Deliverable K - User and Product Manual
GNG 1103

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Table 0.1 *Acronyms*

Acronyms	**Definitions**
belt	Conveyor Belt
BOM	Bill of Materials
Raft Cleaner	The machine we designed

1. Introduction

A problem was proposed on behalf of the client to efficiently clean plantation boards of algae. Currently a labor intensive task, the client wished to explore any method of automation to ease the reliance on human labor. Hence, this project assumed that some human labor access was available, but was to limit as much as possible whilst still providing an equivalent or better rate of return.

This document will explore the cleangineers group method for delivering a prototype that intends to solve the proposed problem for the client. The needs of relevant stakeholders were brainstormed and various concepts were created to address these needs. Using this framework, various design concepts were created and certain elements were prototyped. These prototypes are explained and documented in this report. These prototypes were tested and measured against key metrics to design a final prototype that is suggested at the conclusion of the report.

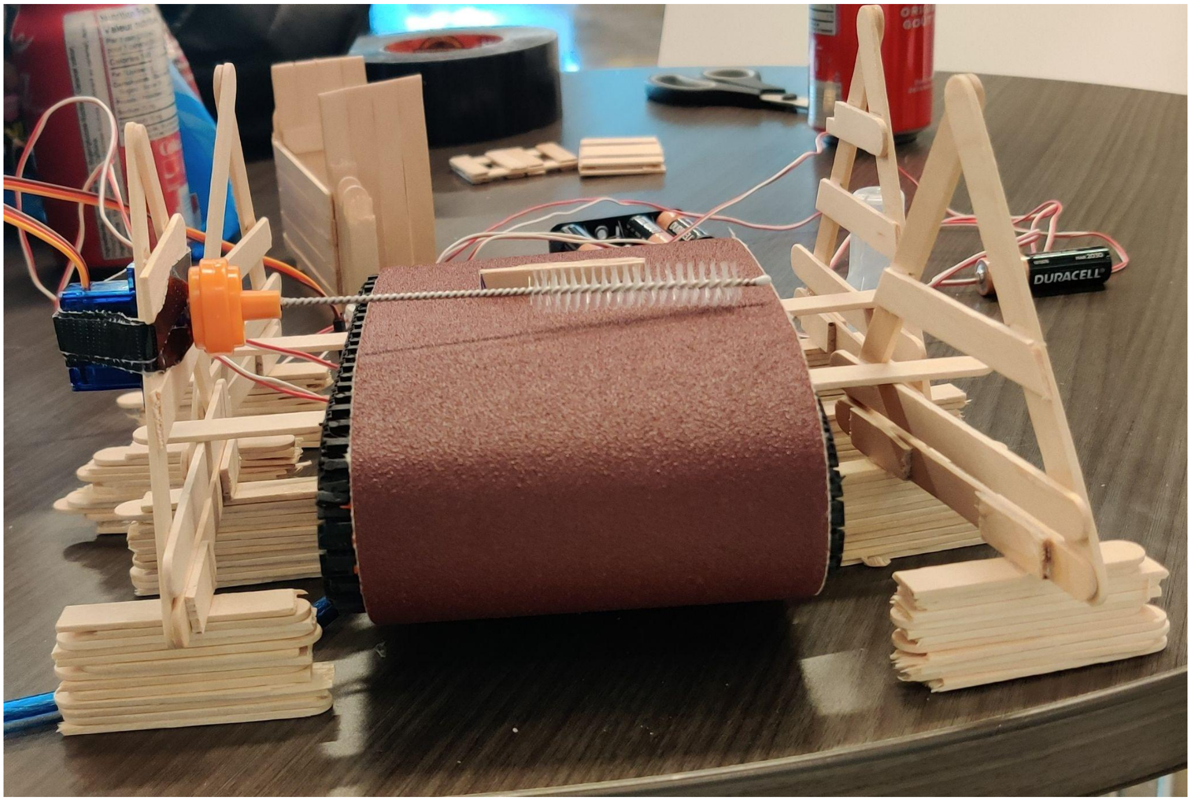
This User and Product Manual (UPM) provides the information necessary for workers to effectively use the raft cleaner and for prototype documentation.

2. Overview

This project is designed for a deep water culture (DWC) company for their hydroponic system. The goal is to design a machine that can remove the algaes from raft floating boards. The workers are working 8 hours a day, the company is looking for a machine that can reduce their labor time. Thus it must be fully automated. Besides the labor time, the client is also looking for a machine that is easy to use for farmers.

In our design, the concept is simple but useful. All we used were brushes and a microcontroller to drive the motors. This allowed us to significantly reduce the cost of the . This machine also has a board tank that can store 20 boards, which can let the farmer do all the boards in one run.

Figure 2.1 *Final prototype I — Cleaner and Conveyor Belt*



This design concept has three subsystems, dispensing system; surface cleaner; and hole cleaner. All these subsystems are working to achieve one goal, automatically clean the raft boards. The supporting truss is either stainless steel or plastic to prevent rusts. The motors are driven by microcontrollers, which will be pre-coded before they get to the users. The belt will be a high friction material to reduce the expected slippery occurs during the cleaning procedure. In our prototype, the machine starts immediately when it receives the power, but in real implementation, a button or a switch can let the operation become a lot easier.

2.1. Conventions

WARNING – Please pay extra attention when you see this keyword

ACTION – Requires action by user when you see this

2.2. Cautions & Warnings

WARNING – The workspace is semi-wet, be careful when working with electricity

WARNING – Do not touch the brushes when they are still in motion

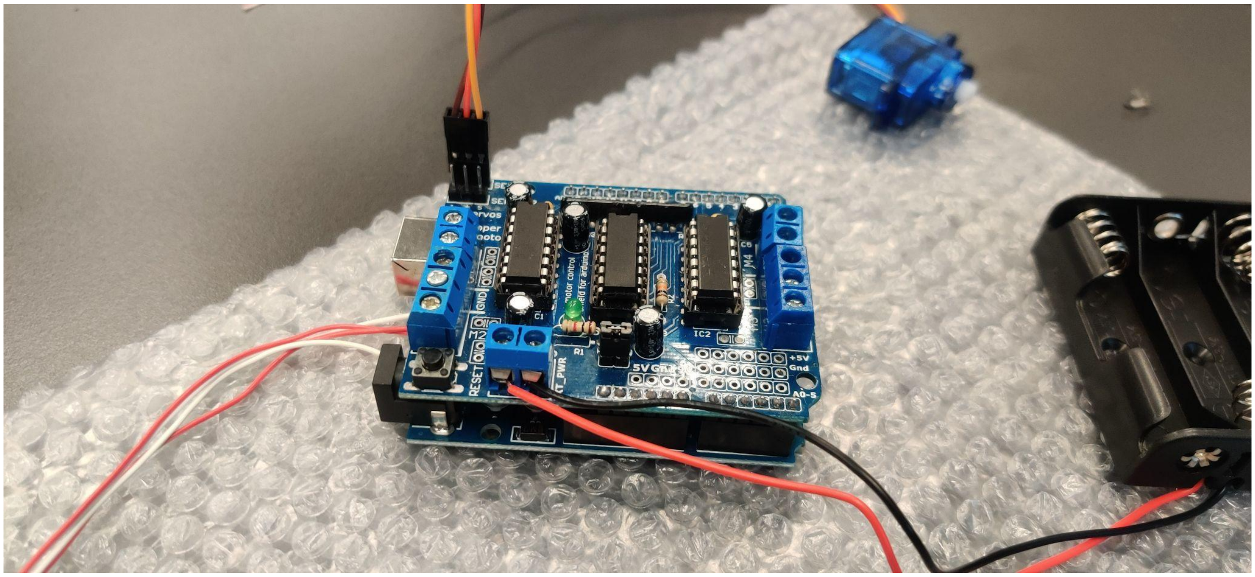
WARNING, ACTION – Stop the machine immediately if you heard irregular sounds

3. Getting started

The steps included from the setup/initiation through exits are very simple for both the implementation and the prototype. Tackling the implementation first,the first step to be performed by the user would be to damp the boards in Sanitol. Once that is done, load the boards in the board tank and with the simple press of a button,one has the machine fully functioning and cleaning boards. We have included a precautionary key that prevents any accidental start-ups.

While for the prototype, once the truss and the circuits are set up, the client will just have to input the batteries and the prototyping will be running and fully functional. For the circuits, everything will already be connected and the one step described above is the only thing required to get it running.

Figure 3.1 *Showing that everything is already connected*



3.1. Configuration Considerations

The code should be pre uploaded to the microcontroller. If not, you can upload the file attached in Makerepo to your microcontroller by your self.

3.2. User Access Considerations

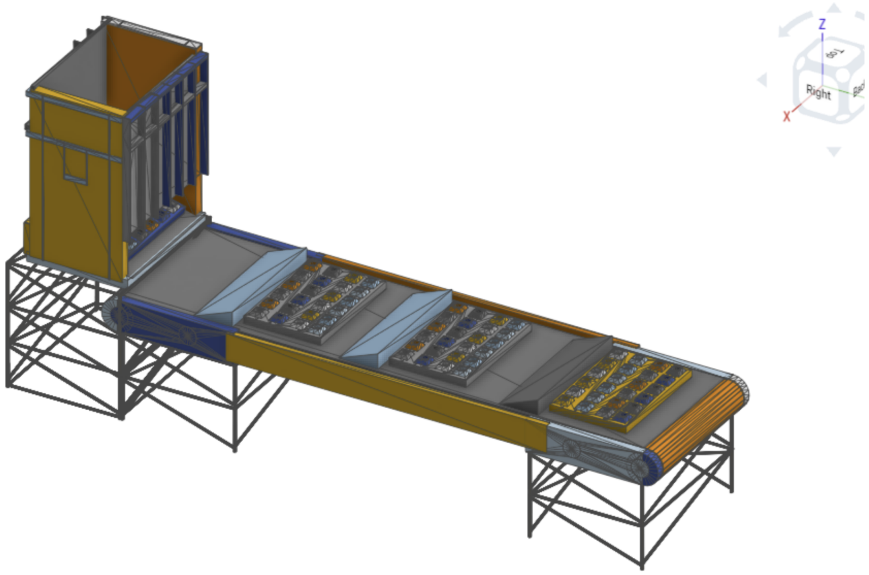
For the machine our team designed, any user is welcomed to make use of it since it does not require any special access except from having the safety key and is not dangerous in any way. The only precaution to be taken is to stay away from the rolling brushes .

3.3. Accessing/setting-up the System

The user will be provided with a safety key just like the one used on treadmills. In order to set up the machine, the user will have to input the safety and then press the start button. No login or password is required, just a safety key that is simple to use.

3.4. System Organization & Navigation

Figure 3.2 *Dispensing system*



3.4.1. Board tank

The board tank is connected to trusses that make it level to the conveyor belt.

3.4.2. Cleaning system

The brushes are elevated to the required height and they are all connected to DC motors that help them rotate at the required speed to clean the boards. For the vertical cleaning brushes the vertical troubleshooting is done by elastic threaded rods and all the brushes are connected to the same motor with the help of a microcontroller.

3.4.3. Conveyor belt

The conveyor belt is also elevated by trusses so that it can be kept on the table. With the help of gears and motors the conveyor belt rotates making the boards travel the distance of its surface. The conveyor track is guided using guide rails which are gears that help keep the belt on its track.

The belt itself is powered using motors and they are connected to an electric inlet.

3.5. Exiting the System

In order to exit the system, only one step will be required and it is the press of a button. Since everything is interconnected, the press of the turn off button will shut the whole system down.However, it would be advisable for the user to ensure that the brushes have completely stopped, then by removing the safety key one completely ensures an accidental start up of the machine which could be dangerous.

4. Using the System

4.1. Distribution System

The role of the distribution system is to move boards in a manner that maximizes the efficiency of cleaning. From the holding tank, to the end of the conveyor belt, the distribution system's motor and belt make cleaning the board as easy as ever before.

4.1.1. Board Tank

After being manually soaked in a detergent solution, boards are to be piled up in the Board tank, where they are stored and dispensed, one at a time. This allows for multiple boards to await intake to the cleaning system and increases the rate of automation within our systems.

4.1.2. Conveyor Belt

The Conveyor Belt is the main transport method for all boards, and the belt is equipped with grooves and a high-friction surface to prevent any slipping of boards during cleaning.

4.1.3. Motors

Motors are the main form of propulsion for the conveyor belt. Along with a gearbox and proper programming, the conveyor belt can move the boards at a speed where we can synchronize brushes and cleaning equipment to optimize efficiency of cleaning.

4.2. Cleaning System

The role of the cleaning system is to clean boards in a manner that is effective in removing algae from the surfaces of the boards. From the beginning of the conveyor, to the end of the last brush, the cleaning system's brushes make cleaning the boards as easy as ever before.

4.2.1. Detergent

The boards are manually soaked in a detergent solution, which has both polar and nonpolar parts, removing any oils and increasing the effectiveness of the cleaning.

4.2.2. Brushes

There are brushes on all angles of the board, and their job is to physically remove particulates of algae from the surface of the boards. The brushes cover the sides and top of the board, hence needing to flip the boards after.

5. Troubleshooting & Support

This section's materials will help you debug and/or fix the problem of this machine.

5.1. Error Messages or Behaviors

ACTION

Table 5.1 *Unusual Behaviors and Solutions*

Unusual Behaviors	**Solutions**
Cumbrous sound from board tank	1. Stop the machine. 2. Check if the boards are stacking correctly
Brush not moving or moving slowly	1. Stop the machine. 2. Check if the brush got stuck by algaes 3. Replace if needed
Belt not moving properly	1. Stop the machine. 2. Check if the belt got stuck by algaes 3. Clean it thoroughly

5.2. Special Considerations

WARNING - Please wait until the machine comes to a full stop before touching anything.

WARNING - Make sure the board is stacked properly

5.3. Maintenance

ACTION - Check the brushes and the belt every time before using it. Clean them if needed.

ACTION - If the brush is worn too much, replace it for best cleaning power

5.4. Support

If you encountered any problem that is not listed there, or you've tried the suggested solutions but still can't fix it, you can contact us through email: **chan091@uottawa.ca**

6. Product Documentation

We have broken our prototype into 3 categories namely the structure, the distribution system and the surface cleaner. Each one of them has been explained in details of how to build them and pictures are provided for visual aid.

For the structure of the prototype, cheap paddle-pop sticks (timber) were selected as these were very budget efficient and had significant strength to hold the prototype. In addition, the wood is easily glued together and cut so it can be used to create arbitrary shapes easily. Other materials such as aluminum or steel could be an option for a life sized prototype, as the environment is likely to be humid or wet, and the sustained weight is likely to be considerably more. A tarnish will be required to prevent corrosion if this is the case.

The electronics and wiring for the conveyor belt system will have to be insulated and protected. This includes water damage as well as possible cutting hazards. This risk was not accounted for in the prototype due to its size and it being not an issue large enough to factor into our budget. All wiring will have to be constructed in a way to remove the risk of live power to any people utilizing the plant.

6.1. BOM (Bill of Materials)

Table 6.1 *Bill of Materials*

	Item Name	Quantity	Unit	Unit price($)	Total Price($)	Links
Programming	Arduino UNO R3 (Clone)	1	board	17.00	17.00	link
	Arduino IDE	1	software	0.00	0.00	link
	AF Motor	1	library	0.00	0.00	link

	Motor shield for Arduino	1	board	15.50	15.50	link
	Breadboard	1	board	10.65	10.65	link
	Battery(AA 1.5V)	1	#	8.43	8.43	link
	Battery Holder	1	#	9.99	9.99	link
	Wires	1	packages(10 per pack)	1.00	1.00	link
	Extra Wires (From Home)	10	#	0.00	0.00	/
Construction	Glue	Bonds materials together	1	bottle	8.48	8.48
	Popsicle Sticks (From Home)	Wooden sticks used for building the truss	0	packages(200 per pack)	0.00	0.00
Cleaning System	Servo Motor	1	#	11.00	11.00	link
	Duster	1	#	0.00	0.00	/
Transportation	Sanding Belt	1	#	9.99	9.99	link

	Wheels/Gears (From Home)	10	#	0.00	0.00	/
	DC Motor (From Home)	1	#	0.00	0.00	/

Total	92.04
Total (after Tax)	104.01

6.2. Structure

6.2.1. Equipment list

- Paddle-pop sticks (truss system)
- Super-glue
- Sticky Tape

6.2.2. Instructions

The truss is constructed using paddlepop sticks, glued together to create a strong triangular truss system. The base of the triangle is reinforced by 5 short lengths of paddlepop sticks to give extra traction and prevent the truss from toppling over. These trusses are then connected using a double length paddle pop stick through the distribution system, to keep it elevated off the ground. In addition, the board tank is held above the system using a similar technique. This is visible in Figure 6.2.2

Figure 6.2.2 *Two of the trusses*

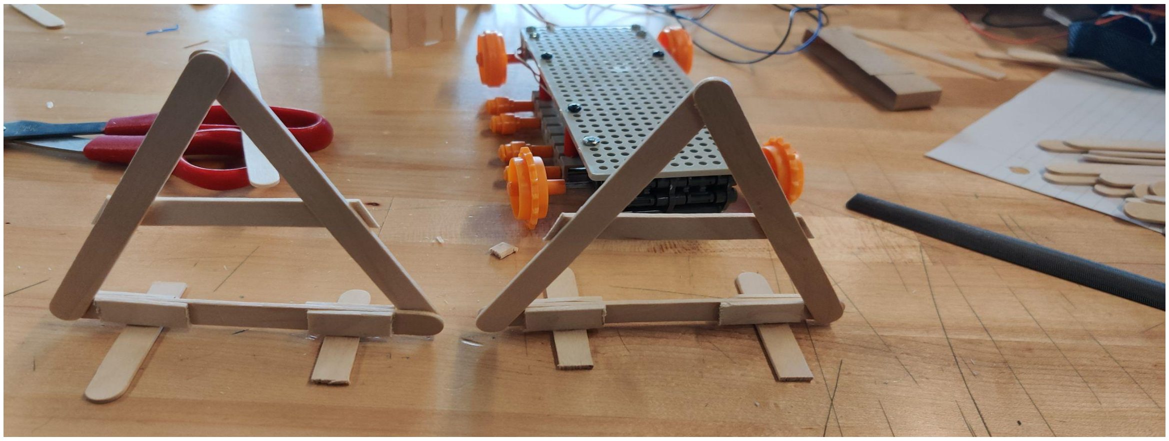


Figure 6.2.2 *Structure of the prototype - Board tank*

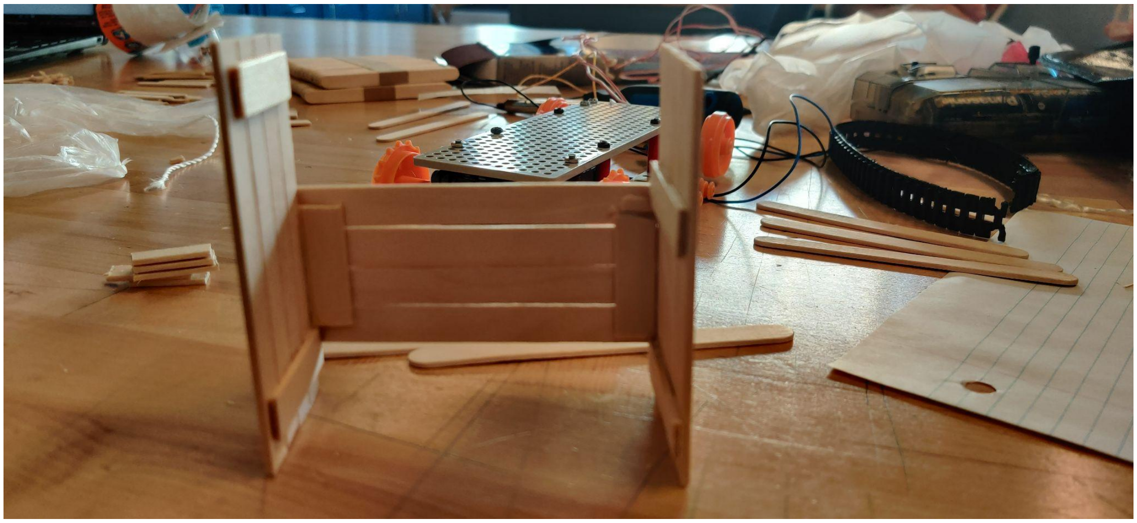
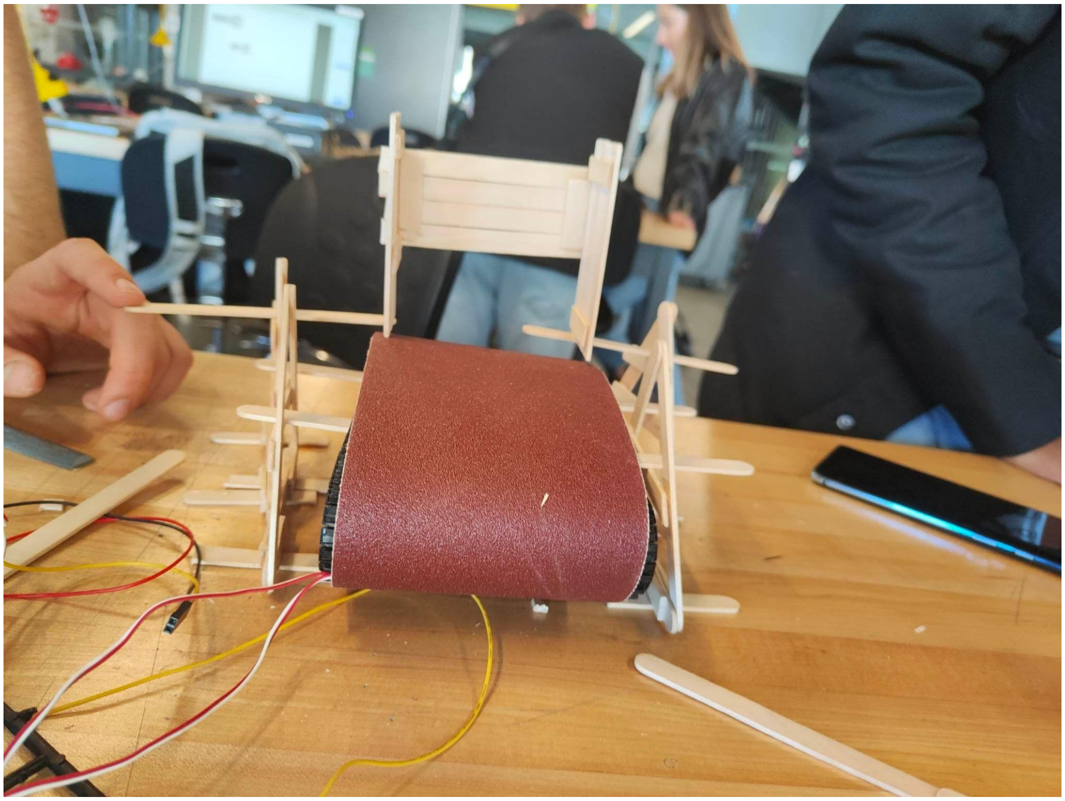


Figure 6.2.2 *Structure of the prototype - Everything together*



6.3. Distribution system

6.3.1. Equipment list

- Gears
- Sand paper
- Glue
- Dc motors
- Screws and bolts
- Conveyor tracks
- Support columns
- Gears as conveyor guides
- Small metal rods

6.3.2. Instructions

The first step when it comes to building the conveyor belt, you have to connect the motors to a gear box(a case with connected gears) then insert small rods into those gear boxes. This way the motors are going to drive the rods.

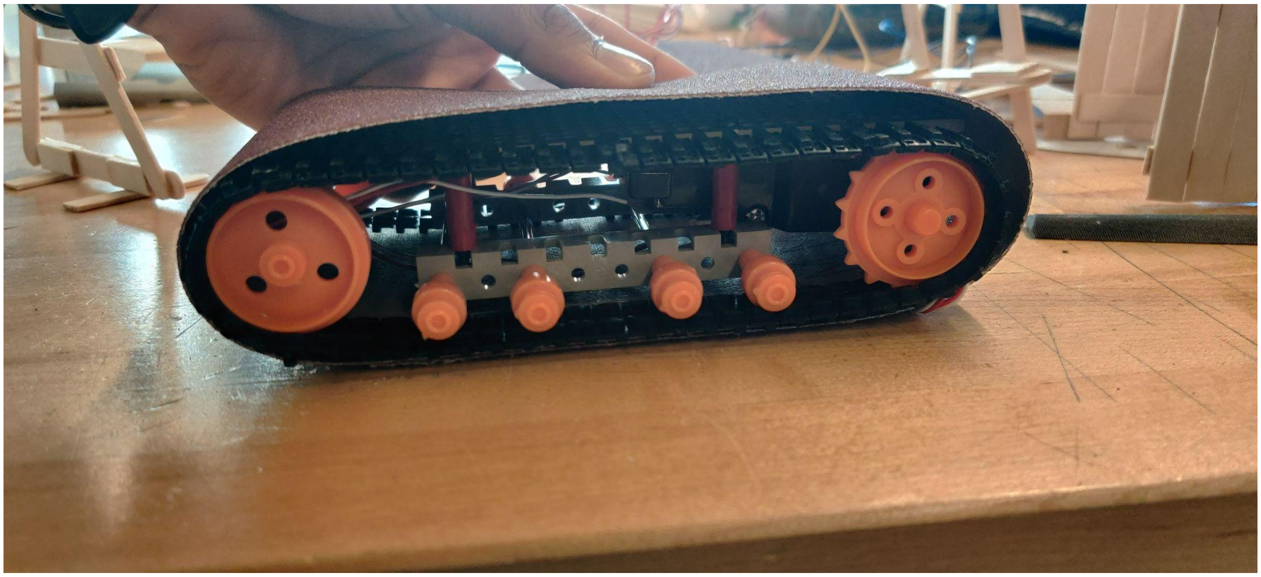
After that insert gears on the rods and do the same thing for the other end of the conveyor system but without the motors and gearboxes.

Make use of support columns and gears that are going to guide the conveyor belt

Now that the body of the system is done, put the conveyor tracks on the gears and attach the sandpaper over the tracks. The sandpaper has to be tight enough so that the gears can drive it.

At the end it should look like this.

Figure 6.3.2 *Distribution system of the prototype - Conveyor belt*



6.4. Surface Cleaner

6.4.1. Equipment list

- Sticky Tape
- Paddle-pop sticks
- Brush
- Servo Motor

6.4.2. Instructions

The surface cleaner is cantilevered off of the truss system at a height that applies the correct amount of friction for effective cleaning of the boards. This system was constructed using a motor that applied torque to the brush and rotated it at a speed prescribed by the arduino. Multiple paddlepop sticks were inserted inside the brush to provide a rigid vessel for the brush to stick to. This was then glued onto the motor, with the brush sticky taped around it.

Figure 6.4.2 *Surface cleaner of the prototype - the cleaner*

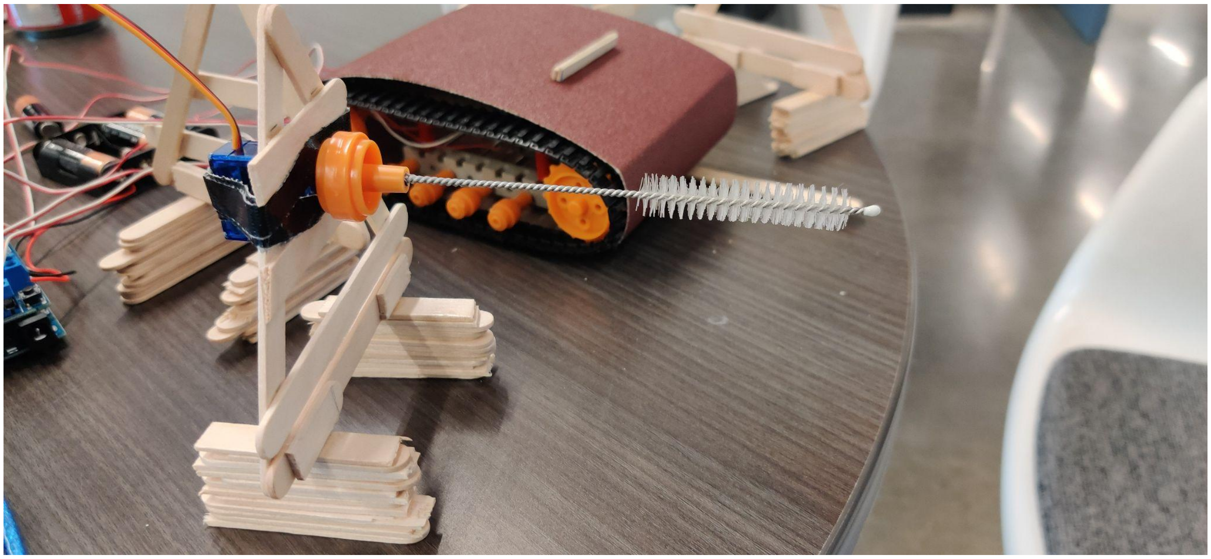
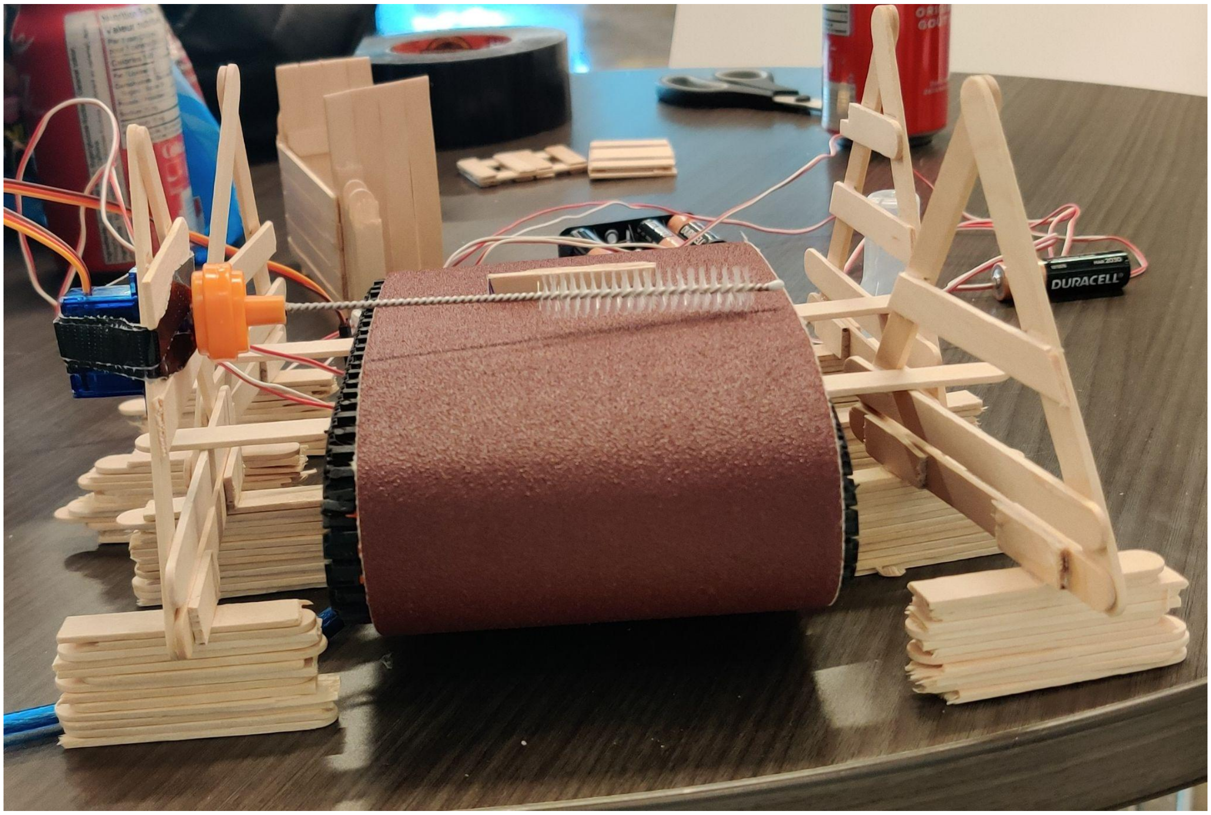


Figure 6.4.2 *Surface cleaner of the prototype - Final prototype*



6.5. Testing & Validation

Table 6.5 *Testing & validation*

Test performed	Results obtained	Validation
A test was performed to evaluate the cleaning ability of the prototype. We placed some pieces of fabric onto the boards and let it run through the prototype.	We used the following formula to get our result: (Amount of fabric removed/amount of fabric placed)*100 We obtained a 99% efficiency	We used fabric to simulate the algae since they were accessible as compared to actually growing algae. Nevertheless, the result obtained shows that our prototype actually cleans the board and based upon that the

	in cleanliness.	implementation should also be able to do so
Another test was performed to test the speed at which the prototype will clean the boards. The same test that was performed to test the speed.	We used a stopwatch to measure the time that the board took to go through the whole journey. The result we got was about 10 seconds. We did several trials and calculated the average of the results we obtained to get that value.	The value we obtained is within the acceptable range and we have concluded that the prototype was a success since it passed both the tests. As for the implementation, it will clean the boards within the 8 hours provided since it is just a bigger version of the prototype.

7. Conclusions and Recommendations for Future Work

Along our journey towards accomplishing this project, we learnt a few valuable lessons and skills such as the importance of proper planning and time management. Juggling this class project work with other classes assignments was not an easy task. This forced us to better plan and manage our time. We also learned that you should be able and ready to compromise because unexpected things are bound to happen.

One lesson which is very particular to this group is about prototyping. Not being able to produce a prototype out of a concept does not mean you have to eliminate the concept. You have to find a way to demonstrate that concept even if it is low fidelity.

If we had more time to work on this project, we would definitely make a foul proof one where it would be functional without having any issues. We would also work on the vertical cleaning system which we completely ignored owing to the lack of time. We would have made a medium-high fidelity prototype to demonstrate the concept.

8. Bibliography

https://learn.adafruit.com/adafruit-motor-shield

APPENDICES

9. APPENDIX I: Design Files

Table 9.1 *Files*

Makerrepo	https://makerepo.com/MannSquared/1254.gng1103-group-a04-raft-cleaner	Project main page
projectMotorCode.ino	In Makerrepo	Code to run the microcontroller
Design.pdf	In Makerrepo	Design diagrams