GNG1103 - Prototyping Test Plan

Why are we doing this test?

*This is an introduction. Capture the reasons for the test, giving enough background information to justify doing **any** prototyping at all. Is the **general** objective one of: learning, communication, de-risking, etc.*

The general objective of our prototype is to communicate. With this prototype our goal is to prove that our final design will be able to deliver on the main aspects that allow the hydroponics system to function properly.

Test Objectives Description

*What are the **specific** test objectives?*

When developing our first prototype we focused on 4 specific test objectives that allow a hydroponics system to be able to grow plants/vegetables:

1. *The capability of having a filter system that easily attaches to the water supply tank. The filter is heavy and the tank needs to have the ability to hold the weight of the filter.*
2. *The ability to implement a user controllable water flow control system to supply the growing pipes with water.*
3. *The ability to contain the plants/vegetables in growing cups that also contain the growing medium.*
4. *The ability to fill the growing pipe with water so that the plants' roots have access to the water.*

GNG1103 - Prototyping Test Plan

*What **exactly** is being learned or communicated with the prototype?*

With this prototype, we are communicating that our design will be able to accomplish the basic tasks that allow a hydroponics system to grow plants/vegetables. Furthermore, we are learning about the fabrication of our device. We are learning how our final prototype will be assembled, and how the different parts of it will be able to work together to accomplish all of the design goals. Finally, we are learning about what the customer thinks of our design, in order to understand what needs to be improved.

What are the possible types of result?

The possible types of result are either a perfect result, which is very unlikely, or a result which allows us to see problems with our design. The result in which everything is perfect is desirable as it would demonstrate that our design is completely capable of growing vegetables. The more likely result is that we are able to find flaws, and areas of improvement in our design that allows for improvements in further development.

How will these results be used to make decisions or select concepts?

From the results we collect, we will be able to make decisions about the design of different parts of the system. Say for example, the only part of the system that does not accomplish its goal was the ability to control water flow to the growing pipe. By isolating the issue to a specific part of the whole system, we are able to improve upon it in order to make the whole system more effective.

GNG1103 - Prototyping Test Plan

What are the criteria for test success or failure?

The criteria for test success or failure are based upon the 4 test objectives we set out to accomplish:

1. Filter to water tank
    a. filter should easily attach and detach from the water bucket
    b. through the filter should be the only way that water enters the water supply
    c. the water bucket should be able to hold the weight of the filter
2. Water flow
    a. water flow going to the growing pipe should be easily controlled by the user
    b. the water flow should be able to be set at different rates
    c. water should be able to be fed to the growing pipe using only gravity.
3. Plant support and growth medium
    a. cups are available to hold and support the plants
    b. the cups are able to contain a growth medium of sand/ dirt
    c. the cups should allow the plants' roots to pass through and access the water below
4. Growing pipe
    a. the long section of pvc pipe should have the ability to contain water
    b. the water in this pipe should be easily accessible by the roots of the plants

When deciding success or failure of our design, we will use the criteria outlined above.

What is going on and **how** is it being done?

*Describe the prototype **type** (e.g. focused or comprehensive) and the reason for the selection of this type of prototype.*

The type of prototype is a combination of comprehensive and focused. We chose to focus on the 4 aspects of water supply, water control, plant support, and root access to water. By setting out to test these four aspects of the design, the result was a fairly comprehensive prototype. We chose to select this type of prototype because not one particular aspect of our design appeared to have much possibility for error in manufacturing and testing. By testing 4 of the main aspects of our design, we are able to prove that all of the most important aspects of our design are functional, and also that any smaller remaining aspects can be easily implemented into our final design.

GNG1103 - Prototyping Test Plan

Describe the testing process in enough detail to allow someone else to build and test the prototype instead of you.

The following is an outline of the building of the prototype:

1. Construct a filter tube with a pvc pipe
2. Attach the filter through a hole in the lid of a bucket that will also function as a water supply tank
    a. seal the hole around the area where the pipe enters
3. attach a rubber hose to the bottom of the water bucket
4. attach a valve somewhere in the water hose
5. at the opposite end of the water hose, attach to the pvc growing pipe
6. ensure both ends of the pvc growing tube are sealed with end caps and silicone
7. put holes of size large enough to hold your growing cups along the length of the pvc growing pipe

To test our prototype, we would follow the criteria for test success from above. All of the success criteria that are outlined can be tested by putting the necessary materials into the filter, putting cups into the growing pipe, and putting water in the filter. From here, the system's water control system can be tested to fill the tube, and all other design criteria can also be tested by observation at this point.

*What information is being **measured**?*

The prototype was fashioned comprehensively to include all physical components, and as such most measurements taken were the physical dimensions of the materials and their respective elements. The filter was measured to be 90 cm in height, and 30 cm in diameter. The PVC piping was 115 cm in length, with a diameter of 10 cm. Finally, the distance between each cup was approximately 15 cm, with each cup housing a radius of 3.5 cm. Furthermore, since all success criteria are observation based, the measure is determined by whether or not the design meets the criteria.

*What is being observed and how is it being **recorded**?*

Upon the construction of the prototype, information was obtained about the fit of each pipe and tube towards its respective insertion point. The connection between the water supply and the filter, and the filter to the PVC pipe was successful and not prone to leakage. The valve controlling the water flow was also observed to be water tight and not prone to leakage. The manoeuvrability was observed when transporting the prototype from the design space to a storage area, and therefore was noted that the prototype could be transported by two individuals with relative ease, when absent of water or filtration rocks. These observations were recorded briefly in an observation document used during the construction and completion of the initial prototype.

GNG1103 - Prototyping Test Plan

What materials are required and what is the approximate estimated cost?

The materials used to construct the prototype were PVC piping, priced at approximately $15 CAD, a valve at $10 CAD, plastic cups costing 8 cents CAD, and hose piping costing $22 CAD. The rest of the materials used to construct the materials were scavenged from previously owned materials, as such materials would exist in the refugee camp. Such an example is the water filter tank. The total estimated cost of all materials, including the purchase of materials scavenged is approximately $78 CAD.

What work (e.g. test software or construction or modeling work or research) needs to be done?

The construction of the comprehensive prototype is the primary area of focus for what work is needed for the first prototype. This includes the attachment of the filter tank to the PVC piping via hose piping. The PVC piping also needs to be punctured by six identical holes evenly spaced and fitted for the plastic cups. Finally, the silicon layer of the filtration systems needs to be laid and set.

When is it happening?

*How long will the test take and what are the **dependencies** (i.e. what needs to happen before the testing can occur)?*

The testing of the prototype will take two hours, to ensure all components of the prototype are working as intended and to identify any problems that exists for the prototype. Before testing of the prototype can occur , the initial prototype construction needs to be completed. See above for the prototyping test plan that outlines the specific details for constructing the prototype.

When are the results required (i.e. what depends on the results of this test in the project plan)?

The results of the prototype are required before the construction date of prototype two, as the construction of the second prototype relies heavily on any and all flaws found with the initial model, due to its comprehensive nature. Without observations on how well the prototype functions, any adjustment to account for these errors in the second phase of prototyping would be rendered mute. The date of completion for testing is specified as March 11th, 2017.

GNG1103 - Prototyping Test Plan

1st prototype

To get the most valuable feedback on our prototype, we decided to go with the physical attributes of a prototype. For this design, we decided to build all of the main components of our system, so that we could get feedback on all of the parts instead of just one. For the filtration part of the system, we used PVC piping (figure 2). The piping was approximately two and a half feet, one foot being sand, rocks and gravel, and the other foot and a half for water, as the water doesn't filter instantly. the piping is attached to the lid of the container that holds the clean water, after being filtered, with silicon. Some of the feedback we received from our client, Hasan, was how the silicon might not be strong enough to keep the heavy weight of the piping and rocks attached to the lid of the bucket. However, he did say that using rocks and gravel was a good, and cheap way of filtering the grey water. For the next part of the system, we used a bucket that we found in a garage, as the storage container for the filtered water. since the lid is able to be taken off, the nutrition will be added to the clean water by using volume calculations to see how much nutrition is needed, for the volume of a full bucket of water. Our client said, this would be an easy task to accomplish, as many people in the camp are intelligent and capable of doing so. The bucket has a hole, with a plastic pipe in it, to allow water to flow to the plants. The water is controlled by a valve located half way down the pipe. Our client said, there might be an issue with having water stay in the piping for too long because of how cold it can get at night. He suggested, we should have the valve closer to the top of the bucket so water isn't in a large part of the water line at all times. The last component of our prototype is the growing medium, for the plants(figure 3), which was made using PVC and paper cups. Our client said, PVC would be a good medium for the plants, but the paper cups wouldn't work too well because they would

damage easily from the water and the weight of the sand inside.

figure 1

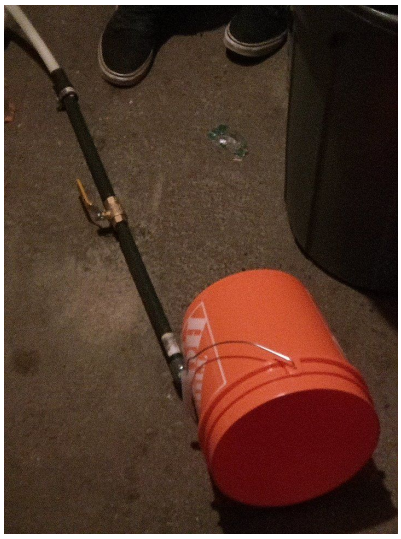

figure 2

GNG1103 - Prototyping Test Plan

figure 3