Status Update

GNG 1103 – Faculty of Engineering – UOttawa

Hydroponics Group 1

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Introduction

This deliverable's objective is to provide an update on our hydroponics project. It will highlight what was done for the past two prototypes, client feedback, and what work would have occurred had there not been a school shutdown.

The digital prototype for prototype II was the final prototype that was created before all CEED labs and in-person classes were cancelled. Some work on prototype III has been done by one team member (Joseph) who had the opportunity to bring the materials home. Joseph tried his best to create as much as he could with what he had. Pictures of his work and the design of our hydroponics system will be in later sections.

Prototype I

This first prototype is a simple proof of concept, which aims to show that the theoretical design will work in practice. This prototype was completed a few weeks ago, before our first client meeting. This prototype allowed us to perform calculations and tests for all the important systems, without having to purchase any materials. It helped us rule out any potential issues/problems and was created with zero cost using tape, and cardboard. This prototype will deal with the macroscopic pieces of this design. It will show that our system can indeed fit within the required area, is properly supported, and will perform its basic functionality. Figures 1 displays the support structure and Figure 2 displays the nutrient solution runs . Figure 3 illustrates the completed prototype. This prototype is at a 1:3 scale for our optimal design chosen in earlier deliverables. Once again, the cardboard model was chosen because it can quickly and easily show and validate our design without us having to go purchase expensive material. Prototype I will help us identify basic strengths and weaknesses in our design. Since the prototype costs little to nothing, it is in compliance with our budget that was set out in Deliverable E.

Figure 1: Prototype I - The plant support structures

Figure 2: Prototype I - The nutrient solution runs

Figure 3: Prototype I - The complete prototype

After meeting with our client, Monique, she was very impressed with our first prototype. The client was intrigued by our composting and nutrient system. The client proposed that she would talk with local schools and see whether or not a compost system would work. If the compost system would work, the team agreed that there would need to be a composting guide provided with the design. Prototype I was a success at demonstrating a basic proof-of-concept of our design to the client and the team. The prototype made the team's ideas and methodology formed in previous deliverables more understandable and easier to present.

Our first two models are intended to be “business models”, they will follow as many of our design criterias as possible while being relatively inexpensive. These measures are taken in order to ensure that our design remains within our $100 budget.

After receiving feedback from our first client, we will be adjusting our first prototype so that it reflects the suggestions made by our client.

Prototype II

Prototype II was supposed to focus on the development of our key subsystems, such as the nutrition and circulation systems. Due to the pandemic, in-person classes were cancelled before the group could purchase all materials and complete the physical prototype. Therefore, prototype II was created using Solidworks. Figures 4, and 5 illustrate the 3D Solidworks model of our design for prototype II. Using 3D modelling allowed us to minimize costs and further complete the design for our nutrition and circulation subsystems. The nutrition system is designed to combine compost with water to provide nutrition which can be used by the plants. The circulation system will pump the water to the top of the hydroponics system properly. The aeration system will aerate the water.

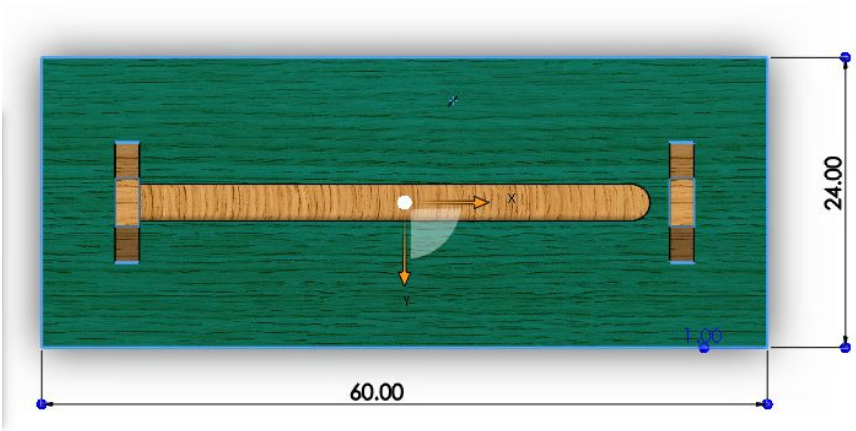

Figure 4: Top view of Prototype II in Solidworks

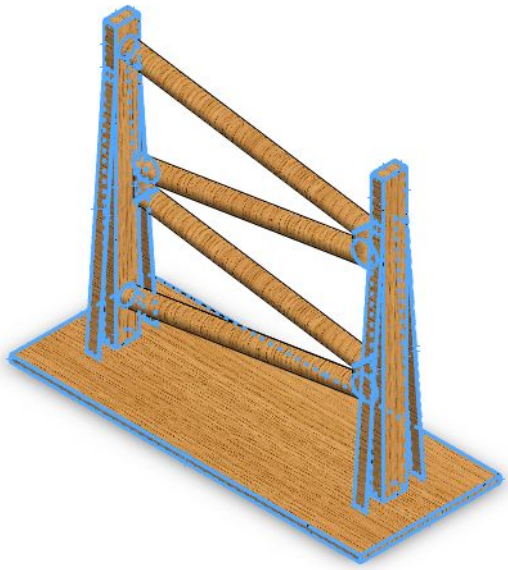

Figure 5: Prototype II in Solidworks

We were able to test the pumps obtained from the Makerspace lab in order to ensure that water can be pumped at a sufficient level. Based on the testing results, we could visually observe that the water pump was strong enough to pump water through the pipes and at a considerable height. Therefore, we can conclude that our selected pump would have had enough power to power our hydroponics system. The test plan for the project will be submitted along with this document.

The following tests should have been conducted during our second prototype:

1) Nutrition System Testing: To test the nutrition system, the team will mix ideal compost with water for 48 hours and examine the nutrition content produced, as to whether the compost mix will provide enough nutrition to sustain the plants.
2) Circulation System Testing: To test the circulation system, pumps received from the makerspace will be tested with a variety of piping at various head heights. This data will then be analyzed to provide parameters for the pump which is to be purchased for the final system.
3) Aeration System Testing: To test the aeration system, further research is needed to determine which type of aeration system will be used. Afterwards, the Dissolved Oxygen

(DO) levels will be tested with the chosen system throughout the circulation system in order to check that the levels are above the minimum required for healthy plant growth

On March 13th 2020, we completed a presentation on our work progress and it was recorded by the TAs. These presentations were submitted to the client for their final feedback. The client's feedback would have been incorporated into our final design, if there was no pandemic.

Prototype III/Next Steps/Future Work

On Friday, March 13th, 2020, the University of Ottawa cancelled all in-person classes and closed all CEED labs due to the COVID-19 pandemic. As of Wednesday, March 18th, 2020, all classes have been on an online platform. Groups were not able to complete their designs in-person and design day was cancelled. Therefore, prototype III was not completed. One of our team members, Joseph Francis, was able to take some of the material with him before leaving campus in an attempt to create/build as much of prototype III as he could at home.

The final prototype, prototype III, was supposed to be the full structure of our hydroponics system. It was to be designed using piping, tubes, and pumps provided by Makerspace. Other materials such as storage bins, buckets, zip ties, plants (leafy-green vegetables and small berries), pots, and growing mediums were to be purchased using our $100.00 CAD budget. We had created a shopping list and were planning to meet and complete the prototype in the past few weeks, but for obvious reasons were not able to. As mentioned before, Joseph went out during the past week to go buy a few materials in order to do as much work as he could on prototype III. Of course the entire prototype was not completed, but the following figures, Figures 6, 7 and 8, demonstrate how far we were able to get with prototype III. Because we had a short amount of time to collect our materials from STEM and the CEED labs, not all materials were able to be picked up. Therefore, more pipings and items were purchased to help complete the prototype.

Figure 6: Materials purchased for Prototype III

Purchases for the third prototype included PVC piping, 3 containers which would serve as water reservoirs, and some tubing (not pictured above). The cut made for the plants in the bottom-left picture of Figure 6 is an example cut made with a saw (future cuts would be made more circular using a reciprocating saw).

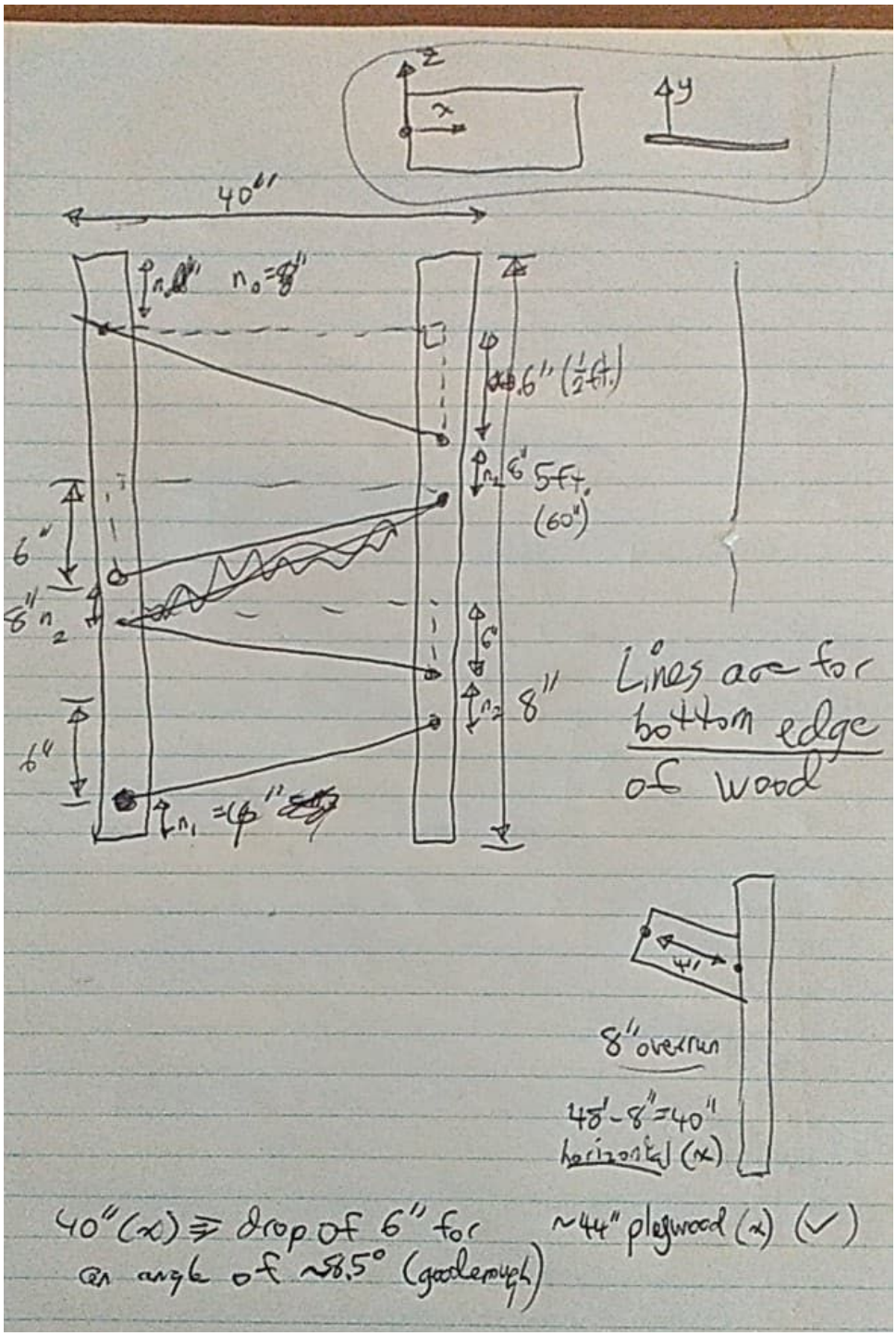

Figure 7: Plan for stage I assembly of prototype III

The idea was to create a stable structure which could hold 4 runs of PVC piping, with the ability to easily connect/disconnect the piping.

Figure 8: Stage I Assembly For Prototype III

The assembly for the structure and PVC piping was not as stable as hoped, therefore the choice was made to have a connection of runs on either side of the wood support structure, balancing weight on either side.

Moving forward, the structure in Figure 8 will receive some additional supports to ensure durability, as well as the addition of piping or tubing in between the runs. Lids for the PVC piping were not purchased originally and are needed. Further support for the piping must be added to ensure it cannot slide out (the addition of the lids may solve this problem). Then the water reservoir system will be assembled and connected to the hydroponics structure with spaghetti tubing. Then durability, compost efficacy, DO and nutrient levels, and compatibility with the greenhouse will be tested before making final purchases (eg: pots and growing medium for the plants).

Future steps include completing the remaining structure by adding more PVC piping, and connecting them all with the tubing. After that we would need to test with a pump and containers/buckets of water to see if the water can be accurately and efficiently pumped throughout the system. Once that is done, we can figure out the composting/nutrient solution and make sure that it is also being pumped efficiently and sufficiently with the water throughout the system. More testing and analysis in regards to the functionality of the system would have needed to happen to ensure that the system worked properly/efficiently. More analytical data on how much power needed to power the system would also need to be done. The testing plan will be included in this submission. Purchasing plants and trying to grow/maintain them using the completed hydroponics system would have been the final step.

Conclusion

Once prototype III was completed, we would have prepared ourselves for design day and our presentation to the judges. Since design day was cancelled, we will be writing this status update instead and giving a presentation on Zoom on April 3rd, 2020. Our final user manual is due on April 10th, 2020. The user manual will provide more details on our project.