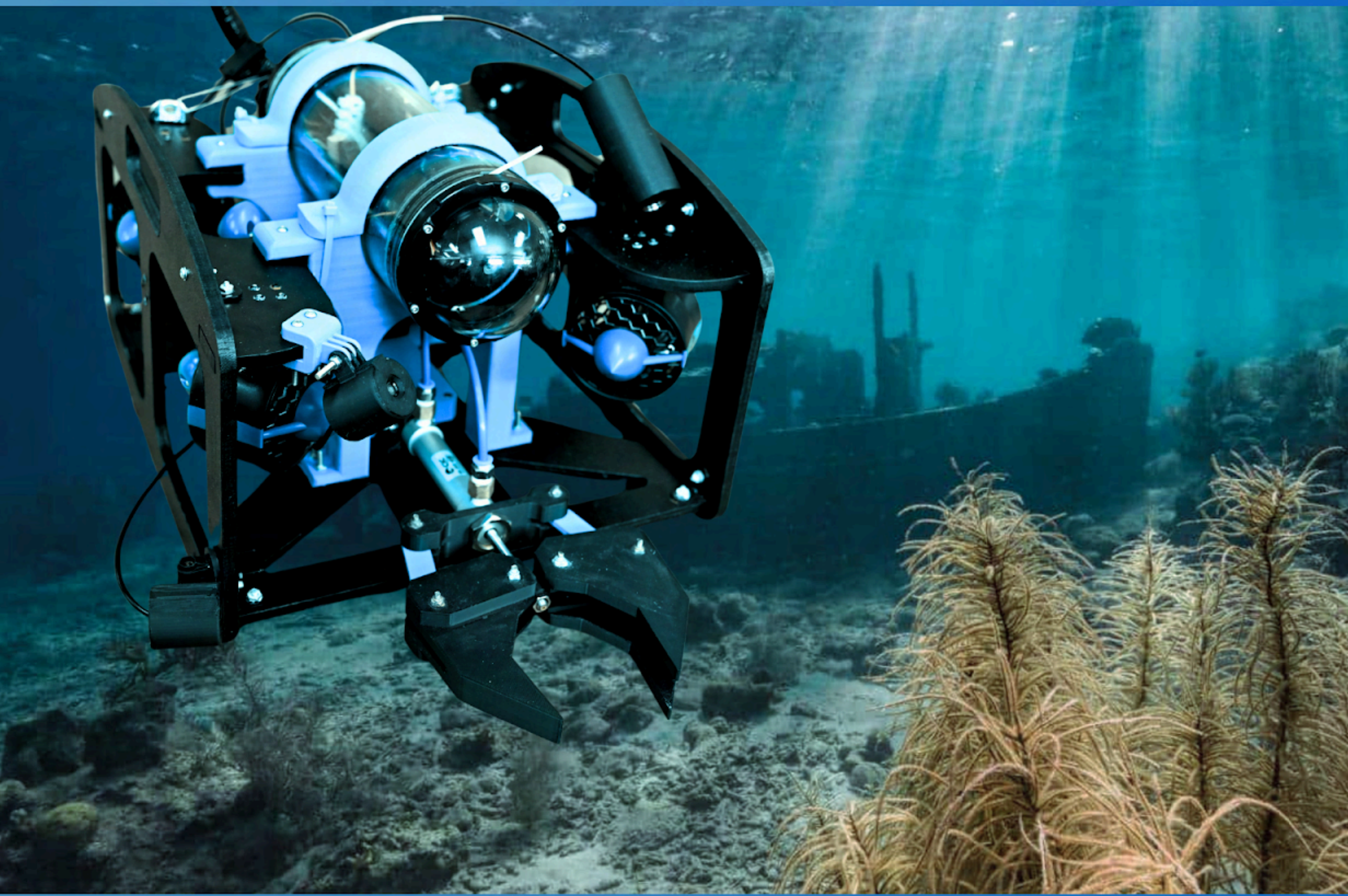
Shark Tech - Siku

Labrador Straits Academy
L'Anse au Loup, Newfoundland & Labrador, Canada
Technical Report



COMPANY MEMBERS:

Marcus Flynn**	CEO	Grade 11	Class of 2026
Yashveen Gunput**	CFO	Grade 10	Class of 2027
James Penney**	Pilot	Grade 12	Class of 2026
Luke Hudson**	Co-Pilot	Grade 12	Class of 2025
Finlay Jones**	Sr. Computer Engineer	Grade 12	Class of 2025
Jerry Cabot*	Jr. Computer Engineer	Grade 11	Class of 2024
Christian Roque**	Electrical Technician	Grade 12	Class of 2025
Owen Hudson**	Mechanical Technician	Grade 12	Class of 2025
Maria Barney*	R&D Technician	Grade 9	Class of 2028
Olivia Normore**	Operations Manager	Grade 10	Class of 2027
Julian Flynn**	Lead Technical Writer	Grade 12	Class of 2025
Madison Cabot*	Technical Writer	Grade 9	Class of 2028
Belle Gibbons*	Marketing Manager	Grade 10	Class of 2027

MENTORS:

Mr. Ethan Allen
Mr. Riley Regular
Mrs. Amanda Chubbs

*** - New Members**
**** - Returning Members**

MATE ROV COMPETITION

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1. ABSTRACT

Shark Tech, based in L’Anse au Loup, Newfoundland and Labrador, Canada, is a leading developer of underwater Remotely Operated Vehicles (ROVS). For the 2025 MATE ROV Competition, Shark Tech designed and built *Siku*, an ROV engineered for reliability and maneuverability across diverse aquatic environments, from freshwater reservoirs to offshore facilities.

To meet the competition’s mission requirements, *Siku* is equipped with a pneumatic claw for precise manipulation tasks, a vertical profiler, and a hydraulic system to operate a water sampler. These components were meticulously designed using Onshape and fabricated through 3D printing, ensuring both functionality and durability.

Safety is a cornerstone of Shark Tech’s operations. An Operations Manager oversees adherence to stringent safety protocols, while the CEO and lead engineers meticulously plan and schedule tasks, ensuring all team members are safe and efficient.

Siku is engineered to perform a range of tasks in diverse aquatic environments, including oceans, lakes, and offshore renewable energy installations. These tasks encompass installing floating solar panel arrays, integrating pCO_2 sensors, identifying and documenting shipwrecks, and replacing components such as sacrificial anodes and thermistors. Additionally, *Siku* is equipped to collect water samples for environmental analysis, including eDNA, dissolved CO_2, and pH levels, aligning with the competition's focus on marine renewable energy and environmental monitoring.

Figure 1: The Shark Tech Company and Mentors - Photo taken by Laquita Normore

Back row (l-r): (Mentor) Riley Regular, James Penney, Finlay Jones, Julian Flynn, Christian Roque, Marcus Flynn, Jerry Cabot, Olivia Normore, Belle Gibbons, (Mentor) Ethan Allan

Front row (l-r): Luke Hudson, Owen Hudson, Madison Cabot, Maria Barney, Yashveen Gunput

2. PROJECT MANAGEMENT

A. Company Overview

Shark Tech is a third-year, student-run company with a mission to "Protect the Blue with Green Technology." This year, the company expanded from 8 to 13 members, all sharing a passion for engineering, underwater exploration, and conservation.

Returning employees either retained their roles or were reassigned based on evolving needs, while new members were placed according to their strengths and interests. Meetings begin with a full-company briefing to outline tasks and objectives. Project progress is tracked in a shared Google Document with real-time updates to ensure accountability and smooth workflow. Mentors support the company by troubleshooting technical issues, guiding ROV development, and strengthening communications. Shark Tech promotes teamwork, positivity, and a safe, inclusive environment.

B. Company Organization

Roles are assigned based on individual strengths under the leadership of CEO Marcus Flynn, who has guided Shark Tech for the past two years. To maximize efficiency within the company, the project management group has members split off into four groups according to their roles:

- The mechanical group, led by James Penney, is responsible for constructing and testing the ROV's props, tools, and parts. This group ensures that everything is safe and ready for competition runs.
- The electrical group, led by Finlay Jones, codes the ROV and vertical profiler's components. They are responsible for ensuring that the ROV can respond to the controls while in the water.
- The marketing group, led by Julian Flynn, is responsible for maintaining Shark Tech's documentation and keeping everything up to date to reduce mistakes and increase efficiency.

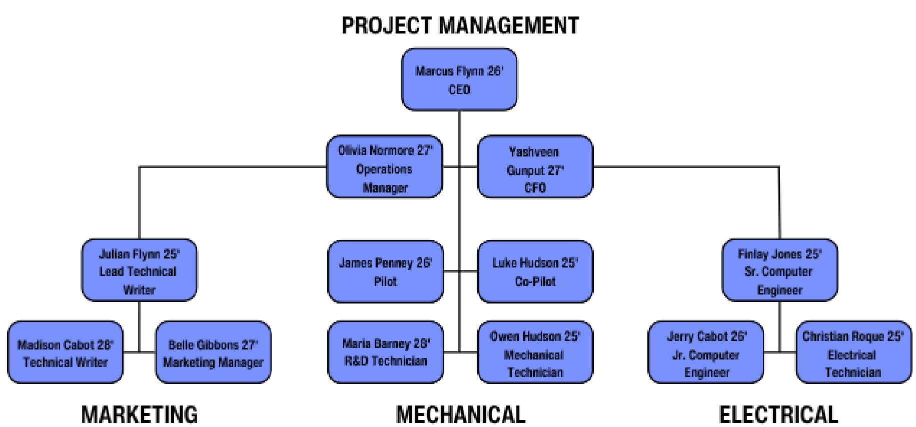


Figure 2: Shark Tech Company Organization Diagram - Made by Madison Cabot

C.Operational Challenges

Shark Tech takes pride in being a well-organized company, as shown by its Design Schedule *(Figure 3)*. The company created this detailed schedule collaboratively in September 2025. In following this schedule, Shark Tech completed various operations ahead of schedule to spare time for reruns, modifications, and backup plans. The schedule also made it easier to manage coinciding tasks, like building the ROV, preparing the marketing display, creating the engineering presentation, and getting ready for the regional event. The company held daily meetings to check progress on various tasks, share updates from each department, and make scheduling adjustments when needed.

One of the biggest operational challenges Shark Tech faced was shipping delays caused by the company's remote location. To navigate this, employees planned and allowed for extra time in the schedule to accommodate shipping. Another major challenge was severe winter weather, which caused the company to lose several production days. In total, the company lost 12 meeting days due to weather-related school closures. Additionally, many employees at Shark Tech were involved in other extracurricular activities, sometimes resulting in company meetings without all staff members. However, by sticking to the design schedule stringently, Shark Tech was able to overcome these challenges and complete the construction of *Siku* on time.

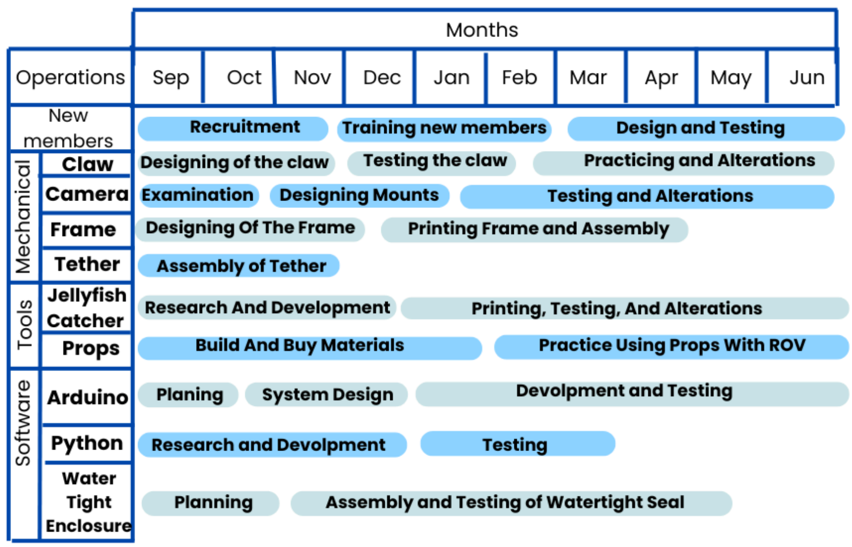


Figure 3: Design Schedule for the Construction of Siku - Designed by Belle Gibbons

Shark Tech developed detailed operational protocols for each mission task to meet mission objectives effectively. These protocols outlined specific roles, step-by-step actions, and procedures. Before the competition, each protocol was tested during trial runs. These structured procedures ensured that the ROV performed consistently, employees remained coordinated, and mission goals were completed on time.

3. DESIGN RATIONALE

Siku is a serviceable, modular, and durable Remotely Operated Vehicle (ROV) designed to meet the specific mission requirements of the 2025 MATE ROV Competition. Engineered with numerous customized features, *Siku* ensures efficient task execution while aligning with the Marine Advanced Technology Education (MATE) Request for Proposals (RFP) and supporting the UN Sustainable Development Goals.

A. Design Evolution

Siku, the third-generation ROV developed by Shark Tech, reflects the company's commitment to producing a safe, serviceable, and reliable underwater vehicle, shaped by years of hands-on experience and iterative design. The journey began with their first ROV, the *Great White 1*, which utilized a PVC frame due to its accessibility and ease of use during initial prototyping. While effective for early learning, this material revealed limitations in strength, precision, and long-term durability. In the second year, the company applied insights from the *Great White 1* to develop *LabraShark*. In shifting to high-density polyethylene (HDPE) for the frame, the structural integrity and underwater performance were significantly improved. The success of HDPE in *LabraShark* validated the material's suitability for competitive ROV applications, leading the company to adopt it again for *Siku*. After finalizing the design through detailed trial drawings and CAD modelling, Shark Tech collaborated with the Holy Heart of Mary Robotics Team to precisely machine the frame using a CNC router. This partnership allowed high-quality fabrication while reinforcing the company's focus on building an ROV that is robust, maintainable, and ready for the demanding conditions of marine environments.

Goals at Shark Tech 2025	Price Friendly	Reliable	Easily Modified	Determination
Create a durable secured water tight enclosure		✓	✓	*To create a waterproof enclosure we bought an acrylic tube which we paced on the top of the ROV to hold and contain all of our code and 1 of our cameras*
Optimize camera placement and visibility	✓	✓	✓	We achieved the optimal visibility by including 4 high-definition cameras, 3 of which were repurposed analog cameras from our previous year
Easy customizable frame	✓	✓	✓	*Our easily customizable frame was constructed out of high density polyethylene (HDPE) since its known for being light weight and corrosion resistant*
Minimize weight and drag	✓	✓	✓	*To control the weight of our ROV, we used a frame that was light weight, 3D printed fully customizable tools we can alter to our needs and modifications where the weight is kept to a minimum*
Achieve the most proficient claw	✓	✓	✓	*To create the most efficient claw for our ROV, we used our previous designs to modify last years claw since it was 3D printed, fully customizable, and our previous design had worked quite well in the past few years*
Develop a water sampler	✓	✓	✓	*We created a water sampler by using 2- 100ml syringes on the bottom rear end of the rov connected to another syringe on the surface connected by a hydraulic line.*

Figure 4: 2025 Goals At Shark Tech - Made by Belle Gibbons

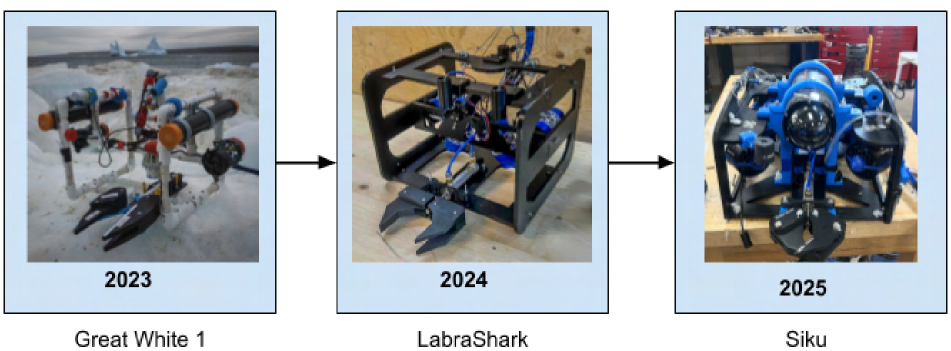


Figure 5: Shark Tech's ROV Design Evolution | Images by James Penney

B.Innovation

Shark Tech has limited resources readily available. Innovation of a high-performance ROV design utilizing easily accessible components was paramount. The vast majority of components found on Siku have been 3D printed, allowing for replacements to be made at a low cost and in a fraction of the time. As a result, *Siku* has an innovative, serviceable, and cost-effective design.

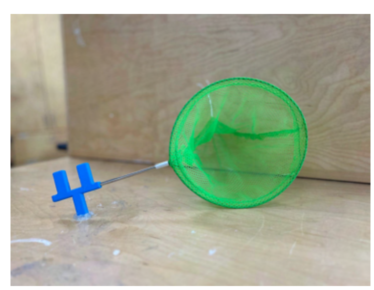


Figure 6: Fish collection tool | Photo taken by James Penney

The company's most significant innovations include adapting a tent peg (figure 16) and the butterfly net (figure 6) to create highly functional tools at extremely low costs. The tent pin is located towards the top part of the *Siku's* frame, with the purpose of removing polyp stage jellies attached to the solar panel array. The pin has a 120 degree hook on the end to stick in the middle of the polyp to pull out of the array. Shark Tech found this strategy was the most successful, rather than options like using the claw.

Shark Tech incorporated a butterfly net into their wide variety of tools. The net is put into a 3D printed mount that the claw grips, which allows the net to be parallel with the front side of the Siku's frame. The jellyfish net is used to collect fish species aggregated underneath the solar panel array. This design was very cost-effective for Shark Tech as the butterfly net only cost $1 USD. More of Shark Tech's innovative designs and tools can be found in section 6 under payload and tools.

4. SYSTEMS APPROACH

Shark Tech approaches every decision with functionality and simplicity at the forefront. This allows customers to be provided with the best product possible. Shark Tech's design team spent countless hours creating the final design of *Siku*, balancing the trade-offs between the various systems and samplers in the enclosure. The company agreed that the ROV required four fundamental systems: Propulsion, Cameras, Pneumatics, and Hydraulics. Each system was designed to be integrated with the ROV's frame to ensure *Siku's* ability to meet the demanding mission requirements of the product demonstration.

A. Vehicle Structure

As mentioned in the design evolution, Shark Tech has constructed *Siku's* frame out of HDPE. This decision was based on several factors, including cost, availability, density, practicality, and past success. These considerations are outlined in the decision matrix presented below in *Table 1*.

In previous ROV projects, the company utilized Polyvinyl Chloride (PVC) piping for the frame due to its low cost and regional availability. However, some challenges were revealed in reliably mounting tools and positioning motors effectively with PVC. Additionally, while the aluminum flat bar was considered for its affordability and high strength, it was ultimately discarded due to its higher weight compared to other materials.

HDPE, with a density of 0.93 g/cm³, is less dense than water (1.00 g/cm³), offering a perfect balance between structural durability and buoyancy to the ROV. Despite it being a higher cost, the company determined that HDPE was the optimal choice to house essential tools such as the claw, cameras, motors and the water sampler.

The frame's dimensions - 43 cm in length, 38 cm in width, and 27 cm in height - were meticulously chosen to enhance maneuverability in confined underwater environments, such as shipwrecks. This compact design facilitates agile navigation and precise control. Additionally, the lightweight construction ensures the ROV to be under 15 kg, aligning with MATE's mission proposal's preference for lighter vehicles. Moreover, HDPE imparts *Siku* with a professional, polished appearance.

Table 1: Decision Matrix for Frame Materials - Made by James Penney

Material	Availability	Density g/cm^3	Cost per Meter (USD)
½ PVC Pipe	Local	1.44	$1.60
⅜ HDPE 24''X 27'' sheet	Order	0.93	$80.68
1 Inch Aluminum Flat Bar	Order	2.73	$7.17

5. VEHICLE SYSTEMS

A. Pneumatics System

Siku's pneumatic system is critical on the ROV, as it provides compressed air to our claw, which allows the ROV to grip onto various objects in the water. The main components of the pneumatic system are located inside the control box. The system features a pressure release valve, an emergency shut-off valve, and a regulator in the system that is connected to the ¼" (6.35 mm) Pneumatic Tubing - rated to 862 kPa, that runs through our pneumatic piston foot pedal (rated to 115 PSI (793 kPa). The pneumatic lines then run through the tether to the double-acting cylinder, rated to 130 PSI (896 kPa). The top side of the pneumatic system has a pneumatic line running to the ¼" (6.35 mm) M-Style plugs, which are rated to 290 PSI(2000 kPa). The pneumatic system is connected to the compressor through the 9 mm x 3 m Ultra-light Rubber Whip Hose, rated to 115 PSI (793 kPa). The *Siku* is also equipped with a pneumatic rotary actuator to help with removing and replacing a sacrificial anode on the base of an offshore wind farm. This will allow the Siku to twist the sacrificial anode without moving. A detailed systems integration diagram of all *Siku's* pneumatic systems can be found in *Appendix A*.

B. ROV Electrical Systems

The electrical control systems on board *Siku* are all housed in a watertight enclosure. The onboard systems are powered using 12V DC power, and control commands are sent via an Ethernet cable.

Figure 7: View of Siku's GUI. Photo by Finlay Jones

Siku features a simple electrical system consisting of only an Arduino Due Board, a USB camera, a USB Extender, and a 12V to 5V buck converter. A detailed Systems Integration Diagram (SID) can be seen in *Figure 22 in Appendix A*.

C. Topside Control System

The control system for the ROV is designed for efficient setup and operation during product demonstration runs. It comprises a hard-shell case and a laptop, facilitating portability and quick deployment.

Hard-shell case components:

- **Electronics Housing:** The case securely contains the electronics responsible for piloting the ROV, ensuring protection and organization.
- **Xbox Controller Interface:** An Xbox controller with dual joysticks is utilized to control the six thrusters, enabling precise maneuvering essential for tasks such as water sampling.
- **Pneumatic System Control:** The foot pedal operates the ROV's pneumatic system, providing responsive control.
- **Integrated Monitor:** A top-mounted monitor displays video feeds from *Siku*.
- **Safety and Regulation Components:** A pressure relief valve, emergency shut-off valve, and a regulator ensure safe operation by adhering to established safety standards and regulations

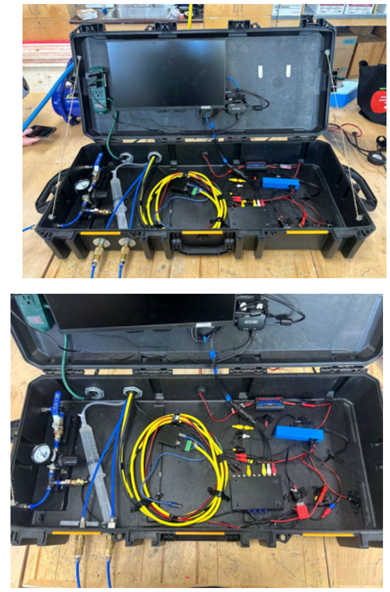


Figure 8: Images of the ROV's control system | Photos taken by James Penney

Laptop Interface:

- **Main Camera Feed:** *Siku's* primary camera view is displayed, allowing the Pilot to monitor the ROV's surroundings.
- **Thruster Control:** Comprehensive operational control is provided via tether to control the six thrusters.

D. Tether and Tether Management

The tether connects the topside control systems to the ROV. *Siku* has a 15 m neutrally buoyant tether which consists of an Ethernet cable, two pneumatic airlines, three camera feed wires, a power wire, and a hydraulic tube. A protective self-tightening weave covering keeps wires and tubing from potential damage and entanglements. To maintain neutral buoyancy, HD foam is attached in half-meter increments inside the tether. This also prevents tangles on the pool deck as well as in the water. This is required to prevent the weight of the tether from impacting the performance of the ROV while in the water.

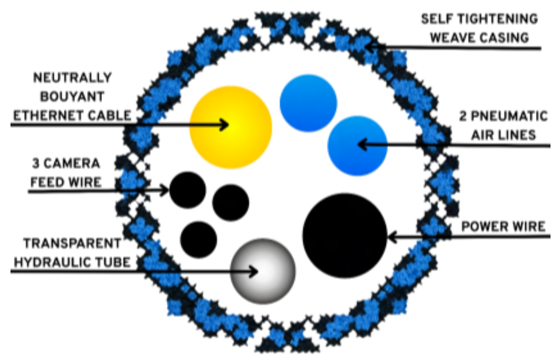


Figure 9: Diagram of the tether. Made by Christian Roque

Shark Tech understands the importance of good tether management during mission operations. The company operations manager and pilot have developed a tether management protocol to efficiently manage the tether during product demonstrations. This protocol consists of having a designated staff member managing the amount of tether on the deck while maintaining communication with the Pilot. This limits tripping hazards, entanglements, and potential damage to the tether.

E. ROV Software Design

Siku's software is a two-part system that handles pilot operations and communications between the control box and the ROV. The first part is located in the control box and consists of a laptop running Python code that takes input from an Xbox controller and converts it into commands for the second part of the system. The second part of the system uses an Arduino Due board, which is connected to the control box via an Ethernet cable. The Arduino reads the inputs from the Python code and sends a PWM signal to the corresponding motor to control the ROV. The power output for the motors is limited in the code to prevent blown fuses. This process continuously occurs while the ROV is in operation. You can find a link to our GitHub page in the reference section of this document [6]

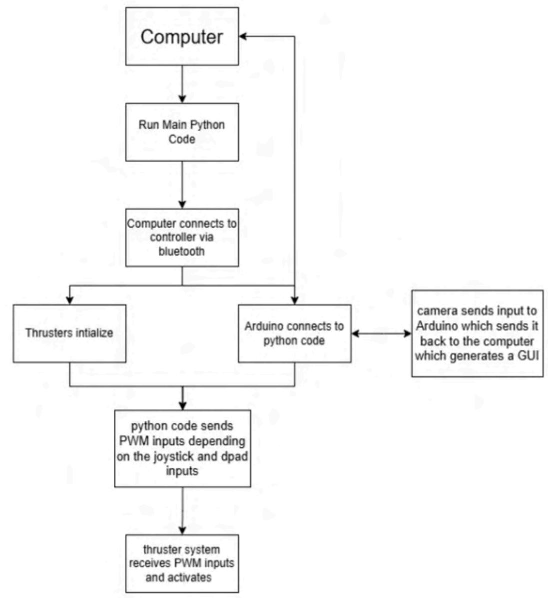


Figure 10: Diagram of the software flow chart. Made by Finlay Jones

There are two types of data traffic between the surface and the ROV:

1. Joystick and button inputs that control the motors.

2. Camera streams that are projected onto the ROV's GUI.

F. Propulsion

The propulsion system of *Siku* is comprised of six TD7 12V motors, selected by Shark Tech due to their cost-effectiveness and favourable thrust-to-current ratio, enabling efficient power delivery. The company chose these motors over previously used bilge pump motors due to their ability to produce almost double the thrust at a similar weight and current draw. This upgrade provides improved directional control, enhancing the ROV's ability to navigate complex underwater environments with precision and stability. These thrusters come pre-shrouded to meet IP20 safety standards and feature integrated mounting brackets, simplifying installation.

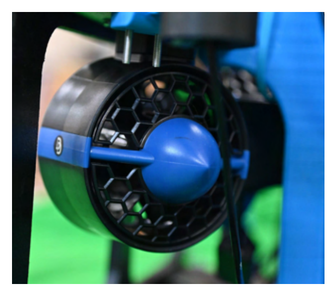


Figure 11: Picture of a TD7 12V motor | Photo taken by Olivia Normore

The design incorporates two front and two rear thrusters mounted at a 45 degree angle allowing for maximum water flow through the frame, complemented by two centrally-positioned vertical thrusters for lift. This configuration provides an optimal balance of maneuverability and propulsion efficiency.

Table 2: Decision Matrix for Propulsion Motors - Made by James Penney

Motor Type	Cost	Current Draw (Amp)	Control Method
1250 GPH 12V Bilge Pump[1]	$50.00 USD	3.2	Analog
Diamond Dynamics TD7 Thruster [2]	$149.00 USD	13.1	Digital
Blue Robotics T200 Thruster [3]	$240.00 USD	17	Digital

G. Buoyancy

Siku is designed to be slightly positively buoyant in water. A positively buoyant ROV was favoured during initial testing because employees observed that the ROV began to sink when lifting submerged objects, such as the pCO_2 sensor, during its delivery in *mission task two*. To achieve positive buoyancy, Shark Tech applied the principles of buoyancy when selecting materials with a density lower than water's 1.000 g/ml. This began with choosing HDPE for the frame material, which has a density of 0.93 g/ml, slightly lower than water.

Additionally, our 4" (100 mm) x 12" (300 mm) watertight enclosure was calculated to have a buoyant force of 23.1 N. When compared to its downward force of 7.36 N, it was able to support an additional 15.74 N (or approximately 1.6 kg) of weight, helping to offset the additional components mounted on *Siku*. Once all components and tools were installed, high-density foam was added to balance how the ROV sat in the water and to finalize its positive buoyancy. High-density foam was specifically selected for its ability to better withstand increased water pressure at a specific depth.

6. Payload and Tools

A. Cameras

Shark Tech prides itself on having a simple design for *Siku* while providing ample live viewing of missions through a series of cameras. The camera system consists of four cameras, one main USB camera and three easily replaceable underwater fishing cameras. The primary USB camera costs $110, while the other three analog cameras cost $88 each. The company's engineers developed simple mounting solutions that were used for each camera on the ROV.

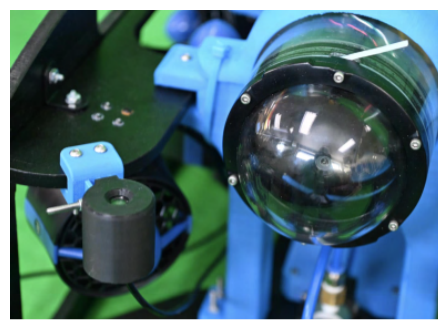


Figure 12: Two of Siku's Cameras | Photo taken by James Penney

Camera 1 is mounted in the watertight enclosure, where it connects to a USB extender to relay the feed to the Pilot's display. This view was selected as it provides *Siku* with better situational awareness and aids in positioning the claw. Camera 2 is placed on the right-hand side of the claw to aid in the movement of cargo, the jellyfish catcher, and the water sampler during the *'Shipwrecks'* and *'Lake Acidification and Invasive Carp'* mission tasks. Camera 3 is mounted facing the water sampler to assist in its usage and positioning for the '*Protect and Restore Ecosystems and Biodiversity'* mission task. Camera 4 is adjustable to view any blind spots that may exist. *Siku* employs these four cameras to provide the Pilot with all the views essential to its operation and the successful completion of missions.

B. Claw

Figure 13: Image of the pneumatic claw in action | Photo taken by Owen Hudson

Based on this year's mission tasks - *Shipwrecks, Spotter Buoys, Marine Renewable Energy, and MATE Floats* - Shark Tech decided it would be beneficial to develop a claw for *Siku*. Building on last year's design, which proved successful, the company opted to use a similar claw design while refining its functionality for this year's specific challenges. The claw is an original Shark Tech design, 3D printed in-house for precision and customization.

The claw features two primary gripping mechanisms, powered by a pneumatic piston to enable it to interlock and securely hold objects. Safety was always our top priority while collecting samples around animals and divers, which is why our claw was constructed with smooth edges. Extensive testing was conducted to ensure that the claw consistently grips objects at the same point every time. This reliability allows the Pilot to approach each task with the flexibility and ease needed for optimal execution.

Siku's claw was tested in the Atlantic Ocean, where it picked up sea urchins from the side of a wharf. Shark Tech successfully brought the sea urchins to the surface and placed them down without damage. This proved that *Siku's* claw can safely pick up objects while still having a tight grip.

C. Water Sampler

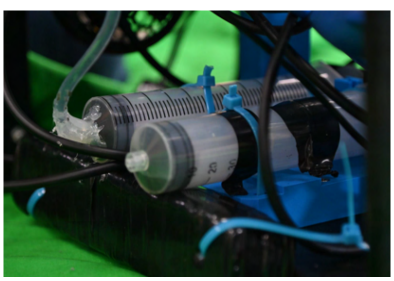


Figure 14: Image of the Water Sampler | photo taken by Yashveen Gunput

Shark Tech's water sampler was originally developed during their first year of the MATE ROV Competition in 2023 and was fabricated using a 3D printer. The design process involved iterative prototyping, employing a trial-and-error approach to refine the functionality and efficiency of the device. The sampler is mounted on the frame that securely houses two 100-ml syringes, one is positioned to facilitate precise fluid collection, while the other acts as a piston to drive the collection of water. A third syringe, connected via hydraulic line, is manually actuated through a control box, allowing the Co-Pilot to draw water samples with accuracy. This hydraulic mechanism ensures controlled sampling, making the device suitable for various field applications.

Throughout the development, our company experimented with multiple design iterations to optimize performance. This hands-on approach allowed employees to identify the most effective configuration through testing and comparing each design, resulting in a functional and reliable water sampling tool. A notable modification in this year's version was the redesign of the nozzle on the syringe. The original, larger nozzle from 2023 was replaced with a more compact and precise nozzle, enhancing the sampler's ability to collect targeted water samples efficiently.

D. Jellyfish Collector

Figure 15: Jellyfish Collection Tool | Photo taken by James Penney

To fulfill the *jellyfish collection* mission task, Shark Tech designed a specialized jellyfish collection device. The collection box features a triangular design, chosen to optimize hydrodynamic flow and complement the orientation and functionality of the ROV's claw. This shape allows the device to move smoothly through the water while increasing the likelihood of guiding a jellyfish into the container. Once inside, the jellyfish can be safely transported to the surface without harm, ensuring both the protection of delicate marine life and the success of the mission.

E. Specialized Mission Specific Hook (SMSH)

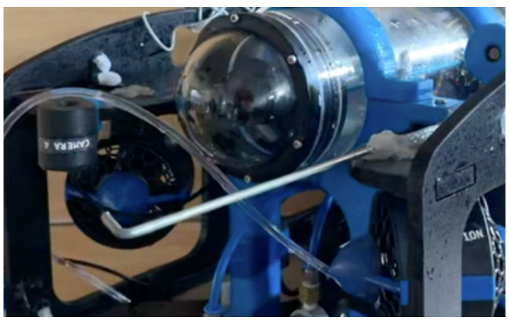


Figure 16: SHMS on Siku | Photo by Marcus Flynn

The SMSH is a specialized tool engineered for Mission *Task 2.1* and *2.2. Task 2.1* involves the removal and replacement of a sacrificial anode, while Task *2.2* is the release of a medusa jellyfish.

Designed for efficiency and safety, the SMSH features two rounded hooks with a precisely calibrated gap. This design accommodates the specific sizes and shapes of both the sacrificial anode and the jellyfish release. By ensuring secure handling and precise operation, the SMSH enables Shark Tech to perform these tasks efficiently, minimizing the risk of damaging the environment and safeguarding surrounding marine life.

F. Vertical Profiling Float

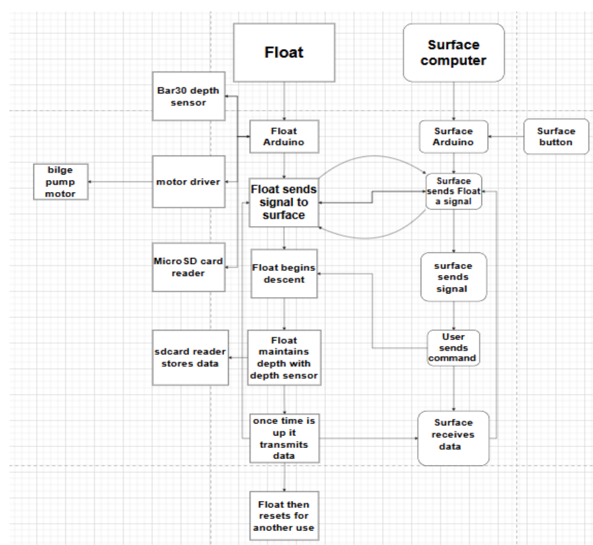


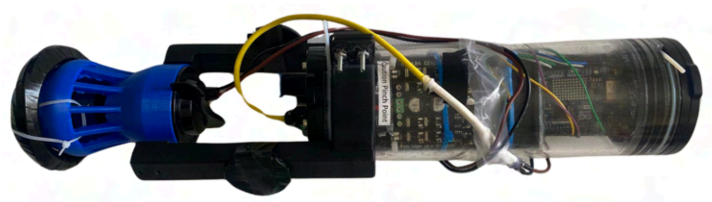
Figure 17: Flow chart of the Float | Made by Finlay Jones

Shark Tech designed and developed a vertical profiling float known as the *Shark Fin*. This device utilizes a built-in Wi-Fi module to enable wireless communication between the onboard Arduino UNO R4 Wi-Fi and a companion Arduino located at the surface. Arduino microcontrollers were selected due to the company's familiarity with the platform and its user-friendly C++ programming language.
The onboard Arduino is connected to a Cytron motor driver, which controls a 12V 1250 GPH bilge pump motor. Upon receiving a descent command from the surface unit, the motor activates to initiate the profiler's descent. During this process, a Blue Robotics Bar30 pressure sensor continuously sends real-time depth data to the Arduino. This data is stored on an onboard SD card and is also used

to maintain a target depth of 2.5 meters. The Arduino dynamically adjusts the motor's operation, either pushing or pulling, based on the profiler's position, relative to the desired depth.

Once the first profile is complete and the surface Arduino has successfully received the stored data, the operator can transmit a command to begin the next descent cycle. All electrical components of the *Shark Fin* are powered by three 12V NiMH batteries wired in parallel. All internal components of the *Shark Fin* are securely housed in a 40 cm acrylic waterproof enclosure. A prebuilt container was selected for this purpose to ensure reliable protection of sensitive electronics during operation. To see the logic of the system, please refer to the flow chart found in *Figure 13* on the page above

Figure 18: Shark Fin Vertical Profiling Float - Image by Finlay Jones



G. Build vs. Buy

Shark Tech prioritizes operational efficiency by carefully balancing whether to build, buy, reuse, or redesign components, typically favouring in-house fabrication when the necessary tools, materials, and expertise are available.

For example, rather than purchasing a commercial claw or reusing an older physical model, Shark Tech chose to reuse and refine the previous year's design, allowing for modifications as needed to meet this year's mission. To aid in making these decisions, our project management team created the pros and cons table, which can be seen in Table 3 above.

Table 3 : Pros and cons table for Siku's construction. Made by Olivia Normore

Componet	Build		Reuse		*Buy		Final Decision
	Pros	Cons	Pros	Cons	Pros	Cons	
Propulsion	N/A	N/A	Cost-effective	Not enough power and company would have to design, print and mount new shrouds	More power and built-in shrouds eliminating the nee for additional fabrication	Cost and if something breaks it would require replacing an entire motor	Buy
Cameras & Mounts	N/A Cost-effective and customizable	N/A Time consuming	Cost-effective and reliable	Wear and tear	Product tailored to mission/task	Extra Expense	Reuse three and buy one
Claw - Pneumatic System	Customizable	Resource-intensive and more efficient to utilize a proven solution	Cost-effective, efficient and user-friendly	Wear and tear	Eliminate fabrication	High cost and not as customizable	Reuse
Enclosure & Electrical System	Customizable	Inexperience with this system as it's the first year using this type of electrical system	N/A	N/A	Made by profesionals	High cost and not customizable	Buy
Water Sampler - Hydraulic System	Modifications could be made to original design	Time consuming	Saves money and familar system	Wear and tear	Eliminate fabrication	Extra Expense	Reuse

*Along with shipping delays and availability, any product purchased has an additional cost due to remote location.

PROBLEM SOLVING

Shark Tech is composed of a close-knit group of students united by a shared goal: to design and build the most effective ROV possible. This collaborative mindset fosters high efficiency in both identifying problems and developing timely solutions. Strong cooperation among company members contributes to a positive work environment and a steady stream of innovation.

Despite this strong foundation, the development of *Siku* has presented several challenges. One significant issue has been coordinating meetings following the relocation of mentor Riley Regular, who moved 1000 km away from the company's base. To address this, Shark Tech has relied heavily on digital communication platforms, particularly Google Meet, to maintain regular and productive contact. The use of collaborative tools has played a vital role in project success. Google Classroom and Google Docs have enabled company members to contribute simultaneously across all areas of development, while providing a platform for real-time feedback and streamlined collaboration.

Additionally, Canva has been employed to coordinate work on the company's visual materials, including the poster, and has improved the overall design workflow. To support communication beyond structured meetings, Shark Tech also utilizes a company-wide message board and group chats for immediate updates and informal coordination.

Throughout each stage of development—from design and production to testing and refinement—Shark Tech has followed a structured and logical approach to problem-solving. This process includes:

1. Identifying the problem
2. Determining the root cause
3. Eliminating alternative potential causes
4. Reducing the issue to its simplest form
5. Evaluating possible solutions based on cost, time, and feasibility
6. Implementing the most effective solution
7. Monitoring the outcome to ensure complete resolution

This problem-solving framework has proven highly effective in overcoming a variety of technical and logistical challenges. For example, during the coding phase, Shark Tech encountered issues where the data would occasionally fail to save properly. Additionally, the motor experienced a period of malfunction, not engaging as expected. These challenges were addressed through extensive debugging, with the employees adjusting the code to ensure proper data logging and refining the motor driver circuitry to ensure reliable motor operation.

SAFETY

A. Safety Philosophy

At Shark Tech, the philosophy of protecting people, preserving oceans serves as the foundation for all operations. Proactive preparation through comprehensive training, proper tools, and clearly-defined procedures is considered essential to preventing incidents before they occur. Safety is a critical component of every aspect of work, whether in the workshop, on the pool deck, or during ROV deployment. (See Appendix B and C)

Shark Tech has an in-house Operations Manager who is a certified lifeguard, along with three trained First Aiders - the Pilot, the Research and Development Technician, and the Operations Manager. The Operations Manager is present during all construction activities to ensure adherence to safety protocols. If any employee has a safety concern regarding the ROV or another individual, they are instructed to notify the Operations Manager, CEO, or mentor(s). Additionally, all personnel must have a thorough understanding of basic safety practices.

By fostering a strong culture of safety, Shark Tech can protect its employees, work efficiently, and stay committed to its mission.

B. Safety Features

Shark Tech prides itself on creating one of the most versatile yet safe ROVS on the market. *Siku* meets all safety guidelines outlined by MATE. A summary of key safety features can be found in *Table 4*.

Table 4: Safety Features of Siku ROV - Made by Olivia Normore

Safety Features	Description
Rounded Edges	Rounded edges prevent injury and reduce the risk of damaging marine or pool environments.
Waterproofed Electronics	A watertight enclosure prevents damage to the electrical system.
Shrouded Thrusters	The TD7 thrusters feature built-in shrouds for added protection and efficiency.
Caution Labeling	All potential hazards are clearly labelled to prevent injury. E.g., the claw and thrusters
Power Supply Fuse	There is a 25A fuse within 30cm of the positive end of the power supply.
Strain Relief on Both Ends of the Tether	The tether is secured on both sides by electrical strain relief fittings to ensure that there is no strain on the tether.

CRITICAL ANALYSIS

A. Troubleshooting

When troubleshooting the ROV, there were several techniques that Shark Tech used to identify and address any issues *(See figure 19)*:

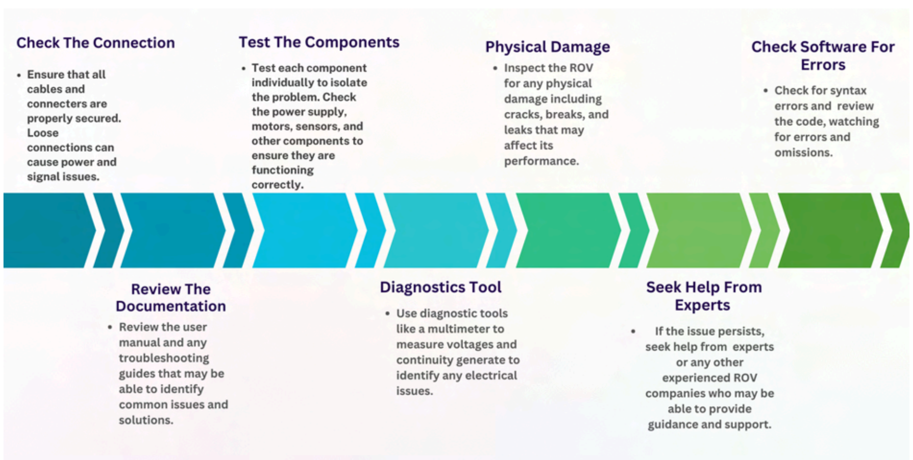


Figure 19: Troubleshooting Flow Chart- Image by Belle Gibbons

Overall, Shark Tech believes it is important to approach troubleshooting systematically and methodically, starting with the most common and easily fixable issues before moving on to more complex problems. Communication and collaboration among the company members help to identify and resolve issues that may occur.

B. Testing Methodology

As part of Shark Tech's testing process, each system is evaluated independently before full integration into the ROV. To minimize variables and isolate potential issues, initial tests are conducted outside of the water whenever possible. Once individual components are verified, in-water testing is performed to ensure that all systems function correctly when operating together. These full-system tests help identify any existing or potential issues, ensuring that *Siku* performs at its highest possible level. Shark Tech tested the *Siku* in water, alongside each prop, in MATE's mission tasks this year. With being able to test the *Siku* multiple times, Shark Tech was able to become comfortable with their product demonstrations, knowing *Siku* is capable of completing the mission within the given time.

Figure 20: Testing the Float in the water | Photo taken by Olivia Normore

C. Propulsion Testing

When testing the *Siku's* propulsion system, the motors were initially operated on dry land to check for electrical issues before being mounted on the ROV frame. Once those tests were completed, Shark Tech employees then looked at various motor placement options to maximize efficiency and maneuverability. To evaluate this, the company conducted a series of in-water trials using a pool, closely observing how different motor placements and orientations affected the movement of the ROV. After numerous trials, the company determined the most effective angles for optimal performance.

To further assess propulsion, Shark Tech conducted a velocity test. The company ran *Siku* through three trial runs in a three-meter-long pool and recorded the time it took to travel the set distance. Calculating the average velocity provided valuable information, allowing the employees to estimate underwater distances during missions without relying on external measurement tools like lasers or measuring tapes. These calculations can be seen in *Table 5* below.

Table 5: Velocity of Siku in Trial Runs - Made by James Penney

Trial	Distance (m)	Time (s)	Velocity (m/s)
1	3	9.50	0.966
2	3	9.48	0.963
3	3	9.70	0.985

Average velocity = (0.966 + 0.963 + 0.985) / 3 = 0.971 m/s

D. Pneumatics Testing

To test the Pneumatic systems, the company followed similar steps as outlined for the propulsion systems. The claw began as cardboard mock-ups, then early 3D-printed models, until fully functional products were developed. The company's engineers tested different tubing to determine which would produce the most force for the claw and support the proper pressure to use the claw. This allowed the company to calculate what tasks the ROV could complete without issue. Shark Tech first tested the pneumatic connection to make sure it would work when the tether was fully deployed. The company then tested how well the Pilot could maneuver with the new addition to the ROV.

E. Vertical Profiler Testing

The vertical profiler underwent extensive testing and was carefully evaluated at every stage of development. Initial testing focused on establishing a reliable Wi-Fi connection between the vertical profiler and its control box while submerged. This process required many hours of live trials conducted in Shark Tech's in-house testing facilities. Further testing was then performed to ensure the float could consistently maintain a target depth of 2.5 meters for 45 seconds.

Figure 21: Float testing | Photo taken by Christian Roque

Once the code and internal components were functioning correctly, Shark Tech's senior software engineer worked on fine-tuning the buoyancy of the float. Achieving the ideal balance, slightly positively buoyant, but not so much that it prevented descent, proved to be a complex and iterative process. Numerous trials and adjustments were required, with refinements continuing right up until the night before the regional competition.

Due to our remote northern location, we lacked a proper facility to test the profiler's ability to maintain a predetermined depth. To overcome this challenge, a large section of unused sewer pipe was capped on one end and filled with water. This provided us with the ability to test the profiler's full capabilities. A photo showing this setup can be seen in *Figure 15*.

Budget and Cost Accounting

A. Budget

As with any growing company, effective budgeting is a critical component of long-term success. At the start of the year, the CEO and CFO, in collaboration with the company's mentors, established the annual budget. The total budget for this year is set at $55,650 USD. This budget encompasses a range of expenses, including the travel costs for 16 individuals attending competitions, ROV construction, marketing initiatives, and various unforeseen costs that may arise. These expenses may include fluctuations in travel costs due to inclement weather and ice conditions, which could result in temporary diversions of ferry and flight routes, as well as extended hotel stays. A detailed breakdown of the budget is provided in Appendix D. It is important to note that the budget accounts for higher-than-average travel expenses due to the company's remote location. Employees and mentors are required to travel over 1000 km to attend the regional competition in St. John's, Newfoundland, and nearly 3405 km to participate in the World Competition in Alpena, Michigan.

To secure the necessary funds, Shark Tech organized a variety of fundraising events, including ticket draws for various items, multiple community barbecues, and weekly lunch fundraisers, during which Shark Tech provided meals at their school. Additionally, the company engaged with several local businesses and community stakeholders to secure sponsorships.

Table 6: Sources of Income for Shark Tech 2025 - Made by Yashveen Gunput

Source	Notes	Amount (USD)
Balance forward	Funds left over from June 2024	$9300
MATE-NL Regional Grant	Funds to travel to the Regional competition and other construction of the ROV	$4865
MATE-NL World Championship Grant	Funds to travel to Kingsport, Tennessee, for the World Championship	$17866
Newfoundland and Labrador Government Support	Funds from the Provincial Government to support our efforts in the competitions	$9300

B. Project Cost

Shark Tech made a concerted effort to stay within the established budget throughout the year. The company worked diligently to identify components from previously built ROVs that could be reused on the Siku model. When it was determined that a new component was necessary, a defined process was followed. Initially, the CFO was informed of the required purchase. The CFO then conducted research, comparing prices and availability from both online and local suppliers. Once the most cost-effective option was identified, the CFO presented the findings to the mentors, who then proceeded with placing the order on behalf of the company. A detailed breakdown of the project cost is provided in *Appendix E.* Table 5 below displays the established budget, actual costs and income. Based on our current projections we are expecting to have a surplus of $13,374.41 USD to support our team in future competition years.

Table 5: Total Project Cost for Siku and Travel in USD - Made by Yashveen Gunput

Budgeted	*$55,650.00*
Costs	*$33,050.16*
Income	*$41,331.00*
Fundraised	*$5093.57*
Account Total	***$13,374.41***

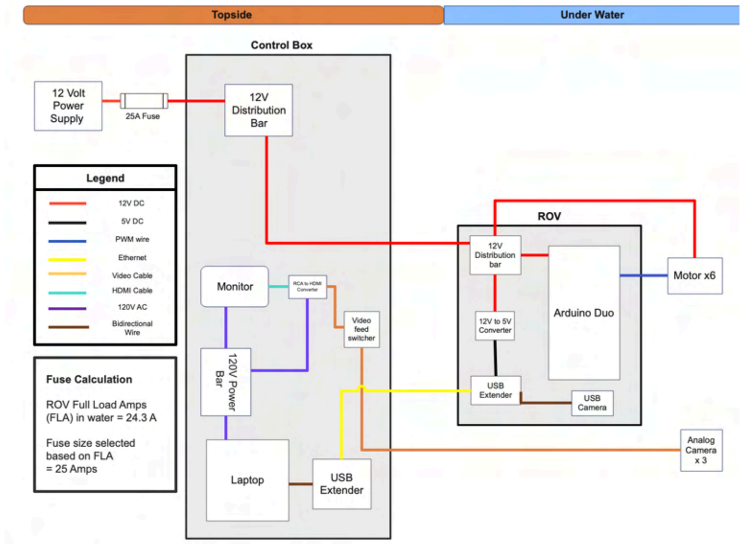
Acknowledgements

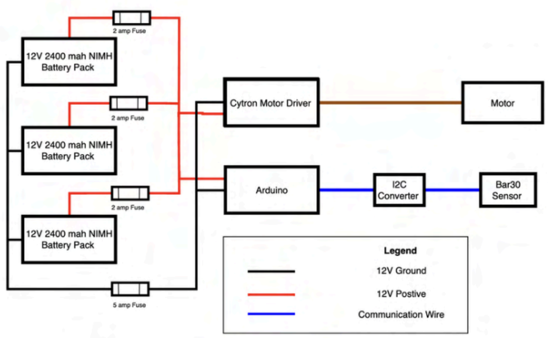
Shark Tech would like to thank the following individuals and organizations for their support:

- Mr. Regular, Teacher Mentor, and Founder of Shark Tech
- Mr. Allen, Math Teacher and Teacher Mentor
- Mrs. Chubbs, English Teacher and Teacher Mentor
- Labrador Fishermen's Union Shrimp Company for their donation of a vat to test *Siku*
- Clubhouse Embroideries for making company polo shirts
- William Normore Limited, C&T Enterprises Limited, Cenovus Energy, SubC Imaging, The Government of Newfoundland and Labrador, Seamor Marine, GRI Simulations, eSonar, and Equinor for sponsoring Shark Tech
- MATE Center and the Marine Institute for allowing us to compete in the competition
- Neil Rowsell and family, for letting us use their swimming pool for testing

Appendices:

Appendix A - Electrical and Pneumatic SID





Float Full Load Amps (FLA) in water = 4.9 Amps

A Fuse size selected based on FLA = 5 Amp

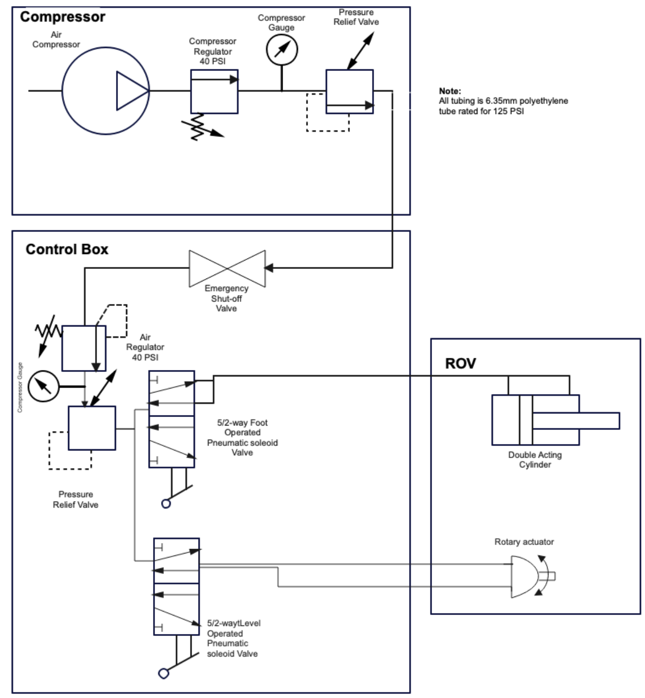


Figure 22: Electrical and Pneumatic SID's for Siku and Shark Fin

Appendix B - General Safety Checklist

- Ensure that all personnel have their hair securely tied up, sleeves rolled up, and earphones/jewelry put away before the use of any tools.
- Verify that all personnel are wearing closed-toed shoes.
- It is crucial to establish clear and effective communication with co-workers.
- Ensure that all personnel are wearing safety glasses.
- Make sure that passageways are clear of objects and wires.
- Hazardous objects and materials should be kept away from members and the ROV when not being used.
- All electronics, except for the tether, should be kept away from water.
- Ensure that all wires are carefully and effectively covered.
- Ensure that the power connection and controller are connected before powering on the control box.
- PFDs are required when around the water.

Appendix C - Operation Protocols

Pre-Power (Pilot, Co-pilot, and Deck Crew)

- [ ] Area is clear and safe (no tripping hazards or obstructions)
- [ ] All team members are wearing safety glasses
- [ ] Verify RPS power switches are off
- [ ] Tether laid out on the deck and is free of damage
- [ ] Tether is connected and secured top the RPS
- [ ] Tether is connected to strain relief and secured to ROV
- [ ] Power source connected to RPS
- [ ] Verify electronics housing is properly sealed and fasteners are tightened
- [ ] Visual inspection of electronics for damaged wires or loose connections
- [ ] Thrusters are free from obstructions

Power-up (Pilot, Co-pilot, and Desk Crew)

- [ ] Verify RPS is receiving 12V nominal
- [ ] Control computers up and running
- [ ] Ensure desk crew members are attentive
- [ ] The Co-pilot calls out, "power on!"
- [ ] Power on RPS
- [ ] Co-pilot calls out, "performing thruster test"
- [ ] Test thrusters and verify thrusters are working properly
- [ ] Verify video feeds from navigation and mission cameras
- [ ] Ensure cameras are positioned correctly
- [ ] Test electrical and pneumatic components that require pilot input (See Pneumatic System Test)

Inspect and Test Pneumatic System (Pilot, Co-pilot)

- [ ] Verify all pneumatic lines on RPS and ROV are properly connected to the MATE air supply
- [ ] Verify that the compressor is switched on
- [ ] Adjust pressure regulator to 40 PSI
- [ ] Activate pneumatic system and open main valve
- [ ] Verify there are no leaks and pneumatic lines are securely connected while under pressure
- [ ] Activate pneumatic tools and verify the pressure returns to 40 PSI after the tool is shut off

ROV launch (Pilot, Co-pilot, and Desk Crew)

- [ ] The pilot calls out, "ROV surfacing"
- [ ] Desk crew calls out, "ROV on surface. Disable thrusters"
- [ ] Co-pilot calls out, "thrusters disabled"
- [ ] Deck Crew call out, "hands on", and remove ROV from the water
- [ ] Co-pilot calls out, "safe to remove ROV"
- [ ] After securing the ROV on deck, Deck Crew calls out, "ROV secured on deck"
- [ ] Co-pilot powers down RPS
- [ ] Team begins demobilizing

Leak Detection (Pilot, Co-pilot, and Desk Crew)

- [ ] Immediately power down the ROV and RPS systems and remove the ROV from the water if a mission is occurring
- [ ] Visually inspect ROV to identify the source of the leak. Do not disassemble any part of the ROV until the source of the leak is detected
- [ ] Install pressure testing equipment and use soapy water to verify the source of the leak
- [ ] Create a plan and repair the leak
- [ ] Check all systems for damage and verify proper operation
- [ ] Document the source and cause of the leak and detail the corrective actions and design changes made.

Pit Maintenance (All Team Members)

- [ ] Pit is well organized and free of debris
- [ ] All tools, cables, and equipment are safely stored in their designated spaces and there are no tripping hazzards
- [ ] Check electrical cords and correct any electrical hazards
- [ ] Check supplies and organize a shopping list if anything is needed for repair RPS, ROV and tether are clean, dry and stored
- [ ] Protective caps for electrical connectors are in place
- [ ] ROV, RPS and tether have been readied for use on the next mission run

Loss Of Communication (Pilot, Co-pilot and Deck Crew)

- [ ] Cycle power on RPS to reboot ROV
- [ ] If no communication, power down ROV, retrieve via tether
- [ ] If communication restored, confirm there are no leaks, resume operations
- [ ] If communication has not been restored, begin troubleshooting procedures and isolate the issue. Determine if the issue is with hardware or software
- [ ] Document the problem and detail the corrective actions made to solve the problem

Appendix D - Project Budget

Shark Tech
Budget 2024-2025

Reporting Period: Sept. 2024 - June 2025

School Name: Labrador Straits Academy

Mentor(s): Riley Regular and Ethan Allen

Expenses				
Category	**Type**	**Description**	**Projected Cost**	**Budgeted Value**
Hardware	Purchased	HDPE Board, Fasteners, PLA	$300	$300
	Purchased	4'' Watertight enclosure + Attachments	$500	$500
	Re-used	Pneumatics System	$400	$400
Electronics	Purchased	Laptop for Control System	$1100	$1100
	Re-used	LCD Screen	$300	—
	Purchased	Motors	$1500	$1500
	Re-used	Float Electronics	$730	—
	Re-used	3 Analog Cameras	$250	—
	Purchased	USB Camera	$100	$100
	Purchased	Power and communication for tether	$500	$500
Travel	Purchased	Travel to Regionals for 16 people for 6 days	$6000	$6000
	Purchased	Travel to Worlds for 16 people for 8 days	$40,000	$40,000
General	Purchased	Marketing Materials for Regionals/ Worlds	$500	$500
	Purchased	Company Clothing	$1500	$1500
	Purchased	Testing pool	$250	$250
	Purchased	Delays in tavel and shipments	$3000	$3000
			Total Budgeted Expenses (USD)	**$55,650**

Appendix E - Project Cost

Shark Tech Project Costing 2024-2025	**Reporting Period:** Sept. 2024 - June 2025
School Name: Labrador Straits Academy	**Mentor(s):** Riley Regular, Ethan Allen

Funds						
Date	**Type**	**Category**	**Expense**	**Description**	**Notes**	**Amount**
	Purchased	Electrical	Motors	6 TD7 Motors	Tools and Components	$894
	Purchased	Electrical	Control System			$380.67
	Purchased	Electrical	Enclosure			$378.27
	Purchased	Hardware	Frame	HDPE Board	24"x 54" HDPE Sheet	$143.64
	Purchased	Hardware	Mounting	Brackets and Bolts	Brackets and Hardware to Construct the Frame	$30
	Purchased	Hardware	PLA+	3D Printed Parts		$201
11/14/2024	Purchased	Camera	Cameras	Cameras	USB Camera system	$176.00
	Reused	Camera	Display	Monitor	Screen and Hardware	$86.19
	Purchased	Electrical	Laptop	Laptop	Screen and Code	$1100
	Purchased	Tether	Covering	Protective Covering	Covering for Tether	$35
	Purchased	Tether	Wires	Ethernet Cable and Power Cable	Tether wires	$502.40
	Reused	Pneumatics	Claw System	Required Pieces for Pneumatic Claw	Full Pneumatic System	$150.36
	Reused	Hydraulics	Hydraulics	Water Sampler	Hydraulic tube	$35.91
02/01/2025	Reused	Float	Computer	Hardware for Float	Motor Controllers and Arduinos	$120
	Reused	Float	Enclosure	Blue Robotics Order	Watertight Enclosure	$475
	Purchased	Travel	Travel	Regionals Trip	Travel Expenses for Employees (Labrador to St.John's)	$6904.21
		Travel	Flights	Flights to Worlds	Flights	$8621
		Travel	Hotels	Hotels for Worlds Trip	Hotels	$6034.70
		Travel	Car Rental	Cars for 15 People	Cars	$3592.08
		Travel	Misc. Expenses	Fund for Food & Other Travel Expenses for Employees	Food, Luggage, Additional Fees	$1250
		Marketing	Displays and Clothing	Clothing & Marketing Materials for Trip	Polos, Hoodies, Hats, Posters, and Paper Items for Worlds	$1939.73

Total Spent (USD)	$33,050.14

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