Deliverable -E-

Project Plan & Cost Estimate

Presented by: Group 8

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1. Detailed Design Solution

The final design solution encompasses all prior deliverables work and the choice of the team for many features and subsystems. The final concept has been chosen to satisfy the cleaning function with the use of power brushes, automation through a micro-controller, safety with an emergency shut-off button, and compactness using a folding system that would be easy to store and use withing the allowed space.

After several work and brainstorming sessions, the team has conveniently divided into 3 subsystems based on its composition and functionality needs:

- The circuitry and automation call for an electrical subsystem with all the wiring and necessary component to drive both energy and programming through the system.
- The water needed for cleaning comes from an inlet source and exits as an effluent while being used to clean and lubricate the device. It therefore has a hydraulic subsystem considering all the necessary water resource management tools and apparatus needed.
- Lastly, the assembly subsystem groups the containing box and all the other assembly parts, bolts, sealing mechanism, etc.

a) Raft dimensions

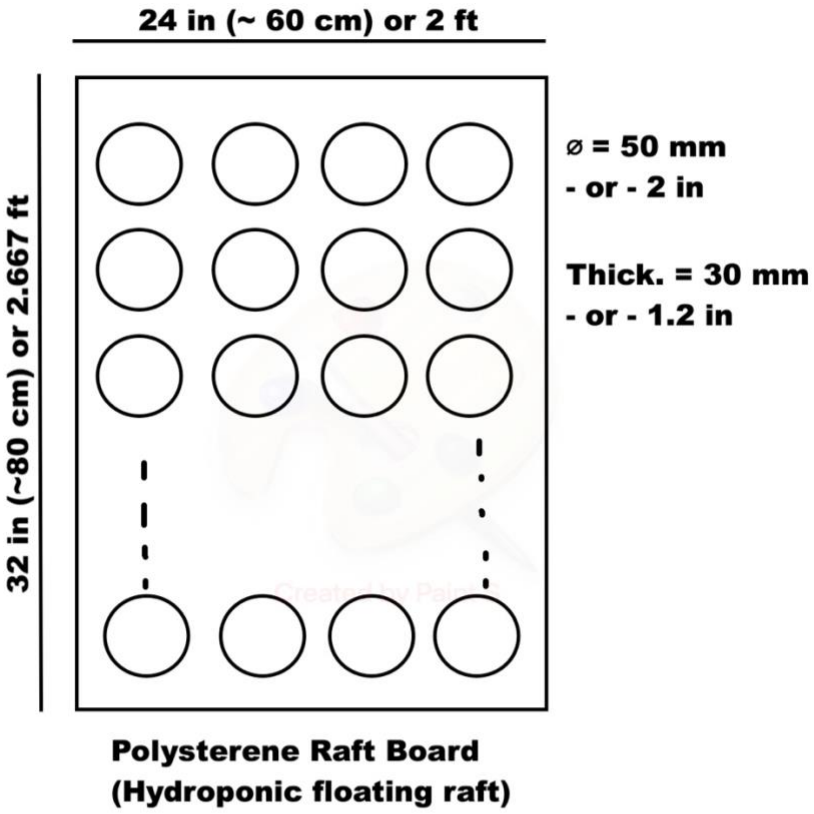


Figure 1 - Tentative Raft Dimensions.

b) Electrical Subsystem

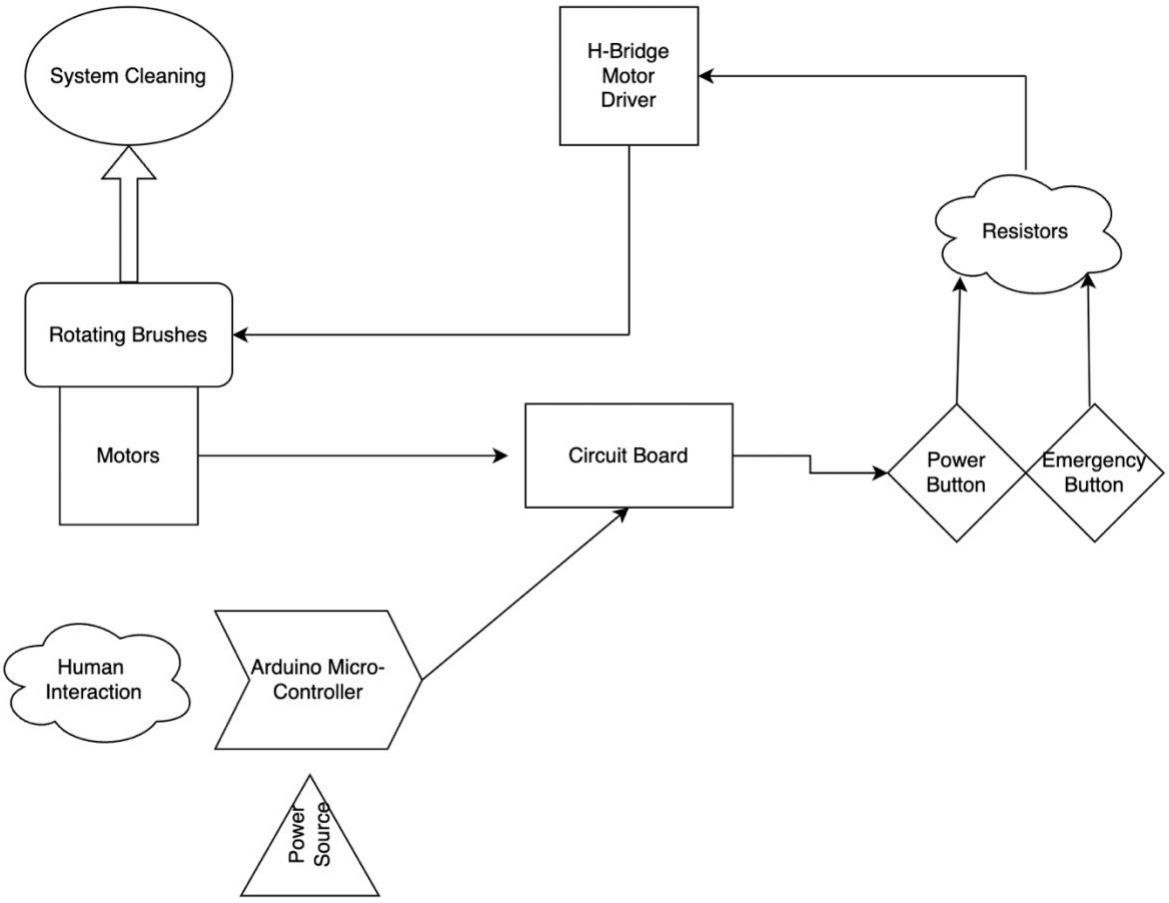


Figure 2 - Electrical Subsystem Diagram.

Figure 1 is a simple diagram that represents what the circuitry of the design would look like and the flow of the system. The electricity would derive from a power source. Our original concept is a removable and rechargeable battery or a 9V battery that is wired into the Arduino board. Batteries are the preferred method to conduct power because it is a simple system that can be replaced, repaired, or recharged.

The current will be led to a circuit where the power will be sent through resistors into two separate buttons. The first button is the power button, it will connect and disconnect the current to power the motors and the other will be the emergency stop button. The second one will stop the current when activated, even if the power source button is connected to allow an electricity flow. In simpler terms, the first button turns the motors ON and OFF while the second button is a safety button to turn off the mechanism while the first button is turned on.

It is important that we have two buttons wired in our system because according to the client, the system must be safe to use so we need an emergency button that will stop the clean process in case of any danger. When the button is on, the power is sent through an H-Bridge Motor Driver to activate a sequence of 20 motors with welded brushes that will be strategically place in our design to fit inside of the holes of the raft to clean the algae. Once the current has gone through the motors, it is sent back to the circuit board to repeat the process.

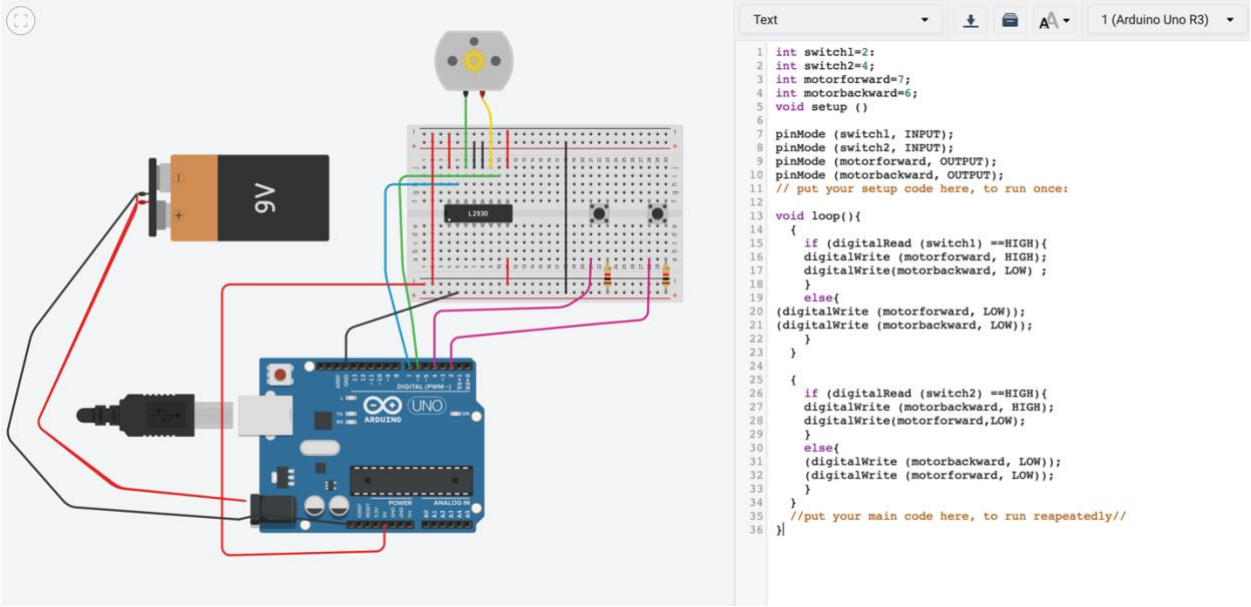


Figure 3 - Arduino Circuitry Scheme.

Figure 2 is a more detailed solution for the Electrical design. Although the length and material of the wires is not specified, this diagram proves how our system will be wired and programmed. The picture indicates that a 9V battery is used, however, it has been discussed the possibility of using a rechargeable battery or a battery with higher or lower voltage. For now, we will continue our design with the 9V battery and make any changes if necessary.

This diagram shows only one motor connected to the circuit board. This singular motor represents multitude of motors that will be wired to our system. The left-hand side shows a general concept for the programming that will be used for our Arduino board. Given that the system must be automated, it is necessary to have a programmed Arduino board to power our system.

c) Hydraulic Subsystem

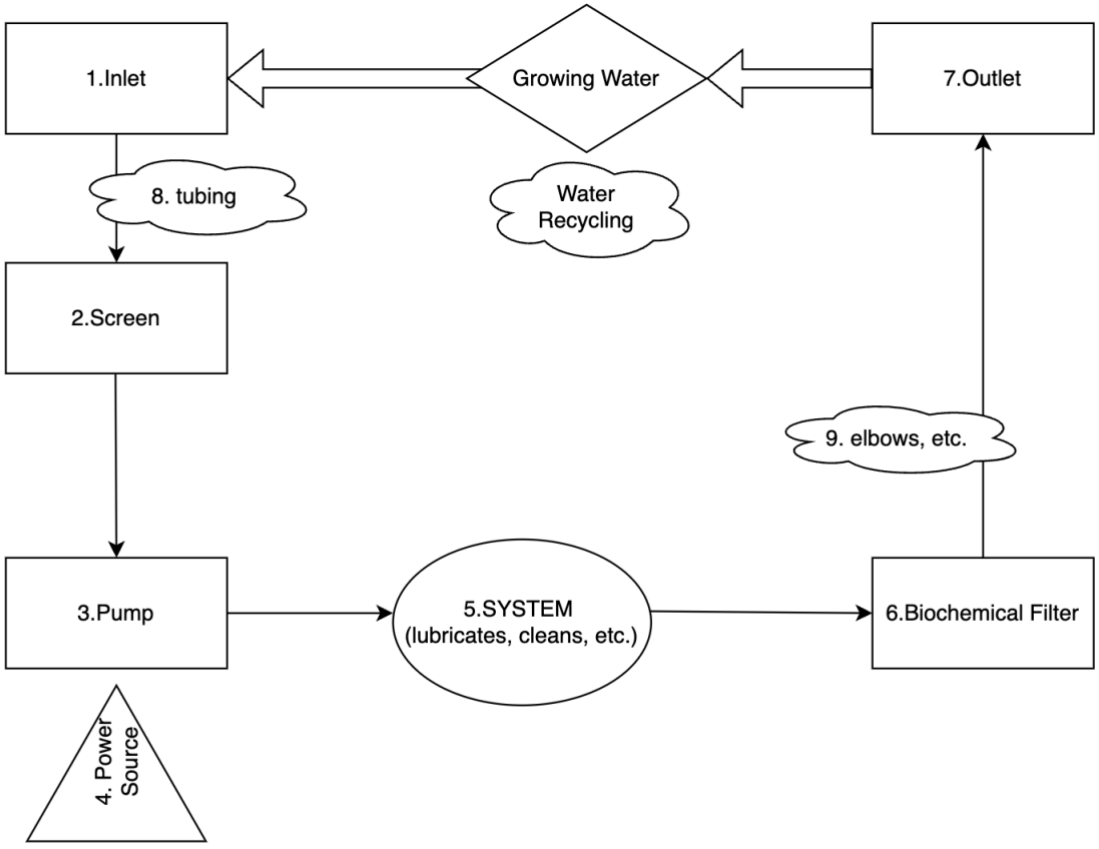


Figure 4 - Hydraulic Subsystem Diagram.

Figure 4 shows the hydraulic subsystem functioning logic in a simple diagram. The inlet of water allows it to enter the system through the different piping and tubing. The screen is a simple way to mechanically rid the water of any debris to protect the inside of the prototype. The pump allows an increase of the hydraulic energy to ensure the water is driven smoothly within an acceptable flow. The system does its work by being lubricated and working on cleaning the raft boards. A biochemical filter is used to filter the water of the algae chunks and all possible residues. The water exits then through the outlet and is filtered and clean, which makes it usable and recyclable to the growcer. Also, since no chemicals are used, the water is safe for regrowing plants.

d) Assembly Subsystem

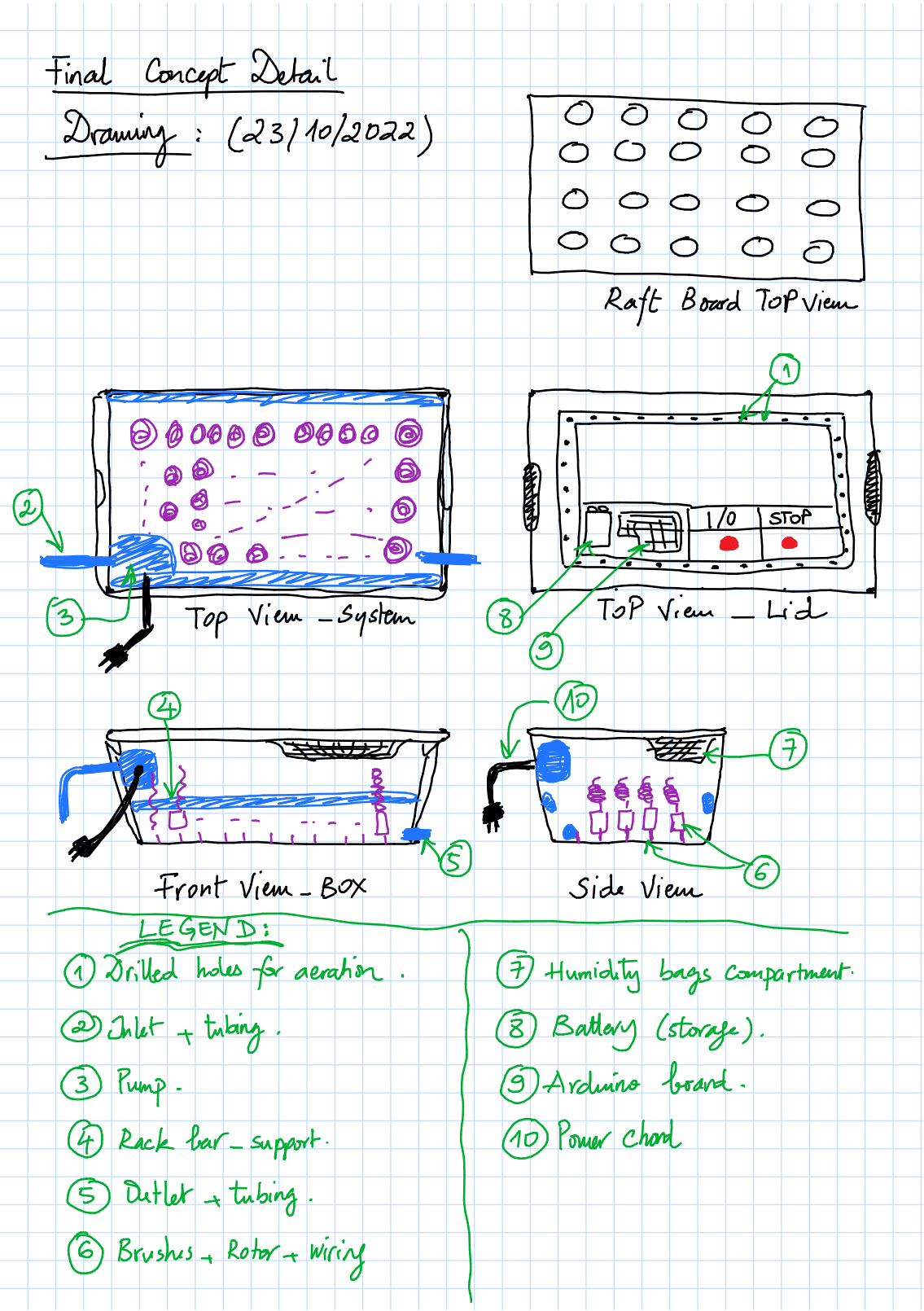
This subsystem consists of the box as a shell and all the other miscellaneous things yet to be considered.

For the box, metals, wood, and plastic are considered. Metals rust, they require a certain craftmanship in the welding and present the disadvantage to not being shape-able like a paste or concrete. Wood is very sensitive to water and humidity, it would cost more to waterproof and seal it but the durability and serviceability will be at risk. Plastic is chosen as it is by nature waterproof. A plastic box could be bought assembled for the desired geometry for instance.

As for the bonding agent, since no welding, wood glue, nails or bolts are necessary, plastic materials are very cost efficient. For that, creative ways like drilling or melting could be used, but mainly a waterproof glue and/or sealing agent. The box would also have a sealing contour to ensure the content stays inside.

Since humidity is a problem, humidity bags could be used in a compartment on the top of the box. Gravity would ensure they remain dry while they efficiently dry out the air and raft, making big savings on the use of waterproof fans or other air-drying technology.

e) System as a whole



2. Project Economics

Table 1 - Bill of Material with Sources.

ID	Item Ideas	Category	Feature	Items to buy	Quantity	Individual price	Price	Link
1	On/Off button	Automation	Automation	uxcell® a12081400ux0336 5 x Momentary SPST NO Red Round Cap Push Button Switch, AC 6 Amp/125V, 3 Amp/250V	1	8.11	9.16	https://www.amazon.ca/Uxcell-a12081400ux0336-Momentary-Button-Switch/dp/B019DSZQ9O/ref=sr_1_2?crid=12P804BH2BV96&keywords=push+buttons&qid=1666579218&qu=eyJxc2MiOiI0LjYwIiwicXNhIjoiNC4xNCIsInFzcCI6IjMuNTYifQ%3D%3D&sprefix=push+buttons%2Caps%2C113&sr=8-2
2	Plastic Box	Box	Assembly	Bankers Box Plastic Storage Bin 24 L (7730603)	1	46.27	52.29	https://www.amazon.ca/Bankers-Box-Plastic-Storage-7730405/dp/B08MJKJ39K/ref=sr_1_5?crid=1Q8E41D5HDNVE&keywords=plastic%2Bbox%2Blarge%2Bbase&qid=1666579862&qu=eyJxc2MiOiIxLjc3IiwicXNhIjoiMC4wMCIsInFzcCI6IjAuMDAifQ%3D%3D&sprefix=plastic%2Bbox%2Blarge%2Bbas%2Caps%2C127&sr=8-5&th=1
3	Humidity Control Bags	Drying	Air Dry	5 Gram Pack of 50 "Dry & Dry" Premium Pure & Safe Silica Gel Packets Desiccant Dehumidifiers - Rechargeable Paper	1	16.99	19.20	https://www.amazon.ca/Dry-Premium-Packets-Desiccant-Dehumidifiers/dp/B00DYKTS9C/ref=sr_1_14?keywords=dehumidifier&qid=1666578801&qu=eyJxc2MiOiI2LjQ1IiwicXNhIjoiNi4yOCIsInFzcCI6IjYuMDAifQ%3D%3D&refinements=p_36%3A-2000&rnid=12035759011&sprefix=dehumi%2Caps%2C114&sr=8-14
4	Wiring	Electricity	Power	Electrical Wire 22 AWG 22 Gauge Silicone Wire Hook Up wire Cable 20 Feet [10 ft Black And 10 ft Red] - Soft and Flexible 60 Strands 0.08mm of Tinned copper wire High Temperature Resistant	1	$7.68	8.68	https://www.amazon.ca/Electrical-Gauge-Silicone-Cable-Black/dp/B0746HG158/ref=sr_1_9?crid=2EVSGE0KLSFS&keywords=small+electrical+wire&qid=1666484645&qu=eyJxc2MiOiIwLjAwIiwicXNhIjoiMC4wMCIsInFzcCI6IjAuMDAifQ%3D%3D&sprefix=small+electrical+wir%2Caps%2C207&sr=8-9
5	Emergency Stop button	Emergency/Safety	Emergency/Safety	uxcell® a12081400ux0336 5 x Momentary SPST NO Red Round Cap Push Button Switch, AC 6 Amp/125V, 3 Amp/250V	1	8.11	9.16	https://www.amazon.ca/Uxcell-a12081400ux0336-Momentary-Button-Switch/dp/B019DSZQ9O/ref=sr_1_2?crid=12P804BH2BV96&keywords=push+buttons&qid=1666579218&qu=eyJxc2MiOiI0LjYwIiwicXNhIjoiNC4xNCIsInFzcCI6IjMuNTYifQ%3D%3D&sprefix=push+buttons%2Caps%2C113&sr=8-2
6	Biochemical filter/Sponge	Filtration	Water cycle	Aquarium Biochemical Cotton Filter Foam Fish Tank Sponge Filter Floss Aquarium Filter Pad Aquarium Filter Pad Bio Sponge Prefilter Media Pad Cut-to-fit Foam, 50x50x2.5cm	1	16.39	18.52	https://www.amazon.ca/-/3n/Mousse-filtrante-biochimique-coton-aquarium/dp/B07MHY1JYG/ref=sr_1_6?crid=3DBWMIW244IP4&keywords=sponge+filter+biochemical&qid=1666496931&qu=eyJxc2MiOiIxLjc1IiwicXNhIjoiMC4wMCIsInFzcCI6IjAuMDAifQ%3D%3D&sprefix=biochemical+filter+%2Caps%2C96&sr=8-6
7	Rotating brushes	Mechanical	Cleaning	Temede Car Wash Sponge, Large Multi Use Sponges for Cleaning, 6cm Thick High Foam Scrubber Kit, Sponges for Dishes, Tile, Bike, Boat, Easy Grip Sponge for Kitchen, Bathroom, Household Cleaning, 5pcs	1	15.99	18.07	https://www.amazon.ca/Temede-Cleaning-Scrubber-Bathroom-Household/dp/B08D6G6SQQ/ref=sr_1_5?crid=QMMW5633054D&keywords=cleaning+sponge&qid=1666579099&qu=eyJxc2MiOiI1Ljg4IiwicXNhIjoiNS42NSIsInFzcCI6IjUuMjUifQ%3D%3D&s=hpc&sprefix=cleaning+sponge%2Chpc%2C102&sr=1-5
8	Motor Connected to the brushes	Mechanical	Cleaning	Gikfun DC 3V -6V 130 Motor 15000 RPM for DIY Electric Arduino (Pack of 10pcs) EK1291x10C	2	$16.68	37.70	https://www.amazon.ca/Gikfun-Motor-Electric-Arduino-EK1291x10C/dp/B06WLL6QM5/ref=asc_df_B06WLL6QM5/?tag=googleshopc0c-20&linkCode=df0&hvadid=292968375828&hvpos=&hvnetw=g&hvrand=9743343232104465780&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9061308&hvtargid=pla-493374726681&psc=1
9	Liquid	Pressure	Cleaning	/	/	/	0.00	/
10	Pump (in and Out)	Pumping	Water cycle	UthCracy Submersible Pump 400GPH Ultra Quiet Aquarium Water Pump 1500L/H 20W 6ft. High Lift Energy Saving Fountain Pump with 4.7ft. Power Cord, 3 Nozzles for Fish Tank, Pond, Statuary, Hydroponics	1	23.99	27.11	https://www.amazon.ca/UthCracy-Submersible-Aquarium-Fountain-Hydroponics/dp/B09VD7QR5J/ref=sr_1_1?crid=1ALXYNGQEJYSU&keywords=UthCracy+Submersible+Pump+400GPH+Ultra+Quiet+Aquarium+Water+Pump+1500L%2FH+20W+6ft.+High+Lift+Energy+Saving+Fountain+Pump+with+4.7ft.+Power+Cord%2C+3+Nozzles+for+Fish+Tank%2C+Pond%2C+Statuary%2C+Hydroponics&qid=1666580192&qu=eyJxc2MiOiIwLjAzIiwicXNhIjoiMC4wMCIsInFzcCI6IjAuMDAifQ%3D%3D&sprefix=uthcracy+submersible+pump+400gph+ultra+quiet+aquarium+water+pump+1500l%2Fh+20w+6ft+high+lift+energy+saving+fountain+pump+with+4+7ft+power+cord%2C+3+nozzles+for+fish+tank%2C+pond%2C+statuary%2C+hydroponics%2Caps%2C206&sr=8-1
11	Piping and tubing	Pumping	Water cycle	Penn-Plax Standard Airline Tubing Air Pump Accessories, 8-Feet	1	2.97	3.36	https://www.amazon.ca/-/en/Penn-plax-Tuyau-flexible-2-5m/dp/B0002563MM/ref=sr_1_5?__mk_fr_CA=%C3%85M%C3%85%C5%BD%C3%95%C3%91&crid=V4C9BFOFL4GJ&keywords=tubing&qid=1666496688&qu=eyJxc2MiOiI1LjM0IiwicXNhIjoiNC4zNCIsInFzcCI6IjMuNzkifQ%3D%3D&sprefix=tubing+%2Caps%2C101&sr=8-5
12	Waterproof Glue	Sealing	Assembly	Gorilla Fabric Glue, 100% Waterproof, No Sew Solution, Washer/Dryer Safe, Permanent Bond, 2.5fl oz/73ml, Clear, (1-Pack), 8215402	1	9.97	11.27	https://www.amazon.ca/-/en/lave-linge-s%C3%A8che-linge-permanente-transparent-8215402/dp/B096N7NXVF/ref=sr_1_6?__mk_fr_CA=%C3%85M%C3%85%C5%BD%C3%95%C3%91&crid=2C0UJYB0DKE5S&keywords=waterproof+glue&qid=1666577709&qu=eyJxc2MiOiI0Ljc1IiwicXNhIjoiMy43NyIsInFzcCI6IjMuMjUifQ%3D%3D&sprefix=waterproof+glue+%2Caps%2C98&sr=8-6
13	Silicone for sealing	Sealing	Water Proofing	(included with plastic box)	1	/	0.00	/
14	Shelf Peg Support	Assembly	Assembly	Slide-Co 241946 Shelf Support Peg, 1/4-Inch, Clear Plastic,(Pack of 12)	1	10.21	11.54	https://www.amazon.ca/Slide-Co-241946-Support-4-Inch-Plastic/dp/B002YGP9PE/ref=sr_1_5?crid=1KS5HFQ4WP5LN&keywords=shelf+peg+support+1%2F4&qid=1666580223&qu=eyJxc2MiOiIyLjAwIiwicXNhIjoiMC4wMCIsInFzcCI6IjAuMDAifQ%3D%3D&sprefix=shelf+peg+support+1%2F4%2Caps%2C110&sr=8-5
						SUM :	**226.05**	

3. Project Management

(Please look at attached Appendix for task lists and other detail)

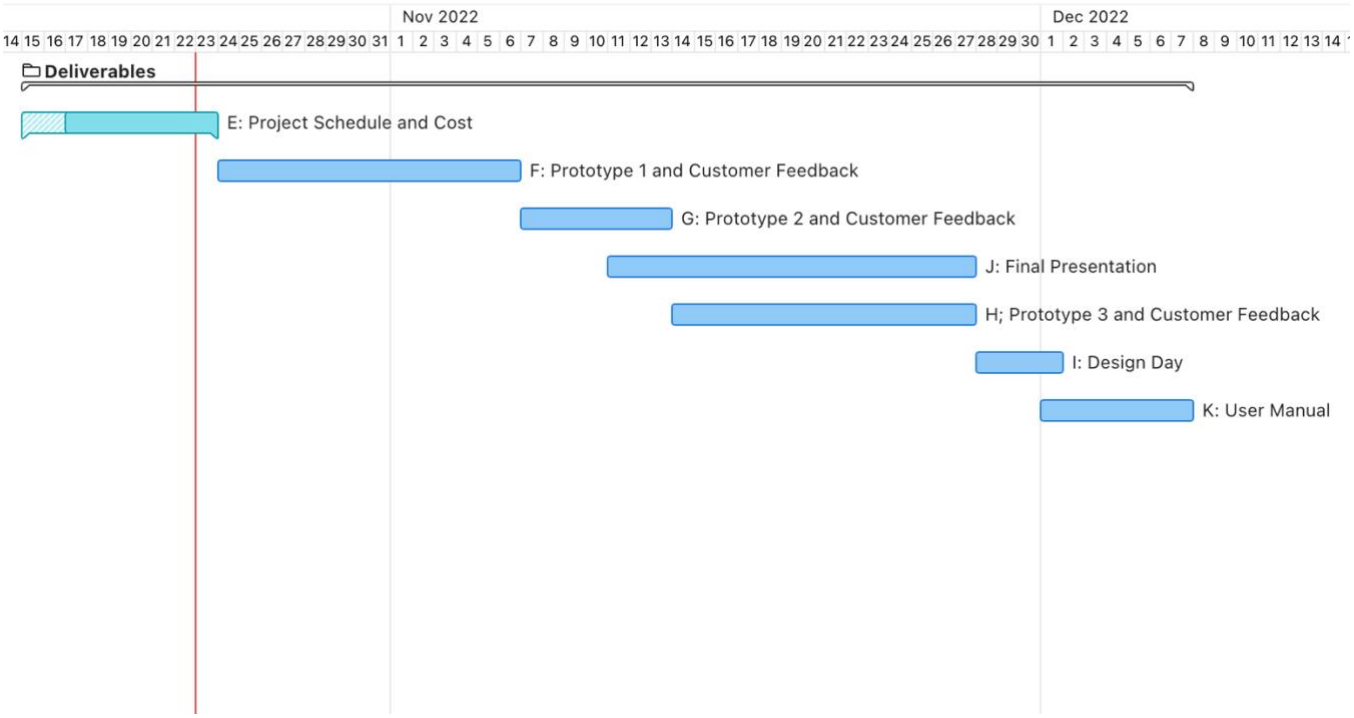


Figure 5 - Wrike Gantt Chart Screenshot.

Risks identification:

Type	Detail	Strategy	Detail2
Contractual			
Cost	Shortage of ressources due to lack of funds		
Environment	None	-	Project considers the environment and the small scale of the project allows to ignore such risk.
External Hazards	Natural (Seisms, floods, etc.)		
External Hazards	Political (Convoy etc.)		
External Hazards	Climate (Extreme conditions, storms)		Project and prototyping occur indoor
Health & Safety		Accept & Mitigate	
People & Stakeholders	Lack of communication between team members	Mitigate	Set up constant meeting with stakeholders and ensure a smooth tasks division and project workflow.
People & Stakeholders	Client changes their mind	Mitigate	Set up constant meeting with stakeholders and ensure a smooth tasks division and project workflow.
People & Stakeholders	Client puts a new delay or constraint		
Professor/ Assessor	TA and/or Professor are not available		
Scope	Unplanned work that requires accomodation		
Scope	Scope Creep	Mitigate	Minimize uncontrolled change to the project scope and decisions made along the execution by better defining the objectives and make unanimously discussed decisions.
Scope	Performance problems	Mitigate	Risk of not achieving the performance objectives and possible delays, decision making and financing to be restudied
Scope			
Technical			
Technical			

4. Test Plan

Prepares a clear and concise prototyping test plan answering the why, what, how and when.

a) Mechanical

Motor Connected to brushes

1. Test durability of the brushes
    a. Use the motor against rough surfaces
    b. Use hard pressure against cleaning surface to determine if the connection between the motor and the brush will last
    c. Test what materials the brush can clean with ease
        i. Use the brush against algae
        ii. Use against dirt
        iii. Use against tough stains

The objective is to determine the durability of the brush itself and how well it cleans. According to the client, the algae is hard work to scrub off and often leads to sore arms meaning that it does not come off easy. Our product must be able to scrub and remove tough stains and algae and must last under constant pressure for long periods of time. Therefore, the durability of our brushes must be tested as well as their cleaning capabilities.

Rotating brushes

1. Test velocity
    a. Use lots of power to make the motor spin fast to test if the brush can handle velocity

It is important that our motors and the brushes can withstand high velocities for long periods of time. This simple test plan will provide us with enough information for us to recognize if our bonding of the brush and motor is successful.

b) Pressure

- Liquid- High pressure:
    - Create high pressure throughout the system to test feasibility.
    - The design will be under constant liquid pressure.
    - The only way to ensure that our lines can support such pressures is by augmenting the pressures within the lines. It is important that our design does not leak or lose pressure at any point in the hydraulic circuit.

c) Chemical

-

d) Electricity

- Electrical current:
    - Send power throughout the circuit and manually test all aspects of the working system to ensure all connections are successful
    - Turn on power
    - Turn off power
    - Turn on power and test emergency stop button
    - Turn on power and visually check to see if all the motors are functioning
    - Our design is an automated project, if the wiring is malfunctioning, the entire project will not work. The testing method isn't about how long it lasts, it is more to ensure that every feature is functioning properly.

e) Emergency/Safety

-

f) Automation

- Programming:
    - On a computer, build and run the programmed and then ensure that it works when programmed to the Arduino board.
    - Our system is automated and we must test and refine the program to make sure that everything works.

g) Foldable

-

h) Box

-

i) Pumping

-

j) Filtration

-

k) Sealing

- Wood water proofing
    - Put water in the box and leave it there to test if there are any leaks

l) Drying

5. References

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Appendix - Project Planning

1. Deliverable E: Planning

1.1. A more detailed Design Solution (Mohammed)

1.1.1. Project Economics (Mohammed+Jacob)

1.1.1.1. Material Research (Jacob)

1.1.1.1.1. Material Selection(Mohammed+Jacob+Owen)

1.1.1.1.2. Material Quantity (Mohammed+Jacob+Owen)

1.1.2.

1.1.3.

1.2. Project Management

1.2.1. Wrike Prep (Owen)

1.2.2. Tasks choice (Owen)

1.2.2.1. appointing tasks (Mohammed+Jacob+Owen)

1.2.2.2. Task deadlines (Mohammed+Jacob+Owen)

1.2.2.3. Variable (Risks) (Owen)

1.3. Test Plan

1.3.1. Test Research (Jacob)

1.3.1.1. Test Research >> Choice (based off needs) (Jacob)

1.3.1.1.1. “Success Value” Choice (Mohammed+Jacob+Owen)

1.3.1.1.1.1. Post-test plan (Jacob)

1.3.1.1.1.2. Measurements (Metrics) (Mohammed)

1.3.1.1.1.3. Additional Testing (Owen)

1.4. Conclusion (Mohammed+Jacob+Owen)

2. Deliverable F: Prototype 1

- 2.1. Dependent on Deliverable E
- 2.2. Material Collection
  - 2.2.1. Finding Material Stores
  - 2.2.2. Pricing
    - 2.2.2.1. Deals
- 2.3. Location Choice
  - 2.3.1. Preparation (Booking/Set Up)
    - 2.3.1.1. Time Slotting
    - 2.3.1.2. Booking Research
    - 2.3.1.3. Prep Plan (Requirements)
  - 2.3.2. Time Management
    - 2.3.2.1. Allotted Time
    - 2.3.2.2. Meeting Time
    - 2.3.2.3. Task Time
    - 2.3.2.4. Task Appointment
  - 2.3.3. Equipment Management
    - 2.3.3.1. Equipment Choice (Research)
    - 2.3.3.2. Equipment Training
    - 2.3.3.3. Prioritization
    - 2.3.3.4. Training (Metal/Wood/AI)

3. Deliverable G: Prototype 2

3.1. Client Feedback
- 3.1.1. Collecting Feedback
  - 3.1.1.1. Note Taking
  - 3.1.1.2. Questions
  - 3.1.1.3. Suggestions
    - 3.1.1.3.1. Changing Plan
    - 3.1.1.3.2. Design Changes

3.2. Material Collection
- 3.2.1. Finding Material Stores
- 3.2.2. Pricing
  - 3.2.2.1. Deals
  - 3.2.2.2. Deals

3.3. Location Choice
- 3.3.1. Preparation (Booking/Set Up)
  - 3.3.1.1. Time Slotting
  - 3.3.1.2. Booking Research
  - 3.3.1.3. Prep Plan (Requirements)
- 3.3.2. Time Management
  - 3.3.2.1. Allotted Time
  - 3.3.2.2. Meeting Time
  - 3.3.2.3. Task Time
  - 3.3.2.4. Task Appointment
- 3.3.3. Equipment Management
  - 3.3.3.1. Equipment Choice (Research)
  - 3.3.3.2. Prioritization

3.4.

4. Deliverable H: Prototype 3

4.1. Client Feedback

4.1.1. Collecting Feedback

4.1.1.1. Note Taking

4.1.1.2. Questions

4.1.1.3. Suggestions

4.1.1.3.1. Changing Plan

4.1.1.3.2. Design Changes

4.2. Material Collection

4.2.1. Finding Material Stores

4.2.2. Pricing

4.2.2.1. Deals

4.2.2.2. Deals

4.3. Location Choice

4.3.1. Preparation (Booking/Set Up)

4.3.1.1. Time Slotting

4.3.1.2. Booking Research

4.3.1.3. Prep Plan (Requirements)

4.3.2. Time Management

4.3.2.1. Allotted Time

4.3.2.2. Meeting Time

4.3.2.3. Task Time

4.3.2.4. Task Appointment

4.3.3. Equipment Management

4.3.3.1. Equipment Choice (Research)

4.3.3.2. Prioritization