



**“The Extendables”
Collapsible Clothing Rack**

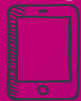
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Uottawa free store- who are they and what they need

The uOttawa Free Store is nonprofit store, that runs off of donations and volunteers. Who is in need of a new clothing rack!

Located on 100 Thomas
More Private #102 Ottawa,
Ontario



Instagram- uofreegratuit



3 Understood ^x REQUIREMENTS

~Durable- safe to use, and can handle a lot of weight.

~Collapsible- the Free Store is small, and space needs to be maximized.

~Accessible- to maintain inclusiveness to all students

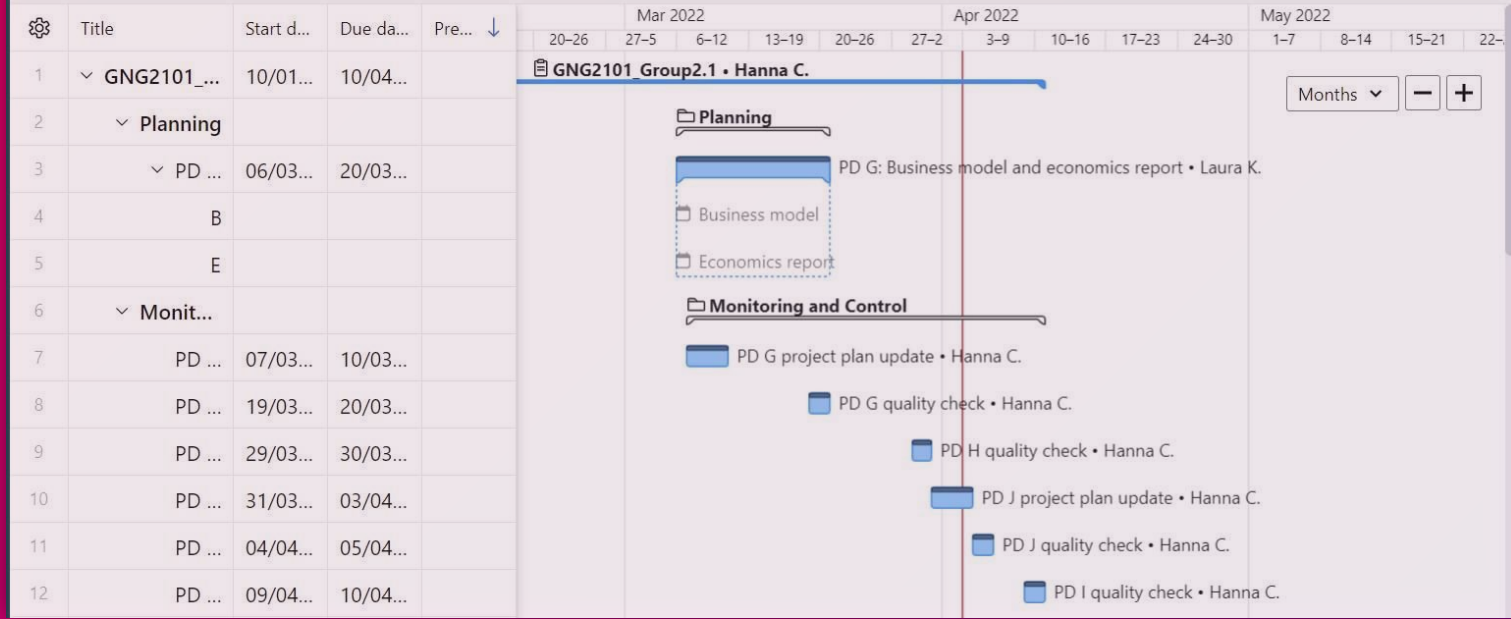
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List Gantt Chart +

All active tasks ▾ By Predecessors ▾ Expand all Collapse all [icon] [icon] [icon] [icon]

Snapshots ... [icon]



Customer Needs

Client Statement	Interpreted Client Needs	Priorities (1- most important 9- least important)
We would like to have racks that can be wheelchair accessible	The rack is adjustable in height	2
We would like to have racks that can be moved to different locations around campus.	The rack is collapsible and movable by hand	4
The clothing rack needs to be able to withstand the "not-very-careful" treatment of the rack by volunteers working at the free store who are in a hurry.	The rack is durable and can withstand rough handling	5
We would like to have racks that have an easy and intuitive set-up	The rack is easy to assemble by a maximum of two people.	6
We would like to have racks that aren't very expensive	The rack is cheap	3
We would like to have racks that can hold a lot of weight	The rack is stable and strong enough to hold a lot of clothing	1
We would like to have racks that can be easily moved by a maximum of two people	The rack is light enough to be carried by a maximum of two people	7
We would like to have racks that are quick to set-up	The rack is fast to assemble	8
We would like to have racks that look very polished and clean	The rack is aesthetically pleasing and simple in design	9



“The uOttawa Free store is looking for a collapsible clothing rack that is both easily mobile and cost effective, with high clothing capacity and moderate weight bearing ability while remaining accessible and easy to set up.”

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Product Benchmarking



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Customer Benchmarking



Target Specifications

Specifications	Desired Value	Justification
Performance- Travel	The Clothes Rack can be moved across campus without the wheels stopping.	The clothes rack needs to be easily moved by one person across campus without any issues.
Service Life of the Clothes Rack	The Clothes Rack will have a continuous service life of 10 years.	The clothes rack needs to be durable to withstand a service life of 10 years.
Aesthetic	The Clothes Rack will have an aesthetic and clean appearance.	The clothes rack should have an aesthetic, clean appearance and to have enough room on the end to place quotes.
Material	The material used will withstand indoor and outdoor conditions	The clothes rack will be made with durable material to withstand moving around indoors and weather conditions in the summer and fall.
Set-Up	The set-up process can be easily set-up by one person within a small-time frame.	The Set-Up process is required to be set up by one to two people maximum as quickly as possible.
Performance- Working Wheels	The wheels will lock easily when required to stop the clothes rack from moving.	The customer had stated that working, locking wheels is essential for the space that is available.
Accessibility	The clothes rack will be lowered to various heights for wheelchair accessibility.	There is a need for an accessible clothes rack for wheelchair accessibility. The clothes rack will be required to be raised and lowered with ease.

Functional Decomposition



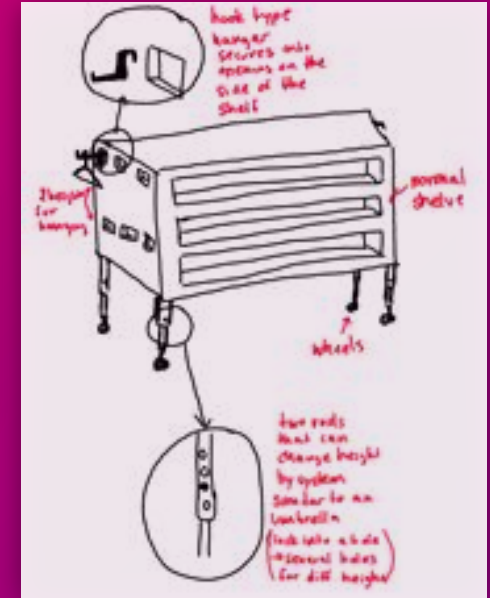
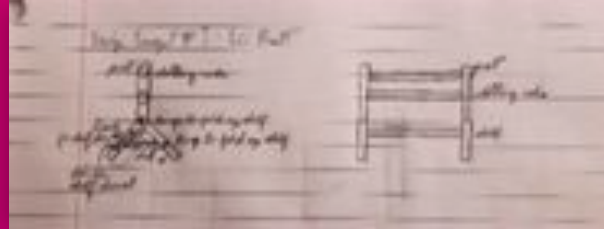
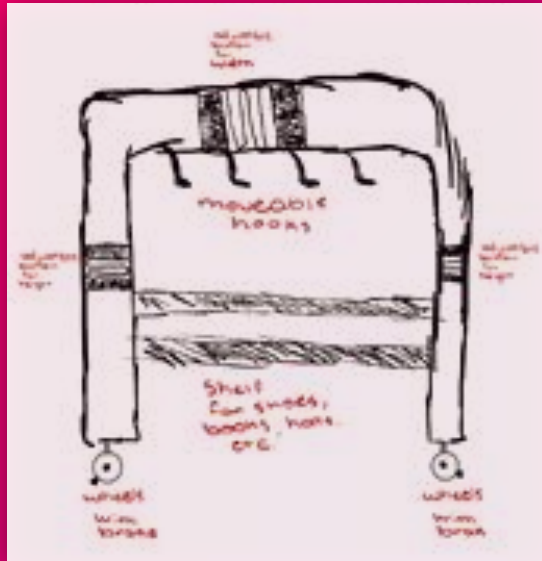
-Durability

-Accessibility

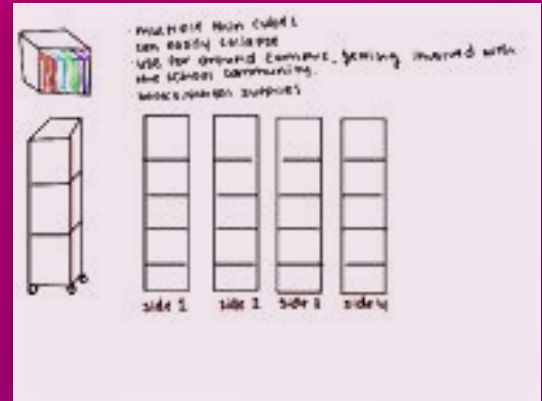
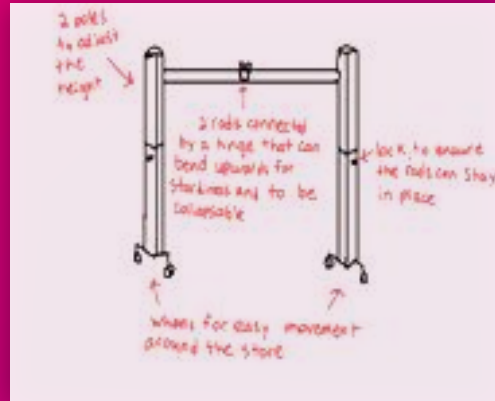
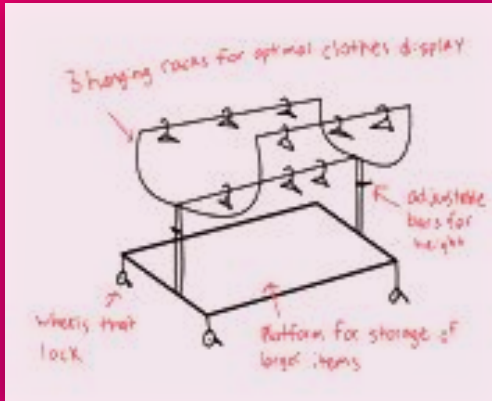
-Adaptability



Concepts



Concepts

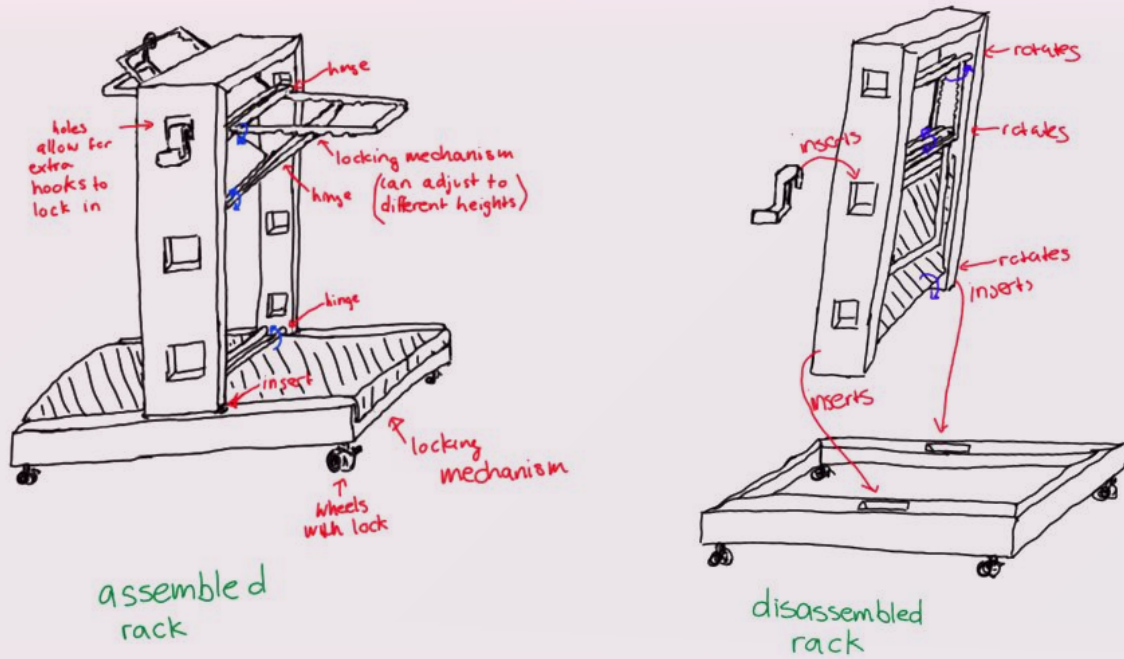




Decision Matrix

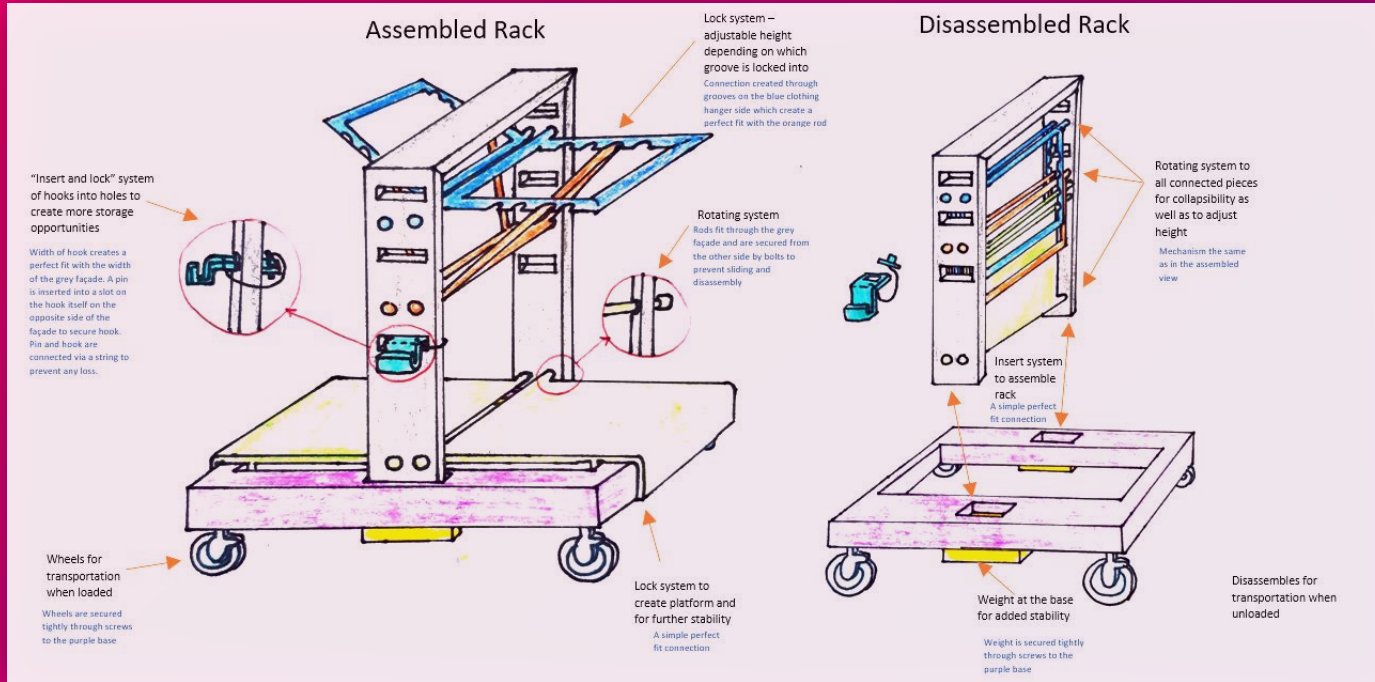
#	Criteria	Weight	Concept														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Moveability/ Able to transport	4	3	3	1	3	1	2	3	3	3	3	3	3	3	1	3
2	Quick set-up time/Collapsibility	4	3	2	1	1	3	3	1	2	2	3	1	1	3	1	2
3	Stability/Durability	5	2	3	3	3	2	2	2	2	3	1	3	2	2	3	3
4	Easy/Optimal storage	3	3	2	3	1	3	3	1	3	2	3	1	2	3	3	3
5	Able to withstand outdoor conditions	2	3	2	3	1	2	2	1	3	3	3	2	2	3	1	3
6	Able to withstand outdoor conditions	4	3	3	1	3	3	2	3	2	3	1	2	2	1	1	3
7	Adjustable	5	3	2	2	2	2	1	2	3	2	3	1	2	3	1	3
8	Cost	4	2	3	1	1	2	2	1	3	2	2	1	2	1	1	3
9	Aesthetic appeal	1	3	2	2	1	3	3	3	3	3	2	3	2	3	3	3
10	Accessible	5	3	3	3	1	2	2	2	3	2	3	3	3	3	3	3
Total			102	96	73	68	82	77	70	98	90	88	73	79	90	65	107

Initial Design





Final Design





Feasibility Study

- Budget
- Timing
- Mechanism



Bill of Materials (BOM)

Item #	Part name	Description	Link	Quantity	Unit Cost (\$)	Extended Cost (\$)
1	Wheels	4pcs of 1.96" Lockable Hard Rubber Wheel	Obtained from Home Hardware	4	9.49	37.96
2	Elbow Joint	1 ¼ inch elbow joints	Obtained from Canadian tire and Home Hardware	16	1.49	23.84
3	PVC Piping	6ft long PVC Pipe	Obtained from home Hardware	3	9.49	28.47
4	Screws	Varying sizes	Will bring from home	50	0.00*	0.00
5	Wood	1"x4"x6'	Will bring from home	10	0.00*	0.00
6	Sandpaper	2 pieces of sandpaper	Obtained from Home Hardware	2	4.99	9.98
Total						100.25



Critical Assumptions

Verifications planned for the rack:

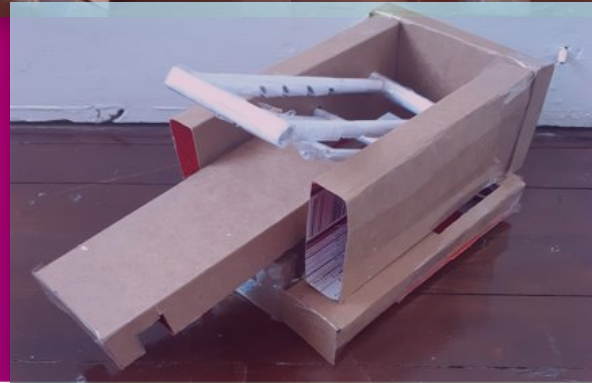
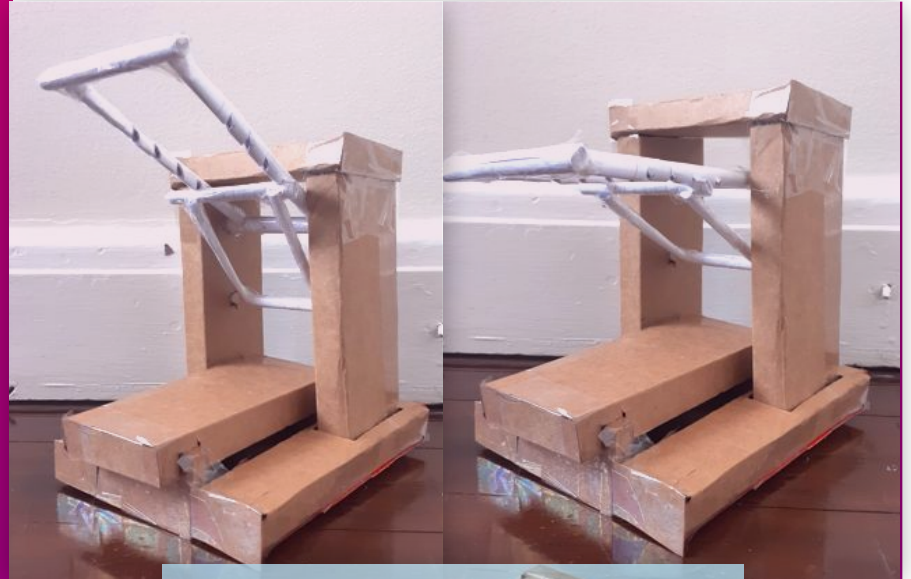
1. Transportability
2. Aesthetically pleasing
3. Can handle up to 15 pounds of clothes on each rack
4. Disassembly/reassembly takes under 20 seconds
5. Wheelchair accessible
6. Rack is stable

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Prototype 1A

- Mechanism Tests
- Structural Test



Prototype 1 B

Tests Planned:

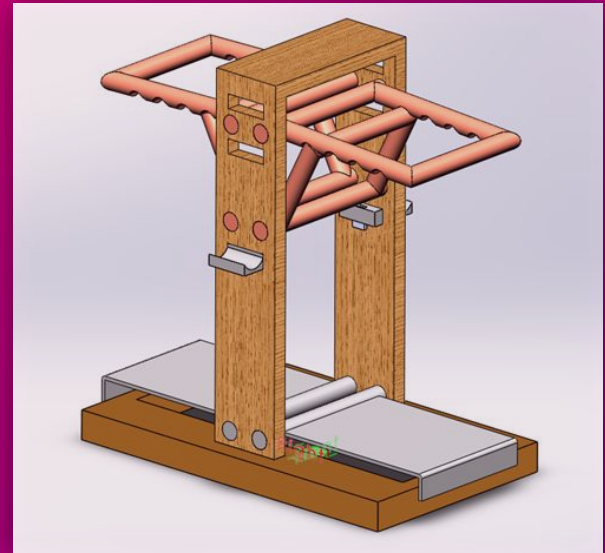
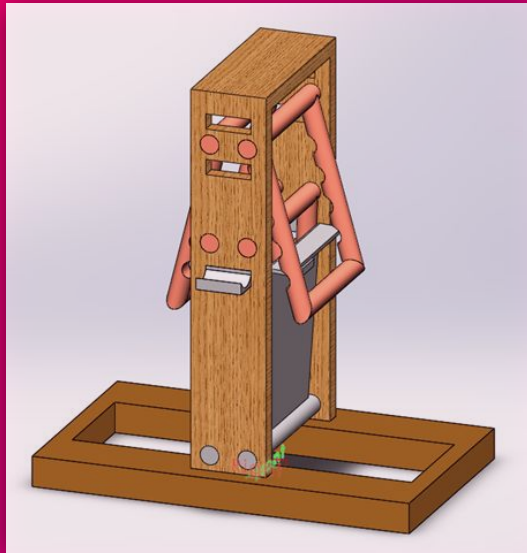
1. Can the ancillary hooks on the side tolerate 5 pounds of force
2. Can these hooks be taken out and adjusted easily?
3. Is there any bending in the hooks under 5 pounds of force



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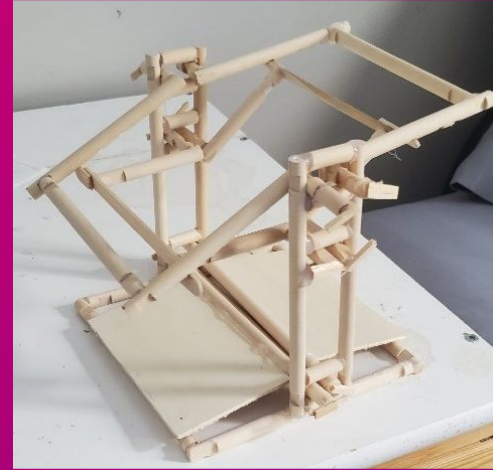
Prototype 2 - Analytical

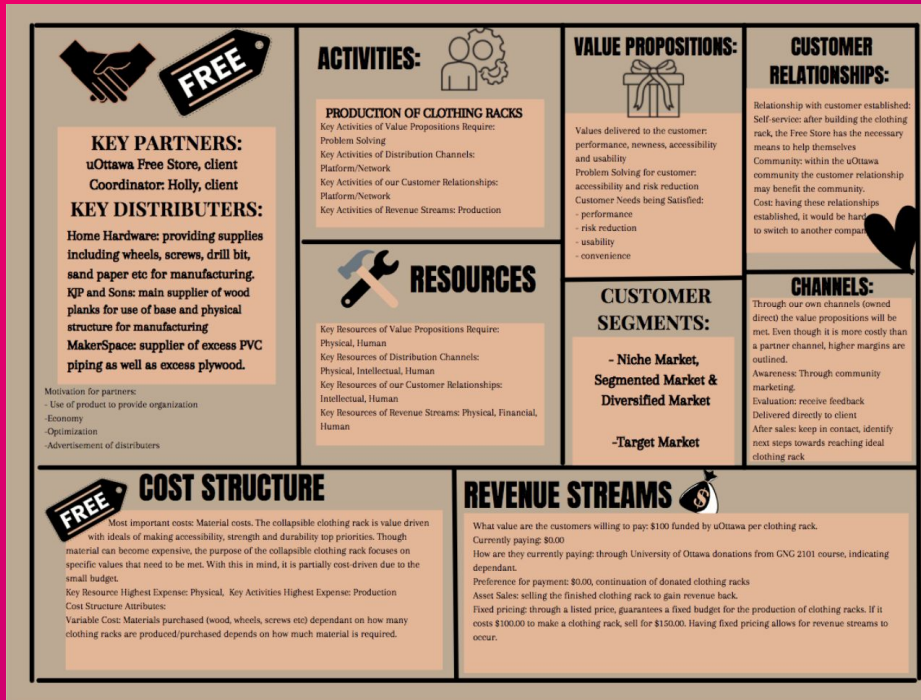


Prototype 2B

Tests:

1. Weight bearing ability
2. Mechanism feasibility





Business Model

Income Statement

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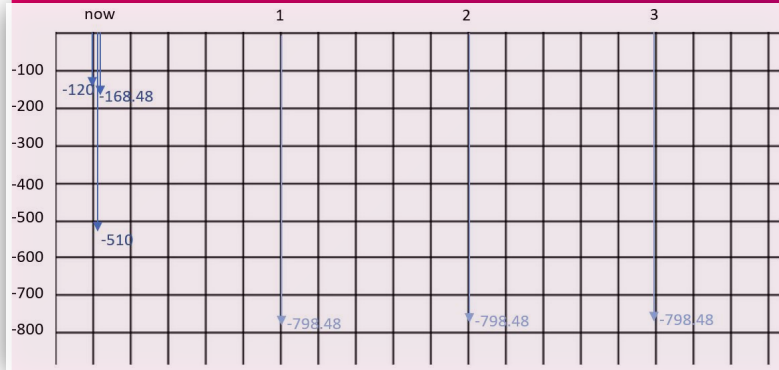
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Gross Profit		
Sales (Revenue)	\$4500.00	
Costs of Goods Sold	\$1705.50	
<u>Gross Profit</u>		\$2794.50
Operating Expenses		
Marketing Expenses	\$360.00	
Boxes for Shipping	\$505.44	
Labour Expenses	\$1530.00	
<u>Total Operating Expenses</u>		\$2395.44
Operating Income		
<u>Operating Income</u>		\$399.06



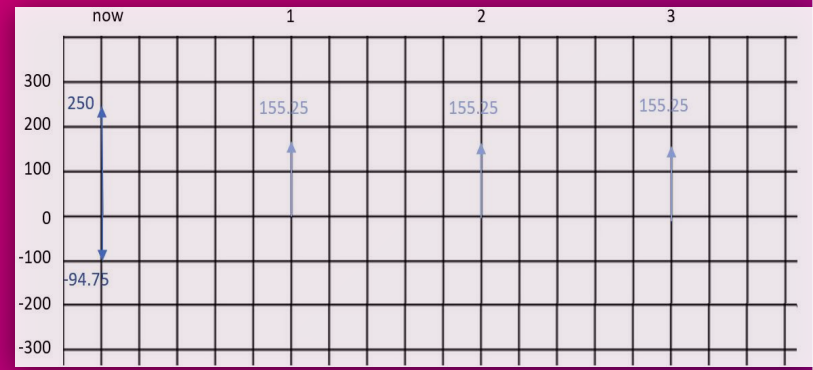
NPV Analysis

Cash Flow Diagram (Income):



Difference in NPV Values:
-\$643.23

Cash Flow Diagram (Expenses):



Break Even point:
6 units/year

Trials:

- 1) Lack of ability in construction
- 2) Budget constraints
- 3) Material sourcing

Lessons Learned:

- 1) Don't overestimate budget
- 2) Be specific and measure twice when making measurements
- 3) Overestimate time required for different tasks

Future work

Future work:

- 1) Increasing conceptual design fidelity
- 2) Redesign ancillary hooks
- 3) Increase aesthetic

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Final Prototype

Live demonstration