GNG 1103

Engineering Design

Deliverable G

**Due Date**: Sunday, March 5th, 2017

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# **Introduction**

After the completion of the first prototype, our group of engineers analysed its capabilities and designed a second prototype with the most critical subsystem in mind. This new prototype would be focused on the transfer of water from one tank to another to test its water efficiency and its ability to flow through the system. The prototype to be produced would also be one on a 1:4 size scale of the actual model to ensure that the actual proportions of the design would be displayed. The scale model would also minimize development costs but ensure the same amounts of data collected. The data collected from this prototype and the previous one added with the input from the customer can be compiled to create a functional full sized project.

# **Discussion**

The second prototype was planned after getting feedback from a client and built shortly after. We made the second prototype to test the water transferring capabilities of the design. To do this, we cut a yogurt container in half, and oriented those two halves in the same way we oriented the parts in our first prototype. A small hole was created in the upper container to simulate the valve and placed a light foam sheet in each half to float in the water as plant containers. We then filled those halves with water and saw how well the water flowed from the first half the lower half. Judging from where the stream of water from the first half was going, we decided to put a small hole in the foam sheet in the lower half to allow water to be added to the lower half more efficiently without it landing all over the top of the styrofoam and evaporating quicker. Adding a hole to the styrofoam would also let the water droplet strike the main body of water helping with the aeration of the reservoir.

From this prototype, we learned that the height at which we punch a hole in the water container determines the maximum amount of water that is dispensed from that container. Using this, we can put our water-flow holes (taps) at appropriate levels to reduce the amount of potential wasted water, increasing water efficiency. This would be an appropriate failsafe for the customer forgetting to empty out the bucket and turning off the valves.

Another thing to take into consideration is how fast water can be evaporated in our design.

*gh = Θ A (xs - x)* can be used to find out how much water can be evaporated in the span of an hour.

*Θ = (25 + 19 v) = evaporation coefficient (kg/m2h)*

*xs = humidity ratio saturated air at the same temperature as the water surface (kg/kg) (kg H2O in kg Dry Air)* (0.012 kg(water)/kg(air))

*x = humidity ratio air (kg/kg) (kg H2O in kg Dry Air) (*0.011)

*v = velocity of air above the water surface (m/s)* (average in this area of Jordan is 8.92 km/h= 2.5 m/s)

*A = water surface area (m2)* (0.851m x 0.522m= 0.444222m2)

By plugging in the values into the equation, we can see that 0.0322 L of water can be evaporated from one reservoir in the span of one hour. This would then be the minimum amount of water lost per hour per reservoir, meaning that 0.0644 L would be lost from the system in the span of one hour.

For the flow rate of water, we found that it took 12 minutes and 54 seconds to drain 1.5 L of water from single reservoir. We took these numbers and found that the flow rate for this prototype was 0.002 L/s which is equal to about 6.98 L/h. From testing with the prototype, we agreed that the flow rate should be increased to 13.35L/h because we want to have water flow constantly without making the users refill the top reservoir too often.

After looking at our prototype our client said that we should put some cut-outs in the styrofoam layer so people can easily lift it up to add water to a reservoir if they have to. Another suggestion he made was to figure out a system in order to keep the same flow rate even after restarting the system.

From our analysis, we felt that because we’re using taps in the final prototype, the flow rate will vary among different users and even uses. So we determined that a flow rate that allows the user to refill the reservoir about every 45 minutes give or take 10 minutes.

After testing, we were satisfied with the way in which the water was flowing, so that fulfilled a stopping criteria for this prototype.

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Figure 1: Side view of prototype 2 Figure 2: Front view of prototype 2

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Figure 3: 3d front view of prototype 2 Figure 4: Top view of prototype 2

# **Conclusion**

After completing the build on the second prototype our group of engineers managed to determine a desirable flow rate and confirm the effectiveness of our design. Once completing the design we obtained information from the customer regarding ease of use of the system. These design changes will be implemented in the next prototype.

# **References**

"Evaporation from Water Surfaces." *The Engineering ToolBox*. N.p., n.d. Web. 11 Mar. 2017.<http://www.engineeringtoolbox.com/evaporation-water-surface-d\_690.html>.

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