uOttawa

Project Deliverable F- Prototype 2

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1. Introduction

The goal of Deliverable F is to review the client feedback received during the third client meeting. From there, future changes to the conceptual design can be discussed based off concerns of the client. The second prototype was created and tested by comparing it to the target specifications.

2. Client Meet Feedback

Through the third client meet the focus was on presenting the prototypes created to the client, including the analytical prototype as well as the physical prototypes. The analytical prototype emphasized the specific measurements as well as a working representation required for the future physical prototypes represented on SOLIDWORKS. The physical prototypes represented a hands-on approach to allow the client to visualize a specific aspect of the collapsible clothes rack, including its working mechanisms, instead of the entirety of the clothes rack. With the prototypes, the goal was to gain positive and negative feedback in order to move forward with the next prototype. The meeting in person occurred on Monday February 28 and focused on enabling the client to express their thoughts about the created prototypes. The client was able to physically hold the prototype and move the various parts around. Instead of asking more question, the goal of the client meet was to present and gain feedback. The Feedback received was recorded in Table 1. At the end of the meeting, the target specifications were also adjusted for the current rack measurements to be 6ft height x 2.4ft deep x 5ft wide.

Table 1. Key details of the second client meeting. Includes the feedback received during the second client meeting. The positive feedback, the concerns, as well as improvements to consider when moving forward.

Positive Client Feedback	Negative Client Feedback (Concerns)	Future Changes/Improvements
• The hooks indicated within the diagrams are an asset to the design. It will allow for further variety of items to be displayed. • Enjoyed current safety features, but additional safety features would benefit the clothing rack. • Dimensions seem plausible currently but may need adjustments in the future as will be noted through the final prototype. • The strength aspect of the design was focused on, which was greatly appreciated. • The client indicated [redacted] likes the collapsibility aspect.	• No direct negative comments. • An improvement of making hooks a permanent fixture would allow for less hassle. • Potential of hurting a customer if the adjustable rack were to fall on them. This could be a potential hazard if the customer were to bump the arm of the rack. • Dimensions need to be tested for accessibility of wheelchair users specifically. • The client empathized the importance of strength and accessibility as a priority above adjustability and collapsibility.	• Will make the hooks permanent instead of removable hooks • Implementation of a secondary safety feature to ensure the arm is fully fitted, and fully supported by the adjustable arm. If this is not feasible (time and budget), explain at the final presentation what could potentially be implemented moving forward with the prototypes. • Will adjust the height and width to become more accessible for wheelchairs as will be tested. • Focus on making the material strong enough to withstand weight. The

		material should also have a longer lifespan and be able to withstand certain conditions.

3. Most Critical Product Assumptions

To break down the major parts of the design concept for the clothes rack, the following Table 2 was created to represent the critical product assumptions that were made. Although the clothing rack does not have many components involved, there are still a wide variety of parts that serve very important/different purposes that need to be investigated.

Table 2. The critical product assumptions for the collapsible clothes rack. Includes the acceptable values for a spec, the availability of the material that is planned to be used, and the critical functions of the major parts of the rack.

Specifications	Acceptable Value
Hanging Racks	Needs to support at least 50lbs of clothing since the free store has a lot of clothing to display and it may be crowded.
Bottom Platforms	Needs to support at least 150lbs of objects since the free store also gets rid of items other than clothing that may be quite heavy.
Side Hooks	Needs to support at least 5lbs each since they may display paintings or other slightly heavier objects.
Materials	**Availability**
Wood	Many stores such as Home Depot, Home Hardware, and Rona have all different types/styles of wood that are readily available during all seasons, so wood may be used for the support system of the clothing rack. Some wood in the Makerspace may also be used to save money.
PVC	Switching from aluminum rods to PVC. PVC can be found in most stores such as Home Depot and Rona. Another option is to use PVC pipes that have been found around the Makerspace in the University.
Metal	Every major store has metal hooks available in all shapes and sizes so it will be very easy to find a good set of hooks for the side of the rack.
Parts	**Critical Function**
Wheels	Wheels can be found at a variety of stores bhut they are rather expensive, so many team members are looking around their houses for any spare wheels. To allow the rack to be easily

	transported around the store/campus by one volunteer with ease.
Wheel Lock System	To ensure the rack is stable, secure, and won't move when people are using it.
Inserted Hooks	To hold any clothes, paintings, and signs on the side of the rack.
Bottom Weights	Weight at the base of the rack to add extra support to ensure the product does not fall over and injure any customers or volunteers at the free store.
Bottom Platform	Extra display area on the clothing rack for any bigger items that are unable to be hung from a hanger.
Platform Lock System	To ensure the bottom platform is stable and can support the weight that is put on it.
Racks/Bars	Two racks/bars that can pull out from the middle to display clothes on both sides of the clothing rack.
Rack Lock System	To ensure the hanging bars will be locked into place and will be able to support the weight being put on them.
Rotating System	A mechanism that collapses the bottom platforms and the hanging racks into the centre of the rack for easy storage.

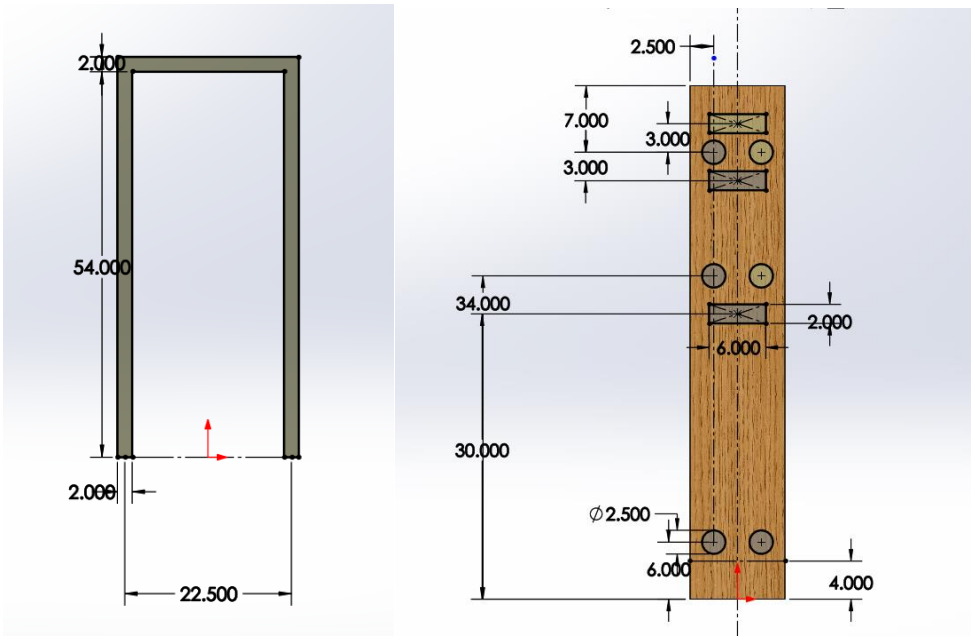
4. Second Prototype Documentation

Prototype 2 was created out of two separate prototypes, Prototype 2A, an analytical prototype to test the dimensions of the product, and Prototype 2B, a physical prototype made from wood and glue to test out relative dimensions and mechanisms of the overall design. Prototype 2A has high fidelity, and if successful will be used to base off the creation of the final product. Prototype B is a physical prototype with low fidelity. The goal of prototype B is to not only use more of the types of materials that will be used in the final prototype, but also to assess the weight bearing ability of the structure.

4.1 Prototype A: Analytical Prototype

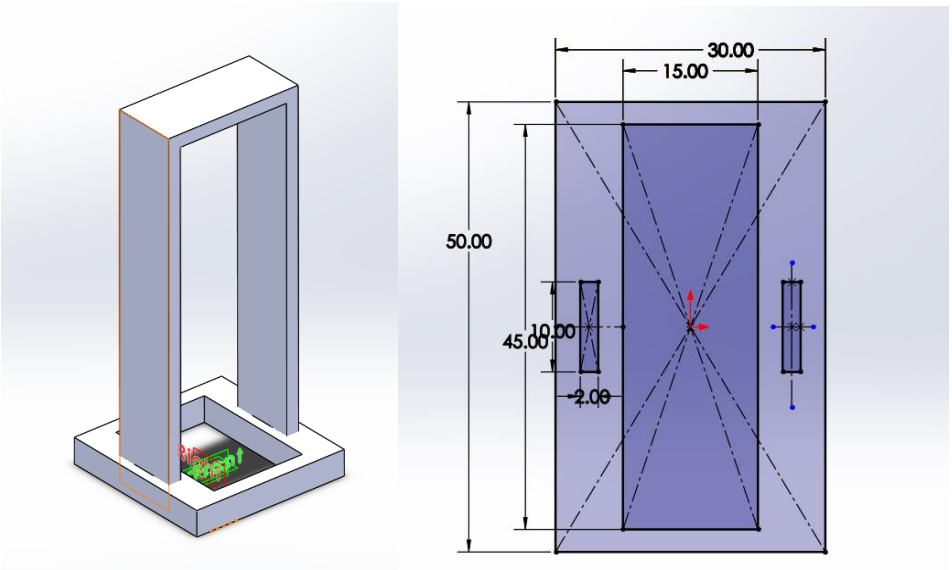
Prototype A is an analytical prototype created on the software "SOLIDWORKS". The goal of this prototype was to ensure that the measurements meet the customer's needs and are feasible.

The first step was to create the frame of the clothing rack. Originally, it was decided that the height would be 60 inches high. When created in Solid Works, it appeared to be too high, so it was shortened slightly. This decision was based on the mechanics of the clothing rack, and the customer's need for accessibility. Accessibility was one of the main priorities required to complete the clothing rack. The height was lowered to 54 inches as seen below in the diagram. The holes for the piping (the bar/piping to fit hangers) to fit through were added. The dimensions are displayed in Figure 1 below.



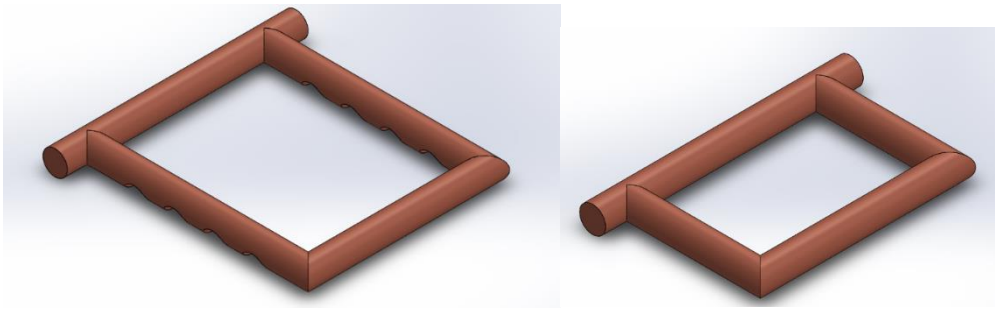
Figures 1. Displays the clothing rack frame with the dimensions.

The next step in the creation of the analytical prototype was to create the base. The original idea for the base was 24x24 inches. When created in Solid Works, the square base did not appear to look right in the assembly. The assembly with a square base did not look like the drawn diagram. It also looked like it would make it hard for people in wheelchairs to reach items, which again was not fitting the dimensions to meet the accessibility requirements. It was decided that a rectangular base would fit the drawn design better, create more stability, and allow people that are wheelchair bound to reach items from the side of the clothing rack. Figure 2 below shows the dimensions of the base as well as the overall combination with the frame.



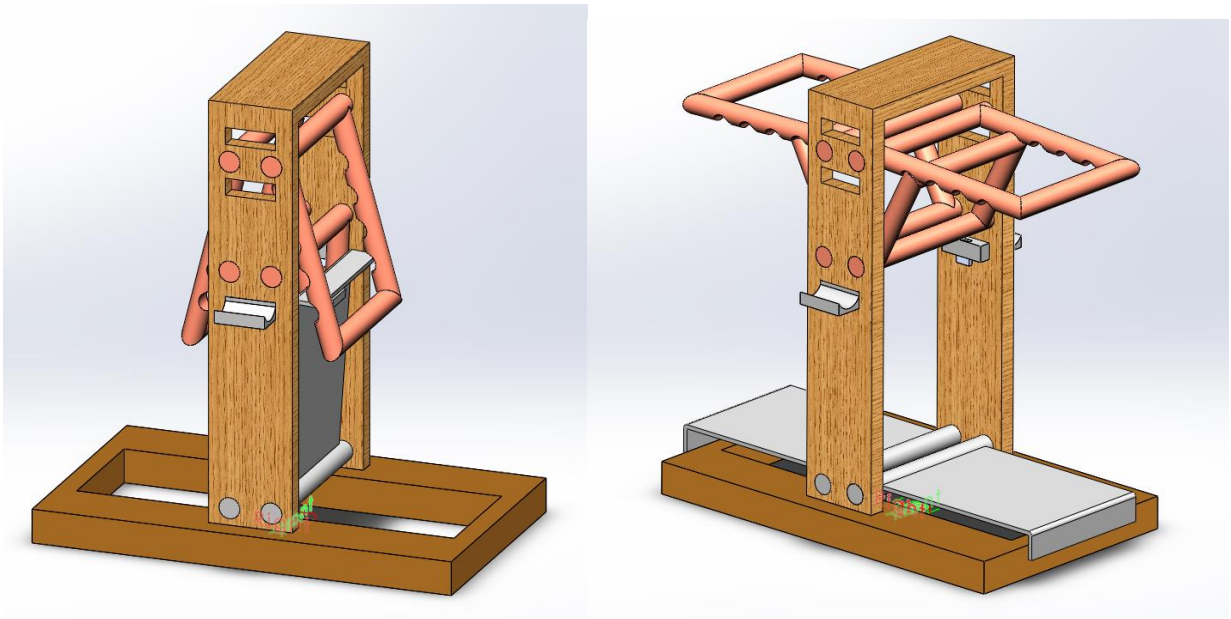
Figures 2. Displays the base with the dimensions, and the assembly of the clothing rack and base.

The copper rods were created next, as seen in Figure 3. The main task of the prototype was to ensure the mechanism of the rods worked, and it can be held up. SOLID WORKS made this possible and allowed an insight of the dimensions which would work and while remaining accessible.



Figures 3. The copper rods were used to hold up the items.

The next step was to assemble all parts. Another goal of this prototype was to ensure all parts fit together well. Figure 4 below show the rack assembled, and the rack disassembled.



Figures 4. The full rack assembly and disassembly.

4.2 Prototype B: Physical Prototype

Prototype 2B is a physical prototype made using hot glue and wooden beams, as is seen in Figure 5. Although in this prototype the central beam is not solid and not able to detach from the base, the folding mechanisms and weight bearing arms of the structure are fully functional. The prototype was able to fully establish all dimensions of the clothing rack such that all parts fit well together and were able to support a load. This prototype was meant not only to use more of the types of materials that would be used in the final product, but also to assess a miniature version of the final product's weight bearing ability.

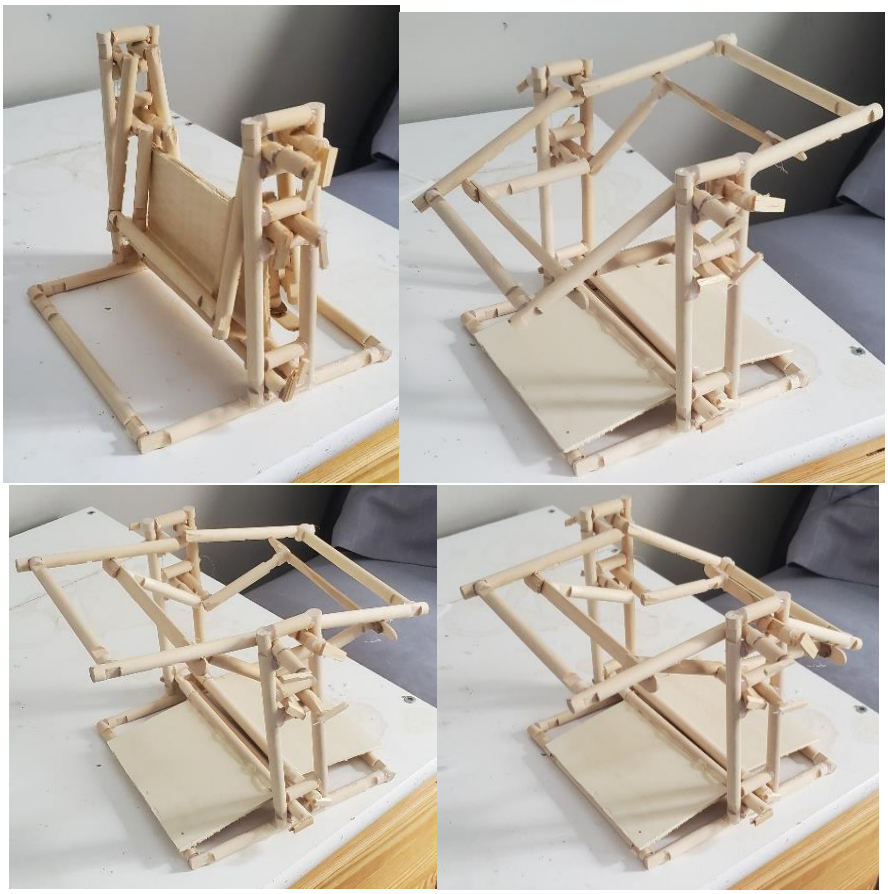


Figure 5: The fully collapsed clothing rack and the clothing rack's arms adjusted to various heights to illustrate adjustability.

Given that the body of the supporting beam was not solid, one disadvantage of this prototype was that sometimes the rotating arms of the supports or the hangers caused friction with one another, resulting in the arms not staying up very easily if one attempted to adjust the rack roughly. The problem is going to be fixed in the final prototype by not only making sure that the central beam is solid, but also by making sure that the indents in the hanger arms are well recessed and have hooks to grab the supporting arm so it doesn't slip as easily.

5. Prototype Testing

Prototype A and B were tested and analyzed against target specifications. The Analytical Prototype, created through SOLIDWORKS, was analyzed as is documented in Table 3.

Table 3. Prototype A Testing. The performance of the analytical prototype was compared to the target specifications developed in deliverable B.

Target Specifications	Description of Test	Expected Results/Value	Prototype A: Analytical Prototype Test Results
Performance- Travel	Can the prototype be collapsed?	Prototype should be able to be able to be taken apart and compacted to move around with ease.	The prototype consisted of three pieces wherein the upper piece could be taken out of the base and the hooks could be taken out of upper piece. The

			rods could be rotated in the upper piece to further collapse the prototype.
Service Life of the Clothes Rack	Cannot be tested with this prototype	N/A	N/A
Aesthetic	Is the prototype aesthetically pleasing?	Yes	Yes, the prototype is aesthetically pleasing in its simple design.
Set-Up	Cannot be tested with this prototype	N/A	N/A
Performance-Working Wheels	Cannot be tested with this prototype	N/A	N/A
Accessibility	Can the prototype clothing rack be accessed for people in wheelchairs?	The clothing rack rod at the top of the upper piece is longer than the base.	The prototype clothing rack, when adjusted to its highest setting at a 90 degree angle to the frame, is longer than the base.
Stability	Can the rack tolerate a moderate weight both on the hangers and the shelf?	One hanger can tolerate a minimum of two thirds of the rack's total weight and the shelf can tolerate at least 2 times the weight of the rack	N/A

Prototype B was a physical Prototype and could therefore be tested and analyzed for its performance as well as its relative weight bearing capacity, as was documented in Table 4.

Table 4. Prototype B Testing. The performance of the physical prototype was compared to the target specifications developed in deliverable B.

Target Specifications	Description of Test	Expected Results/Value	Prototype B: Physical Prototype Test Results
Performance- Travel	Can the prototype be collapsed?	Prototype should be able to be able to be taken apart and compacted to move around with ease.	The prototype consisted of one piece, and as such the rack itself cannot be further collapsed past the racks folding into the body.
Service Life of the Clothes Rack	Cannot be tested with this prototype	N/A	N/A
Aesthetic	Is the prototype aesthetically pleasing?	Yes	The prototype is relatively aesthetically pleasing in its simple design.
Set-Up	Cannot be tested with this prototype	Design can be expanded and operational within 3 minutes	Prototype can be assembled within 15 seconds.
Performance-Working Wheels	Cannot be tested with this prototype	N/A	N/A

Accessibility	Can the prototype clothing rack be accessed for people in wheelchairs?	The clothing rack rod at the top of the upper piece is longer than the base.	When the clothing arm is adjusted at a level so as to be perpendicular to the vertical beam, the arm extends past the outmost part of the shelf, allowing for wheelchair accessibility.
Stability	Can the rack tolerate a moderate weight both on the hangers and the shelf?	One hanger can tolerate a minimum of two thirds of the rack's total weight and the shelf can tolerate at least 2 times the weight of the rack	The prototype's hanger can tolerate up to 10 times the weight of the rack itself, while the shelf can tolerate beyond 40 times the rack's weight.

6. Conclusion

For this deliverable, the purpose was to do further prototyping and testing to ensure that the design would perform the way that it was intended. There were two prototypes that were developed for this deliverable. The first prototype that was created was an analytical prototype built using SOLIDWORKS. The purpose of this prototype was to determine the proper dimensions for the clothing rack and to make sure that it is feasible. This prototype included the base of the clothing rack and the frame being built separately and testing that they were able to fit into each other. The second prototype that was created was a physical prototype to test the locking mechanism of the bars on the clothing rack and to test the weight that the miniature design would be able to hold. Both of the prototypes performed much better than anticipated and when the client was shown the designs, they were more than pleased with the direction that the project was going. They gave a few suggestions for improvements for the third prototype, such as thinking about how safe/sturdy the rack would be if it is collapsible and if the collapsibility feature should be sacrificed to make it safer. They also suggested that the hook be attached directly to the side of the rack, and not removable as previously designed, to make it easier on the volunteers to setup and take down while lowering production cost. Working forward on this project, the team members are going to be having multiple meetings throughout the week to discuss what to test for the final prototypes and will begin meeting in Maker Repo to begin building the final product.