GNG1103

Design Project User Manual

Deliverable K- User Manual

Submitted by:

Hydroponics 6

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April 10th, 2020

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Abstract

Hydroponic is a method where you can grow plants without any soil, and instead using a water based, nutrient rich solution. The main goal behind a hydroponics system is to allow the plant roots to come in direct contact with the nutrient solution, while also having access to oxygen, and therefore the plant has proper growth. After meeting our client, it was discovered that there is a need to construct a functioning hydroponics system for a small school near Rapid Lake, Quebec. As a group, we were tasked with designing and constructing a system that was self sufficient, affordable, and could function for three seasons, excluding winter.

In this document, the reader will experience the design and construction steps that were implemented to come up with a final, fully functioning prototype. This is demonstrated through early steps such as determining client needs all the way up to construction and testing of the prototype. A bill of materials is also provided to indicate the cost estimate to build this prototype.

After reading and following the steps in this manual, the reader should be able to construct the prototype and have a fully functioning hydroponics system.

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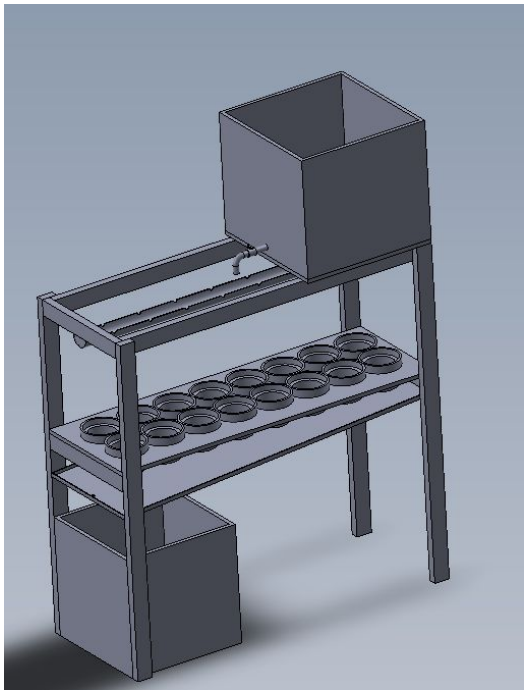
1 Introduction

This document explains how to build the drip hydroponic system designed by the collaborative efforts of the authors of this document step-by-step. The aim is to answer how, why, what and who to all questions pertaining to this project.


(P1)

There is a need for a functional hydroponics system in a greenhouse that can supply a small family of people from spring to fall in a small town.

On a fundamental level,the client needs a hydroponics system that is;
Fully-functioning: The system needed to be able to perform its most basic function, grow plants, without a hitch.
Easy to maintain and use: The greenhouse would be located in a school in a small town. As a result, the system cannot have avoidable/unnecessary complexities or be difficult to maintain because children and people who are not familiar with intricate tools are to make use of this system.

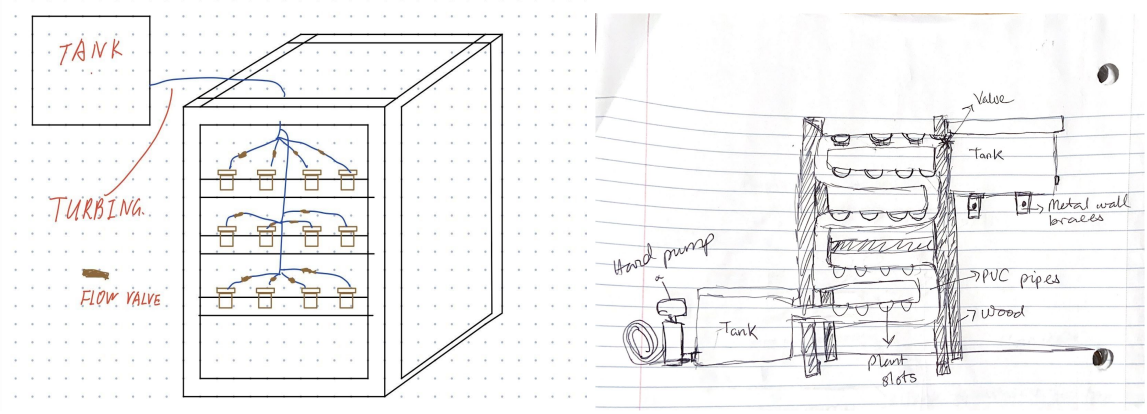
Usable for three seasons: It does not require year-round use.
Able to feed a group of 4-5 people: The hydroponics system needs to be able to grow enough plants to feed four to five people.
Self-sufficient: It's important that the system runs with minimum external help.

Our product performs the basic functions of a drip hydroponic system without the high cost, building cost is less than a hundred dollars. The plant feeding system of our drip system is non-conventional and uses polyvinyl chloride pipes instead of numerous tubes and connectors, this saved us some money. Our design also features two tanks for storage, this means that we could have a somewhat recirculating system which means less waste.

The main function of our product is to be able to grow plants and fulfil the client needs using the concept of a drip hydroponic system.

2 How the Prototype is Made

Initially, two design concepts were chosen based off of high scores obtained from a design criteria table. Both designs had frames that would be built out of wood and would have been sturdy enough to support either system. Following the conclusion of the first client meeting, the drip system from pictures 2 and 4 would be the chosen design that was developed further and turned into the final prototype.



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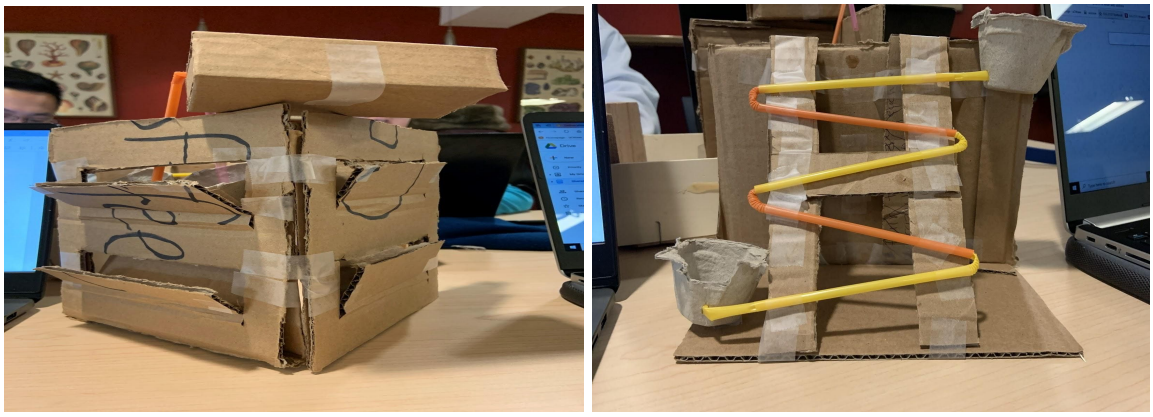

(P4-5)

Following further designing and analysis, the frame for prototype 2 was built out of wood and featured PVC piping. The shape and support beams placed inside the frame would have been sturdy enough to support the reservoir that sat on top and support the plants that would be placed in the second layer of the frame.

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2.1 Category

2.1.1 BOM (Bill of Materials)

Table 1: Bill of Materials

Components and Materials	Quantity	Dimensions	Cost
Reservoir Tanks	2	19L	3.97 each
Tubing	1	60 * ¾ inch	0(Provided by school)
Control Valve	1	¾ inch	0(Provided by school)
PVC pipe	1	ID: 2cm OD:2.2cm	0(Provided by school)
2*4 Wood leg	4	85cm*2*4	0(Provided by school)
2*4 Wood bar 30	4	30cm*2*4	0(Provided by school)
2*4 Wood bar 82	3	82cm*2*4	0(Provided by school)
Wood plate 1	1	86cm*30cm*1cm	0(Provided by school)
Wood plate 2	1	34cm*34cm*1cm	0(Provided by school)

Plant Pots(or we can use plastic cups, still work and much cheap)	16	3.5-inch diameter	4.46
tray	1	N/A	0(Provided by lou)

2.1.2 Equipment list

List all the equipment that was needed to build this part.

Table 2: Equipment Used

No.	Equipment
1	Spirit Level
2	Power Drill
3	Power Cutter
4	Screws
5	Tape Measure

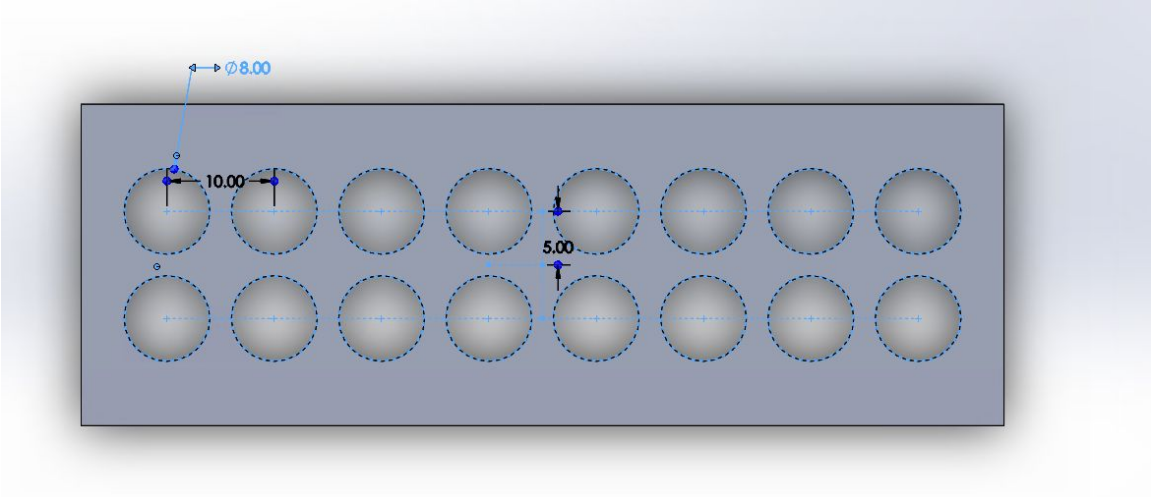
2.1.3 Instructions

Step1

Get the materials and equipment needed
Cut the bars and plates by the dimensions shown above in the Bill of Materials table

Step2

Drill 8 holes on wood plate1



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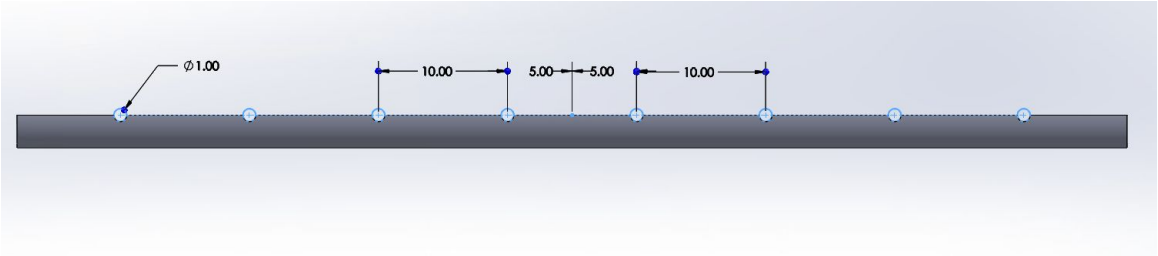
Unit in cm

Step3

Cut the PVC pipe by 84cm length and cut in half.
Drill 8 holes on the top side as shown in the diagram below.



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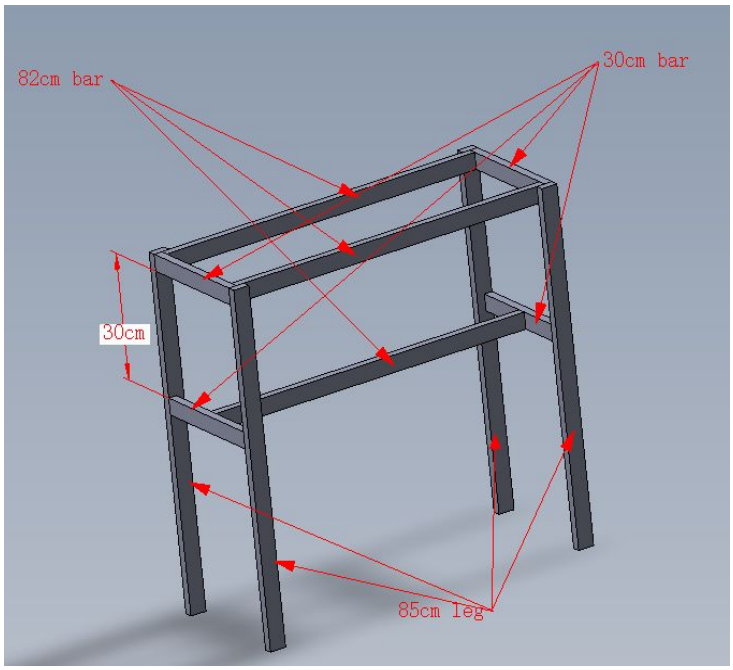
Step4

Build the wooden frame



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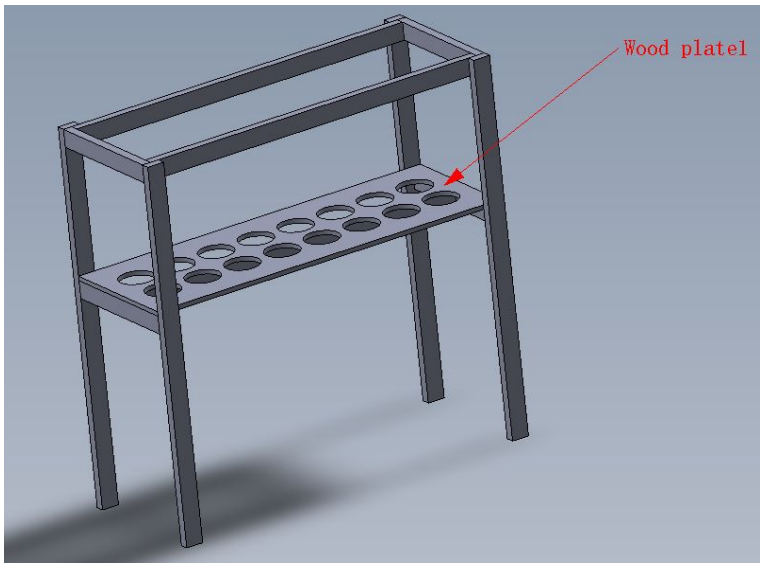
Step5

Install the wood plate1 on the second layer



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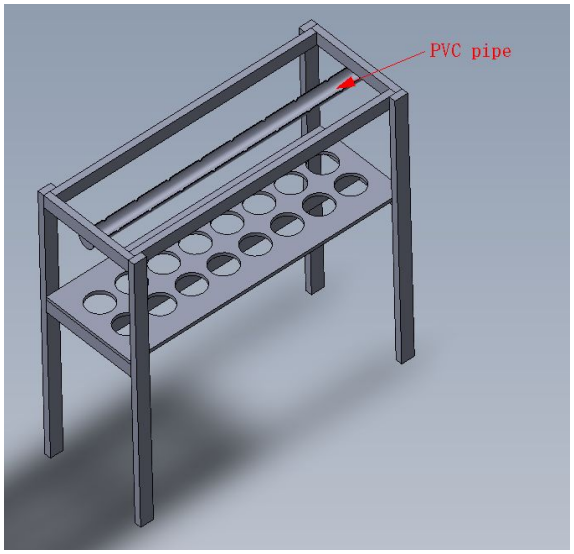
Step 6

Install the PVC pipe on the bottom mid of the top layer and make sure it is balanced (important)



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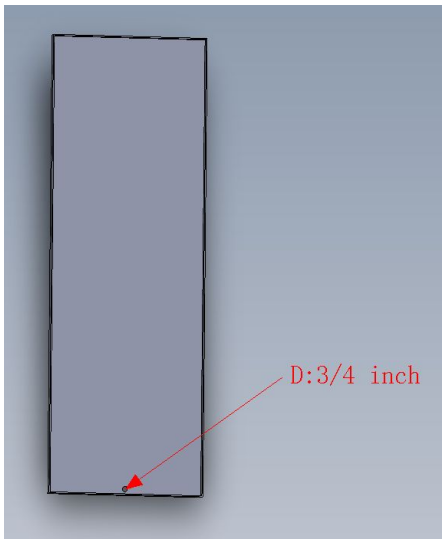
Step 7

Drill a hole at the mid bottom of the tray



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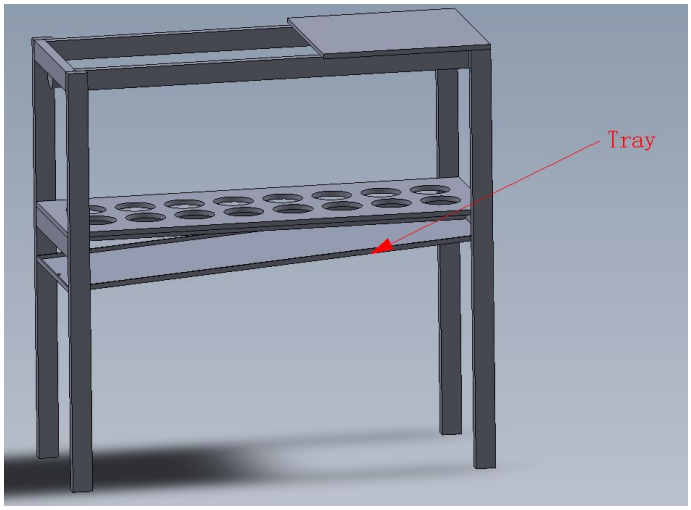
Step 8

Install the tray 10cm below the second layer with an angle, the side with hole must be the lower side.



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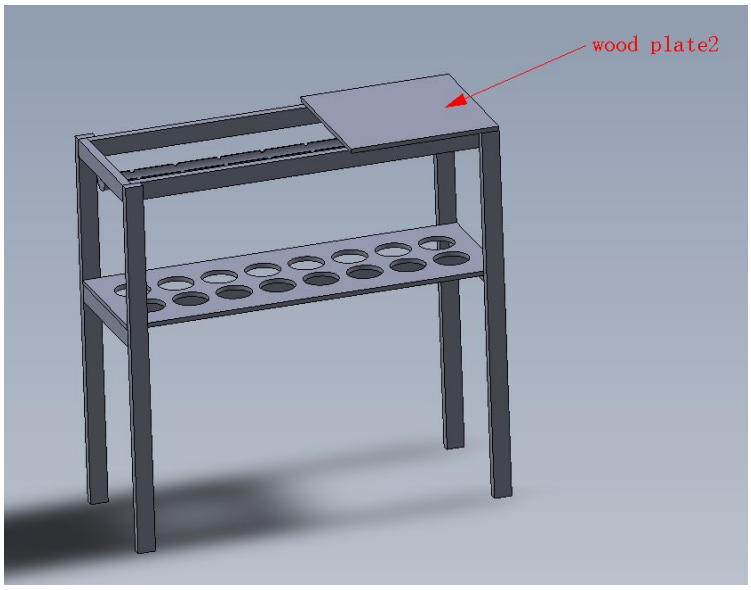
Step 9

put the wood plate 2 on the side of top layer



(P14)

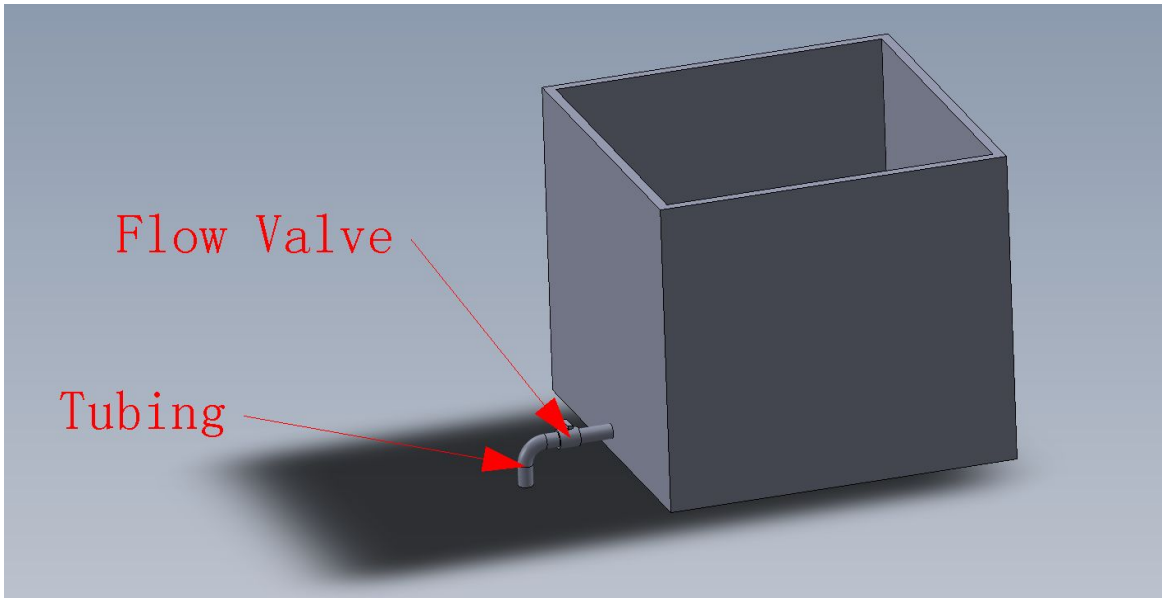
Step 10

Drill a ¾ inch hole on the side bottom of the one tank

Install the tubing on the hole and seal it.

Cut the tubing to a reasonable length (it should long enough to get the pipe)then cut it by two part

Connect two tubings with the flow valve



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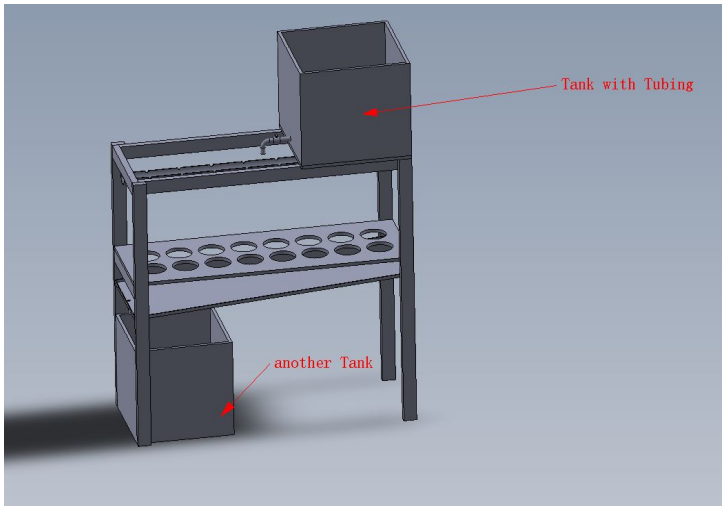
Step 11

Put the tank with tubing on the top plate and put the tubing into the PVC pipe

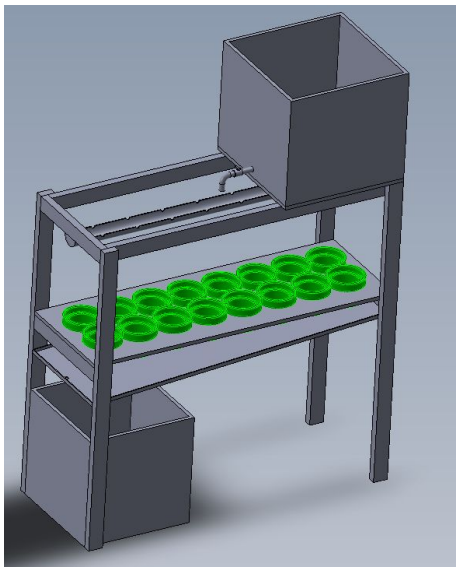
put another tank under the hole on the tray, make sure it can get the water from the hole



(P16)

Step 12

Put all pots in the holes of the wood plate 1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3 How to Use the Prototype

Explain in detail the functions of the prototype and how it works.

The purpose was to create a drip system that was able to evenly distribute the nutrient solution to each plant slot and to have consistent flow control of the nutrient water. It starts by filling up the reservoir tank with water. Then, the flow valve is slowly turned on and water is set on a leveled PVC pipe. Then through the created holes, water leaves the PVC pipes, and into each individual plant slot located at the center of the system. Then, the leftover water drains underneath the plant plots and water falls onto the tray. The tray is placed on a downward angle so that the water can slide into the second reservoir tank located underneath the tray. Then, the water can be reused by the students, and the process can be repeated. Through sufficient testing, our final prototype would have been fully functional and able to successfully grow plants for our client.

Explain how the user safely operates the prototype

In our case, we will have a mini-staircase for the students to climb to the top level of the system, and there will be space where water can be filled in the reservoir tank safely. The drip system should be monitored every other day. Students should be careful with the amount of the water they add to the reservoir tank, but when closely monitored, the hydroponics system should be safely used.

Explain how the user installs the prototype to use (if applicable).

There is no complex installation required to install the prototype. Once the entire system is built, it is placed in the desired location and the top reservoir is filled with the solution to feed the plants.

4 How to Maintain the Prototype

Explain the tests that were done on the prototype for validation of the final design. Present all of the applicable results that you obtained (i.e. data collected; performance graphs, etc.). List any issues or special requirements for sustained usage.

Comprehensive testing would have been conducted had the final prototype been built. This would have included: determining the proper flow rate of the control valves, ensuring that the centre pipe is balanced, ensuring that all drip holes were level, and that the overflow system at

the bottom of the frame caught all of the overflow solution. Due to the COVID-19 pandemic, our group did not reach the testing stage for all of the above mentioned steps.

Describe regular maintenance that should be performed on the prototype to avoid failure.

Daily maintenance required would be to empty the overflow reservoir into the top reservoir and to make sure that the top reservoir has enough solution to last at least a day. Also, the top reservoir and tubing should be checked daily so that there is no debris inside either location to prevent any clogging of the solution flow.

Explain what parts may be prone to break and need to be replaced.

The only real pieces that may be prone to break would be the pot plants. For our prototype, the pot plants used are the red solo cups that you can buy from any dollar store or supermarket. These cups are thin, made of plastic, and over time may fall apart given the amount of solution that flows through them and depending on how heavy the plants can get. These can be easily replaced by buying new cups and drilling small holes into the bottom.
Another thing that needs to be replaced in the future is any piece of wood from the frame. if enough water spills onto the wood over a long period of time, the wood may eventually rot and then the frame would fall apart. Any piece could be replaced using the dimensions that were used in the construction of the frame. It is very unlikely that any piece would get wet enough and need to be replaced though.

5 Conclusions et Recommendations for Future Work

Over the course of the semester, we have learned many valuable lessons that have helped us improve our product and work together as a team. With the unexpected occurrences that have happened over the semester, it was important that our team have various contingency plans to adapt to any situation. It was also important that we not only meet every deadline on time, but to complete the task in a sufficient time frame. Due to unforeseen circumstances, we have failed to complete our prototype, and part of it was because we did not give ourselves enough time to complete each task. In the future, we should be more prepared for any type of scenario to occur, and plan ahead for each task to be completed weeks ahead. Another lesson to be learned is that we need to ensure that the problem is well defined, and we should be more prepared to find a solution to every problem. In the future, we should create a more detailed task list, highlighting the important deadlines and detailed problems so everyone stays on track.

In the future, our team would like to continue working on building and improving a functional prototype for our client. As a group, we would want to maximize our potential and build a prototype that will feed 4-5 people, have many functional plant slots filled with nutrients, and create a hydroponics system that can be used daily. With our remaining budget, we would buy more nutrients to start off for our client.

In conclusion, our goal was to design, build, and test a functional hydroponics system for our client. Overall, we have created a well-designed prototype that can be improved and built upon in the future.

6 Bibliography

PVC piping;
https://www.homedepot.ca/product/ipex-homerite-products-pvc-4-inches-x-10-ft-solid-sewer-pipe-ecolotube/1000421825
PVC pipe fitting;
https://www.homedepot.ca/product/pvc-bds-long-90-elbow-4-inch-hub/1000119224
Reservoirs;
https://www.walmart.ca/en/ip/storex-storage-utility-file-tote-lid-and-locking-handles-black-grey/6000163069315
Drip valves;
https://www.amazon.ca/three-carriage-Automatic-Irrigation-Plants-12/dp/B07QQR51R8/ref=sr_1_10?hvadid=75385355916184&hvbmt=be&hvdev=c&hvqmt=e&keywords=drip+valve&qid=1582140003&rnid=5264023011&s=lawn-garden&sr=1-10
Pots;
https://www.amazon.ca/ICYANG-Seedling-Lightweight-Washable-Reusable/dp/B0799FK1V8/ref=sr_1_10?hvadid=75247913958898&hvbmt=be&hvdev=c&hvqmt=e&keywords=plant+pots&qid=1582140871&s=lawn-garden&sr=1-10

APPENDICES

APPENDIX I: Design Files

MakerRepo link to our project:

https://makerepo.com/Travis/gng1103kelthydroponics-6

On MakerRepo, we have a summary of our project including a project file. This design file is a 20-second video of our prototype crafted on SolidWorks and showing all views of the design.