Project Deliverable H: **Prototype III and Customer Feedback**

GNG 1103 – Engineering Design

Faculty of Engineering – University of Ottawa

Divine Ciroma-(300110246)
John Zhou-(300066864)
Omolola Omowa-(300130234)
Magd Abdelmelek-(300068369)
Saad Rana-(300137756)
Brian Zhau-(300128528)

Vedashri Patil

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# Abstract

This deliverable provides information about the tests, purpose, analysis, and a small description of our final prototype. Furthermore, it shows our justifications and reasoning for the final prototype, which include a detailed description of our results from prototype 1 and 2 and how both prototypes improved our end product.

# Introduction

This deliverable focuses on the final prototype status update and planned execution under normal conditions. Beforehand, we have outlined the problem and have constructed a prototype 2, as shown in figure 1 below, using inexpensive materials like small popsicle sticks and a clear plastic bag bought from the Dollarama store and put together using adhesive, which all cost around 20$. During the semester, we have interacted with our client as well as the Professor to get clear feedback on what needs improvement and how we can accomplish a better final prototype based on what we already have. Our original plan was to present some standard objectives which will make sure whether or not the performance testing for the final prototype is achieved. Unfortunately, due to the pandemic outbreak of COVID-19, our building construction was still not yet completed. In this case, the report will present a precise statement of the existing status of the final prototype with as much work completed while noting social distancing limits for safety reasons, and a detailed plan, which will show the remaining activities that would have been completed if COVID-19 did not exist.

Figure 1: Front and side view of Prototype 2

# Final Prototype Status Update

The Final prototype status update will provide descriptions and documents of the final prototype, purpose and function of the final prototype, and client interaction of the final prototype.

## Descriptions and documents of the final prototype

Improvements were made to prototype II to create the final prototype. The final prototype consists of the reinforced walls and base using triangular support boards on each of the corners of the greenhouse. Since there was leftover wood from creating the walls and base of the greenhouse, we used the extra wood to construct a gambrel roof in order to help reduce the risk of the roof collapsing under snow weight and reduce the budget. We also used the leftover wood to reinforce the roof with support beams. To keep the water from going into the greenhouse, we have placed PVC roof panels that will also allow the water to flow down into the gutter for water collection for the hydroponics system. We planned to add the gutters along the side of the greenhouse. Next to further waterproof the greenhouse, we will put sealant to close up the gaps in the roof and anywhere else where water may enter. As for the walls, we will wrap it with a clear vinyl wrap to ensure it is fully enclosed. To keep the animals out, the team has decided to put copper mesh around the bottom of the greenhouse.

**Figure 2: Documentations (images) of the current construction of Prototype 3 (more in appendix)**

## Purpose and function of the final prototype

The purpose of this final prototype entails that: "The need exists for members of the Algonquin of Barriere Lake community to increase their food supply with the availability of sustainable greenhouse (hydroponic system) that is self-sufficient, easy to control, compact, insulated, affordable, and able to provide warmth all year for growing plants."

The function of the final prototype was to ensure our customers the best accomplishment toward the finished project. Prototyping enhances the quality of the specifications and requirements given to clients. Taking everything into account, the model helped us to decide early what precisely the customer needs and what we have to alter in our plan with quicker and design specifications.

## Client interaction of the final prototype

The main objective of this project is to make our customer happy and keep her satisfied. Monique's feedback from previous client meetings helped us to modify the quality of the design specifications and requirements she required. With the prototype, our client would have been able to interact with a working model of the project, give her immediate feedback, request project changes, and alter model specifications. It most importantly helped us eliminate misunderstandings and miscommunications.

## Feedback and Video of the final prototype

Our client, Monique, has been satisfied with what we had already completed since the start of the project. She had some concern about the overall protection of the building, so we took her feedback very highly, and we were supposed to add copper mesh the following week to the base of the greenhouse. Furthermore, the professor and the TA's have assisted us in every way they could by giving us their full support and guiding us throughout the construction of our physical greenhouse, as well as the prototypes. The TA's made sure we were managing our budget strictly, and they also gave us constructive feedback about the kind of solar panel, batteries, and generators to use too. The conclusion of the final prototype went well. One area that the lab coordinator discussed with us was regarding the design of the roof. Overall the greenhouse stands firm, and everyone that has seen it only had positive feedback. Moreover, we are confident that the finished product will meet the client's expectations.

*Please find the attached video submitted on Brightspace.*

## Final prototype testing

The test to observe the ability of our greenhouse to supply the needs of the client while keeping our client's specifications was paramount. If our materials are strong enough, in spite of different weather conditions or seasons, it would significantly conserve the plants inside.

For the testing of the final prototype, we used a cup of water to splash on top of the model to see if any water leaked inside. Based on the testing it has passed all the targeted specifications needed by the client.

### Table 1: Target Specification (deliverable C)

| # | Design Specification | Relations (=, < or >) | Value | Units | Verification Method |
|---|---|---|---|---|---|
| | ***Functional Requirements*** | | | | |
| 1 | Easy to Assembly | = | yes | N/A | Test |
| 2 | Weight supported | = | yes | lbs | Analysis |
| 3 | Contains an hydroponic system | = | yes | N/A | Test |
| 4 | Should allow plants have access to sunlight (nutrient solution) | = | yes | N/A | Test |
| | ***Constraints*** | | | | |
| 1 | Size (length, width and height) | < | 8 * 8 * 6 | ft. | Analysis |
| 2 | Cost | < | 500 | $ | Estimate |
| 3 | Temperature | = | -33 to 4.1 | (°C) | Test |
| | ***Non Functional*** | | | | |
| 1 | Aesthetics | = | yes | N/A | Test |
| 2 | Product Life | > | 5 | Years | Test |

| | | | | | |
|---|---|---|---|---|---|
| 3 | Security | = | yes | N/A | Test |

**Table 2: Expected vs. Actual results**

| # | Test | Expected result | Actual result |
|---|---|---|---|
| 1 | Strength test | The plywood should be strong enough to provide more stability for the final prototype. | Success |
| 2 | Physical test | The roof paneling should easily collect the water, and allow the sunlight to enter through the final prototype. | Success |
| 3 | Analysis Test | Gambrel roofs provide excellent drainage because of its steeper slope design, it can easily manage the rainfall the best, as the water simply runs off of the side of the building without getting captured. | Success |
| 4 | Analysis Test | Copper mesh around the base plywood to prevent any rodent from entering the greenhouse. Copper mesh has really tiny holes and it is easy to install, so it was a suitable choice for protecting the greenhouse. | Success |

As seen above, the *Target Specification* and the *Expected vs. Actual results* are similar.

# Planned Execution under Normal Condition

**Describing every aspect of not completing the final prototype due to COVID-19 facility closures and "social distancing" as well as step-by-step action plan.**

Note: Since social distancing was the only way to keep us safe from the virus, tasks 1 & 2, listed below, could not be achieved in the final prototype.

*Detailed Gantt chart of the project plan*

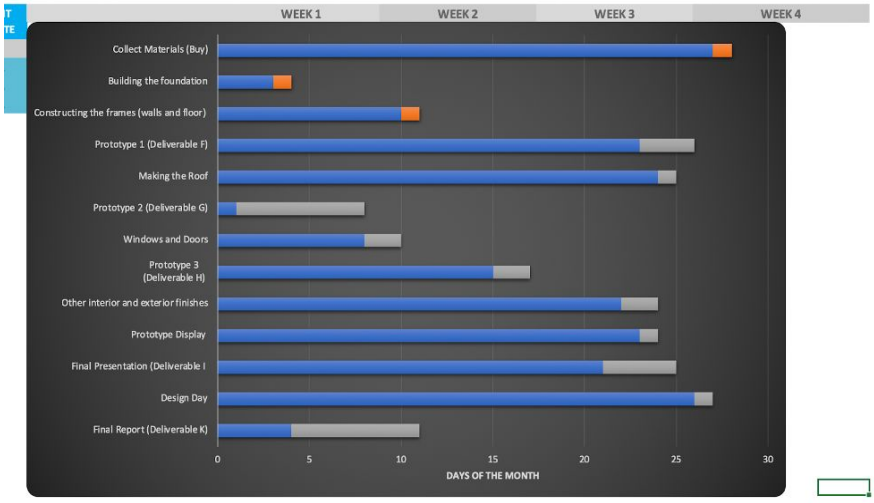


**Figure 3: Previous Gantt Chart**

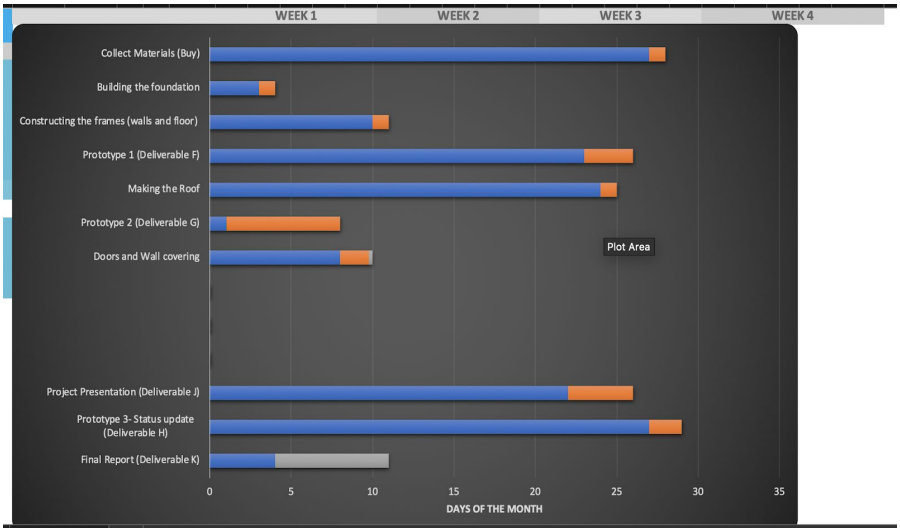


**Figure 4: Updated Gantt Chart**

Note: There is a huge gap between *doors and wall covering and Deliverable J* and this was due to the Pandemic outbreak. Below, find attached the list of tasks, the estimated duration of these tasks and a detailed description of each task:

# Project Plan

| # | Task | Estimated Duration |
|---|---|---|
| **1** | Doors, Wall covering, copper mesh, and Gutters | 2 days |
| **2** | Other interior and exterior finishes | 4 days |
| **3** | Prototype Display | 1 day |
| **4** | Design Day | 1 day |
| **5** | Final Presentation (Deliverable J) | 4 days |

**Task 1:** Doors, Wall covering, copper mesh, and Gutters

The door will open outward to prevent space loss in the greenhouse. It will be the height of 5 ft and it will have a width of 2 feet . The door will be made out of plexiglass to provide maximum light.

For the wall covering, wood planks will line all 4 sides of the walls. The planks will be 2 feet in height. This will increase the strength of the structure of the greenhouse, which will provide protection against strong winds. The wooden planks will also provide a barrier for the plants from rodents. The Vinyl sheet will provide airtight insulation allowing the heat to stay within the greenhouse, while also allowing in ample sunlight, and it will also provide protection against harmful UV rays.

Copper mesh is used at the bottom of the wall attached to the wooden planks in order to prevent any rodent from entering the greenhouse. Copper mesh has really tiny holes and it is easy to install, so it was a suitable choice for protecting the greenhouse.

There will be a gutter, made of plastic, at one side of the roof of the greenhouse to collect the water from the roof to the rain barrel.

### **Task 2:** Other interior and exterior finishes

This task was supposed to be based on correcting errors that were found and adding any finishing touches before any further projections for future tasks. Also, the hydroponics concept was going to be added here

### **Task 3:** Prototype Display

This task involves the disassembling and assembling of the completed greenhouse in preparation for *Design day*.

### **Task 4:** Design Day

Design Day guarantees to stun the public with students' invention and creativeness. Our engineering knowledge is put to the test by explaining the developed solutions for the greenhouse we built to potential clients and judges. Our presentation was supposed to be graded by the professor and the judges physically.

### **Task 5:** Final Presentation (Deliverable I)

The Deliverable I was supposed to be a written Project submission on Brightspace after Design day and it was supposed to be detailed.

## Final prototype target specifications.

This section does not apply to our deliverable because we specified that we have tested our final prototype above, and we used our engineering knowledge to evaluate and compare the testing results and target specification.

# Conclusion

Heretofore, the construction of prototype 3 was going well. Using knowledge of theories from various disciplines, we carried out multiple physical testing and analysis testing; the overall design and lessons learned from the previous prototypes were also used in the creation of the final prototype. We were confident that the design of the greenhouse was going to be a success. We were really proud and looking forward to its completion and to see the reaction of the client to the finished product, but due to COVID 19, we would never get the chance to see the prototype come to life.

# Appendix


**Figure 5: Vinyl sheet**

**Figure 6: Roof Paneling**

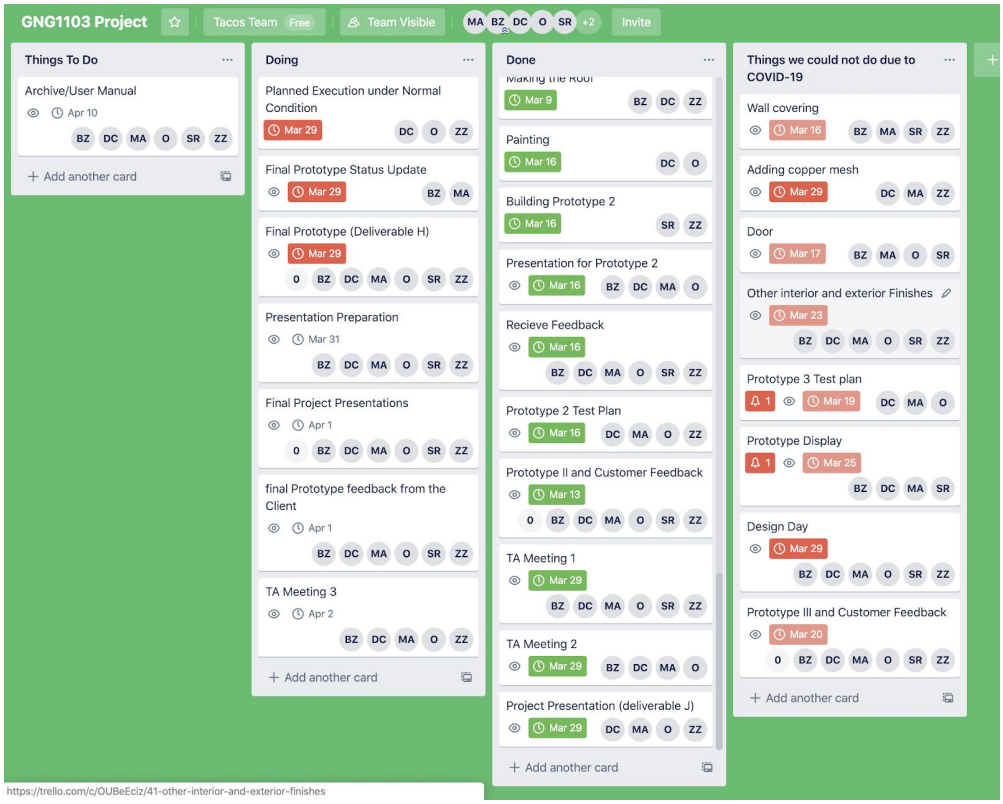


**Figure 7: Trello Week 10 (changed due to COVID-19)**

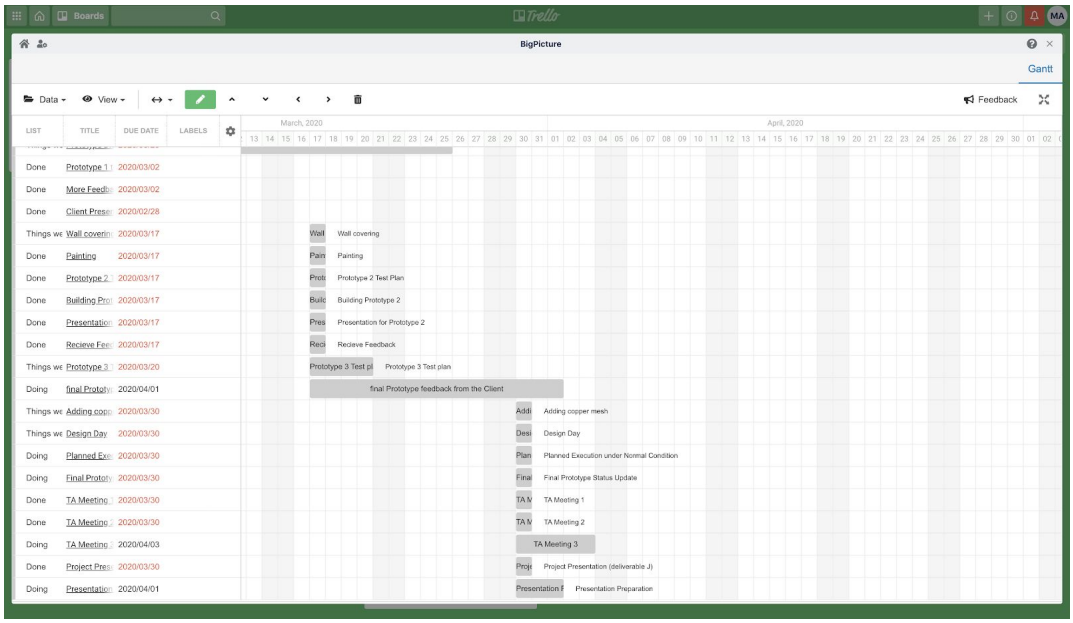


**Figure 8: Trello Week 10 (Gantt Chart)**

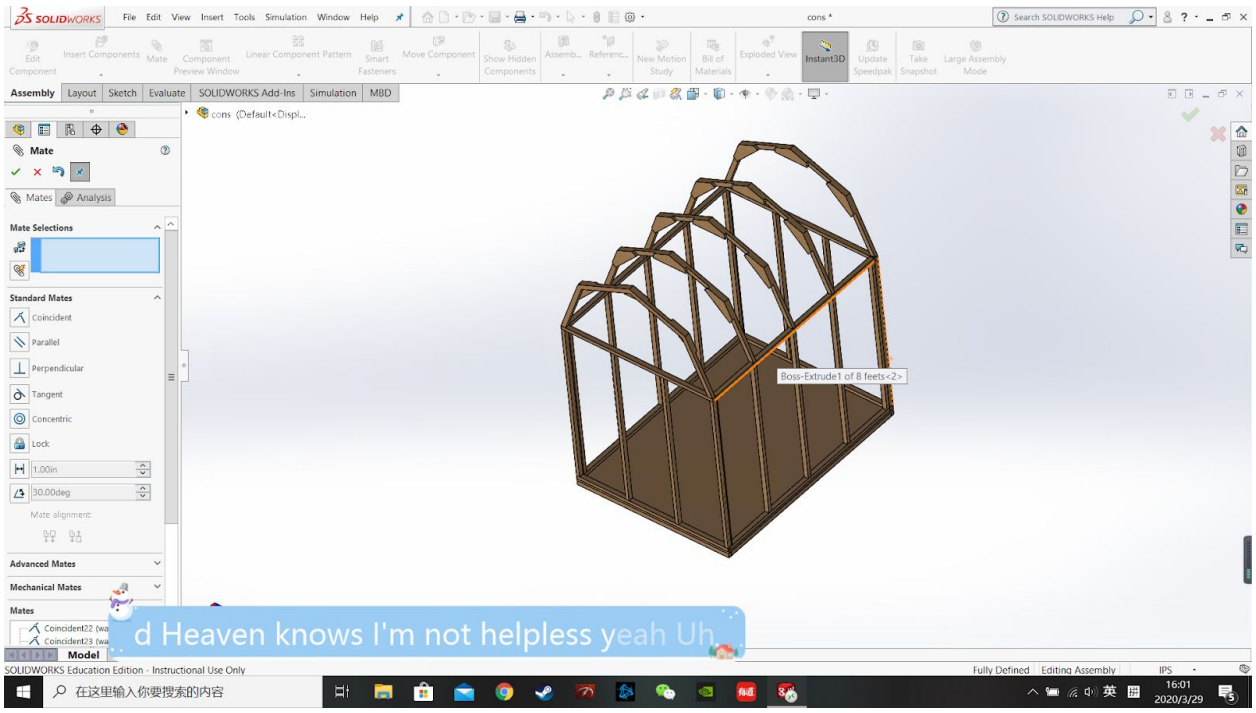


**Figure 9: SOLIDWORKS (Top view)**

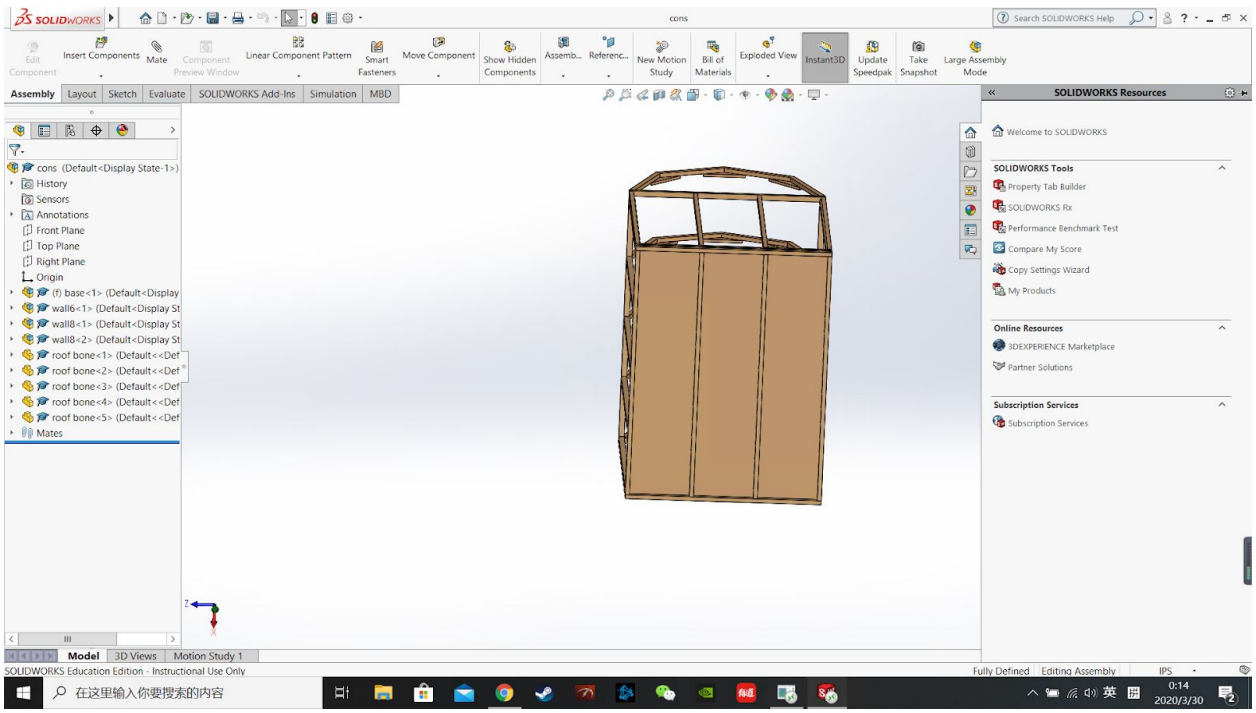


**Figure 10: SOLIDWORKS (Bottom View)**