

GNG2101
Design Project User and Product Manual

One Handed Walker Steering

Submitted by:

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List of Acronyms

Table 1. Acronyms

Acronym	Definition
BOM	Bill Of Materials
CAD	Canadian Dollars
CM	Centimeters
DEG/S	Degrees (Rotation)
H	Hours
KG	Kilograms
M^3	Cubic Meters
MIN	Minutes
N/A	Not Applicable
N	Newtons (force)
REF	Reference
REINF	Reinforcement
REV	Revision
QTY	Quantity
VA	Value Analysis

1 Introduction

This User and Product Manual (UPM) provides the information necessary for walker users with one functioning arm to effectively use the one handed walker steering device and for prototype documentation. Here we will provide all the details necessary to go from step 1 to the completion of the final product so anyone who reads this manual can replicate the process and obtain the same results.

2 Overview

As we talked to our client, we have learned that she has severe mobility issues which are caused by a hypermobile Ehlers-Dalos syndrome (hEDS), so using a walker is a challenge for her knowing that her shoulders can dislocate constantly. Her condition is rare and is getting worse day by day which can make daily tasks difficult such as going to the park, getting groceries and even moving around her house. The task is to create a device to attach to the client's walker in order to make it steerable with one hand. This would enable the client to do her daily tasks independently while one of her shoulders is dislocated. This potential solution could help many people around the world with similar conditions to improve their quality of life.

● Client Statements

1. I want the device to be long-lasting, be permanent
2. I want to be able to walk over snow banks
3. I want the device to be detachable and versatile
4. I want the device to be stable, balance is key
5. I want the device to be able to fold on itself with the device on
6. I want the installation of the device to be easy
7. I want a light on the walker to turn on at night
8. I love the big wheels on my walker
9. I would like for the walker to not get snow stuck in the wheels
10. I want to be able to steer the walker

11. I want an LED light (no strobe lights) to attach on the device

Problem Statement:

“A need exists for walker users with one operational arm to safely and easily steer the walker with a straightforward, attachable device that is versatile, durable, and cost effective.”

Final design and key features:

Metric #	Needs #	Metric	Unit
1	9	Force required to use device	N
2	9	Manoeuvrability (Turning Radius)	m
3	9	Agility (Rotational speed)	deg/s
4	8	Total weight	kg
5	7	Dimension	m ³
6	2,7,1	Reliability (MTBF)	h
7	1,8	Material	N/A
8	3,5	Detachability (Time to assemble)	min
9	4,9,10	Ease of use	N/A
10	6	Cost	CAD

In the previous table we have the final design key features which are crucial to understand the way the final prototype can be made, this includes the client needs as given by their statements and interpreted by our team. This communication with the client and clear understanding of the problem statement is really important because it makes our product a valuable piece of engineering, it's safe to use, adaptable, durable and fulfills and exceeds the functionality the client was expecting.



In the previous picture we can observe the final prototype which is attached to a walker to serve its purpose. This device works by using the existing brakes on the walker to steer by differential braking, this means that whenever the user needs to turn right, then the right wheel will be stopped and the opposite wheel will freely rotate to allow natural turning ratio of the walker. Our device consisted in a separate pair of brake handles that transfer the input force using a steel wire that is attached to the walker brake handles thus not requiring a complex installation or any permanent modifications. The cross bar the supports the steering system is made of galvanized steel for rigidity and is adaptable to different walker models, also it is important to mention that detaching the bar is quickly done by unscrewing the end bolts (no tools required) so that the user can fold to walker for easy transportation or use the walker seat to rest without any obstacles.

2.1 Cautions & Warnings

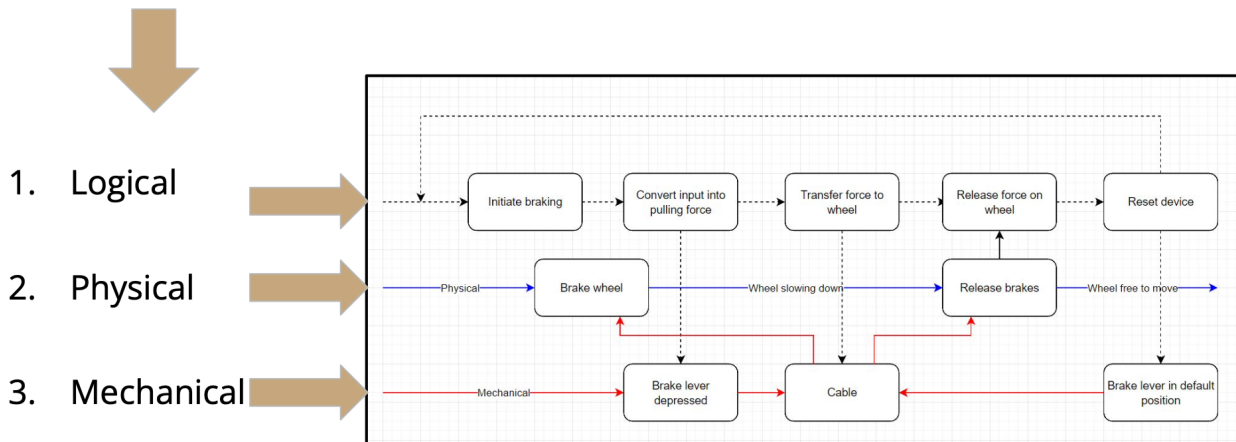
Even though the product is safe to use it is important to properly secure the crossbar on both ends by using the bolts included with the device so there is no risk the device might fall off the waker and potentially result in injuries to the user. Also it is important to make clear that the cross bar was not designed to seat on it, so it is not safe to do so even if it seems possible.

3 Getting started

Functional decomposition



Decomposition of all needs into logical separable Tasks



1. The first thing that needs to be done is to locate on the walker a spot large enough (usually by the end 5 cm of the walker handles) to attach the mounting brackets.

2. Attach the mounting brackets by placing the flat slips facing up.

3. Use the $\frac{1}{4}$ in bolts provided with the fastener, insert the screw on one side and the $\frac{1}{4}$ in nut on the other.

4. Tight with 2 wrenches of $\frac{1}{4}$ in size until the mounting slips are secure and not moving (do not over tight).

5. Repeat steps 2-4 on the remaining side of the walker.

6. After the mounting brackets are properly secured, place the crossbar with the brake handles facing forward.

7. Line up the perforated sides at the end of the bar with the center whole on the mounting bracket.

8. Insert the 1 in bolt through the slip and tight with the hand nut provided until there is no gap between the bunting bracket and the crossbar

9. Repeat steps 7-8 on the opposite side.





10. Now that the device is properly attached to the walker, it's time to attach the braking wires.

11. Pull the loose wire from the steering handles into the mounting bracket.

12. Attach the end of the wire directly above the walker brake handles.

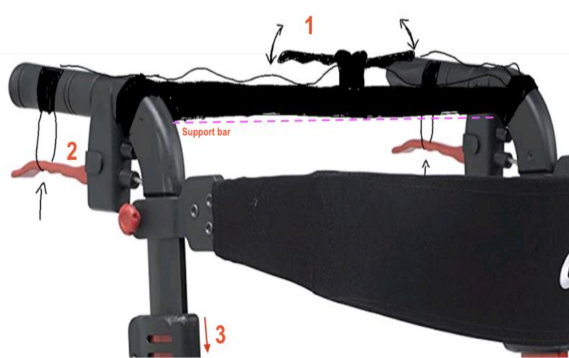
13. Use 2 zip ties on the end and strongly tight them until the black wire casing is not loose.

14. Pull the metal wire and make a loop through the walker brake handle.

15. Repeat steps 11-14 on the opposite way making sure that the right wire goes to the right brake and the left wire goes to the left brake.

16. After both sides are properly attached, test the steering system by pressing the device in the desired direction.

17. Do a 5 minute walk if you are a new user to familiarize with the product and successfully steer your walker with one hand.



3.1 Configuration Considerations

If there is excess wire after the attachment is done it is recommended to cut it with a wire cutter, however the device can still be used with excess wire but the user needs to safely store it in the brake handles.

3.2 User Access Considerations

This waker can be used by any user that has one functioning arm and is able to walk, it is important to mention that it's not a medical device, and it only supports steering of the walker so it should not be used by users with weak limbs or with medical conditions that result in dizziness.

3.3 Accessing/setting-up the System

These steps are described in the “getting started” section of the document specifically from step 1 through step 17.

3.4 System Organization & Navigation

The organization of the system follows the steps described in the “getting started” section of the document specifically from step 1 through step 17.

3.5 Exiting the System

Exiting the system is quick and easy, the user just needs to undo the knot made on both braking handles of the walker, then unscrew the crossbar on both ends, and finally unscrew both mounting slips with the ¼ in wrenches. It's important to keep all the components in a safe, dry place for further use in the same, or a different walker.



4 Using the System

The following section provides detailed, step-by-step instructions on how to use the various functions or features of the one handed walker steerer.

1. Turning right: Fully press only the right handle of the device and keep pressed while pushing the walker at the same time.
 - a. To stop turning right just completely release the handle.
2. Turning light: Fully press the light handle of the device and keep pressed while pushing the walker at the same time.
 - a. To stop turning right just completely release the handle.
3. Caution: Do not press both handles at the same time if you decide to steer; this would result in a complete stop of the walker.

4.1 Breaking the walker

Even though the main function of the device is to steer the walker in the desired direction, it is possible to use the handles to completely stop the walker given that we are using differential steering and this works by activating the brakes. To do this, the user needs to fully press (and keep pressed) the device's two braking handles and the walker will stop completely. Furthermore, if the user decides to continue walking, the only necessary step is to release both brake handles at the same time and continue with the normal operation of the device.

5 Troubleshooting & Support

If any unintended behaviour occurs feel free to email our team at crystaldreamsboutique@gmail.com for further assistance, it is important not to use the device if its not working as intended for your own safety.

5.1 Error Messages or Behaviors

Given that the product has only mechanical components there would not be any error messages but if any doubles or unintended behavior occurs you can contact our customer support given in the previous point.

5.2 Special Considerations

If the crossbar becomes loose, it is important to tighten the end nuts again by turning the hand nut.

5.3 Maintenance

If the brake handles do not return to their original position use a small amount of WD-40 to lubricate the release mechanism.

5.4 Support

If any unintended behaviour occurs feel free to email our team at crystaldreamsboutique@gmail.com for further assistance, it is important not to use the device if its not working as intended for your own safety.

6 Product Documentation

6.1.1 BOM (Bill of Materials)

Bill of Materials			
Material required	Amount	Cost (shipping included)	Link
Brake wire with black tubing	10 pcs	\$12.29	https://amzn.to/3MfO362
Aluminum Brake handle	2 pcs	\$15.99	https://amzn.to/3CKcw0n
Aluminum tube 28x26x500 mm 6063-T6	1 pc	\$32.49	https://amzn.to/3fUZOTu
Sail tie Optiparts	1 pack	\$19.35	https://bit.ly/3T5VChR
Scotch-Mount ½” x 15”	1 pack	\$15.50	https://amzn.to/3fSzGIW
Total Cost =		\$95.62	

6.1.2 Equipment list

The equipment that was used is

- a lathe
- a pipe cutter
- a vice
- allen keys

- 2 $\frac{3}{4}$ wrenches

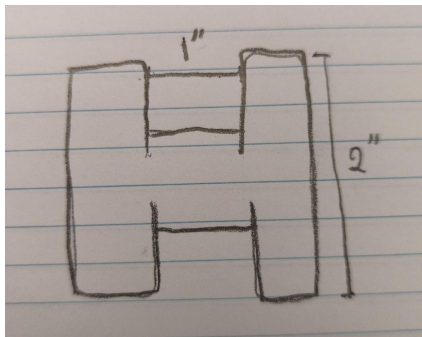
6.1.3 Instructions

Step 1: cut the bar to where both sides have been removed so there is no threads anymore and at a length around 20 inches

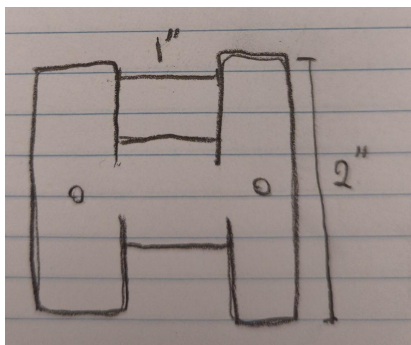
step 2: with a lathe drill 3 holes spaced 1 inch apart on each side through both sides of the pipe with a diameter of $\frac{5}{16}$ inches

step 3: use a file to file down the edges of the drilled hole and the edges of the cut pipe

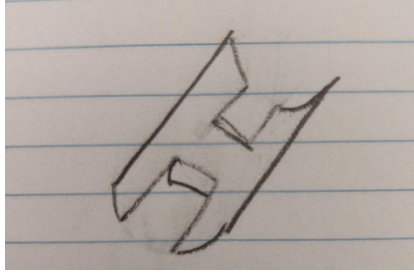
step 4: use tin snips to cut out this shape :



step 5: drill 2 holes into the metal sheet cutout in the spots in this image with a lathe with diameter of $\frac{5}{16}$ inches :



step 6: fold up the 2 flaps in a curved fashion so they can receive the bar:



step 7: cut a 6 inch strip of the metal strap with tin snips

step 8: wrap the strip around the bracket on the thin part then around the place where you want to attach the bar around and secure the brackets with a bolt and nut in the holes to tighten the bracket to the walker

step 9: attach the brake onto the bar and making sure that both brakes can be activated at the same time without interference

step 10: insert the brake wire with the typing into the brake and attach the loose end of the tube with the zip ties to the area above the handle

step 11: wrap the bare brake wire around the walker's brake and tie a knot very tight

step 12: attach the bar to the bracket and secure it with the longer bolt and wing nut

6.2 Testing & Validation

Brake displacement testing: We tested the brake displacement ratio to how much the brake gets pulled so we would know if the brake would pull the walker brake fully with minimum pull the tests were conclusive and indicated that with medium brake displacement the brake would fully be applied to the walker.



Figure 1

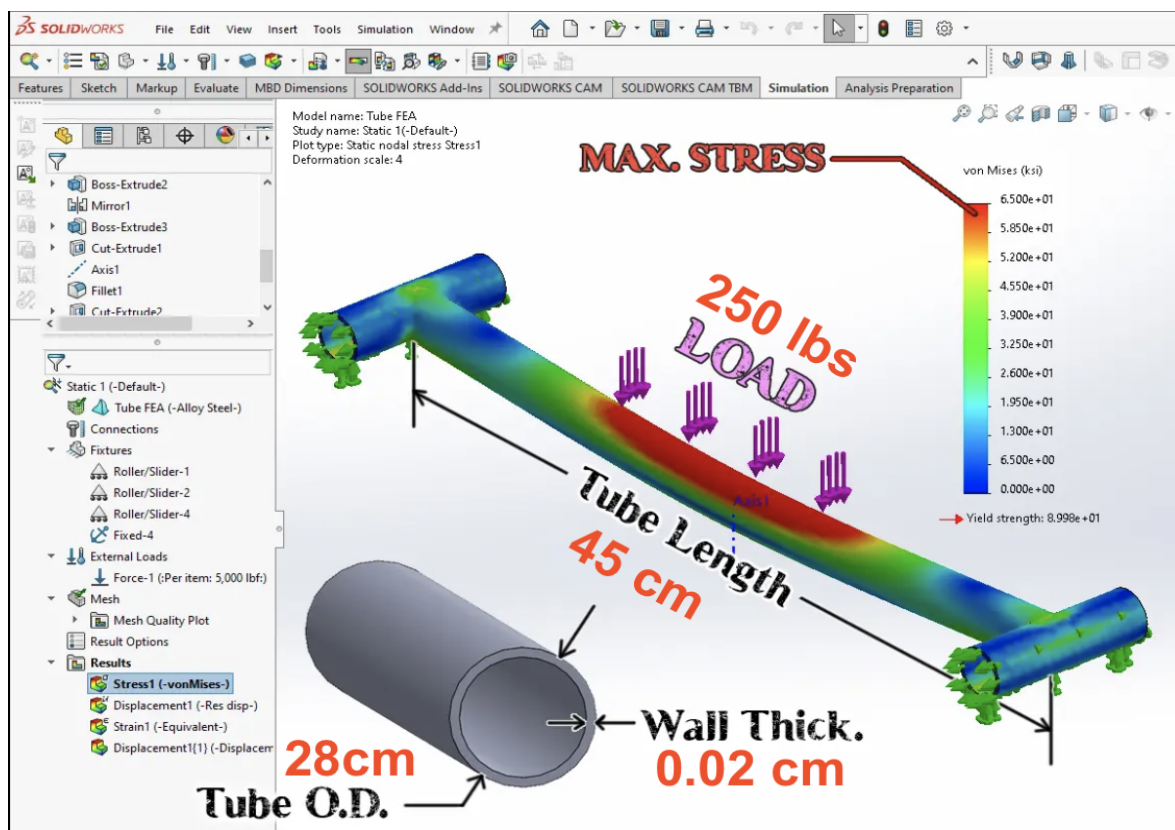
Figure 2



Figure 3

Figure 4

Cross bar testing: we tested the strength of the bar we would use with a weight on the middle of the bar and we found out that the bar would be very sturdy and would hold the weight of the person fully.



Brake testing 2 we redid the testing for a brake displacement again to get values and we used force values to get better data



Metric#	Metric	Measured Specifications	Target Specifications
1	Force required to use device	5.6 N	< 10 N
2	Turning Radius	N/A	< 2 m
3	Rotational Speed	N/A	> 30 deg/s
4	Total Weight	3.1 kg	< 8.5 kg
5	Dimension	0.13 m ³	< 0.55 m ³
6	Reliability	>2500h	> 2500 h
7	Material	Steel, Plastic	Aluminium
8	Time to assemble	15 min	< 20 min
9	Ease of use	Good	N/A
10	Cost	\$30	< \$100

Subsystem compatibility testing: we assembled all the parts and made sure that the systems worked well together and that they would solve our problems.

7 Conclusions and Recommendations for Future Work

This project was a great learning experience and we have worked on a solution for our client through empathizing, benchmarking and design specifications. We also did a business analysis of our product with a 36 month NPV analysis. Possible modifications that could improve our device would be: making it lighter, being able to detach it faster and improve the brakes reliability. If we were allowed more time for our project, we would definitely improve the aesthetic aspect of our project, work on a faster way of detaching our device, improve reliability and find a better way of actuating the brakes. There are all things we had to give up because we didn't have enough time.

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APPENDICES

9 APPENDIX I: Design Files

Table 3. Referenced Documents

Document Name	Document Location and/or URL	Issuance Date
PD-A	https://docs.google.com/document/d/1tnpJ3O8TVBljphWYCFkLji4bqPvgx8m/edit?usp=sharing&ouid=108678463649539841720&rtpof=true&sd=true	SEP/17/2022
PD-B	https://docs.google.com/document/d/1InZMmhbXBUy9M-qX377EqsF-qiC6EDNe/edit?usp=sharing&ouid=105839611378613521083&rtpof=true&sd=true	SEP/25/2022
PD-C	https://docs.google.com/document/d/1JsaRhmgvq0CIY_K4IDwnvWK7Q54gSevlr2w3ujlLCD4/edit?usp=sharing	OCT/02/2022
PD-D	https://docs.google.com/document/d/1FVFTKo3HR3L8jQeZTrADy9-P9QSoTR3y8QRj35l8lxg/edit?usp=sharing	OCT/09/2022
PD-E	https://docs.google.com/presentation/d/1moGk1r5jyAsKsYzqGGB6hb2bn96aqMR_EhDiapeQ80gw/edit?usp=share_link	OCT/19/2022

PD-F	https://docs.google.com/document/d/1GLhchlA1EdSTZrwIIZDdzW83v4-F5DsiH-ubzhQLA5M/edit?usp=sharing	NOV/06/2022
PD-G	https://docs.google.com/document/d/1cZbQIODxzyCY9Jc0OfefeDHAFtlOKbcAmbL6Z-yczCs/edit?usp=share_link	NOV/20/2022
PD-H	https://docs.google.com/presentation/d/1bpxqmHuVoW1iswhENhfXwwm7wB7pX5uUgrDV5C5xE4I/edit?usp=sharing	DIC/01/2022
PD-J	https://docs.google.com/presentation/d/1moGk1r5jyAsKsYzqGGb6hb2bn96aqMR_EhDiapEQ80gw/edit?usp=share_link	DIC/05/2022

Here is the link for the video that summarizes our project & product:

<https://youtu.be/1cqSLTNtBYU>