead to some serious injuries for our client, the ductility that metals generally offer is enough for the purpose of our design. Additionally, through the iterative testing that we have done and will continue to do, we will be able to reach a certain degree of certainty that our product will be able to withstand forces greater than our client will provide and hence will not plastically deform, the ductility is just a safety measure that we have discussed to ensure the safety of our design.

5. Conclusion

Following the procedure outlined above, our group has created and tested our second prototype, and recorded the results. Based upon the testing of both a PVC tube and a metal alloy tube for the handlebar, we have determined that the metal alloy, with a rubber grip, is the optimal material for this project, with respect to its strength, cost, weight, and other factors described above. We continue to not have spent any money on the prototyping of our project, by using scrap materials provided by the school and materials found at home, so our budget is still completely intact as we move onto building our final project. Based upon the results of prototypes I and II, our group has a clear idea of how to successfully create our one-handed walker steering device, and we are ready to move on to our final design. Upon hearing from the client, she continued to be impressed with the versatility and functionality of our design, but she had some opinions on the way in which we would make our product foldable for transportation, which we will be taking into consideration. As we have many goals and much to accomplish to create this final prototype, we have divided the tasks according to each group member's strengths to optimize efficiency, as described on our Wrike.

6. Project Plan Update

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