GNG 1103

Design Project User and Product Manual

RAFT ALGAE CLEANER

Submitted by:

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List of Acronyms and Glossary

Table 1. Acronyms

Acronym	Definition
BOM	Bill Of Materials
CAD	Computed Aided Drawing
HRCS	Hydroponic Raft Cleaning System
UPM	User Product Manual

1 Introduction

This User and Product Manual (UPM) provides the information necessary for Commercial and Retail users to effectively use the Hydroponic Raft Cleaning System (HRCS) and for prototype documentation.

Throughout this manual the reader will be brought through the suggested regulations and the creation process of the HRCS. The document will go over cautions for the process, how to set up and prepare the HRCS, and the process of using it. As this document is a general manual for all users it will explain some suggested methods of usage, this document is formatted to guide the "owner" (Person who purchased HRCS) through the process of training, safety, and usage of the machine.

This document can be freely given to anyone. The North Design is not responsible for any damage or injuries caused by the HRCS.

2 Overview

Hydroponic growing is a growing trend among all people, from particulars to industry professionals. It generally consists of a growing tray or board made of a non-toxic releasing light material like polystyrene (or foam) floating on the water surface with several openings for the plants to be grown inside. The different benefits of such systems include the independency of the weather and soil conditions and space advantage among several others.

However, plants as being living things need a stable biosystem to grow and thrive, which is essential for both their health, aesthetics, and industrial profit and consumption. The presence of nutrients in parallel to light and water create a suitable living environment for algae plants as well, which end up building up as small green layers around the raft orifices, threatening the stability of the said biosystem and risking the contamination and asphyxiation of all future plantation and harvests.

The problem statement has been defined as a need for the client of an automated, reliable, and cost-efficient device that would safely clean algae build up on the rafts while limiting dangerous chemicals that would compromise the produce quality. In that sense, our product is simple, safe, and reliable. Using the device is easy, and it does the job of cleaning off the algae build up on the rafts based on the hydroponic needs of any plant or leafy vegetables grower.

The fundamental needs of the user are shown in the table below in order of importance:

Numbers	Needs	Importance
1	- The product is automated.	1
2	- The product works within a defined timeframe.	2
3	- The product is user friendly.	2
4	- The product is compact in size.	3
5	- The product is cost efficient.	2
6	- The product is reliable.	1
7	- The product considers water usage.	5
8	- The product limits or does not use dangerous chemicals.	3
9	- The product controls moisture content and drains it away when needed.	4
10	- The product has a good client satisfaction rate.	3
11	- The product is capable of monitoring both humidity and temperature.	5

During our preliminary benchmarking, we have defined many key aspects that would make our products better compared to a lambda similar project. As such, the device was to be easy to store and compact, as well as automated to minimize labor work. It also takes advantage of

gravitational energy to push out the boards when the task is done and safely does the job as a closed box system without causing any splash or significant hazard.

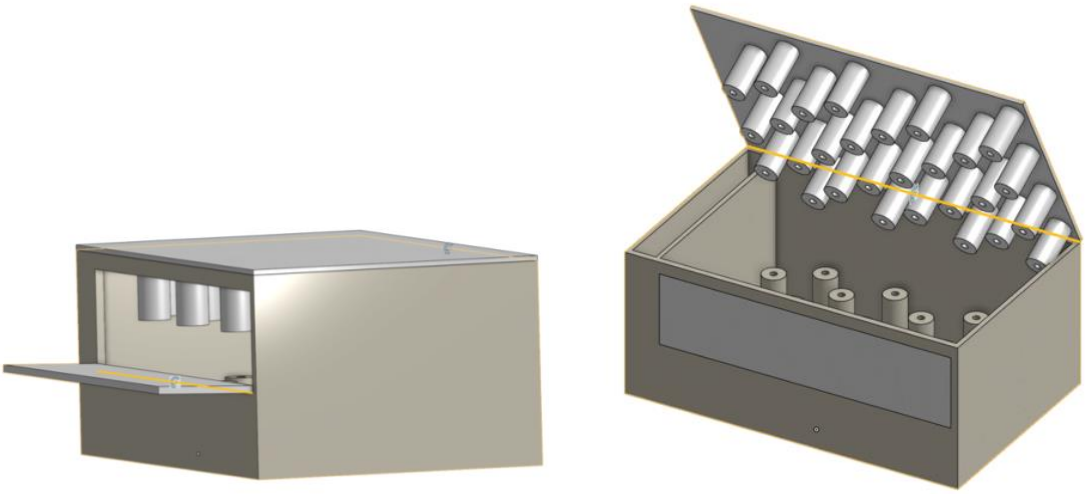

Figure 1 - Final Prototype CAD.

Among the key features or major functions of the product is the algae removal through both rotational and pressurized washing, automation and energy saving, cycle variability with a reservoir capacity and humidity control, and a drainage system for the outflow water, which could be optimized by being filtrated and reused. It also uses electrical energy through a battery system and circuitries, and a small pump that smoothly drives water from the batch to the inside of the device.

The architecture of the system could be easily represented through its different subsystems:

The following figures (1, 2, 3) represent the different subsystems flowcharts displaying both the order of operation and processes, and the different steps and system components worked on during the ideating phase.

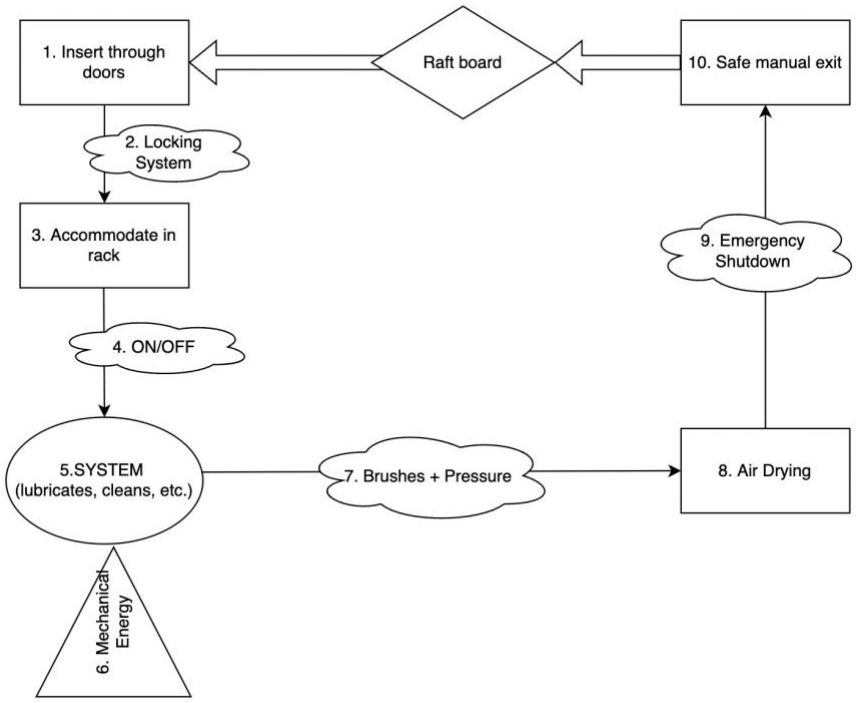

Figure 2 - General Assembly Subsystem Flowchart.

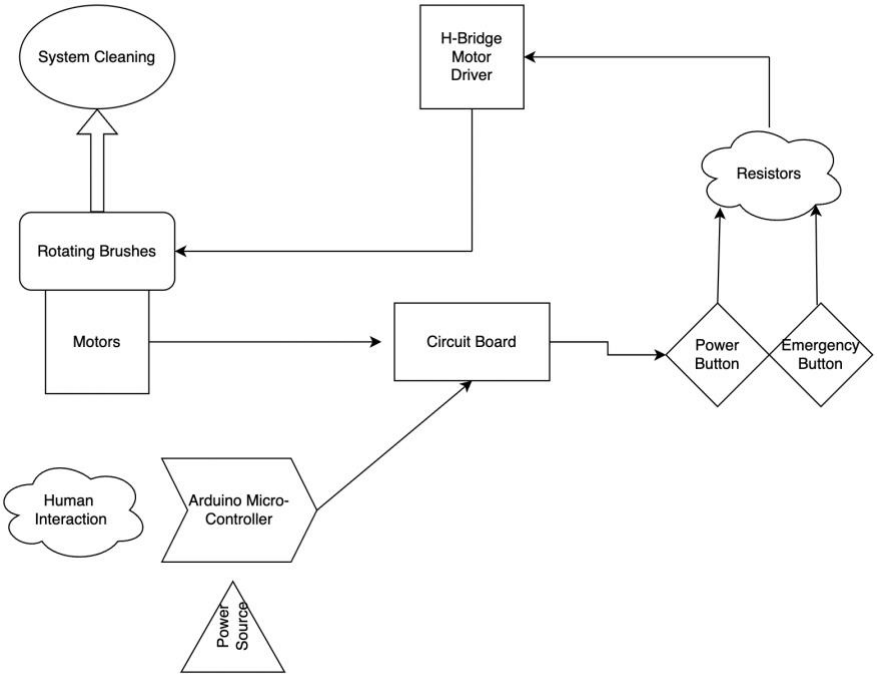

Figure 3 – Circuitry Subsystem Flowchart.

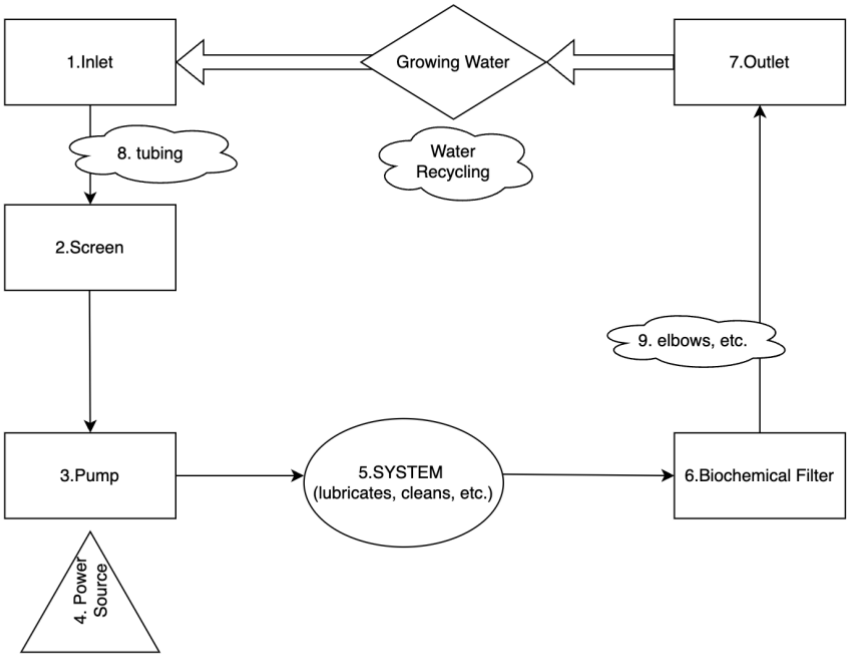

Figure 4 – Hydraulic Subsystem Flowchart.

2.1 Conventions

No convention is to be considered since no code or software is to be used during operation.

2.2 Cautions & Warnings

This document instructs on the use of the raft algae cleaner device. Any use beyond the instructions or any disregard gets the user to assume their responsibility in doing so.

- Do not touch any circuit components on the circuit board while the main AC or DC power is on.
- Do not use the battery if defective or a liquid is leaking.
- Do not put the battery or any other circuitry element in your mouth.
- Do not open the device while operating.
- Do not stick fingers in brushes.

Always ensure the user is of legal age and in sober conditions. Do not operate if in doubt, or under any substance influence.

3 Getting started

3.1 Configuration Considerations

Based on the level of algae generation found on the individual boards, it is suggested to select and change the input hose size to alter the required water inflow (Figure 1). This can be done through the inflow tube on the upper left side of the HRCS. (An additional manual will be given including the correct inflow & outflow tubing diameters and suggested length of cycle). Ensure that the sufficient inflow and outflow hoses are connected to the water source/outflow port.

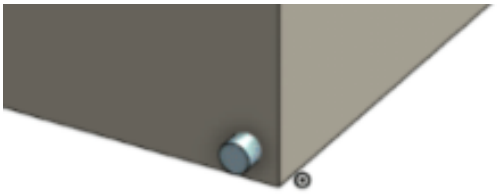

Figure 5 – Outflow Drainage Corner of Device .

3.2 User Access Considerations

As the HRCS will be used at the owner's discretion (Farmers, Retail, Commercial, etc.), it is highly recommended that the future user undergoes a training session on proper and safe use of the HRCS. With the levels of training ranging from "Basic" which includes the raft loading/removal and the overall basic uses of the HRCS (Emergency Stop, standard cleaning). The next level of training would entail the cleaning of excess algae found inside the HRCS as well as adjustments of inflow/outflow measures as mentioned in 3.1 "Configuration Consideration."

These various levels of training are interchangeable at the discretion of distributors/owners. These training courses are crucial in ensuring the safety of all users and protecting the HRCS from damage due to improper usage.

3.3 Accessing/setting-up the System

As the user approaches the HRCS, they must complete the security measure on the left-hand side of the HRCS (passcode, lock, keypad, etc. as shown in Figure 2). After this step is completed, the user must check that all inflow and outflow ports are correctly secured to avoid leaks. After the visual inspection is completed of the HRCS, the user may open the front door and place the raft inside, after closing and securing the door, the user will use the power switch to turn on the machine. At this point the user may exit the task while the machine finishes.

A system lock from a key system is a probable manner of machine security and safety. This key will be given to the client receiving the HRCS. An additional port will be found on the left side of the HRCS. This key should only be given to trained users to avoid misuse of the HRCS and putting the untrained user at risk.

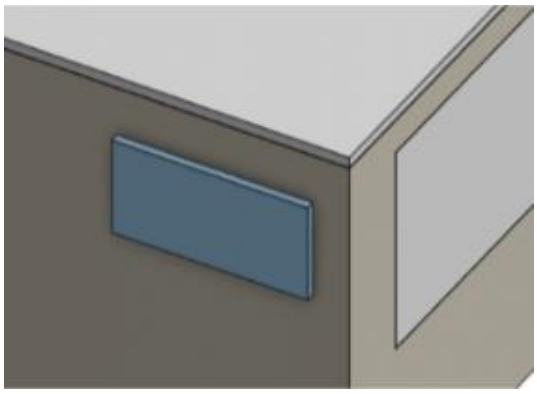

Figure 6 - Left Side of Device with Security Board.

3.4 System Organization & Navigation

With the overall idea each piece being easily interchangeable and readily available in any location, each sub functions can be pieced together to create the end HRCS. While the overall frame is going to be the longest living, the other moving/mechanical functions such as the brushes, battery and pump are at a higher risk of misuse or manufacturing defection. As these functions within the HRCS are designed to be easily changeable.

- Brushes

This function is found all over the interior of the frame each of these brushes will be swappable and are available to be “snapped” in and “snapped” out as necessary, whether this is to upgrade to stronger motors or in the case of a broken motor being replaced. These motors will be

connected to the battery system via waterproof wiring on the exterior of the HRCS.

Figure 7 - Brush Component.

- Battery

This function is found in the compartment on the left side of the frame (the box near the front), this is accessible by opening the top door. This battery is responsible for the powering of the motors, while it will be powered by the generators provided by the Growcer Unit the small battery will act as a short reserve if the case of a generator failure. This allows the current cycle to finish, and the breaker will protect the circuitry from being damage. This system can be replaced by opening the top door and manually pulling out the battery, then inserting the new battery.

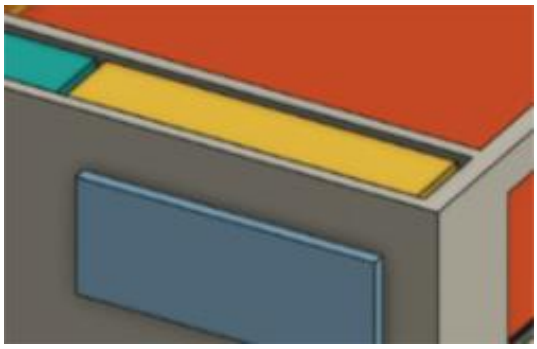

Figure 8 - Battery in Yellow.

- Pump/ Water Supply

The pump function will be responsible for producing the water flow through the high-pressure nozzles that are used for pressure washing the board. This pump is located behind the battery in the left compartment. This pump has an inflow port sticking out of the left side of the HRCS, this port is to be connected to the external water source provided by the Growcer's unit. As

this pump is accessible it is possible to be replaced by opening the top door and physically pulling the system out of the HRCS then the new pump is inserted.

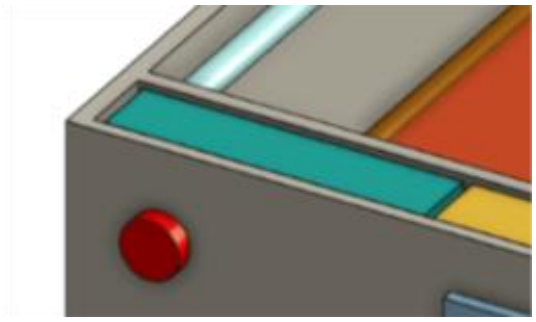

Figure 9 – Pump Compartment in Blue.

3.5 Exiting the System

When leaving the system, the user should complete a final inspection for any visible damages or malfunctions. The user should ensure that the HRCS is properly turned off and reset to the starting position. Inspect the bottom of the HRCS main body and evaluate if the algae excess needs to be cleaned. If the HRCS has passed the inspection, then the user may leave the machine until the next cleaning procedure is started.

4 Using the System

The following sub-sections provide detailed, step-by-step instructions on how to use the various functions or features of the HRCS.

4.1 Top Lid

This is the hatch that is situated on the top of the box. This feature was put in place to allow the user to access the interior in case of any failures. All parts are replaceable and must have an easy access placement. To lift the top hatch, you must unluck the clip situated on the side of the box to break its seal. Once the latch has been unlocked, you may open the lid to an extensive 65 degrees.

4.2 Main Door

The main door is to place and remove the algae boards. Firstly, you must unlock both latches on the side of the main door. The left one turns clockwise and the right one turns counterclockwise. Once the door is opened, you may gently place the board on the screen mesh. When you are finished, you close the door and lock the latches.

4.3 ON/OFF Switchc

The on and off switch is to operate and stop the cleaning. This is a simple feature designed for all users. When the boards are placed on the mesh and the main door is locked shut, all you have to do is press the button to actuate the cleaning mechanism.

4.4 Slider

When the cleaning process is done and the machine is turned off, there is a slider placed on the right-hand side of the box to allow for an angular movement of the screen mesh to cause the board to slide out. To operate this feature, you must turn off the machine, unlock and open the main door, and gently slide the slider up towards the front right corner of the box. This movement will cause the board to slide and catch itself on the lid. Remove the board, replace the slider to its original position and place either a new board inside the machine or directly close the main door and start another cleaning process.

4.5 Electrical Components and Pump

When the top lid is open, you have access to all the features and components of the machine. This is for ease of repairability. In this diagram, the blue box represents the pump of the pressurized water system, and the yellow box represents the electrical components. These features are permanently placed and can only be removed with tools. To remove the boxes, you have to remove four 10mm Hex screws from each of the box to then be able to lift them out of their compartments.

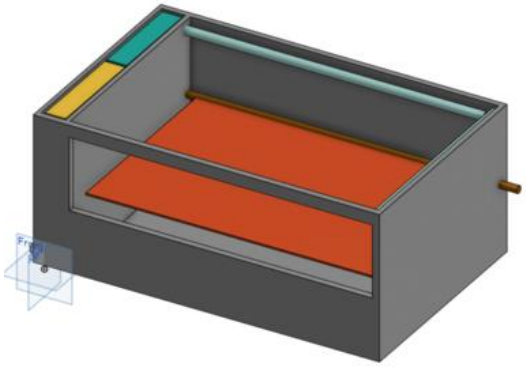

Figure 10 - Device Representation without Door nor Lid Systems.

4.6 Box

The box itself is made of a water-resistant material. There are no instructions on use because it doesn't have any necessary steps to operate. However, the box is replaceable. If there is wear, drainage, leakage, or sealing problems, please refer to our contact list and notify a service manager.

5 Troubleshooting & Support

Damaged may be caused on the machine. If the machine is malfunctioning, call our service number for some aid, however, here are some likely scenarios and how to temporarily fix them.

- If any of the machine's pieces are broken: Remove the piece using proper tools on the hardware and return the piece for a new one
- If the box is leaking: Use appropriate sealing from your local hardware on any surface on the exterior. If the leak is on the inside, please call our service line for help.
- If the electronics are malfunctioning Press and hold the On/Off button for 5 seconds to restart the machine or call our service line for help.
- If there are any other issues that have not been stated: Please call our service line

Service Number: 613-GET-HELP

5.1 Error Messages or Behaviors

The machine will not display any error messages. There are some common behaviors that are reason for concern. Some of these behaviors include:

- Brushes falling
- Motors not turning
- Electrical components not working
- Improper sealing
- Wear and tear

Caution: Harsh usage may accelerate or increase chance of failure

5.2 Special Considerations

If any problem or behavior found has not been listed above, please contact any service help.

5.3 Maintenance

Here are some helpful tips to help maintain your machine:

- Apply heavy amounts of white lithium grease (or any high-performance grease) on all moving parts to avoid seizures.
- Dry and clean after a day of use to keep the machine proper and to avoid any chance of bugs.
- Wipe down the inside of the box and all its components with some SC1 spray clean.
- Apply some lubricant to any moving parts as well.

5.4 Support

For support, here is a list of contacts that are helpful:

- Service Support → 613-GET-HELP
  For questions or inquiries
- Service Manager → 613-673-8939; Email: servicemanager@gethelp.ca
  For immediate support and emergency
- Contact Official → 613-835-3750
  Contact an official for any other reason

IF INJURIES OCCUR: CONTACT YOUR LOCAL EMERGENCY NUMBER!!!

6 Product Documentation

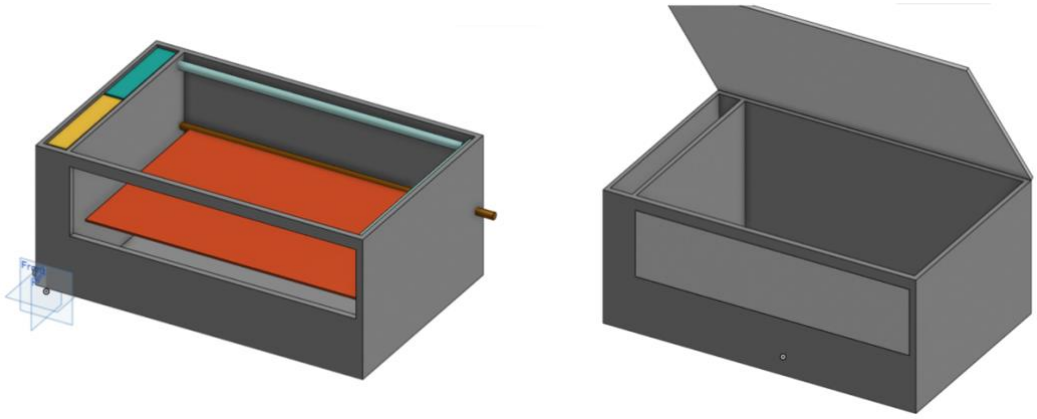

Figure 11 - General View of the Device.

We included all the components from every prototype. We have set out to test multiple aspects of our design to better improve our last prototype.

The final design was built using the CAD design shown above. All components were calculated and measured to a certain precision.

During this design process, we decided to include all these crucial details for the final prototype:

- Pump.
- Tubing.
- Box.
- Screen mesh.
- Electronics.
- Brushes.
- Motors.
- Lid (Top and Bottom).
- Path for the screen mesh.
- Plastic box for water resistance.

6.1 Mechanical Subsystem

6.1.1 Motors

- These provided the power to the brushes to allow for better cleaning. Placed around the interior of the box to hit all parts of the boards.

6.1.2 Screen Mesh and Path

- The screen mesh isn't considered mechanical; however, it follows a path with a toggle on the end to tilt the mesh and drop the boards out of the box.

6.1.3 Brushes

- Attached to the motors the scrub off all the algae. Important aspect to aid in the cleaning.

- Lid
  - This is used to access the components on the inside as well as reach the interior of the cleaning bay. If any mechanical failures are to occur, it is possible to reach the components and switch them out.

6.2 Electronics Subsystem

6.2.1 Pump

- This creates a pressurized system throughout the box to use water to clean off the algae

6.2.2 Tubing

- The tubing is connected to the pump and carries the pressure throughout. Very important to have a path to follow to allow the water to pass

6.2.3 Wiring

- The wiring is a necessity to ensure that all the brushes are functioning

6.2.4 Motors

- Highly important electrical component to clean the algae. Apart from the pressurized water, this is the only other source of cleaning power that is insider the machine

6.3 Materials used

6.3.1 Plastic

- Plastic is water resistant, cheap, and easily replaceable
- Other materials that can be used is metal and wood, however, if this is used, you need a sealing to accommodate the water and it is more expensive.

6.4 BOM & Costs

THENORTHDESIGN

BILL OF MATERIALS 27/11/2022

(1/2)

ID	Component	Feature	Unit price	Qty.	Price	Prototype
1	Brushed DC Motor	electrical	$ 15.81	1	$ 15.81	1
2	Scrubber Brush	electrical	$ 5.62	1	$ 5.62	
3	Push button	electrical	$ -	1	$ -	
4	24V Battery	electrical	$ -	1	$ -	
5	Drilling Machine	assembly	$ -	1	$ -	
6	Drill Bits	assembly	$ -	1	$ -	
7	Other Drill Accessories	assembly	$ -	1	$ -	
8	Plastic tupperware	assembly	$ 4.00	1	$ 4.00	
9	Epoxy Plastic Weld	assembly	$ -	1	$ -	
10	Wiring	electrical	$ -	1	$ -	
11	Dish Detergent	testing	$ -	1	$ -	
12	Cutter	assembly	$ -	1	$ -	
13	Plastic Plate	testing	$ -	1	$ -	
14	Cardboards	assembly	$ -	1	$ -	2
15	Chopstick	assembly	$ -	1	$ -	
16	Brush	cleaning	$ -	1	$ -	
17	Straw	tubing	$ -	1	$ -	
18	Tape	assembly	$ -	1	$ -	
19	Epoxy Plastic Weld	assembly	$ -	1	$ -	
20	Knife	assembly	$ -	1	$ -	
21	Sharpie	assembly	$ -	1	$ -	
22	Pencil	assembly	$ -	1	$ -	
23	Screen Mesh	cleaning	$ -	1	$ -	
24	10 ft Plastic Tubing	hydraulic	$ 6.43	1	$ 6.43	3
25	Clamp hose	assembly	$ 1.68	1	$ 1.68	
26	60 mL syringe	hydraulic	$ 6.20	1	$ 6.20	
27	Screen Mesh Roll	cleaning	$ 10.99	1	$ 10.99	
28	Plastic Box	assembly	$ -	1	$ -	
29	Epoxy Plastic Weld	assembly	$ -	1	$ -	

Total = $ 50.73

6.5 Testing & Validation

6.5.1 Testing for first prototype

6.5.1.1 Cleaning efficiency – Low fidelity + focused

- Ensure mechanical cleaning is effective using a cleaned area by original dirty area ratio.
- Test could be made many times for results accuracy.
- Test aims for over 90% efficiency as a success criterion.

6.5.1.2 Automation – Low fidelity + focused

- Improve automation and ease of use.
- Qualitatively and subjectively evaluate the system and the push button.

6.5.1.3 Feasibility – Comprehensive + Analytical

- Measure feasibility using available resources like cost and time.
- Also, could be measured by ergonomics and allowed space (box has to fit within a certain limited space).

6.5.1.4 Sealing & waterproofing – Low fidelity + focused

- Ability of the box to retain water and not get the circuitry and other component wet.
- Measurable using the leaking or exiting volume of water by placed water volume ratio.
- Ideally this test aims for 100% waterproofness.

6.5.2 Testing for second prototype

6.5.2.1 Surface area cleaned

- Measured distance between brushes to ensure that all surface area is making contact and are being cleaned.
- Test if the board will be cleaned.
- Apply our knowledge to this concept to find any possible faults with this idea.

6.5.2.2 Sealing of the prototype and understanding of the components

- Epoxy glue is effective to ensure that everything is connected and sealed.
- Ability to withstand pressure has been tested and analysed using chopsticks.
- The measurements of all components were assembled using cardboard to deal easily manipulate or change any details necessary to make our project effective.

6.5.2.3 Automation

- Red taped button was glued on the side to represent the automation of our system.
- It was strategically placed on the side with the inflow system.
- The placement is important as to keep the prototype logical and intact.
- All electrical components must be sealed and evade any water that flows in or out of the machine.

6.6 Testing for third prototype and final

6.6.1.1 Water pressure system – Low fidelity + focused physical

- Designed by fastening a 60mL syringe to a vinyl tube that carries the water pressure throughout the box and sprays high volumes of water to clean the boards.
- Testing was used with water.
- Water is directly present on the boards and does maintain its objective for cleaning.

6.6.1.2 Automation – Low fidelity + physical focused

- Used a separate structure to represent the automation of the system.
- Included a path for the screen mesh to follow to represent its automated release system
- Wiring is waterproof and is carrying a current through the exterior of the designated washing area and is currently not exposed to the exterior of the box.

6.6.1.3 Motors and brushes – Focused + Analytical + Physical

- The brushes have measured accordingly to ensure proper cleanability of the boards.
- Motors are attached to the box.
- All components of the prototype are designed and structured to standardize ease of repairability.

This exhaustive list is a history of our past testing objectives and analysis. All of these contributed to improving our next prototype that eventually led us to our final design.

7 Conclusions and Recommendations for Future Work

To conclude, the project has been successful in the sense that all the involved designers have learned many lessons during their work and could be more proactive into continuing and improving the design work or assisting anyone interested in doing so in the future.

Since prototyping is essential, not only is it better to start on a low fidelity prototype with minimal cost and more representative features to get feedback, but the prioritization of the features and subsystems should be made such that, in consequence, one prototype at least should be given or focused on each individual subsystem.

It was learned as a team that plans are useful but not concrete, that perspectives play a huge role in determining and allocating the different resources, time being one of the most important and thus should be managed as such. Also, as designers, planning must account for many risks and failure scenarios to occur, primarily that the client might change their mind or not be satisfied with what they see. It has also been learned that ideas are judgement-free concepts that can come from anywhere and in any form, and that prototypes are merely but a representation of the testing of the final product, and not the complete final design itself or all its features.

As to future work recommendations, many assessments could be made amongst which the motor-brush system could be further optimized as to how it gets down to reach the board surface areas, or the circuitry could be further investigated and optimized. A motherboard could also be implemented, and the automation level could be taken a step further.

If the team had a few more months to work on this project, it would focus on many aspects, such as improving the dishwasher-type interface of the system or further optimizing the drainage water with including a filtration system. A stackable/ wall-mounted design could also be instigated with a self-ejecting system rather than a manual push of the side lever. The product could also be further improved to be more compact and user-friendly, minimizing space and labor time and skill, as well as making it easier to move, store, and operate.

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