Deliverable D: Conceptual Design

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Abstract

The following report outlines the conceptual design ideas for a raft cleaner machine for group A11 of GNG 1103. All conceptual designs the group has developed, based on the problem statement created in the technical deliverable as well as from previous benchmarking, will be split up into subcategories and reviewed by the group with the goal of deciding on a single concept. This has been done, through analysis and evaluation of previously mentioned concepts as a group, using different communication techniques such as diagrams and descriptions.

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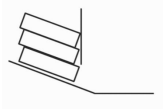
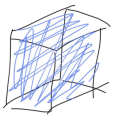
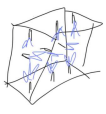
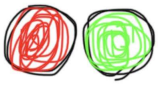
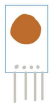
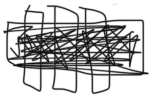
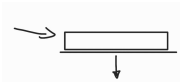
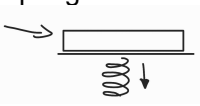
1. Introduction

The purpose of this document is to develop a solution for the problem statement previously created. Our current problem statement is that “A need exists for an automated solution that effectively cleans algae off of produce rafts in an eco-friendly manner. The product takes up minimum space within the unit, and requires minimal technical knowledge and labour from users.” To meet these design criteria, we have identified subsystems to our solution and ideate multiple solutions to each subsystem.

2. Subsystem Concepts

The following table lists different subsystems of our conclusion that can be combined to create possible solutions for our system.

Loading	Stack and push method  Rafts are stacked and something pushes the bottom board in, preferably automated	Horizontal slanted method  Bottom board slides through the opening	Vertical slanted method  boards slide down slant using gravity and maybe rollers	Specialised racks  - similar to a dishwasher, but modified for rafts
Running	Rollers 	Solid belt  similar to a treadmill	Chain belt  same as treadmill option, but with a chain or holes in belt	Stationary  influenced by dishwasher, like loading dishes in racks
Cleaning method	Soak 	Jets  preferably from all angles	Brushes 	
Starting / stopping method	Button	Switch	Pull chain	Sensor

			 like a lightbulb chain	 sensor knows when a board is ready to be cleaned and starts the system
Number of board during cycle	1 	2 	3 	4+  loaded like racks in a dishwasher
Collection	Bucket 	Weight sensor stack  The “plate” the boards sits on moves down the height of one board when in detects the weight of one board	Spring stack  The “plate” the boards sits on moves down when weight is added	Manually take out once cycle is completed
Placement	Table	Wall		

3. Solution Concepts

3.1 Concept 1

Stationary running system, loaded using specialised racks, water jets, button to activate system, multiple boards during one cycle, manual removal from system, table mounted.

3.1.1 Reasoning

This solution is heavily based on a dishwasher, with a start/stop button and water jets to clean stationary racks of rafts, and allows the cleaning processes to be automated and able to clean multiple boards at one time. However, the loading and collection method of this solution is still manual, which is a drawback as the client presented the need for an automatic system, and this system is only partially automated. Due to multiple boards being cleaned at once it would significantly reduce the amount of time to clean the boards, which clearly represents the clients need for a time-efficient solution. There are concerns about a dishwasher style solution's ability to clean the board enough without being scrubbed

beforehand, which is not ideal as we would prefer the amount of human labour required to be at a minimum.

3.2 Concept 2

Rollers, horizontal slanted loading method, water jets, button to activate system, two boards per cycle, bucket collection, table mounted.

3.2.1 Reasoning

This solution uses a button to activate the system which is beneficial because it is cheap and it allows the user to decide when the machine runs. It is not as convenient as the sensor, but is a good option for automation. The horizontal slanted loading method makes stacking and loading more difficult than other options however it uses gravity to slide the rafts into the machine which may be cheaper and simpler to implement. We use rollers to move the raft into the machine which allows the water to get in between the rollers and clean all board contours, unlike a solid treadmill-like belt. When the rafts are clean they drop into a bucket which is cheaper and easier to implement than a collection system however it risks damaging boards, it is messy, and it requires more space than stacking. This meets the clients need for technological simplicity, though is not entirely ideal. In addition, this solution uses water jets to clean the raft from multiple angles which will clean the entire board quickly and efficiently. This method cleans 2 rafts at a time, which saves time, however it makes the machine larger and more complex. Finally the system is mounted on a table which uses the table space available and is easier to install than permanently mounting to a wall.

3.3 Concept 3

Chain belt, stack and push loading method, water jets, sensor to activate system, one board per cycle, spring stack collection, wall mounted.

3.3.1 Reasoning

This solution allows for a sensor activation system, making the product simple to use which was a need highlighted by the client. It also requires a stacking and pushing method to load one board per cycle. This is time consuming and needs constant labour to re-load, though if we can make this process automated it would reduce the amount of human labour necessary and would allow for the product to be left unattended, a need brought up by the client. This solution uses water jets to clean the boards on a chain belt, which would theoretically effectively clean all contours of the board. Finally, the client preferred a product that takes up minimal space, thus this solution is optionally wall mounted and allows for more table and floor space.

4. Conclusions and Recommendations

The final solution concept that we plan to move forward with is concept number 3. This solution combines multiple subsystems that meet our problem statement, as well as other prioritised user needs. We aim to make our product completely automated, as to be time-

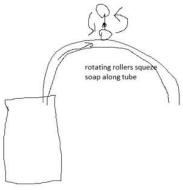
efficient for the user with limited to no supervision required. The rafts will initially be stacked by the user, and once the rafts are in place a sensor will recognize this fact and activate the machine. A system using DC motors will then push the bottommost board onto a chain belt that will carry the raft through the system. This completely automated system will significantly decrease the amount of human labour required to clean the rafts, and is safe to be left unattended. Jets inside the system will use pressurised water to clean all contours of the board, which is why we decided on a chain belt rather than a solid one - the holes in the chains will allow the water to access the bottoms of the rafts, as well as the algae to fall through. After making their way through the system, the rafts will fall onto a platform supported by a spring, which will move down as more weight is added to it and restack the rafts. To highlight another need brought up by the client and found within our problem statement, the system must take up minimum space within the unit. We will accomplish this by mounting it to the available wall space. From our three developed potential solutions, this is the most feasible to implement in regards to capturing our clients needs.

5. Future Work

The solution needs to be modified based on the feedback from the client and research is required into specific parts and availability. A more specific concept is needed which incorporates every aspect of the design and has a completed structural frame and appearance. All of the subcategories need to be designed with precision and preferably using parts and materials which have been researched. Prototyping will be needed to see what works and what doesn’t. Deciding on shapes and dimensions is important to make sure everything fits together. The solution should be compared against metrics once it is developed enough to be comparable so that it can be improved upon.

6. Appendix A - More Generated Ideas

Material / Structure - steel, L bars, rods in holes of rafts

Water filling	Solenoid valve (Electronically controlled valve) - reuse less water by circulating and pumping water	Open valve		
Draining	Solenoid valve (Electronically controlled valve) reservoir - reuse water	Open drain - no reuse		
Adding detergent - Sanatol	Detergent pump  Mixes concentrate with water through a tube with a pump	No Detergent	Detergent pods	Manual detergent added as needed 
Waste Collection	Drain Filter			
Heating	Heating element in water reservoir			
Control Method	Microcontrol (automated)	Manual		