Deliverable F – Prototype I and Customer Feedback

Jacob Olaveson, Alec Fraser, Nicole Milman, Matas Minkstimas, Khalid Ahmad Al-Satari, Cyrille Zakaria

Table of Contents

Client Feedback after 2nd client meeting (Initial Design Critiques)

- More interaction from the students – 2nd hydroponic system is probably better, kids might not always be there in the summer so the automated part is also a good idea
  (The client was suggesting that a manual watering system was preferred for the grow wall, however some automated system would be nice for the times that nobody is around)

- The lighting system – LED is lower maintenance and longer lasting, she likes the idea of controlling with her phone. She might like the cycle (sunrise, sunset) idea.
  (The client liked the idea of LED panels or strips to give artificial light to the plants that will need it. She also liked the ability to have everything controlled from her phone)

- Prefers sections, gives the children options about what they want to grow.
  (For the planting setup, the client would like small sections for children to reach in and plant their own individual plant.)

- We would use a pump to bring water to higher elevations, no tank. Shouldn't be an issue to get a rain barrel.
  (The client liked the idea of a simple pump to bring water across the irrigation system to water the plants.)

- No battery, cable system.
  (The client stated that there will be wall plugs nearby to power all the needed accessories for the grow wall)

- 12 kids in a class roughly.
  (The client stated that there are roughly 12 students per classroom, and we should make sure to accommodate enough room for plenty of students)

Hydroponics/Irrigation

Prototype 1:

The first hydroponics prototype involves an analytical comprehensive model of the water trajectory via PVC pipes and perforated polyethylene tubes that water the plants at three height levels using the drip irrigation method. Using a fluid mechanics simulation program, we are testing the adequacy of our water pump (with a known pressure capacity) to generate a flow pressure powerful enough to run water through the entire system.

List of items represented in the Fluid Pressure Simulation:

Adapters:

1. Size adapter (0.75in to 0.5in)
2. Size adapter (0.5in to 0.25in)

PVC:

1. Initial pipe coming from pump (0.75in)
2. 0.5in PVC pipe
3. 0.75in PVC pipe
4. T fitting (0.5 in)
5. Cross fitting (0.5in)
6. Elbow fitting (0.5in)

Polyethylene:

1. 0.25in polyethylene tubing
2. Elbow fitting (0.25in)
3. Cross fitting (0.25in)

Prototyping and Testing Plan

Now that we have successfully tested the adequacy of the water pressure which our selected water pump will be able to generate, our next crucial step is to test the distribution of water through the perforated polyethylene tubes to all of four pot sections of a shelf, as well as create a structural model of the pvc pipe and fitting system for one of three vertical structures travelling along the support beam. We will also be testing the compatibility of our chosen materials with several stopper valve types to compare effectiveness. Finally, we will need to simulate the drain water system, or create a comprehensive virtual model of the water flow into the reservoir.

Test ID	Test Objective (Why)	Description of Prototype used and of Basic Test Method (What)	Description of Results to be Recorded and how these results will be used (How)	Estimated Test duration and planned start date (When)
1	Testing the	We will run the water	If they work properly	10 minutes

	functioning of each stopper valve (that each valve prevents the flow of water to the tubes)	system and turn off each individual valve one by one to see if the water flow to that section is successfully blocked.	then we can proceed with the process	
2	Testing the pressure of the water pump (that the flow is strong enough to supply higher up plants)	We will turn on the system to test the pressure necessary / if the pressure capacity is sufficient in bringing water to the furthest pot laterally and vertically.	If they work properly then we can proceed with the process	5 minutes
3	Checking the distribution of water by the perforated tubing acting as sprinklers	Attaching the clamps and testing the water distribution / checking moisture levels at each soil section by touch.	If they work properly then we can proceed with the process	1 hour
4	Testing the stability of the pipes that are fixed to the beams	Mechanically testing with moderate shaking and application of force, as well as running the system and checking for leaks	If they work properly then we can proceed with the process	20 minutes
5	Check all fitting and adapters, check for leaks	Create a grow wall for one tower of trays and check leaks.	If there are no leaks, the design is good	1 hour
6	Check if clamps/brackets can be used to attach tubing	Try this on the actual model and see if it works	If the tubing is tightly in place and fluid is still flowing through, then the design is good.	1 hour

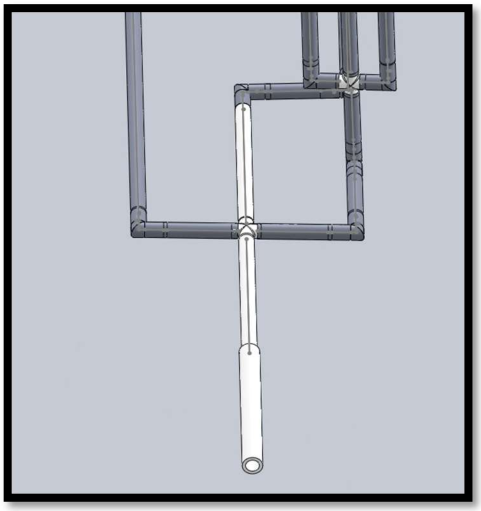
Review of Simulation and Peer Feedback

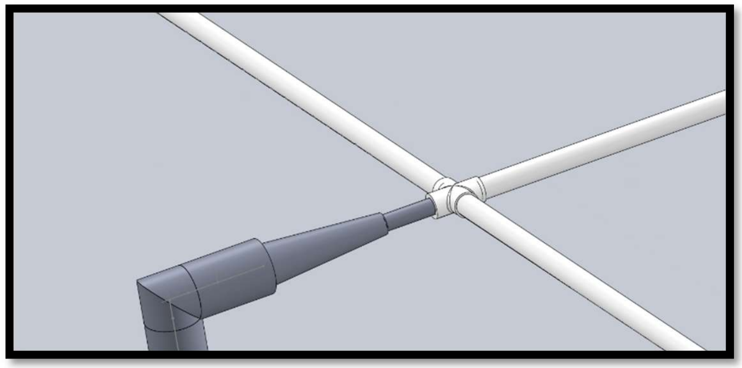
Review:

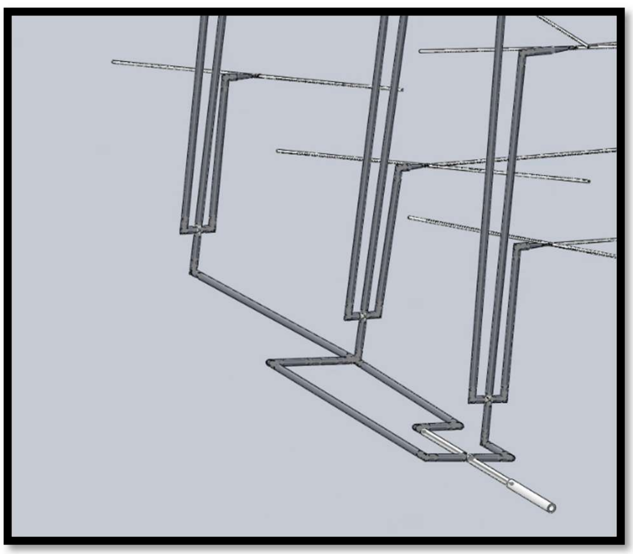
The goal of the simulation was achieved as we successfully verified that our pump is not limited by the pressure capacity factor in theory. This deliverable also gave a chance to the team to explore SolidWorks, which will be used for our next presentation of the design model to our client to assemble the three parts of our hydroponics team into one comprehensive model. Our goal before then is to work through the techniques for building slip joint connections and adapters to replace simple fixed mates and cylinders as diameter conversions.

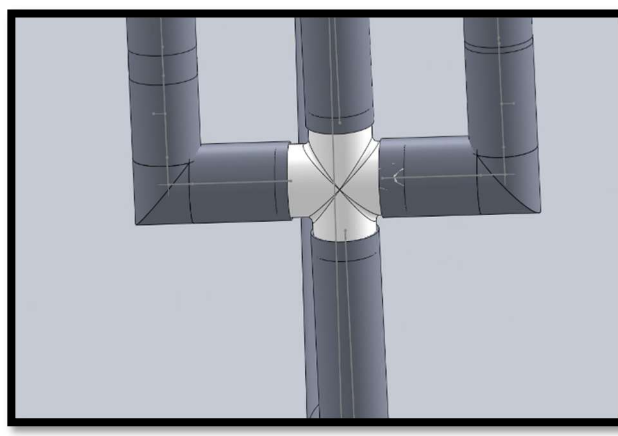
Peer Feedback:

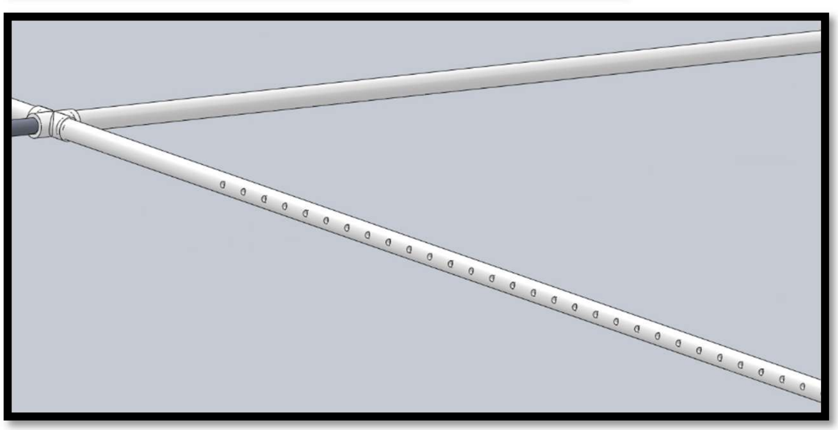
After consulting with the rest of the team, we are on the right track to building an automatic irrigation system for use when educational programs aren't running. One suggestion that we're considering implementing is having the pump and initial ¾ pipe and water tank curve under the structure in order to reduce hazards for the youth that will be occupying and utilizing the premises. Another option that we will discuss with construction is to build a frame to enclose these protruding pieces of equipment and prevent injury.











User Feedback

With the feedback outlined above, a design was created to fit the user's needs. This design is created in such a way that the main watering system well be by hand, with an option If the user's needs change and/or they are not satisfied with our design, we would change the design so the user's needs could be met.

Prototype 1

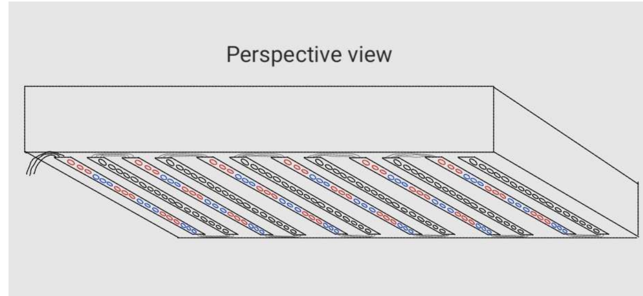
A simpler irrigation system that can be switched on and off was chosen so that the users' needs of being able to teach would be met. There will be an initial pump that will split through pipes and ultimately reach the plants through semi-perforated tubes. The design is pictured in the picture below. A simulation was created to test the power of the pump, as that was the biggest question mark in our design process.

Critical Components

Critical components in the hydroponics system include adapters, fittings, piping, tubing, and finally the pipe. They are modeled in SolidWorks and SimScale to simulate the fluid flow with in the individual components.

Peer Review/Client Issue

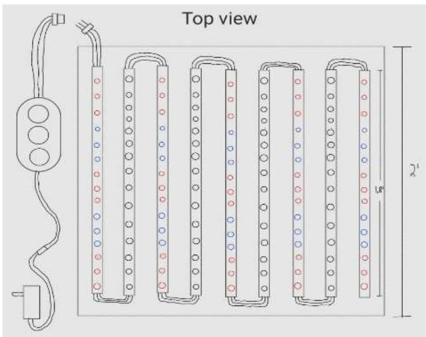
Mounting and how the pipes will be mounted was the biggest peer review issue. It was decided that the pipes will be mounted along the 4x4 post supporting the plant sections. This will work well because no extra infrastructure will have to be added to support the tubing.

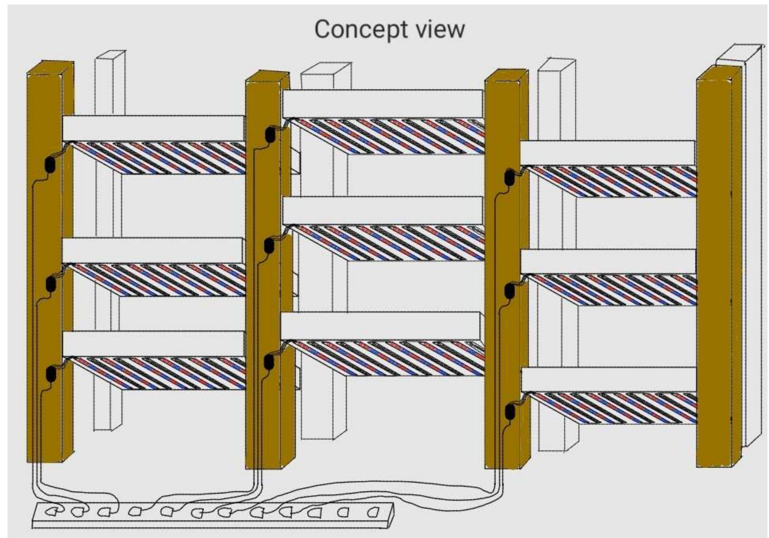


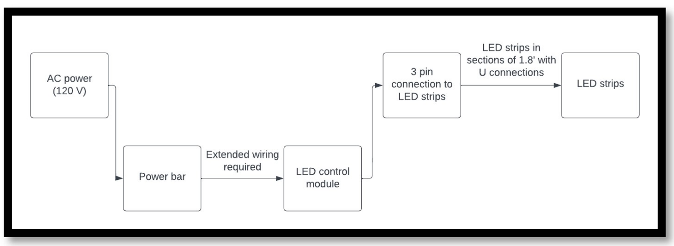
Grow lights

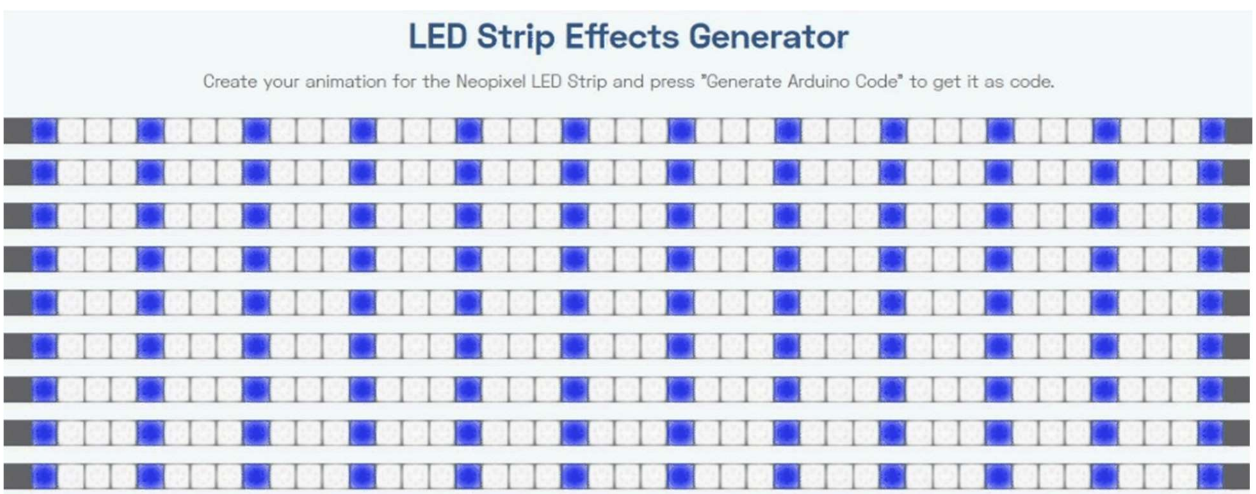
Prototype 1:

This prototype is a pictural representation of the lighting setup for each shelf of the grow wall. There are design concepts and a simulation to help depict how this system will work.



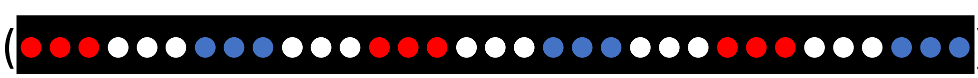






This is not an exact replica of the desired LED design; however, it gives a solid idea on how the system will work. * This simulation has the lights flashing but this will not be the case on the real system. *

The proper setup will be; **3 red**, **3 white**, **3 blue**, **3 white**, **3 red**, **3 white**, **3 blue**, **3 white** **and so on.**



(LED Simulator Source: https://adrianotiger.github.io/Neopixel-Effect-Generator/)

Prototype and Testing Plan

As part of prototype one we have been able to simulate the exact configuration for the grow lights. The next crucial step is to finally start testing on our products to ensure they fulfill their required design implementation. This is why it is important for us to get our product and start doing physical testing and prototyping. This table represents our exact tests and plans needed to complete the lighting system.

Test ID	Test Objective (Why)	Description of Prototype used and of Basic Test Method (What)	Description of Results to be Recorded and how these results will be used (How)	Estimated Test duration and planned start date (When)
1	Check if the Govee lights can be cut and still work	Cut the Govee lights and plug them in to see if they light up and still have all the feature or not	If they work properly then we can proceed with the rest to place under the shelves	10 mins
2	Check if the Govee lights can be reconnected and still work	Connect the 2 separated strips and see if they light up and still have all the feature or not	If they work properly then we can proceed with the rest to place under the shelves	10 mins
3	Check if the app works properly with the lights	Connect the strip and use the app	If they work properly then we can proceed with the rest to place under the shelves	10 mins
4	Check if the different sections of light work properly with the app	After connecting each strips using the wires, try the app and see if it recognizes each section as it should or not	If they work properly then we can proceed with the rest to place under the shelves	20 mins
5	Check if the wires conduct the right amount of electricity	Connect the cut strips with the wires and see if they work or not	If they work properly then we can proceed with the rest to place under the shelves	20 mins
6	Check if the polyurethane spray protects the system from water spills	Spray the strips and place water on them and try to light them to see if the work or not	If they work properly then we can proceed with the rest to place under the shelves	30 mins
7	Check if the 3M clips can properly stick and support wires	Place the 3M clips and place the wires in them to see if the hold or not	If they work properly then we can proceed with the rest to place under the shelves	A couple of days
8	Check if the app allows for timers and specific lights presets	Play around with the app	If they work properly then we can proceed with the rest to place under the shelves	30mins

Feedback and Review of Prototyping

After some peer feedback, people have suggested we need a better solution to waterproofing and how to stick the LED strips to the underside of the shelf.

Solution to Mounting: The initial plan was to use 3M tape and some 3M clips, but the sticky tape may ware off. We would need to test this possible problem, however some solutions could be;

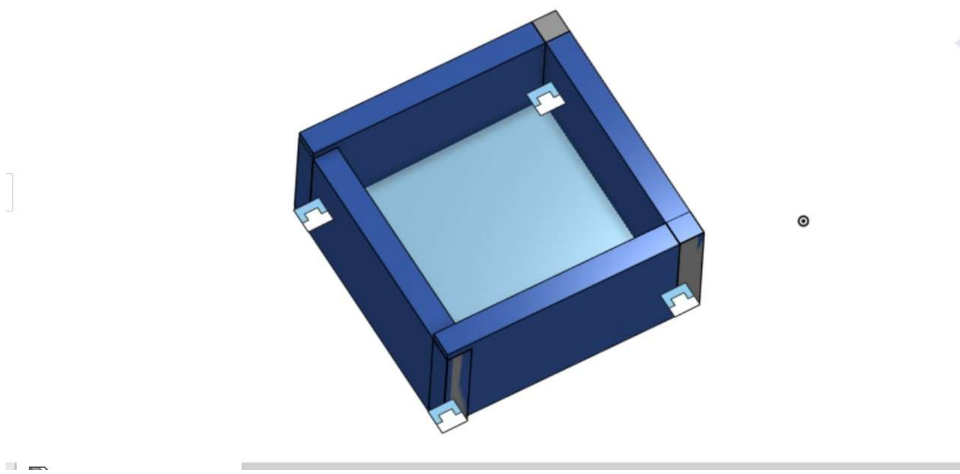
a. To have a slim clear plastic or film sheet to cover the lights and hold them in place.
b. To create a secondary mounting plate where 3M tape sticks a lot better than on wood.

Solution to Waterproofing: The initial plan was to spray silicone spray on the LED strips and this might work but a test would need to be carried out to confirm. Possible alternatives could be:

a. To apply a different waterproofing solution on the LED lights. For example, epoxy resin or polyurethane glue.
b. To use clear heat shrink that conforms to the LED strips.

Regarding the above solutions, the BOM may need to be changed depending on the tests carried out.

Pot and Soil Design



The pots will be designed to be 0.8ft by 0.8ft it will be 5in depth, each shelf will have 4 pots. The last row of shelves will be having 2 pots instead of 4 so that it can be used for plants that require more space.