Deliverable G: Prototype II and Customer Feedback

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Abstract

The following report outlines the second prototype and client feedback for a raft cleaner machine for group A11 of GNG 1103. In this report, we accumulated the feedback from the third client meeting to allow us to construct better design choices. The document also discusses the second prototype's analysis and results. Finally the document outlines the third prototype plan.

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1. Introduction

The purpose of this document is to discuss the feedback from the third client meeting on the first prototype. This feedback was given directly by the client as well as by peers. Additionally this document will discuss the second round of prototyping. This includes discussing the objectives and test plan the group had made for the second prototypes, the critical components of these prototypes and the results from the second round of prototyping. Lastly the third, and final, prototyping plan will be discussed and planned as well.

2. Feedback and Design Changes

In the third client meeting, the group gave a two-minute presentation to update and inform the client of our progress and changes. The presentation was also listened to by a group of our classmates. This was an opportunity to receive feedback from multiple perspectives in addition to the client's feedback. The feedback we received from the client included approval of some of the changes we had made to the previous idea. These changes included a significant update to the loading and collection mechanism. The client also expressed an idea to simplify the design; the client thought taking advantage of the weight transfer of the boards from the loading to the collection sides of the design could be used. Some of the group's peer feedback included others expressing concern about the amount of electronics involved. By this, they mean they worry that the workers, who may have little to no skill in circuitry, may have trouble fixing parts of the machine if it were to break. The concern about workers fixing the electronics was not as concerning to our group because electronics, once set up, have very few failure points. Our prototype, of course, could be improved, so it has more weak points than the actual system would. Prototyping the circuitry has helped us troubleshoot these problems in advance.

Additionally, the group discussed potentially identifying the most likely “weak spots” of the circuitry and including step-by-step instructions in the manual on how to fix it. As for the client's suggestions on using the weight transfer of the boards, the group discussed using a pulley system. However, this presented many issues. After loading approximately 30 boards into the loading side of the machine, the loading platform would be at the lowest position, and the unloading platform should be at the highest position. The top board would be pushed onto the machine's rollers off the loading stack and onto the unloading stack. The client’s idea uses a pulley system to move the platforms up and down. By taking one board off the loading stack and transferring it to the unloading stack, the mass of each stack would change; therefore, they would balance differently, ideally moving the loading stack up by one board and the unloading stack down by one board.

However, two different masses will only balance when they are very similar in mass. If 30 boards are on the loading side and one is on the unloading side, the loading side will have a mass 29 times larger than the unloading side. The two sides will not balance out linearly each time a board is transferred, and the platforms will be closely balanced or at one of the two extremes. This issue could be resolved using calibrated springs to move the boards as the mass is transferred. However, this is difficult, and we already thought of using springs for the unloading side and removed them for this reason.

Additionally, if the platforms are calibrated to each other, it means that the loading and unloading sides always have the correct board ratio. The user would always have to load and unload the machine entirely. If the user has several boards to wash, which are not divisible by 30, the remainder would have to be washed manually. This system does not account for the boards while a board is partially on either stack. It does not account for the mass added by dirt and water. It also does not account for friction; the change in mass must be able to overcome the friction of the platforms to move them. The system would have many complex components that need to be calibrated and maintained and would only work under ideal conditions. It would be highly likely to fail. It would increase the manufacturing tolerance requirements. The parts cost would likely be more expensive than the electronics. It would be an unreliable, over engineered solution to avoid a simple, reliable electronics solution that can adapt to unpredictable situations based on the unfounded fear that electronic systems are inherently more likely to fail than mechanical systems. Since all the electronics are readily available parts, maintenance would be as simple as finding the broken part and replacing it using screws and plugs. A motor could be used on only one side with pulleys connecting the two sides; however, this would have minimal benefit and make the machine less versatile. For these reasons, the group has decided that it is best to stick with the current concept, which uses a motor to lift both platforms.

3. Second Round of Prototypes

3.1 Objectives and Test Plan

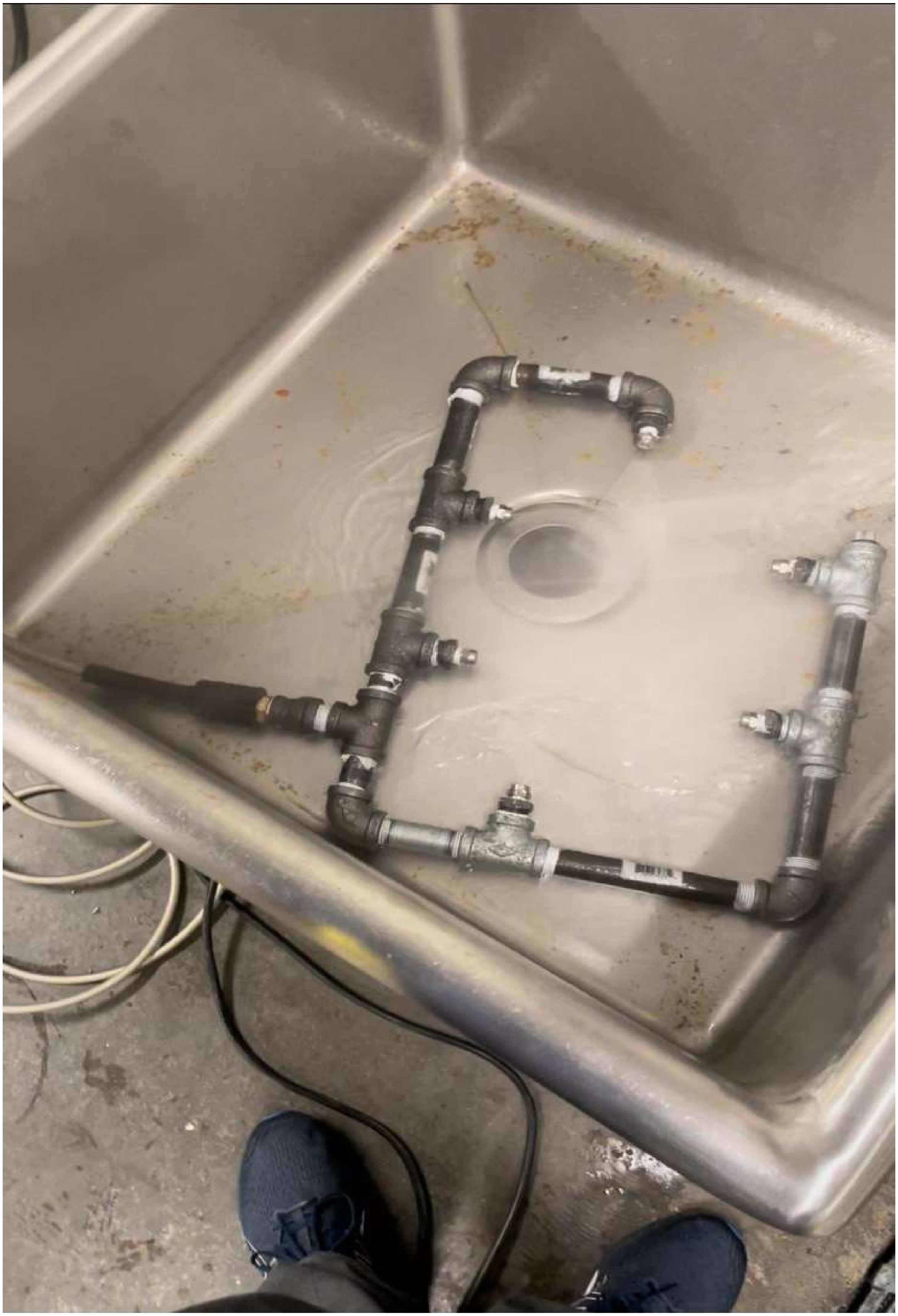
For the second round of prototype, we had planned to execute two prototypes. The first one is a low fidelity analytical prototype, while the second is a medium fidelity physical prototype that will test the water jet system. We did not have time for the analytical prototype and plan to do it later. The water jet system is a vital aspect of our product as cleaning the rafts relies heavily on this system. To assure the product meets the clients requirements, the rafts need to be completely clean once they arrive at the unloading subsystem. Therefore, assuring that the jet systems functions is a priority as it determines the success of the product. Additionally, asserting the correct angle of the jets is very important as it is a key component in cleaning the rafts, as well as the holes in each raft. If the angle is not adequate, the water will not clean the algae and dirt from the holes well. This prototype will help determine if the jet system has enough pressure to clean the boards and if the jets cover the entire surface enough to clean them completely. This data will allow the group to concentrate on improving the subsystem and determine any next steps. Due to timing conflicts, our group was only able to construct the physical prototype, and we were not able to carry out our plan for the analytical prototype.

3.2 Critical Components

The critical components of this subsystem are the water pressure pump, the nozzles, and the pipes. The water pressure pump is a critical component because the water pressure is directly related to how well the boards are cleaned. We are using 6 nozzles which increase the water flow rate to a flow rate which is more than the pump is designed to handle so pressure is going to drop. Additionally the nozzles are a crucial component as they are the main element that cleans the board. The nozzles must be at a certain angle as well as be able to hit the boards at an adequate pressure to ensure the cleanliness of the boards. All these components contribute to the cleanability of our solution concept, something that is extremely important as it relates to both our design criteria and clients needs.

3.3 Results

After creating and testing our prototype, we learned what would need to be changed for our final design. To begin, we were hoping that when exceeding the maximum flow rate of the pump, the pressure would drop in relation to the amount it was exceeded. The group assumed that the drop of the pressure would be linear; however, that was not the case as the pump requires a higher flow rate. Unfortunately, high pressure pumps generally have lower flow rates than low pressure pumps. To lower costs and save electricity, we will settle for a lower pressure pump to obtain the required flow rate. Testing the water pump in a medium fidelity prototype has allowed the group to understand that our current pump is not able to sustain the flow needed. Additionally, after testing the nozzles, we noticed that the pressure of the jet streams were concentrated on the edges and weak in the center. After doing research we found other nozzles have the same issues, however if the pump pressure is high enough it is usually negligible. It is vital that the nozzles work at the correct pressure as this pressure removes the algae and dirt off the rafts.



4. Updated BOM

Part	Description	Qty	Unit Cost	Final Cost
Aqua-Dynamic Galvanized Fitting Iron HEX Bushing, 1/2 x 1/4-in	Adapts pipe to fit nozzle.	6	2.49	14.94
Clean Strike CS-1048 40-Degree Threaded Spray Nozzles	Create Jet Streams	6	5.04	30.24
Aqua-Dynamic Black Galvanized Nipple, 1/2 x 6-in	Pipe	1	3.49	3.49
Aqua-Dynamic Black Galvanized Nipple, 1/2 x 4-in		5	1.59	7.95
Aqua-Dynamic Black Galvanized Nipple, 1/2 x 3-in		1	1.69	1.69
Aqua-Dynamic Black Galvanized Nipple, 1/2 x 2-in		2	1.19	2.38
Aqua-Dynamic Black Galvanized Nipple, 1/2 x 1-in		1	1.07	1.07
Aqua-Dynamic Galvanized Fitting, Tee,		5	2.89	14.45

1/2-in				
Aqua-Dynamic 90-Degree Galvanized Fitting, Elbow, 1/2-in		4	2.49	12.45
Forney 75117 Pressure Washer Accessories, Male Screw Nipple, M22M by 3/8-Inch Male NPT	Adapts pressure washer hose to ⅜" MNPT	1	18.35	18.35
Greenworks 1700 PSI 1.2-Gallon-GPM 13 Amp Cold Water Electric Pressure Washer, GPW1704	Pressurizes water	1	119.00	119.00
6ft garden hose			9.99	9.99
Canadian Tire Plastic Food Grade Safe Bucket, 5-Gal/19-L	Use prototype without hose available		4.99	4.99
Aqua-Dynamic Galvanized Fitting, Iron Plug, 1/2-in	Close the unused pipe ends		1.89	3.78
Total:	Before Tax:	$246.66	After Tax:	$276.47

5.Third Prototype Test Plan

Test ID	Test Objective (Why)	Prototype Used & Basic Test Method (What)	Expected Results and How They will be Used (How)	Test Duration & Start Date (When)
5	We want to build a prototype that demonstrates all critical components of our solution concept that we can bring with us to Design Day.	The prototype will be a comprehensive and fully functional version of our solution concept. We will test this concept against the class test method for cleanability, a design criteria necessary in our design.	Ideally, the dirty rafts should come out of the unloading subsystem to be very clean, and we would expect them to be around 95% clean. All critical components would have functioned correctly; the mechanic and automated systems should work in sync to demonstrate a working product. These results will be used to improve and establish any final issues.	For this prototype, we have two weeks; from November 14 to the 27th. Since this prototype will have many components, we have decided to meet more than one to ensure an effective and smooth prototype transpires. We will meet Thursday the 17, Sunday the 20th as well as Thursday the 24th. If more time is needed, the group can also meet Sunday the 27th.
6	Calculate the percentage of board cleaned, to ensure we meet and can prove the class's design requirements	We will create an analytical prototype that focuses on the cleaning ability of our device. We will use factors such as the number of jets, the placement of the jets around the board, the water pressure and the cling factor of the algae on the board to calculate how much algae will be cleaned from the board.	Our results will come in a percentage, and we expect them to be between 90% and 100%. This is within the tenth percentile of cleanliness and can prove to the client that our system is effective. We will use these results and show them to the client on Design Day.	We plan to do research and calculations for this prototype on November 15th.

6. Conclusion

In conclusion, the second round of prototyping has allowed the group to understand the functions of the automated and mechanical aspects of the project, as well as the importance of all the components working together. Although the water pressure pump we used in this prototype did not function in the expected manner, we are now able to take the necessary next steps to ensure this issue is fixed for our third prototype. Additionally, the pressure of the nozzles is something we will be focusing on in an analytical manner for the final prototype, since the cleanliness of the rafts depend on high pressure. This medium fidelity prototype has also allowed our group to decide on the information and feedback we would take into consideration from the client and classmates. All in all, this prototype has prepared us for the analytical and final prototypes.