GNG2101[A]

# Design Project User and Product Manual

CLAMPS

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**Table 1. Acronyms**

| Acronym | Definition |
|---|---|
| UPM | User and Product Manual |
| PWT | Posterior Walker Tray |
| | |
| | |
| | |

**Table 2. Glossary**

| Term | Acronym | Definition |
|---|---|---|
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| | | |
| | | |
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# 1 Introduction

**Purpose, Scope, and Intended Audience:**

- **Purpose:** The User and Product Manual (UPM) aims to guide users on the effective use of the foldable posterior walker table, ensuring a safe and satisfactory experience.
- **Scope of Activities:** The document covers user instructions, maintenance, safety considerations and user education.
- **Intended Audience:** The primary audience includes users of the foldable posterior walker table, caregivers, and healthcare professionals who may recommend or assist in the use of the product.

**Security/Safety or Privacy Considerations:**

- **Safety:** Emphasizes safety precautions and guidelines to prevent accidents, ensuring users understand the importance of stability and proper usage.
- **Privacy:** The document does not involve sensitive personal data. Please reach out to medical professionals for personalized recommendations.

This UPM serves as a comprehensive guide to facilitate the effective use and maintenance of the foldable posterior walker table, promoting user safety, and enhancing the overall user experience.

This UPM provides the information necessary for people to effectively use the foldable posterior walker table and for prototype documentation.

# 2 Overview

## 2.1 Design Purpose and Client Needs

Our foldable posterior walker table stems from us trying to find a solution to the challenges faced by individuals with mobility impairments, particularly those who require walking aids. Conventional walker tables, especially ones for posterior walkers, lack portability and limit the user's ability to navigate different environments easily. This is especially true when being used in confined spaces, making day-to-day activities more challenging for users with mobility issues.

By addressing this problem, our aim is to enhance the overall quality of life for individuals facing mobility challenges. Independence and accessibility are crucial elements for maintaining a sense of autonomy and well-being. By providing a solution that addresses the limitations of traditional walker tables, we aim to empower users to engage more actively in daily tasks and social interactions, thereby fostering a more inclusive and fulfilling lifestyle.

The fundamental needs of our users revolve around achieving a balance between support, functionality, and independence. Our users require walking aids that not only provide stability and support during movement but also facilitate everyday activities such as dining, reading, or using a laptop. The need for adaptability to various environments is also important, considering the diverse settings users navigate in their daily lives.

The fundamental needs can be summarized as follows:

- **Stability and Support:** Users require a walking aid that ensures stability and support to enhance mobility.
- **Functionality:** The ability to perform daily tasks independently is crucial, necessitating features that accommodate various activities.
- **Adaptability:** The walker table is adaptable to different environments, including tight spaces.

What sets our foldable posterior walker table apart is its emphasis on portability, versatility, and user-centric design. Unlike traditional walker tables, our product integrates a foldable mechanism, allowing for easy storage and transportation. This addresses a significant pain point of users who often find it challenging to carry or store their walking aids conveniently.

Key aspects that differentiate our product include:

- **Portability:** The foldable design enables users to easily transport the walker table, promoting independence both at home and outside.
- **Versatility:** Our product goes beyond providing a stable surface; it is designed to accommodate various activities, offering a multipurpose solution for users' daily needs.
- **User-Centric Design:** The entire design is crafted with user comfort and usability in mind, ensuring a seamless experience for individuals with diverse mobility requirements.
-

By combining these elements, our foldable posterior walker table not only addresses the existing problem but redefines the user experience, contributing to a more active and empowered lifestyle for individuals with mobility impairments.

## 2.2 Design Overview

The posterior walker tray design that was produced can be seen in Figure 1:

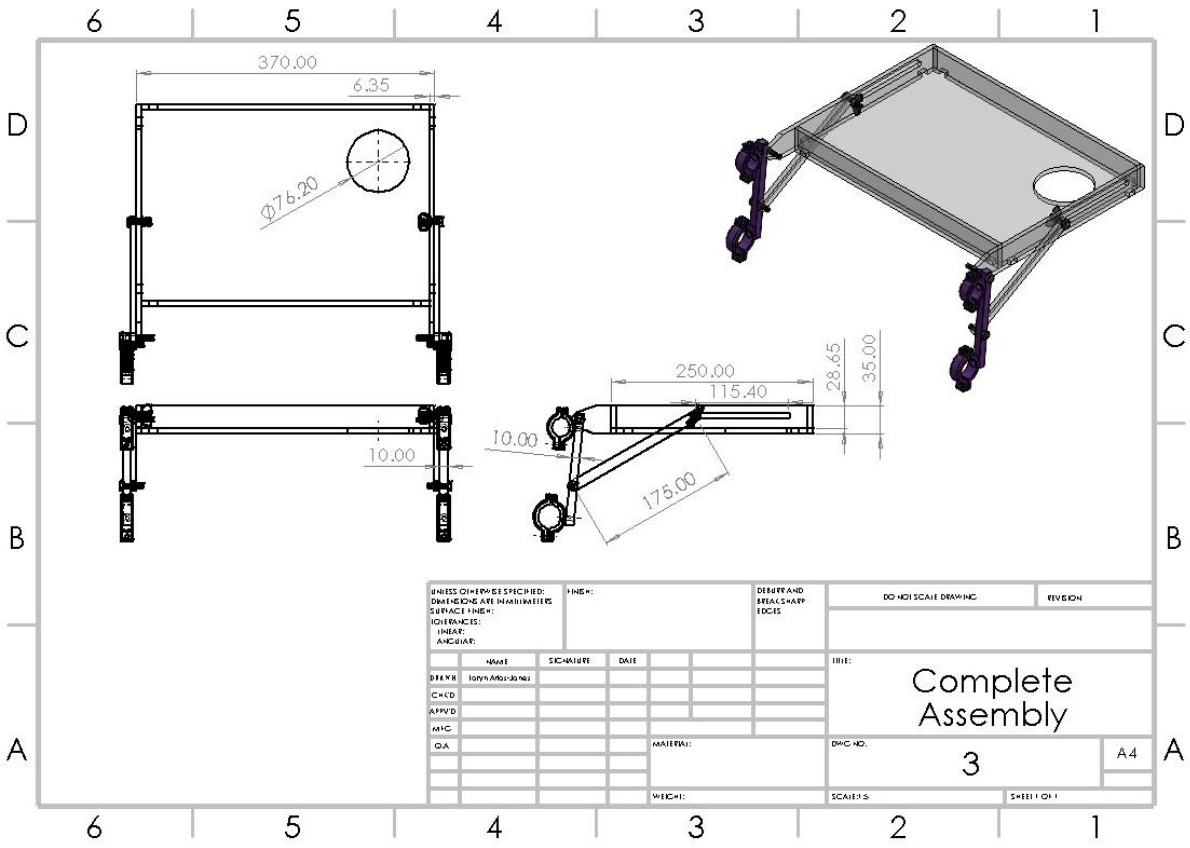


**Figure 1. Posterior Walker Tray Assembly**

As shown, the assembly consists of three critical subsystems: the tray, the lateral supports, and the clamps. The tray is where food and light items can be placed when the assembly is in its upright position. This component was constructed using acrylic due to its high strength, durability, and pleasing appearance. It has walls around its perimeter to prevent items from sliding off, and a cupholder added to a diameter which fits a standardized cup. Within the walls on the tray's sides are slits, in which a wing screw connects the tray to sliding supports, also made of acrylic. These

sliders extend to the clamps, which secure tightly around the horizontal beams of the posterior walker. The wing screws function as a tightening mechanism, allowing the position of the slider to be adjusted. In this manner, when the wing screws are loosened, the sliders can be moved to position the tray in either its upright or stowed position. When in its upright position, the tray is perfectly level with the ground. This is when the tray is prepared to support light items of up to 5 pounds of force. When the sliders are moved to position the tray in its stowed position, the tray becomes nearly vertical, minimizing its protruding distance from the walker and making it easier for the walker to maneuver. Figure 2 depicts an exploded view of the entire assembly with every component labelled:

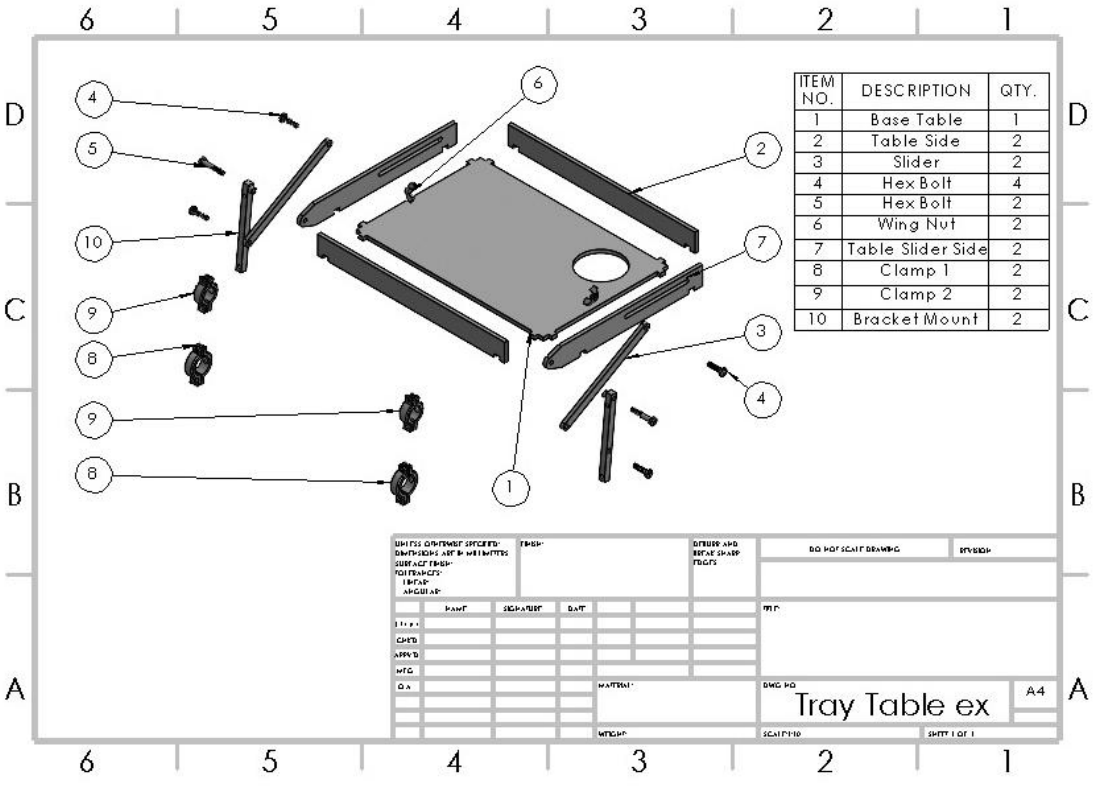


**Figure 2. Posterior Walker Tray Exploded View**

A critical component of the design is the clamp subsystem. There are two sizes of clamps used in this design which are intended to securely fit around the two different-sized horizontal beams of the posterior walker. Figure 3 and Figure 4 depict the dimensions and structure of the two sizes of clamps:

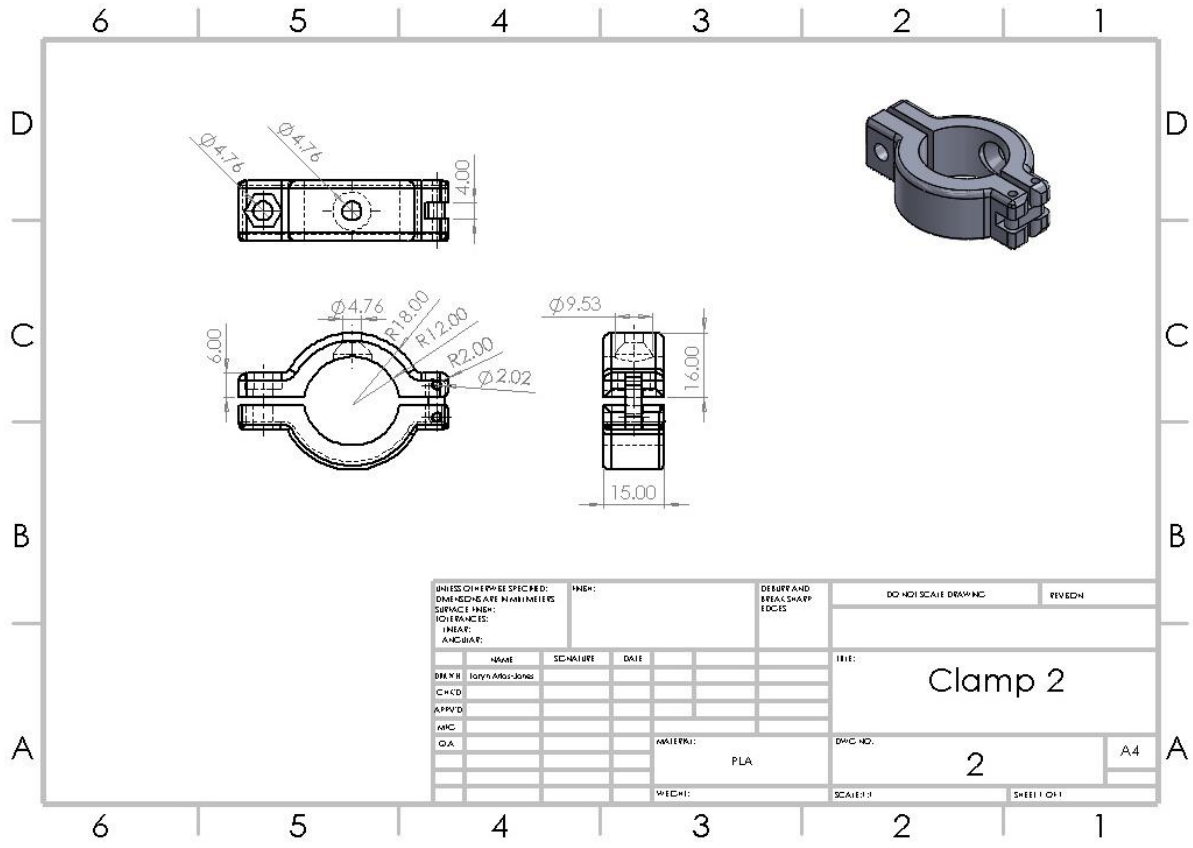


**Figure 3. Small Clamp Subsystem Assembly**

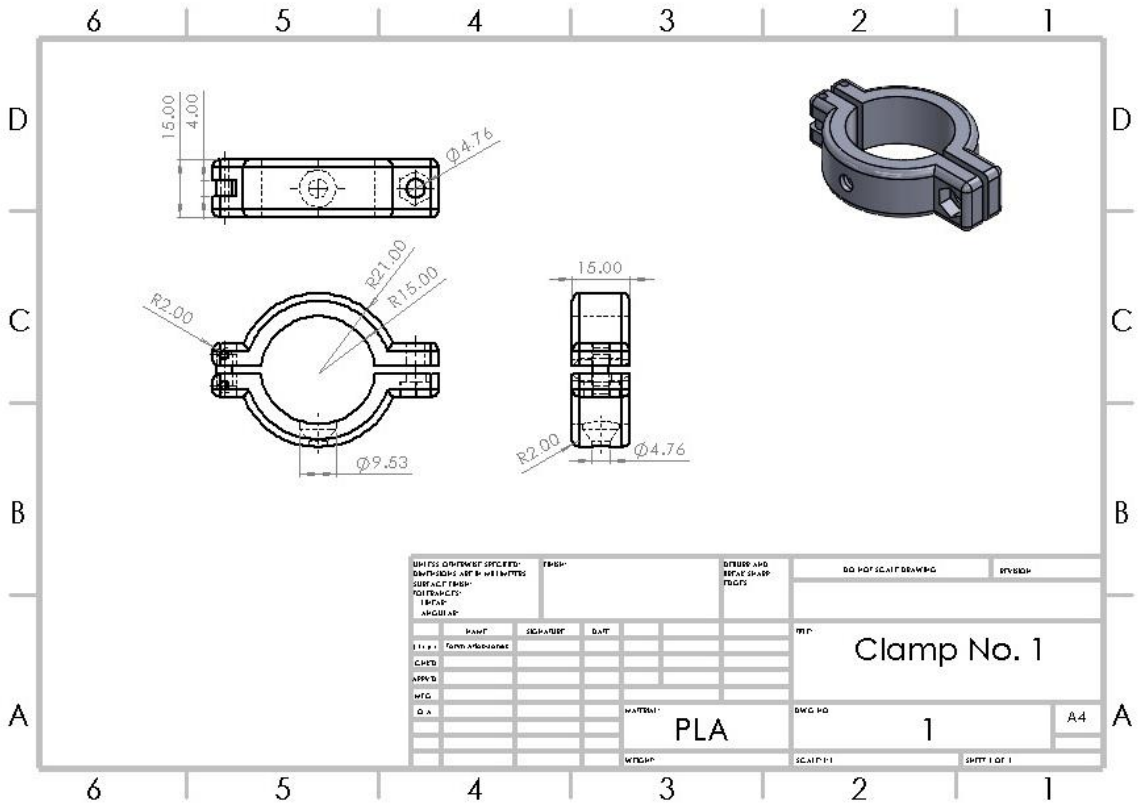


**Figure 4. Large Clamp Subsystem Assembly**

The clamps consist of six different elements: a hex nut, a bolt, two dowels, a pivot, the top of the clamp, and the bottom of the clamp. The top of the clamp, bottom of the clamp, and pivot are all 3d printed. Aluminum dowels connect the two sides of the clamp to a pivot around which the clamp opens and closes. In the top of the clamp is a indent in which a hex nut rests, and through the bottom side of the clamp is a hole for a bolt. When the bolt is slid through this holt, it can tighten into the nut of the other side of the clamp, securing the clamp tightly shut. The bolt can then be untightened to re-open the clamp. The hole in the clamp in which the bolt rests was tolerance to ensure the bolt does not fall out when the clamp is opened.

Finally, an additional component of the design can be seen in Figure 5. This component is a cover which rests over the top of the tray. The cover is made of non-slip material, stopping items from sliding around when placed on the tray. In addition, it can be easily removed, allowing for the cover to be easily cleaned in the event of a spilled drink. Instead of fully disassembling the tray to clean a spill; instead, the cover can be simply removed, washed in a sink, then dried and placed back atop the tray.

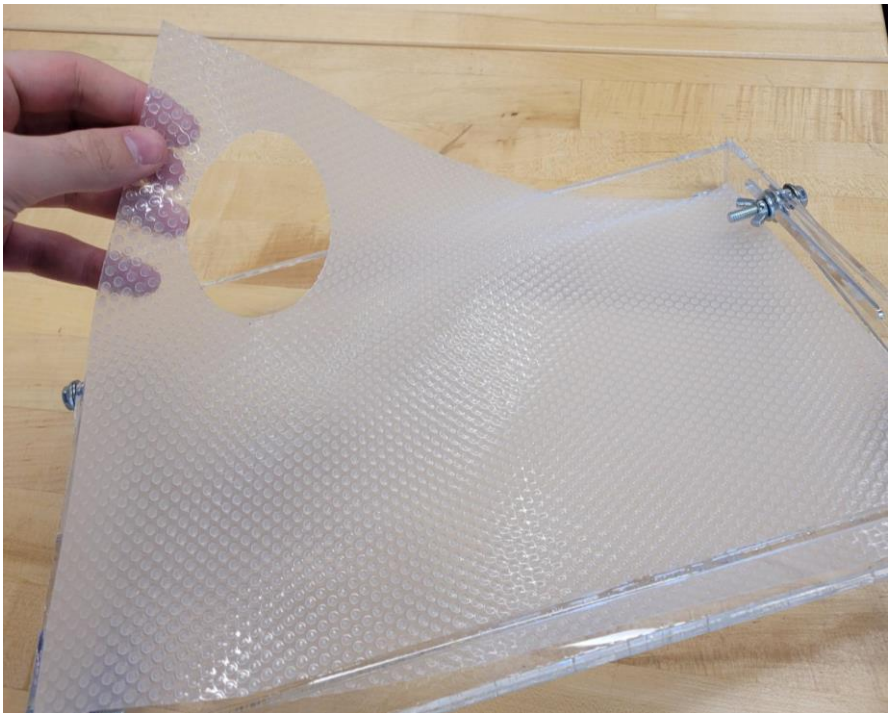

**Figure 5. Removable Tray Cover**

## 2.3 Cautions & Warnings

- This product is just a prototype and may not be as durable as products that can be found on the market.

- The table is only designed to support a load of 5 lbs, putting more than 5 lbs of load onto the table can cause the tray to experience catastrophic failure.
- All the bolts should be examined before use to ensure they are properly tightened to reduce the risk of the tray breaking or causing injury to the user.
- The tray must be handled with care especially folding and unfolding it to avoid it falling and injuring the user.

# 3 Getting started

There are three subsystems in the tray table set up. These sub-systems are clamping system, slider or folding system, and the tray system. The clamp system is the system most important in the set up of the try. The clamps attach the table to the posterior walker's horizontal bars. They consist of two clamps of different sizes attached to a beam on each side of the tray table. The clamps close around the horizontal bars on the walker. They then tighten onto the walker with an M5 hex bolts, these components can be tightened by hand, but it is better to tighten with a wrench or screwdriver. There are many wrench options that could be used to tighten these bolts. If using an open or a box wrench seen in Figure 6 (wrench 2-4 from the left) ensure the wrench is the correct size to fit an m5 bolt. A crescent (adjustable) wrench (Figure 6 first wrench on the left) is also a great option for this as it can be used on the clamps especially because it can also be used to tighten any other bolts on the design. One of the four M5 bolts is a thumb screw, this should not be tightened using a wrench and should instead be tightened using an Allen key which can be seen in Figure 6 furthest to the right.

**Figure 6. Types of wrenches [1]**

Once the clamps are properly secured to the table the table can be used. The table many need to be put into the upright position before use. If this is necessary instructions on putting the table in the upright position can be found in section 5.1 Raising the Tray.

## 3.1 Configuration Considerations

The configuration of the table tray can be seen in Figure 7 below. The tray table attaches to the top two horizontal bars at the back of the walker. The upper smaller clamps attach to the highest bar and the lower smaller clamps attach to the lower of the two bars. Figure 7 depicts the tray table in the upright position, when the tray is folded down it will rest on the lower horizontal bar.

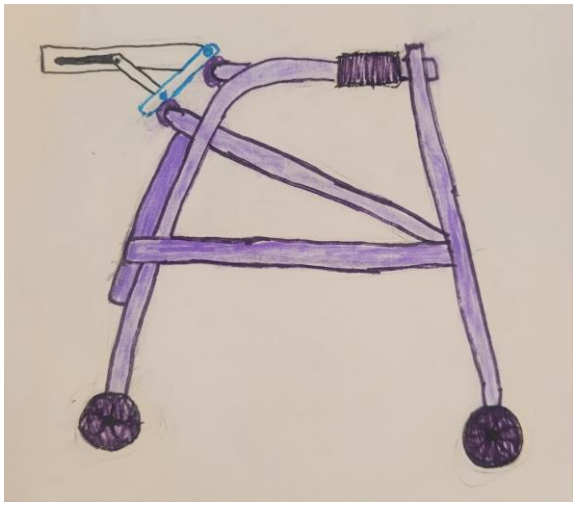

**Figure 7. Configuration of Tray Table**

## 3.2 User Access Considerations

The users that are likely to use this prototype are people with neuro muscular disorders or any other mobility impairment that causes them to require the use of a posterior walker. This table is

designed to attach to a posterior walker and allow the user to have more independence. Different users may have different motor abilities. This may mean that some users do not have the mobility to be able to manipulate the tray in and out of the upright position unassisted. Users may also not be able to turn around to the back of the walker to place objects on the tray table or remove them from the tray. Because of this the tray designed may not be an adequate solution for some user's mobility needs.

In considering user access for the foldable posterior walker table prototype, it's essential to recognize the diverse needs of potential users and address any specific restrictions to ensure inclusivity and usability. Here's a breakdown of different user groups and the associated considerations:

# 4 Primary User Group - Individuals with Mobility Impairments:

- **Description:** Individuals with varying degrees of mobility impairments, such as seniors with reduced stability or people with conditions affecting their ability to walk comfortably.
    - **Considerations:**
        - Fine motor skills are needed to manipulate the wing nuts.
        - Tools are needed to set up the product to the walker.

## 4.1 Accessing/setting up the System

When assembling the posterior walker table, delicately unfasten the thumbscrews that secure the clamps together. Afterwards, carefully clamp the clamps of the table onto the posterior

walker, ensuring a snug fit, and proceed to tighten the thumbscrews securely. Upon successfully clamping the table into place, proceed to the next step by unfastening the wing nuts situated on either side of the table. Next, raise the table using one hand until it is level with the ground. The final touch in the setup process require the user to tighten the wing nuts located on the inner side of the table when the product is raised level. This ensures a robust and secure configuration, preventing any unwanted movement or instability during usage. The careful execution of this step contributes to the overall structural integrity of the set up posterior walker table. With each step completed, the posterior walker table is now fully assembled and ready for use.

## 4.2 System Organization & Navigation

The small wing nuts embedded within the inner portion of the posterior walker table serve as pivotal elements in its configuration, acting as the linchpin in the secure placement of the table during both utilization and storage phases. These diminutive components, while amenable to manual manipulation, are best managed with the assistance of a wrench applied to the hex side of the bolt. This added mechanical advantage becomes indispensable when faced with the exigency of loosening wing nuts that have become excessively tightened, providing a seamless means to disengage and facilitate the subsequent disassembly or repositioning of the posterior walker table. The product's inherent design intricacies come to the forefront when contemplating its optimal orientation during usage with a walker versus its prescribed position for storage. The downward orientation during active use ensures ergonomic compatibility with the walker, while the need for unscrewing during storage accentuates the dynamic adaptability of the product. The significance of selecting a storage position that upholds the structural integrity of the item cannot be overstated,

emphasizing the importance of thoughtful consideration in navigating the transition from utilization to stowage. Critical to the table's stability is the clamping mechanism, a multifaceted apparatus that demands particular attention during the stowage process. Beyond merely ensuring that the clamping mechanism remains free from compromise, the meticulous positioning of the product becomes a strategic imperative. By safeguarding the clamping components from potential breakage and insulating them against inadvertent external forces, users fortify the very core of the product's functional prowess, creating a robust defense against any compromise to its integrity. Each screw constituting the securing apparatus emerges as a linchpin in the structural fortification of the posterior walker table. The imperative to diligently tighten each screw during the stowage ritual is rooted in the overarching commitment to resist any external forces that might assail the product's stability. This conscientious effort to buttress the table against the unforeseen and fortuitous variables of its environment stands testament to the dedication to long-term durability and steadfast functionality. As the product is poised for stowage, an additional layer of precaution pertains to the elimination of loose components. This meticulous scrutiny and rectification of any elements susceptible to detachment during the stowage process serve as a preemptive measure against inadvertent breakage or damage, underscoring the holistic approach to safeguarding the product's overall structural integrity. Acknowledging the clamp as a potential Achilles' heel within the product's structural ensemble, handling this mechanism with the utmost care becomes an overarching imperative. The intricacies of the clamp, with its myriad moving parts, underscore the necessity for precision and caution in its manipulation. By exercising due diligence in navigating the complexities of the clamp, users actively contribute to the sustained durability and reliable functionality of the posterior walker table.

## 4.3 Exiting the System

To stow the posterior walker table, locate the wing nuts that are secure in position. Unscrew the wing nuts and return the tray to its stowed position. Next, use a screwdriver to untighten the clamps by turning their bolts counter-clockwise. When all four clamps are loosened, remove the tray system from the walker. When storing the walker, it is recommended to slightly re-tighten the clamps. This will prevent bolts from falling out during storage, ensuring that every component is readily available the next time the tray is used. In addition, the tray should be stored gently and without other items stacked on top of it to prevent damage and undue stresses. This involves positioning the item in such a way that shields the clamping mechanism from potential breakage, ensuring that the clamps remain safeguarded against any unintentional damage that might jeopardize the table's functionality. Adhering to these guidelines ensures the long lifetime of the tray table.

**Figure 8. Clamping mechanism**

**Figure 9. Wing nuts and bolts**

# 5 Using the System

The following sub-sections provide detailed, step-by-step instructions on how to use the various functions or features of the posterior walker tray.

## 5.1 Raising the Tray

To raise the tray into its upright position, stand in front of the tray. When in position, the first step is to ensure that the thumbscrews are loosened. To do this, turn the screws in a counterclockwise manner until there is no resistance and the tray can swing freely. Next, use one hand to lift the tray until it is perfectly horizontal and level. At this point, use your other hand to tighten the two thumbscrews by turning them in a clockwise direction. Do this until the screws are adequately tightened. At this point, low-weight items can safely be placed on top of the tray. Figure 10 depicts the manner in which the thumbscrews can be tightened.

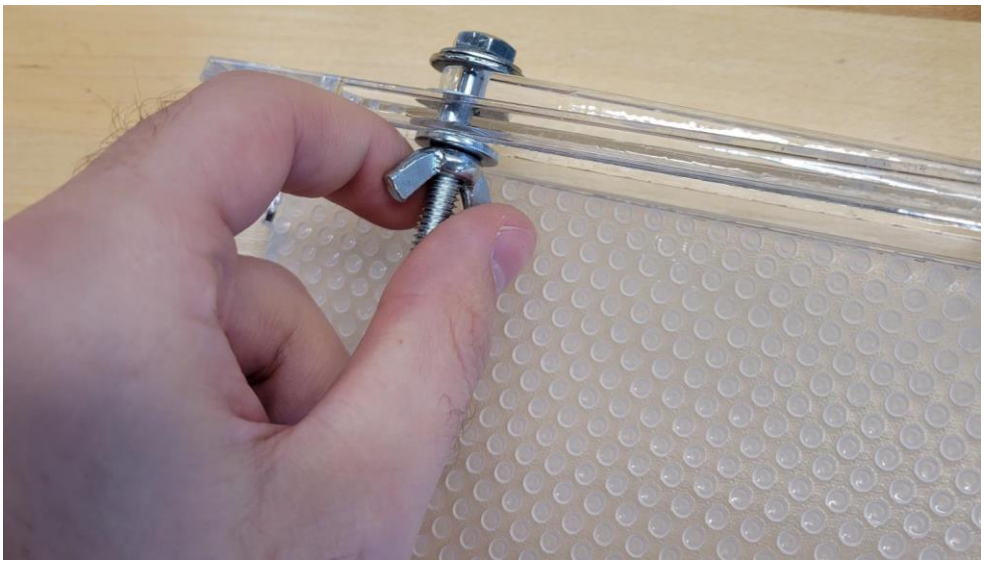

**Figure 10. Tightening the Thumbscrews**

## 5.2 Lowering the Tray

To lower the tray into its stowed position, first remove all items from the top of the tray. When the tray is clear, use one hand to turn the two thumbscrews in a counterclockwise manner to loosen them until there is no resistance to their turning. At this point, the tray will naturally fall into its stowed position.

## 5.3 Attaching the Tray

To attach the tray to the walker, first loosen the bolts of each of the four clamps until each clamp can open freely. Next, position the tray over the horizontal bars on the rear of the posterior walker, with the clamps positioned to secure to the crossbars of the walker. At this point, tighten the screws on each of the four clamps until they are securely attached to the walker. It is advised

that a wrench is used to make sure the table is attached securely. Figure 11 depicts the manner in which the clamps can be opened and closed.

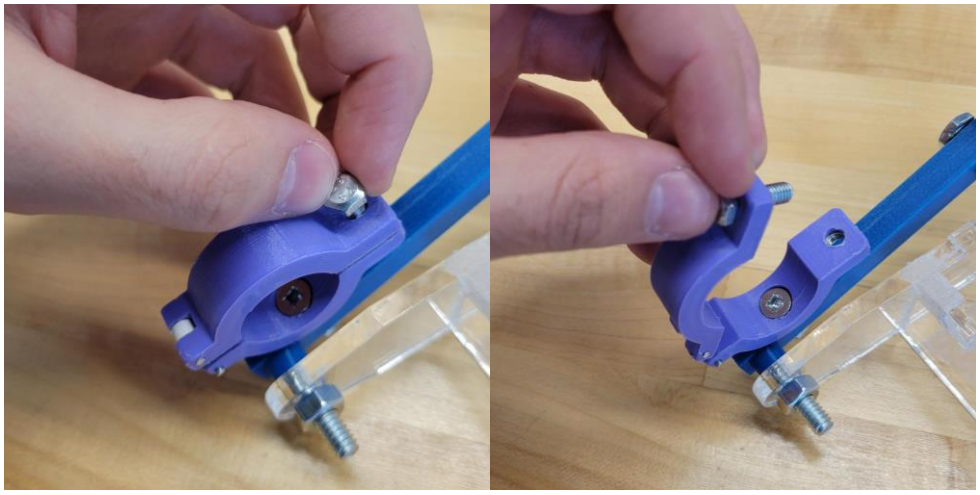

**Figure 11. Opening and Closing the Clamps**

# 6 Troubleshooting & Support

## 6.1 Error Messages or Behaviors

**Troubleshooting & Support:**

In this section, we'll outline the recovery and error correction procedures for the foldable posterior walker table prototype. The goal is to provide clear and straightforward instructions that can be easily followed by users, including those who may not have an engineering background.

## Error Messages or Behaviors:

- Issue 1: Difficulty in Folding/Unfolding the Walker Table:
    - **Probable Cause:** Obstruction in the folding mechanism.
    - Corrective Actions:
        - Ensure the area around the folding mechanism is clear of any obstacles.
        - Verify that the wing nuts are fully loosened before attempting to fold or unfold.
- Issue 2: Uneven Height Adjustment:
    - **Probable Cause:** Uneven adjustment of the height settings.
    - Corrective Actions:
        - Double-check that the sliders are free from obstruction and are set to the same position on both sides.
        - If the issue persists, inspect for any damage or misalignment in the slider mechanism.

- Issue 3: Instability During Use:
    - **Probable Cause:** Uneven weight distribution or loose components.
    - Corrective Actions:
        - Ensure that items placed on the table are evenly distributed.
        - Check for loose screws or connections and tighten as needed

## 6.2 Special Considerations

- Consideration 1: Limited Mobility or Dexterity:
- **Issue:** Users with limited mobility may find it challenging to operate certain features.
- Corrective Actions:
    - Get help from a caregiver when attaching the table to the walker.

## 6.3 Maintenance

The bolts in the system are prone to loosening so it is important to regularly check up on them to ensure they are properly tightened. The bolts that hold the tray to the bracket side, and the ones that attach the slider to the beams should be tightened the most regularly. These can be tightened by hand or with a wrench. Keep in mind that as these bolts are used as pivot points tightening them further may add more resistance to the table when folding and unfolding the table.

Each of the four clamps are attached to the support beam with 3/16in bolts. These may require tightening from time to time if they become loose. To do this a wrench of the correct size should be used to stabilize the nut at the back of the support beam and a Robertson (square

shaped) screwdriver should be used on the inside of the clamp to turn the bolt and subsequently tighten it into place. This process can be seen in Figure 12.

**Figure 12. Tightening the Clamp to the Support Beam**

Because this tray table is designed to be used in the kitchen it will be prone to getting dirty. The entire tray table is washable as it is made of plastic and metal, however if washed it is important that it is fully dried after to avoid any rusting of the metal components. For day-to-day cleaning, the nonslip tray insert should be removed and washed. The nonslip tray insert can also be wiped down to keep it clean using all-purpose cleaning spray and a cloth.

## 6.4 Support

**Support and Emergency Assistance:**

In the event that users encounter issues requiring emergency assistance or general system support, the following information outlines the available avenues for help.

**Product Support:**

- **Contact Person:** Centre for Entrepreneurship and Engineering Design (CEED), University of Ottawa
- **Email Address:** ceed@uottawa.ca
- **Phone Number:** 613-562-5800

**Emergency Assistance:**

- For urgent matters requiring immediate attention, please contact your local emergency number for a rapid resolution.

# 7 Product Documentation

## 7.1 Final Prototype Construction

### 7.1.1 BOM (Bill of Materials)

**Table 3: Bill of Materials for Product**

| Item | Material | Qt. | Size | Price ($ CAD) |
|---|---|---|---|---|
| ¼ in hex bolt | Steel | 2 | ¼ x 1½ in | $0.98 |
| M5 Hex bolt | Steel | 4 | M5-0.8x16 mm | $1.52 |
| Flat Head Square Drive Stove Bolt with Nut | Steel | 16 | 3/16 x 3/4 in | $3.97 |
| ¼ in wing nut | Steel | 2 | ¼ in | $1.38 |
| ¼ in hex nut and bolt | Steel | 4 | ¼ in | $2.29 |
| M5 hex nut | Steel | 4 | M5-0.8 mm | $1.60 |
| Dowels | Steel | 10 | 2 mm | $10.69 |
| Acrylic board | Acrylic | 1 | ½ x 18 x24 in | $37.00 |
| Shelf liner | Plastic | 1 | 12 in x 10 ft | $9.99 |
| Adhesive | - | 1 | 59mL | $8.87 |
| 3-D printing Filament | PLA | 1 | 1.75 mm - 1 kg | $31.99 |
| **Total (with tax)** | | **$125.98** | | |

### 7.1.2 Equipment list

There were multiple tools used to construct the prototype:

- 3D Printer
- Laser Cutter
- SolidWorks
- Scissors
- Wrench
- Allen key
- Screwdrivers
- Pliers
- Drill bit
- Vice clamp
- Hacksaw
- Round file
- Sandpaper
- Masking tape
- Mallet
- Dry erase marker
- Computer

### 7.1.3 Instructions

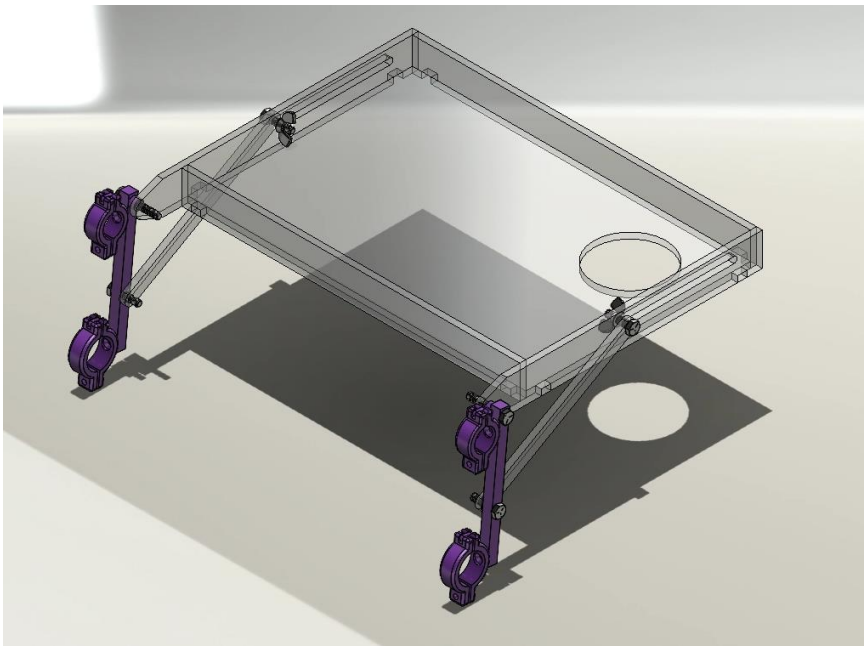

**Figure 13. Final Assembly**

I. Clamps Sub-system

1. Get the CAD files for the Clamps, Pivots, Side Beams
2. Open a 3D printing software such as Ultimaker Cura and prepare the parts for printing.
    a. Configure software to match with your 3-D printer model and set nozzle size, setting used can be seen in Figure 14.
    b. These parts will print best on a printer with a 0.4mm nozzle (however a 0.25mm nozzle will also work but will take much longer). The Ultimaker Cura settings needed can be seen in Figure 14.

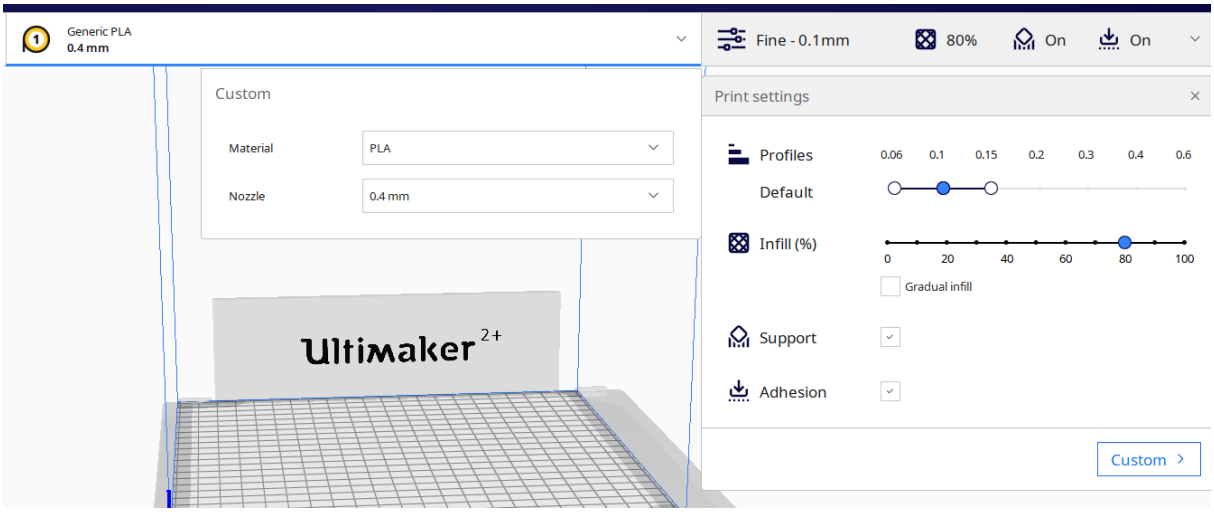


**Figure 14. Ultimaker Cura Setup**

c. Place both sides of 2 large clamps, both sides of 2 small clamps, 4 bracket pivots, and 2 side beams into the Ultimaker Cura software (these can be printed separately depending on printer size and time constraints)

d. Take an SD card, click slice, and upload the print model from Ultimaker Cura

e. Put SD card in printer and begin the printing process.

3. When the print is complete, remove the pieces from the printer.

**Figure 15. Bracket After Print with Supports Still Attached**

4. Remove excess supports from parts using plyers and sandpaper.
5. Holes in the parts can be drilled out using a drill bit or pushed through using an awl. The holes that bolts go through should be further filled using a cylindrical file until they fit the bolts adequately.
6. Cut 2mm steel dowels cut into 15mm pieces and sand down ends to remove sharp corners using high grit sandpaper.
7. The brackets can now be assembled. The bracket pivot should sit within the slot of one bracket side, lining up the hole from the pivot with the holes on either side of the bracket.
8. Insert the 15mm x 2mm steel dowels into the hole holding the pivot in place. A mallet can carefully be used in this step.
9. Now repeat this on the other side of the bracket. The pivot side should be configured like Figure 16.

**Figure 16. Pivot configuration**

10. Repeat steps 8-10 on the other 3 brackets.
11. Using epoxy attach the M5 nut into the hexagonal cutout on the one side of the brackets, being carful not to get epoxy on the inside threads of the nut.
12. Attach the bracket to the bracket side beams, with smaller brackets being on the top with the cylinder jut out and larger brackets being on the far side. Brackets should be attached using the flat head 3/16 in bolts. They can be attached by supporting the nut on the one side with a wrench and turning the bolt using a Robertson (square head) screwdriver as seen in Figure 17.

**Figure 17. Attaching the Bracket to the Bracket Side**

13. The bracket subsystem is now assembled, make sure to wait 72hrs for the epoxy on the nut to dry before testing out the clamp.

II. Tray sub-system

14. Get the CAD Model for the Tray and the sliders
15. Download the files as .DXF file type.
16. Acquire ¼ ” x 18” x 24” acrylic board
17. Open a laser-cutting software such as Inkscape and import the .DXF files
18. Open document properties and set file size to 18” x 24”
19. Organize the shapes to fit onto boards size within Inkscape (the tray base, 2 non-slider sides, 2 slider sides, and the 2 sliders)
20. Double check dimensions of the tray components to match model.

21. Set line size to 0.001 in
22. Save as a pdf
23. Set to print on laser cutter setting speed and frequency to correct level for your laser cutter and the given material.
24. Take the sides of the table and glue them to the base, tape the pieces in place to hold the pieces together for 72 hrs until the glue cures. Making sure to leave gaps in the tape to allow the glue to cure properly.

III. Assembly

25. Once all the glued components have been given the appropriate amount of time to cure assembly can begin.
26. Roll out the non-slip shelf liner and trace the table onto it using a dry erase maker.
27. Cut out the tray liner and erase the dry erase marker.
28. Start assembly by attaching the bracket side beam to the tray table. One of the ¼ inch bolts can be used to do this with a ¼ inch bolt. The bracket side should be attached cylinder extrusion to the pivoting side of the table.
29. Next the slider can be attached to the lower side of the bracket side using another ¼ in bolt and nut. The slider should sit between the bracket side and the table.
30. The other side slider can then be pulled up to the slider slot on the side of the table. Another ¼ in bolt can be used to hold this in place and a wing nut can be attached to the other side. Washers should be put between the bolt and slider between the slider and table side and table side and wing nut.

31. Repeat steps 29-31 on the other side of the tray.

32. Insert the tray liner into the tray lining up the cupholder whole with the one on the liner.

33. The table is now build it should look like Figure 13.

## 7.2 Testing & Validation

**Figure 18: First Prototype**

Multiple tests were conducted on the prototypes to validate the final design. Prototyping started with prototype 1, which was a scale miniature model of the tray support subsystem shown in Figure 18. The primary purpose of this prototype was to evaluate the folding mechanism of the supports. Multiple parameters were measured to do this. First, the difference in angle of the tray when in its stowed position versus in its upright position was measured. Ideally, the upright position should have the tray at 0° relative to the ground to prevent objects from rolling around on its surface. Similarly, the stowed position would ideally be nearly vertical at 90° relative to the ground, to maximize its ability to fold out of the way. Through our testing of this prototype, it was determined that the tray can fold 80° vertical when folded, and is perfectly level when upright. An

additional metric evaluated by this prototype was its ability to support a weight. A 1 kg weight was applied to the tray while in its upright position, and the tray did not buckle or fold. Given that the prototype is only constructed of cardboard, this was an effective prove of the designs ability to support weight. Finally, the ease of movement of the supports and the lateral sway of the design were also tested and found to be satisfactory. Table 4 depicts the overall performance of the first prototype.

**Table 4. Decision Matrix to Evaluate First Prototype**

| Priority | Metric | Target Specification | Prototype 1 Tested Value | Score |
|---|---|---|---|---|
| 3 | Length, width, and thickness | 400 x 300 x 40 – 600 x 450 x 50 | 220 x 180 x 60 mm | 1 |
| 4 | Weight of the product | < 1 kg | < 0.1 kg | 5 |
| 5 | Weight capacity | > 2 kg | 1 kg | 2 |
| 2 | Has cupholder | Yes | Theoretically | 3 |
| 4 | Height of lip | 10 mm | 30 mm | 5 |
| 5 | Length product extends out from the walker in stowed position | 100 mm | 100 mm | 5 |

| | | | | |
|---|---|---|---|---|
| 5 | Length Product extends out from the walker in upright position | 300 mm | 180 mm | 5 |
| 3 | Angle range | 80° | 80° | 5 |
| 3 | Ease of movement | 5/5 | 4/5 | 4 |
| 5 | Lateral stability | 4/5 | 3/5 | 4 |
| 3 | Cost. | <$100 | $0 | 5 |
| | **Total** | | | **171** |

The second prototype tested was to-scale 3d-printed early versions of the clamp designs. These prototypes can be seen in Figure 19.

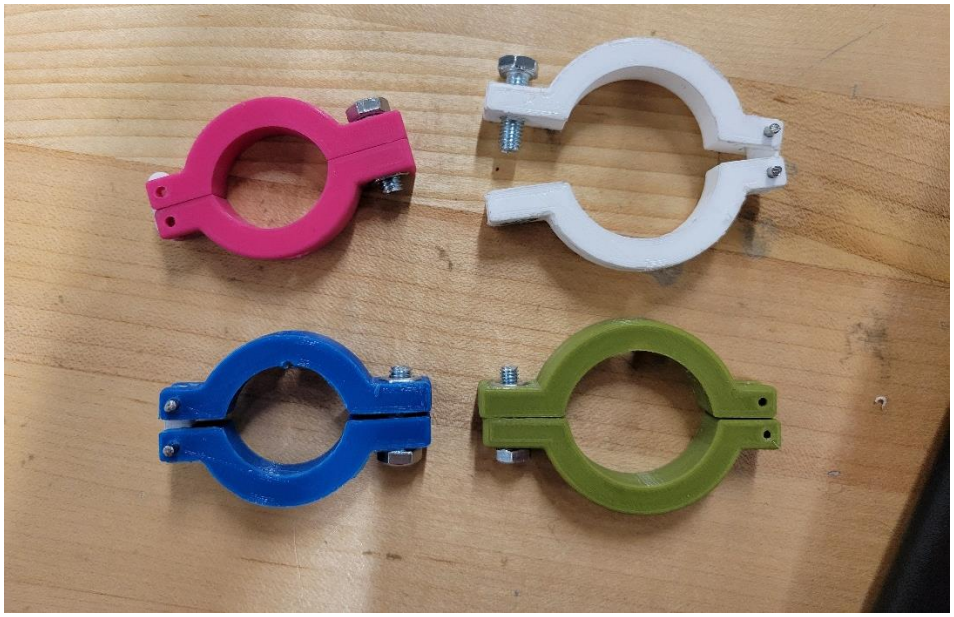

**Figure 19. Clamp Subsystem Prototypes**

The main purpose of these prototypes was to test how effectively the clamps can attach to the lateral beams of the posterior walker. To evaluate this, the clamps were tightened around metal beams of similar diameter to the posterior walker, and a lateral force was applied to determine how much force would be required to move them laterally along the beams. This parameter could only be tested qualitatively due to the lack of a force gauge. From this testing, it was found that the clamps are an effective means of securing the walker to the tray, with a high force being required to move them laterally. In addition, the clamps were easy to operate, further validating the efficacy of their design. Table 5 depicts the entire results of testing the second prototypes.

**Table 5. Decision Matrix to Evaluate Second Prototype**

| Priority | Metric | Target Specification | Prototype 2 Tested Value | Score |
|---|---|---|---|---|
| 3 | Lateral Force required to Slide Clamp along Beam | 5/5 | 3/5 | 3 |
| 5 | Ease of use in tightening thumb screw | 4/5 | 3/5 | 3 |
| 3 | Ease of clamp opening and closing | 5/5 | 5/5 | 5 |
| | **Total** | | | **11/15** |

Having tested all of the critical subsystems at this point, we could then begin to test the overall design. To do this, we started by constructing a to-scale MDF version of the design. This prototype can be seen in Figure 20.

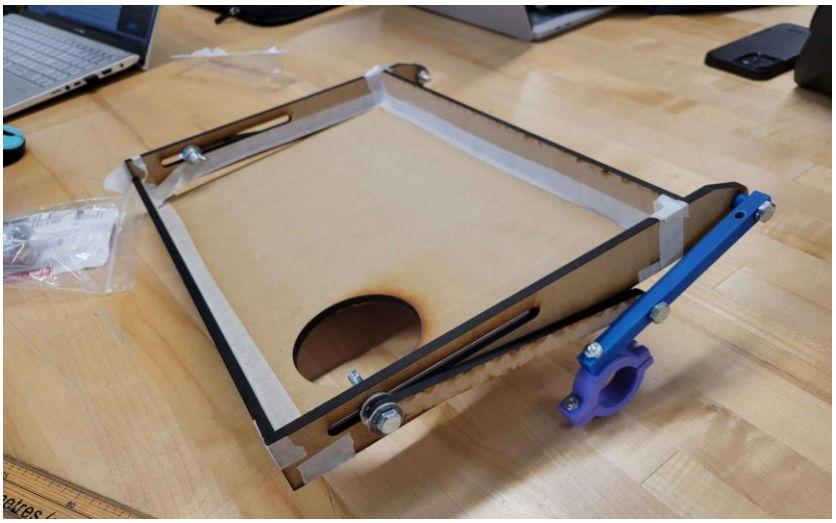

**Figure 20. MDF Prototype of Final Design**

This prototype allowed us to evaluate the efficacy of the entire solution. Multiple elements of this design were tested. First, the ease of use of the clamps was evaluated while they were attached to the tray. All testers found them to be easy to operate; however, it was discovered that the use of a screwdriver or wrench was needed in order to obtain satisfactory tightness around the lateral poles of the walker. Next, the simplicity and effectiveness of the slider design was evaluated. From this, it was discovered that thumb screws were a great solution, with strong tightness being produced without the use of wrenches or screwdrivers. In addition, a 5-pound load was applied to the tray while in its upright position, and the design had no difficulty supporting the weight. Overall, this prototype proved the design to be a promising and effective solution.

# 8 Conclusions and Recommendations for Future Work

There are multiple manners in which the prototype could be improved. To start, grooves could be added to the slots in the side of the tray to increase the stability of the tray in its upright position. The current design relies entirely on the friction of the tightened thumb screws to secure the tray and prevent it from falling back to its stowed position. If grooves were added, as shown in Figure 21, then the tray would be unable to fall back to its stowed position without a user manually lifting the sliders out of the grooves. In this manner, the thumbscrews may possibly be able to be removed, increasing the ease of use of the design. However, testing should be done to ensure that this design is adequately stable before removing the thumbscrews. Potentially, both the thumbscrews and slider slot grooves could be added, further increasing the stability of the design, and providing redundancy in case the grooves or thumbscrews fail.

**Figure 21: Improved Slider Slot Design**

Another method in which the posterior walker tray design could be improved would be to add screw caps to the bolts in the clamps. Figure 22 depicts potential designs of these screw caps. They function by increasing the diameter of the cap of the screw, giving one increased leverage when tightening the screws by hand. In this manner, they would enable the tightening of the clamps without the assistance of a screwdriver or wrench. These parts could be 3d-printed, and existing standardized designs exist on TinkerCAD which can be easily 3d-printed and added to

the screws. This addition would allow the client's daughter to attach and detach the tray without assistance, increasing her independence when using the tray.

**Figure 22: Example Screw Caps [2]**

# 9 Bibliography

[1] SkillCat Team, “All about Wrenches,” SkillCat. [Online]. Available: https://www.skillcatapp.com/post/all-about-wrenches

[2] 3dprintingworld, “Screw Caps,” Thangs. [Online]. Available: https://thangs.com/designer/3dprintingworld/3d-model/Screw%20Caps-214709

# APPENDICES

# 10 APPENDIX I: Design Files

**Table 6. Referenced Documents**

| Document Name | Document Location and/or URL | Issuance Date |
|---|---|---|
| Table Tray - GNG2101 - Team 4.2.zip | Maker Repo | December 6, 2023 |
| Walker Table Instructional Video | https://www.youtube.com/watch?v=4HMviR72QSg&ab_channel=AkhilChawathe | December 5, 2023 |
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