GNG2101

Design Project User and Product Manual

The Rack

Submitted by:

The Rack – Team C3.1

Essraa Alqassab, 300094423

Sheetal Harakh, 300123274

Borel Sikadi, 300088224

Midas Chin, 300066761

Shuyuan Bai, 300023989

April 10, 2022

University of Ottawa

Table of Contents

List of Figures

List of Tables

List of Acronyms

Table 1. Acronyms

Acronym	Definition
UPM	User and Product Manual

1. Introduction

This User and Product Manual (UPM) provides the information necessary for mobility impaired individuals and volunteers to effectively use the Collapsible Clothes Rack and for prototype documentation.

The purpose of this document is to inform the clients and technicians about our product. Our product was developed to make the rack accessible to the disabled people and easy to use by volunteers. It has durable casters with locks that make it easy to move outdoors. A feature of our clothes rack is that there are two racks of different heights, which means that the disabled people can easily use the lower rack, while the higher rack can accommodate long clothes. Also, a shelf can store sundries. According to the instructions in this manual, it can be quickly assembled and disassembled. Detailed information about the conception, the specifications, all features, components, tasks and subtasks can be found in this manual to help the readers to fully understand the operation of the product. For security and privacy reasons, the names of the team members will not be disclosed in this document.

2. Overview

Our client, Holly Gordon, the sustainability coordinator, at the uOttawa free store is looking for a collapsible, clothing rack to replace the current ones thaty are in use. The free store is an important part of the campus where someone can drop off unwanted items and pick-up things that you want for free with the goal of creating a campus where waste is a thing of the past. By creating a space where anyone can drop off and pick up stuff, the store aims to reduce consumption by offering free items and reduce overall waste. This is an important mission for a sustainable future.

However, the free store suffers from limited space and requires more suitable racks to store and display items. Furthermore, the current storage system in the free store is large, bulky and lack mobility options as indicate in Figure 1 below.

Figure 1 Current situation of the uOttawa free store

As indicated in Figure 1, many storage units are essentially shelving units and cannot be quickly disassembled. The remaining racks are large and bulky which are difficult to transport. This poses an issue since an important part of the free store mission is community outreach and participation. The free store often participates in events such as “Welcome Week” where they set-up a huge area to give away items. However, the racks currently in use are heavy, bulky, and difficult to assemble which negatively affects the volunteers. By providing a rack that is more suited to not only small spaces, but also for pop-up events, the rack could be more useful in modular for all circumstances. The rack itself should also be durable and can handle wear and tear since clients will be somewhat rough with the rack itself and be handling it frequently to access articles and items. Lastly, accessibility is a core value of this university and ideally the rack should be designed to cater to that ideal. It is important to make sure the rack is easily accessible to wheelchair users.

To summarise, the clients’ needs are:

Table 2. Client Fundamental Needs

• Lightweight	• Mobile
• Durable	• Accessible
• Collapsible	• Large carrying capacity
• Compact	• Stable

Figure 2 Final design of our clothing rack

Our solution meets the client's above requirements by focusing on a lightweight, mobile, and durable metal frame with click-in joints for quick assembly and disassembly. From client discussions, it was understood that within the collapsibility definition, what was truly required was for storability and short assembly and disassembly times, which our solution fulfilled. It was also compact due to its relatively smaller size with dimensions of 30.5'' by 58.75'' by 15''. However, it still maintained a large carry capacity due to the miscellaneous item rack and extendable double clothing rod which provided more capacity when necessary. It is also accessible for wheelchair users since both clothing rods have been adjusted to the appropriate height for a 5'8'' wheelchair user. The rack is also stable and was tested with various loading conditions. Lastly, the wheels have been selected to be functional within rougher terrain.

For a visual description of the described features, please look at figure 3 to better understand the design.

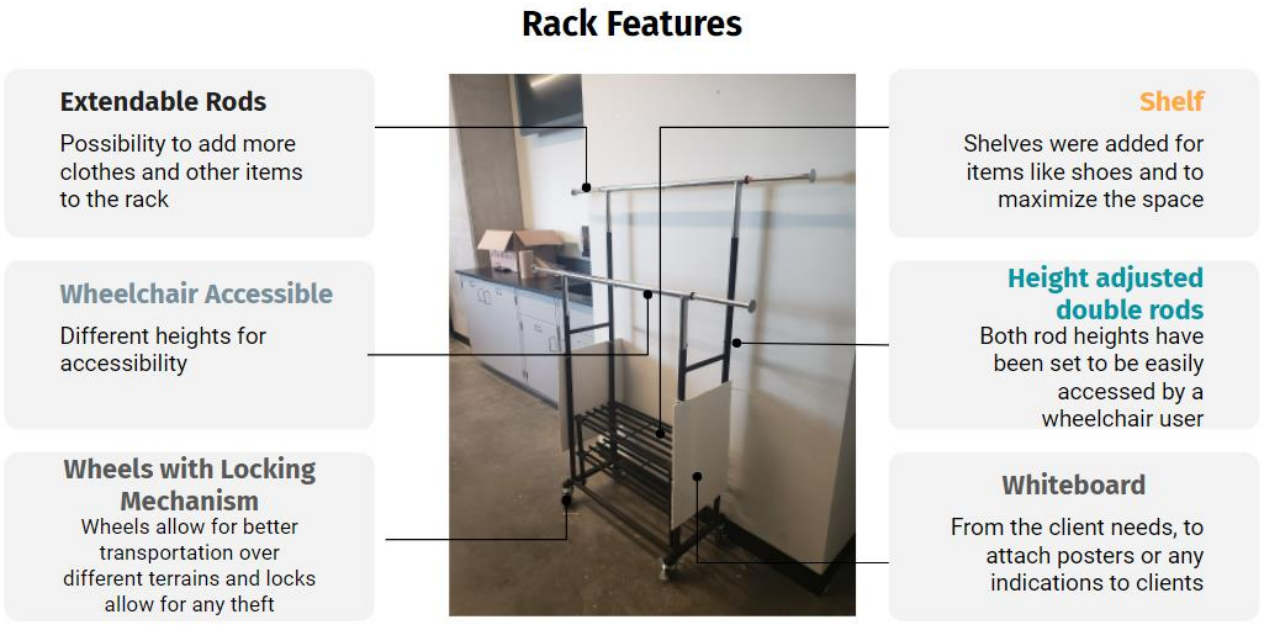


Figure 3 General features of clothing rack

2.1 Cautions & Warnings

- The clothing rods are extendable up to 15 extra inches on both sides, but we have red stickers used to help indicate when it's nearing its max length to prevent accidents.
- Blue stickers are used to indicate disassembly joints. It is used to make it easier for volunteers to understand where they are meant to disassemble the rack.
- When disassembling the rack, be careful of fingers and make sure they aren't stuck near any connections to prevent injury.
- The item rack is not designed to handle a person's weight. Please do not sit on the item rack.

3 Assembly and Disassembly

This section of the report will walk the user through the assembly and disassembly of the rack. No special tools are needed. Ideally, two people will work together to finish these steps. Predicted assembly time is less than 5 min and disassembly time is less than 1 minute.

3.1 Assembly

Figure 44 Components of the rack

- Take part 1 and insert the rods into the tubes in part 3. Ensure that the whiteboard is facing outwards.
- Take part 2 and insert the rods into the tubes in part 3. Ensure that the whiteboard is facing outwards.

Figure 55 Assembled parts 1, 2 and 3

- Take part 4 and insert it into part 1. This piece will compose the lower rack.
- Take part 5 and insert it into part 2. This piece will compose the higher rack.

Figure 66 Assembled final product

3.2 Disassembly

Chapter 1. To take this product apart, note the blue stickers on key joints.
Chapter 2. Pull part 4 from its insertion in part 1.

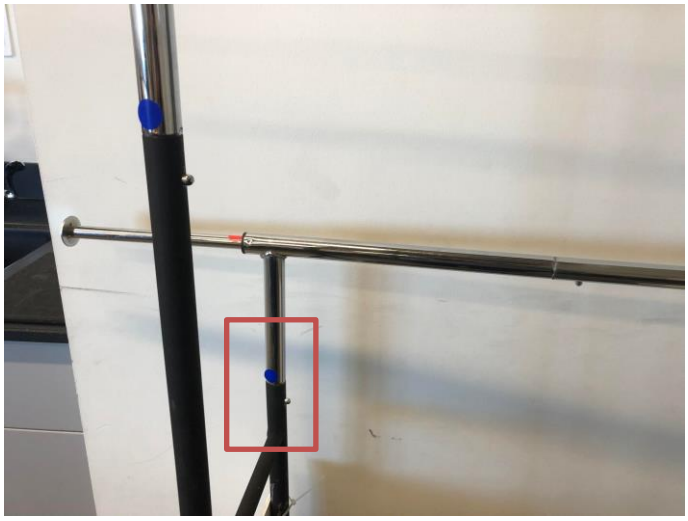


Figure 77 Connection between part 1 and part 4

Chapter 3. Pull part 5 from its insertion in part 2.

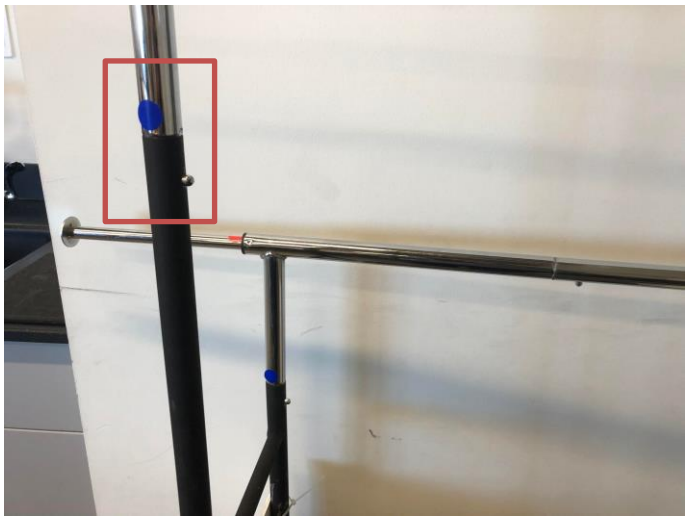


Figure 88 Connection between part 2 and part 5

Chapter 4. Pull parts 1 and 2 from their attachment in part 3.

Figure 99 Connection between part 1 and part 3

Chapter 5. Disassembly is complete!

4 Troubleshooting & Support

In terms of general troubleshooting, it is a very simple system, so there should not any need for troubleshooting. However, for general maintenance of the product a few things could be done. When the connections are tight, additional lubrication and grease will help keep the connection smooth. Similarly, regularly applying grease to wheels will help keep the mechanism clean and free of debris. Regular cleaning of the product will also help prevent damage to the frame and rack.

For support purposes, feel free to contact any of us by email which can be found on https://makerepo.com/shara079/1141.gng2101-team-c31-the-rack.

5 Product Documentation

5.0 <Building Process>

The building process of the final prototype is straightforward and will be explained here, along with the considerations made for the design. The feasibility of these choices will also be discussed, as well as the constraints that were present.

The first step to creating the final prototype had been to add the additional storage shelf on the base of the rack. This was done by using the 3-Tier Shelving unit (6.1.2 [2]) and the Rack Frame (6.1.2 [1]) from the previous prototype. The shelving unit was fastened to the metal frame using standard 1/8-inch nails. With an electric drill, 1/8-inch holes were created in the legs of the wooden shelf and the corners of the metal rack. Screws of the same diameter were then used to fasten the rack to the shelving unit. Next, the wheels from the previous prototype were removed. This was

done using a wrench to loosen the bolts and unscrew the wheels before adding the Caster Wheels (6.1.2 [3]).

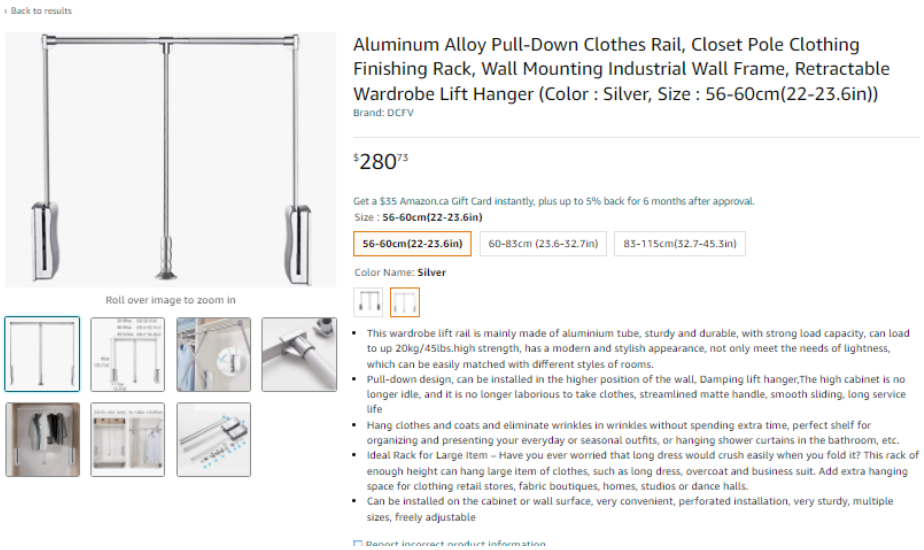
Once the previous wheels had been removed, the Caster Wheels were added by screwing the wheels in and tightening the included bolts with a wrench. The next part of the building process was painting the rack. This was done using a standard black Acrylic paint (6.12 [4]). The parts of the rack that were not chromatic had been painted, including the wooden shelf, for a total of 2 coats.

Finally, the Posterboards (6.1.2[5]) were added using Zip Ties (6.1.2 [6]). With scissors, the Posterboard was cut in half evenly and attached to each side of the rack. In order to attach the boards, holes were cut in the corners and zip ties were fed through. Then, the zip ties were attached to the poles of the metal rack and adjusted accordingly.

The final step of the building process had been the addition of assembly stickers. Using color coordinated stickers (6.1.2 [7]), the rack was marked in order to indicate assembly sites, with blue stickers, and extension limits, with red stickers.

5.0.1 Feasibility

During the building process, the feasibility of each choice made was considered. When determining the materials for the frame, the feasibility of our options were constantly questioned. The weight of the rack was an important aspect of the design and therefore required a lightweight material. Because of this. the feasibility of having an aluminum frame or a steel alloy frame were compared. Initially, aluminum was chosen due to its lightweight and durable properties. However, after researching what was available and within the budget, it was determined that using an aluminum frame was not feasible. Most options available were not within the budget or meet the design requirements.



Instead, the material was determined by comparing racks that met the client's needs and fit within the budget. With this method the Rack Frame (6.1.2 [1]) was chosen. The rack is made of a

steel alloy and meets the durability and weight requirements of the design while being accessible. With these characteristics, the rack allowed for a functional prototype to be feasible.

For the addition of the wooden rack, it was initially designed to be made of wood planks. After comparing the price of wood and the cost of manufacturing a rack from scratch to the 3-Tier Shelving unit, it was determined creating a rack from scratch was not a feasible option. Because of this, the wooden rack was chosen. The rack fit the size requirements and budget, however lacked in stability. After consideration, it was determined that the 3-Tier Shelving unit was the more feasible option, and the stability could be improved with fasteners.

5.0.2 Constraints

During the building process there were many design constraints. The first constraint being the client's needs. The client wanted a rack that was accessible, durable, easy to assemble and disassemble, lightweight, transportable, and capable of holding miscellaneous items. This created a constraint on the design and size of the prototype. The other main constraint had been the budget. Since the total budget had been $100, the quality of materials had not been ideal.

5.1 <Subsystem 1 of prototype>

5.1.1 BOM (Bill of Materials)

ID	Description	Vendor	Link	Qty	Cost before tax ($CAD)
1	SimpleHouseware Double Rod Portable Clothing Hanging Garment Rack,	Amazon	https://www.amazon.ca/dp/B08N2X92S7?ref=ppx_pop_dt_b_product_details&fbclid=IwAR18H96s1hcvl7196_3fDJ23fdExI0mWskrg4yKettUOPqK2W_PH1cEu8Gw&th=1	1	49.87
2	Mainstays - 3-Tier Wood Shoe Rack	Walmart	https://www.walmart.ca/en/ip/mainstays-3-tier-wood-shoe-rack-brown/6000195341218	1	15.47
3	Caster Wheels 3-inch Locking Stem Casters, 3/8" -16 x 1-1/2" (Stem Diameter 3/8", Stem Length 1-1/2") Threaded Stem Casters Swivel – Pack of 4	Amazon	https://www.amazon.ca/Locking-Casters-Diameter-Threaded-Furniture/dp/B09GFCW7CH/ref=sr_1_5?crid=QIRNPZEAA3F9&keywords=Set%2Bof%2B4%2BCasters&qid=1647878713&sprefix=set%2Bof%2B4%	1	26.99

			2Bcasters%2Caps%2C77&sr=8-5&th=1		
4	Black Acrylic Paint	Dollarama	https://www.dollarama.com/en-CA/p-black-acrylic-paint/0201773	2	3.00 (1.50/unit)
5	Whiteboard	Dollarama	https://www.dollarama.com/en-CA/p-white-foam-board/3005411	1	2.50
6	Multi-Purpose Ties 7.5" 40PK	Dollarama	https://www.dollarama.com/en-CA/p-multi-purpose-ties-75-40pk-assorted-colours/0601235	1	1.00
7	Stickers 35+PK (Assorted Colours)	Dollarama	https://www.dollarama.com/en-CA/p-stickers-35pk-assorted-colours/3051265	1	1.00

Total Sum of Material Costs: **CAD $ 99.83**

5.1.2 Equipment list

Tools:

a. Electric Drill

b. Wrench

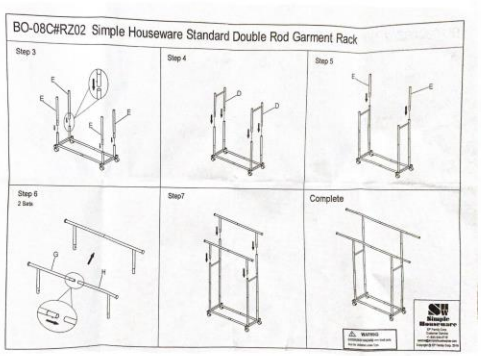
c. Paintbrush

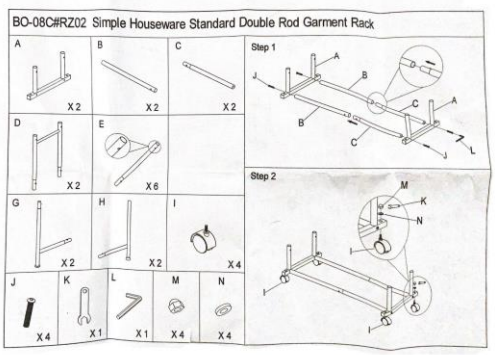
d. Flathead Screwdriver

e. Scissors

5.1.3 Instructions

1. Assemble Rack Frame. Ensure frame is properly put together by following the included instructions





2. Assemble wooden rack. Follow the instructions given but remove the first tier of the rack

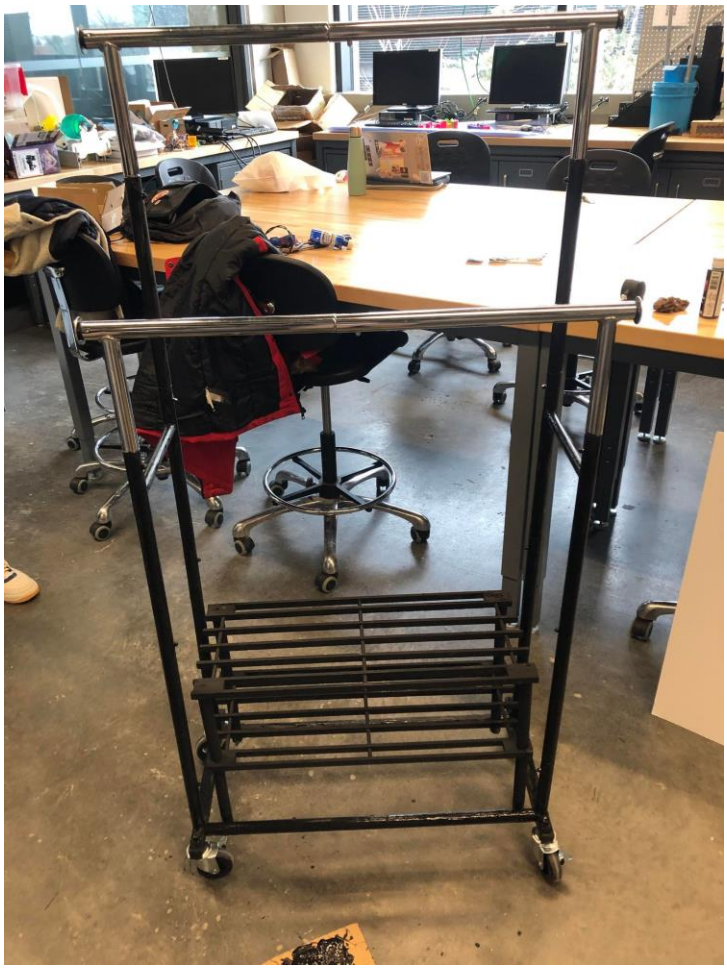
3. Using an electric drill fitted with a 1/8-inch drill bit, create holes in each corner of the rack.

4. Take the assembled wooden shelf and temporarily fasten it to the metal frame.

5. Using screws, fasten the wooden rack to the metal frame. Cover the exposed nail with hot glue to avoid injuries.

6. Using a wrench, remove the wheels on the rack by untightening the bolts. Then unscrew the wheels and replace with the caster wheels.

7. Paint the rack as shown: Use at least two coats and wait to dry.



8. Cut the whiteboard in half then using scissors create holes in the top corners of each half. With zip ties, fasten the whiteboard to the rack using the holes and the side poles

. 

9. Add stickers to the assembly and overextension spots

5.2 Testing & Validation

Fitting through a door

Description*:* Examine the rack and the clearance it has when fitted through the door.

Results:

- Fits through doors with good clearance.
- No issues with interference detected.

Indoor and outdoor transportation

Description: The rack is tested to see if it is easily transported in indoor and outdoor environments.


Results:

- Dimensions of the rack enable easy transportation: 30.5"W x 15"D x 58.75"H
- The existing 2-inch casters work well indoors. The casters need extra forces to pass the threshold. The size of casters should be increased.

Weight offset

Description of test: All weight is placed on one side of the rack.

Results:

- No twist was detected.
- The rack can hold the weight being applied to only one side.
- Items were easily placed and removed off the rack.

#	Metrics Descriptor	Unit	Marginal Value	Ideal Value	Actual Value	Justification
1	Load capacity	lbs	>30	>50	50	The main load on the rack is clothes, according to client requirements, the ideal value is 30lbs and minimum value is 30lbs.
2	Height after assembly	cm	120-140	120	1.143-1.492	The product needs to be accessible, so the height should be adjustable or limited to a height that can be easily used by people in wheelchairs. According to research, the ideal height of the racks they can use is 1.2 meters.
3	Width after assembly	cm	25-40	>40	38.1	Considering the direction of stability and space use, the ideal width of the rack is 0.4m.

4	Length after assembly	cm	100-150	>150	77.5-121.9	According to the client's needs, the length of the rack should be long enough to hold a certain number of clothes.
5	Weight	lbs	30-40	<30	<10	Racks will be moved frequently, so the weight range is what most people can easily handle
6	Time to assemble	s	<600	<300	<300	The product will be displayed in different places, so assembly time should be as short as possible. The maximum time allowed by the client is 600s
7	Budget	$	100	<100	99.83	The client provides a budget of $100

6 Conclusions and Recommendations for Future Work Borel

In conclusion, we achieve our goals in our product. We successfully created a collapsible clothing rack that is reliable, lightweight, easy to assemble and accessible. We have learned that it is important to continuous iteration in product development and learn from mistakes and failure. The most productive avenue for future is that empathize with customer feedback to improve products. Due to the lack of the time, we cannot get the feedback of long-time use of our product, and we were not able to implement every idea perfectly. If we had a few more months, I wish guard rails could be added to the shelves on our products to avoid items falling off in transit. Also, the coating of the rack can be done better.