

Hydroponics

Group B4

Introduction

After showing our updated prototype to our client, we received helpful feedback on how to work on our final prototype. After discussing our prototype II and our plan on what to include for our hydroponics system, our client gave us feedback and approved us to start on the final prototype.

Testing Plan

Goal: To Continue construction of the Hydroponics system using items already purchased, as well as decide on the method of implementation of the heating and water collection systems.

Process:

1. Purchase styrofoam insulation lid for Water Reservoir
2. Cut holes for the planting cups to rest in. Hole Diameter must be chosen to maximize the number of planting cups while remaining structurally strong.
3. Continue research on greenhouse heating systems, and deciding on the proper solution(s) for our project.
4. Decide on the criteria for the water storage reservoir.
5. Find 3D-printable alternative to costly drainage valve.

Results

Insulation styrofoam was chosen as the lid of our Hydroponics system because it is more rigid than most traditional packing styrofoams, has some UV resistance, and floats. This buoyancy property will allow the plants to rise and lower with the changing water level in the reservoir. If the plants consume water quickly, this will allow the plants to always have access to water, regardless of whether or not the water level has been adjusted frequently.

It was decided to use plastic drinking cups as our planting pots because alternatives from stores were much more expensive, and we could not find the sizes needed at a reasonable price. The cups are easy to replace, and a good size for the small to medium sized plants that we are aiming to grow with our system. The size of cups

Hydroponics

Group B4

chosen allowed us to find a balance between the size of plants, the number of plants, and the spacing between each plant that we think will match the needs of our clients.

The circles have a diameter of 8cm. This is less than the actual 9.3cm diameter of the cups. This allows the cups to sit above the styrofoam, allowing for more material to be left for structural purposes, while still maintaining the same number of planting pots. The ridged design of the cup also helps keep the cup in place.



Hydroponics

Group B4



Hydroponics

Group B4

The next goal to be reached for this prototype was to decide on the heating system. The constraints on possible heating solutions were very limiting. Not only were we able to budget approximately \$50 towards the heating system, but we also had to contend with the 260W maximum power output of the solar panel, as well as the limitations of the included battery. Conventional space-heaters had 500W and greater power requirements, so we had to find alternatives. It was decided that a plant-focused heating solution would be necessary. It was decided that a 50W aquarium heater, and a 100W heat lamp would be our best option. The aquarium heater ensures that the water in the reservoir doesn't reach freezing temperatures, while the heat lamp will be hung above the system and heat the air around the plants.

On top of electrically based heating systems, some other methods can be employed to heat the greenhouse. By filling water bottles with water, painting them with matte black paint, and positioning them around the greenhouse, solar energy can be absorbed into the water during hours of sunlight. The energy is then released during the night. Furthermore, our rain collection barrel and Water Reservoir can also act as thermal masses.

The next aspect of the project to be decided for this prototype was that of the water storage system. Criteria decided on was that the volume of the container must be greater than that of the Hydroponic System water reservoir so that the system could be completely re-filled at once. The barrel would also have to be made of a soft plastic so that drainage holes could be drilled into the side without cracking. Lastly, if a black barrel was to be found, that would help the water storage double as a thermal mass for heating.

Lastly, a cheaper solution for adapting our water storage system and water reservoir for pumpless drainage than the solutions described in the deliverable E parts list had to be found. A 3D model was found that appears to offer the same functionality of the previous solution. Time will have to be allotted to print out the adapter and valve to ensure that they will meet the needs of our system.

Hydroponics

Group B4

Conclusion

By finding a suitable product and material for the lid of our Hydroponics system, as well as making the cutouts for the planting cups and testing the fit, we were able to confirm that our system is able to hold a suitable number of plants for the client. The choice to use the plastic drinking cups from our original prototype as planting pots ensures we were able to meet our budget specifications, without compromising the quality, reliability and maintenance level of our system. Selecting a 50W aquarium heater (as opposed to our previous idea of a conventional space heater) for heating the water inside the system allowed us to stay within the 260W maximum output of the solar panels, and using a 100W heating lamp helps maintain a warm temperature in the air surrounding the plants. The implementation of both these heating solutions allowed us to fulfill our client's need for keeping crops alive in temperatures as low as -40°C . Finding the water bottle heating method for keeping the greenhouse warm, along with the possibility of utilizing the rain collection bottle and water reservoir as heating agents, enabled us to free up some wattage from our solar panels and stay on track financially. Finally, printing a 3D model for adapting our water storage system and water reservoir allows us to free up even more budget by no longer needing to purchase an adapter, as well as enabling pumpless drainage for our system by using the force of gravity to transport water between storage intermediates, the latter of which was suggested by the client.