uOttawa

Project Deliverable D - Detailed Design, Prototype 1, BOM, Peer Feedback and Team Dynamics

Group 2.1

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1. Introduction

The goal of this deliverable is to review the client feedback received during the second client meeting. From there, future changes to the conceptual design can be discussed based off concerns of the client. Once a conceptual design was agreed upon, a bill of materials was established. The first prototype was created and tested by comparing it to the target specifications.

2. Client Meet 2 Feedback

During the second client meeting, valuable feedback was received. The feedback received was recorded displayed Table 1.

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.

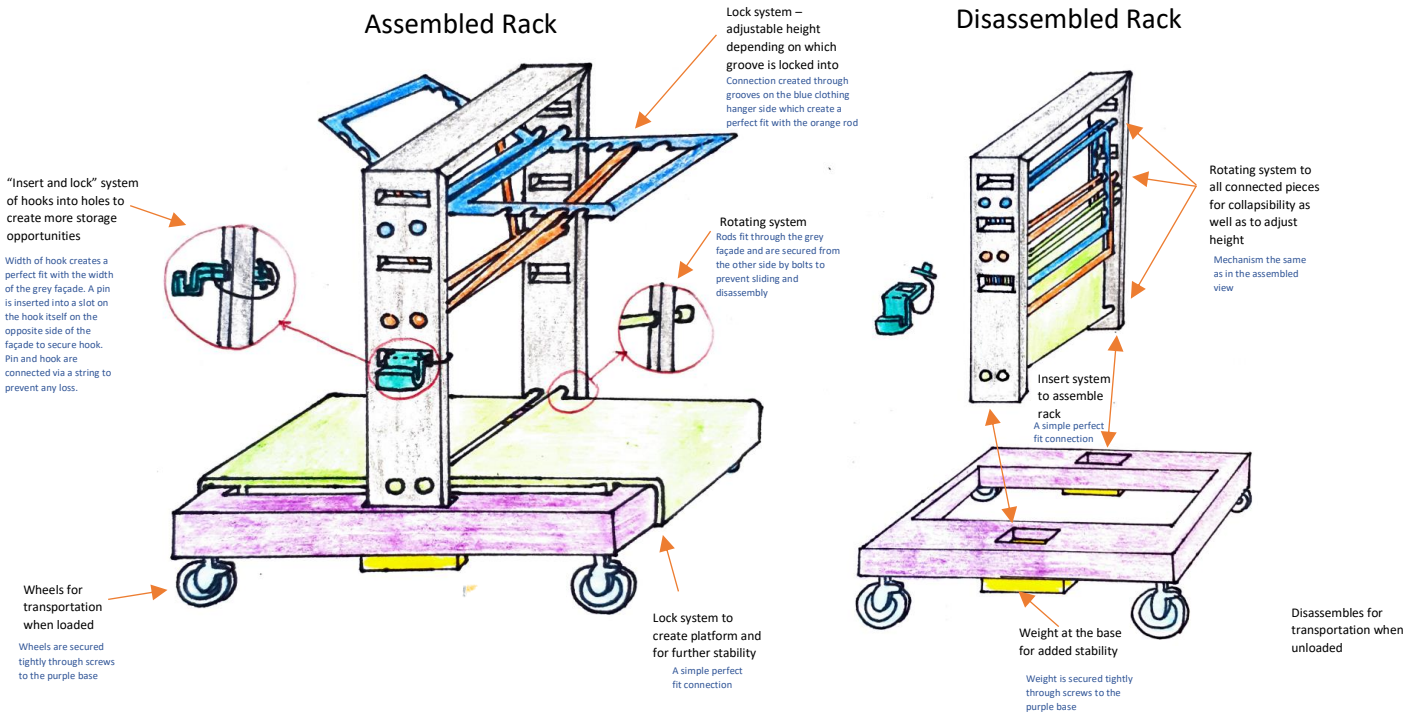
Positive Client Feedback	Negative Client Feedback (Concerns)	Future Changes/Improvements
• Overall, [redacted] liked the conceptual design. [redacted] seemed to like that it appeared to be stable. There is a strong base that will remain sturdy despite having a lot of weight added to it. • Since the conceptual design seems so stable, [redacted] likes that safety does not seem to be a concern. The conceptual design seems sturdy enough that it should not collapse. • [redacted] likes that the conceptual design has wheels. It will be easy to move around. She also likes that the wheels will have a locking feature. This will make it possible to bring the clothing rack outside, without worrying that it will roll away. • [redacted] likes that the clothing rack can be taken apart and	• [redacted] likes the accessible features, although she is concerned that the base of the clothing rack may be too big, and people in wheelchairs may not be able to reach the clothes. [redacted] encourages more testing to make sure that people will be able to reach even with the base. • [redacted] had mentioned that she does not have a particular size in mind, although she does not want the clothing rack to exceed 6ft tall. She wants to ensure that the clothing rack can fit through doorways and can possibly go in elevators in the future. After talking to the TA, it was decided that a smaller final product will be better. In interest for cost and transportation.	• When moving forward with the design, there will be an empathize some testing on accessibility with the base. It is important to ensure that people can reach the clothes, despite being in a wheelchair. This will be an aspect that will be tested through every iteration. • When moving forward, it will be ensured that the rods used to hang the clothes has a roughly rounded shape, which will allow for the possibility of hanging clothes from the side as well. Different materials have been mentioned. The possibility of using wood rods, copper rods, and plastic rod will be explored. • When moving forward, it was agreed to create a relatively small clothing rack. A smaller clothing rack will be

compacted. What she likes about the compact design, is that it does not have a bunch of small parts. There are only two main parts, so it will not be easy to lose. She also likes that it appears to be very easy to set up and takedown.	• [redacted] had mentioned that she prefers a clothing rack that is round. The reason for this is it is easy to hang the clothes that way.	easier to transport and will require fewer materials.

3. Updated Conceptual Design

Relatively few changes were made to the general design of the product concept, as can be seen in Figure 1, due to the positive feedback of the client. The TA did mention that stability may become an issue if the weight loaded onto the system is not balanced; hence, it was decided to add weights to the center of the base for added security. Furthermore, as concerns regarding the accessibility of the rack were raised due to the size of the base, it was noted that, for the aforementioned concept, the length of the blue rod should be longer than the length of the green part. Moreover, the blue rod was determined to be the same diameter all around (excluding its connection hinge to the grey façade) to allow for clothing to be hung around its whole frame.

Figure 1. Concept design of collapsible storage rack. An assembled and disassembled view of the collapsible storage rack for the uOttawa free store is visualized, along with details of its connective parts and how they will be built. The design is colour coded to identify pieces from the assembled rack in the disassembled rack view.



4. Bill of Materials

It is important to have an idea of what materials will be needed to build the product as it ensures the cost remains in budget. Listed below in Table 2 are the different materials needed, the approximate cost, and where they can be purchased.

Table 2. Bill of Materials needed to create the product (BOM).

Item #	Part name	Description	Link	Quantity	Unit Cost ($)	Extended Cost ($)
1	Wheels	4pcs of 1.96" Lockable Hard Rubber Wheel	https://www.amazon.ca/DICASAL-Casters-Castors-Markless-Bearings/dp/B0753F2GJ9	1	22.99	22.99
2	Thread knob	1/4-20 Thread Knob	https://www.leevalley.com/en-ca/shop/hardware/jig-and-fixture-parts/61652-1-4-20-thread-knobs	12	2.80	33.60
3	Dowels	Hardwood Dowel 5/16 In. x 48 In.	https://www.homedepot.ca/product/alexandria-moulding-hardwood-dowel-5-16-in-x-48-in-yellow/1000115244	18	2.12	38.16
4	Screws	Varying sizes	will bring from home	50	0.00*	0.00
5	Wood	1”x4”x6’	Will bring from home and if necessary buy https://shop.wood-source.com/collections/lumber/products/poplar-project-board?variant=32344400855129	10	0.00*	0.00
					Total	**94.75**

*cost barring need to purchase

5. Most Critical Product Assumptions

To break down the major parts of the design concept for the clothes rack, the following Table 3 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 3. 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.
Metal Poles	Almost every major store has metal bars/racks readily available for use of the collapsible hanging bars on the product.
Hooks	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 insertion in the side of the rack.
Parts	**Critical Function**
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.

6. First Prototype Documentation

Prototype 1 was created out of two separate prototypes, Prototype A and Prototype B, made from cardboard, paper and tape to test out dimensions and mechanisms of the overall design. The prototype was a physical focused prototype with low fidelity. The use of Prototype 1 was communication, particularly to validate design concepts of components.

6.1 Prototype A

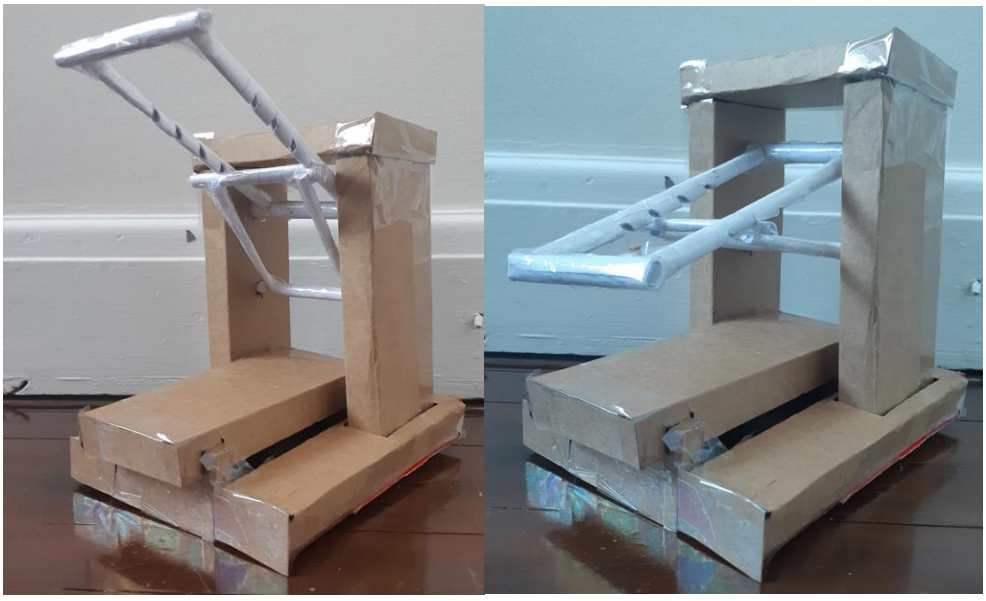
Prototype A was created on a much smaller scale than the target specification of the final prototype out of cardboard, paper, and clear tape, as can be seen in Figure 2. The prototype was used to establish relative dimensions of the final prototype relative to other parts of the design, such as the relative

length of the clothing rack rod to the base, and to test the feasibility of the turning and fastening mechanism in the design.

Figure 2. Prototype A assembled rack. Cardboard prototype is made up of two separate pieces that fit into one another and lock via the base, while the clothing rack is adjusted in its 'standard' state.

The protype created simplified hinges out of tightly rolled paper to create the clothes rack and cut indents into the side rods to fit the middle rotating piece and adjust the height, as can be seen in Figure 3.

Figure 3. Prototype A adjustable height. Height of the clothing rack to hang clothing hangers from can be adjusted through the slots on the side of the upper part which the rotatable middle piece fits into to create a solid hold.

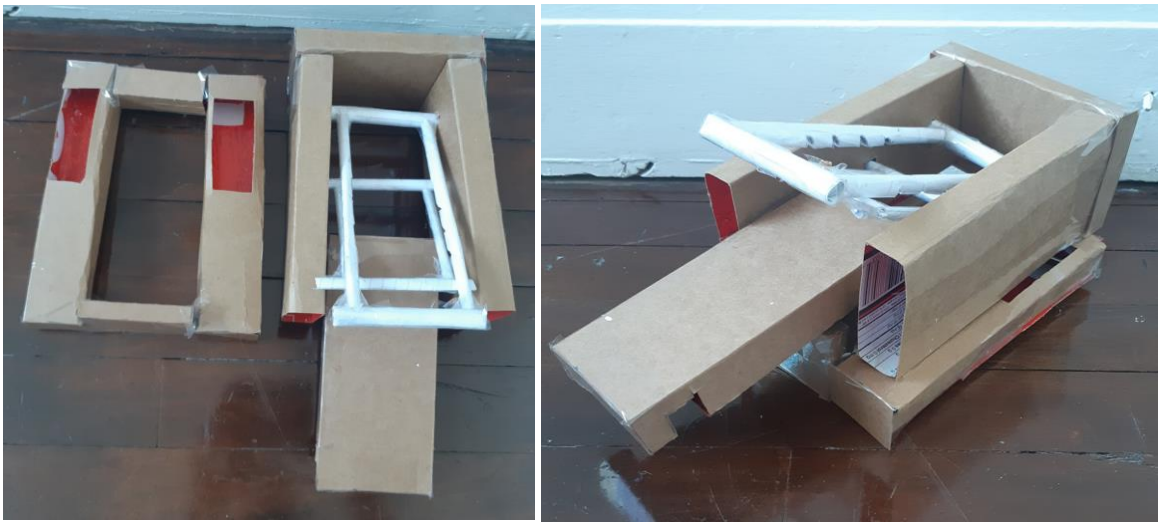


Moreover, the lock system of the base of the upper part of the deisgn to the lower part of the design was tested by cutting a groove into the turnable base of the upper base that fits into the higher front end of the lower end; Figure 4 demonstrated the locking system by showing it disassembled.

Figure 4. Prototype A perfect fit base mechanism. Base is rotated upwards to disengage the perfect fit to the lower piece of the design.

Lastly, Prototype A of Prototype 1 also explored the collapsibility aspect of the design by allowing the rack to fold into itself through the hinge mechanisms, as well as the upper part of the design fitting into the lower part via a perfect fit, as is seen in Figure 5. The Prototype also gave a visualization of the relative width of the upper part in comparison to the lower part when placed on top of one another as is intended of the design when stored.

Figure 5. Prototype A disassembled rack. Cardboard prototype can be taken apart by disengaging perfect fit of the base mechanism and pulling the upper piece out of the insert system into the lower piece; the upper piece can be further collapsed by rotating the center pieces inwards. When stacked on top of each other, the upper piece is slightly narrower than the lower piece.



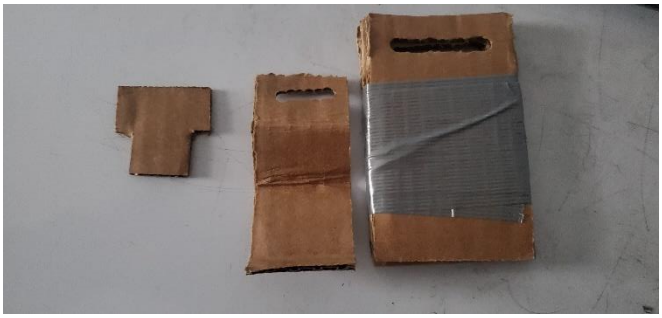
6.2 Prototype B

Prototype B was much more focused on a particular aspect of the product in comparison to Prototype A, specifically the mechanism by which the adjustable hooks on the side of the body could change positions and be fastened to be sturdy, as can be seen in the assembled view in Figure 6.

Figure 6. Assembled Mechanism of Prototype B. The carboard prototype was assembled wherein the prototype hook was inserted and secured via a pin into a cardboard slot meant to represent the rack façade.

The prototype implemented an "slot and pin" system, wherein the main body of the hook would be inserted into a slit on the side of the central support beam of the rack and be locked into place through a pin secured on the back that is inserted into a slit on the main body of the hook itself. Figure 7 expands on the individual pieces necessary for the execution of the mechanism.

Figure 7. Dissembled mechanism of Prototype B. A view of the individual pieces of the "slot and pin" system, including, from left to right, the pin, the hook, and the cardboard slot meant to represent the rack façade.



The prototype was used not only to illustrate the nature of the mechanism itself, but also to test whether the "slot and pin" system was able to bear weight while remaining easy to use and adjust. Further discussion led to the idea to integrate string to attach the hook and pin together in future prototypes (as is seen in the design in section 3) to prevent loss of individual pieces.

7. Prototype Testing

Through the last client meeting, the main target specifications were enforced and created. The prototypes made needed to pass the target specification requirements to be considered further. Listed below in Table 4 are the target specifications and the results of the testing performed.

Table 4. The performance of both prototypes was compared to the target specifications developed in deliverable B.

Target Specifications	Description of Test	Expected Results/Value	Prototype A Test Results	Prototype B Test Results
Performance- Travel	Can the clothing rack prototype be taken apart and compacted?	Yes, it can be compacted and moved around with ease.	The prototype was able to be taken apart easily.	Yes, the hooks are easily removed and can be stored on top of each other.
Service Life of the Clothes Rack	Cannot be tested with this prototype	NA	NA	NA
Aesthetic	Is the prototype aesthetically pleasing	Yes	Yes, the overall design of the prototype is aesthetically pleasing and with nicer materials, should at least meet client specifications.	Yes, the hooks are very aesthetically pleasing and with nicer materials should at least meet client specifications.
Material	Cannot be tested with this prototype, as it is not the material that will be using for the final product.	NA	NA	NA
Set-Up	Can the clothing rack prototype be taken apart and put back together easily and quickly?	Takes less than 1 minute to put together the clothing rack prototype.	The prototype is able to be put together in 12 seconds and 91ms. and taken apart 7 seconds and 12 ms. **It is important to mention that this prototype is much lighter, smaller, and easier to maneuver**	Prototype is able to be put together in under 5 seconds, and while the final product will have larger, heavier materials, the setup time and fast adjustability of the hooks should remain.
Performance- Working Wheels	Does the clothing rack prototype have wheels?	Yes	No, this prototype does not have wheels.	NA
Accessibility	Can the clothing rack prototype be accessible for	Yes	Yes, this prototype has a lower-level base to place items and the rack can be adjusted in height.	Given that the hooks are design to be easily adjustable for different levels on the side arm of

	people in wheelchairs?			the prototype, the hooks remain very accessible.
Stability	Is the clothing rack prototype stable?	Yes	Yes, the prototype is stable. Weak point was found to be on the beam containing the grooves in the upper piece – reinforcement may be required.	Yes, the prototype is stable given its ability to lock in place with the rear pin.

8. Client Meeting Preparation

The next client meeting will discuss the current/most recent prototypes. The goal of the next client meeting will be to discuss what aspects the client likes about the current prototype and what aspects the client is not fond of. The feedback from the client will allow the design to be adjusted for the final prototype. The meeting will also serve to ensure that the team is on the right track.

The first step will be to show the current conceptual design to [redacted], the client, while the group discusses changes made and current target specifications. Next, the current prototypes (Prototype 1 A and B) will be shown, and their functionality will be demonstrated. Moreover, listed below are some questions that will be asked to start a discussion:

1. What do you think about the prototype? Is there anything you really like? Anything you dislike?
2. Is the material what you are thinking? Do you have any concerns with the material of choice?
3. Is there anything else you would like to add before we proceed with the next prototype?

9. Conclusion

For the deliverable, the original concept design formed in the previous deliverable was redesigned based off the information acquired from the second meeting with the client. After a new design was created, it was time to start breaking down the major aspects into smaller components that can be tested. The deliverable focused on breaking down the materials that are planned on being used, thus a bill of materials (BOM) was created as a way to plan out what to spend the $100 budget on; the current BOM predicts that the final cost will be $94.75. Once the bill of materials was created, a low-fidelity prototype of the entire system was created out of cardboard to test how the different components of the prototypes would work, such as the locking mechanism, the hinge mechanism, and the “slot and pin” mechanism. Through various methods of testing, it was determined that the prototype passed many of the criteria that [redacted] wanted with this project, such as the ability to change the height of the rack and the ability to disassemble the product. One aspect that may be changed in the future is the grooves on the top of the prototype for further stability, but the problem may also solve itself whenever the full-sized prototype is built and the correct materials are used. Working forward on this product, the team is going to be having many more weekly discussions to determine what material should be used and to prepare for the next upcoming client meeting as well as the next prototype.