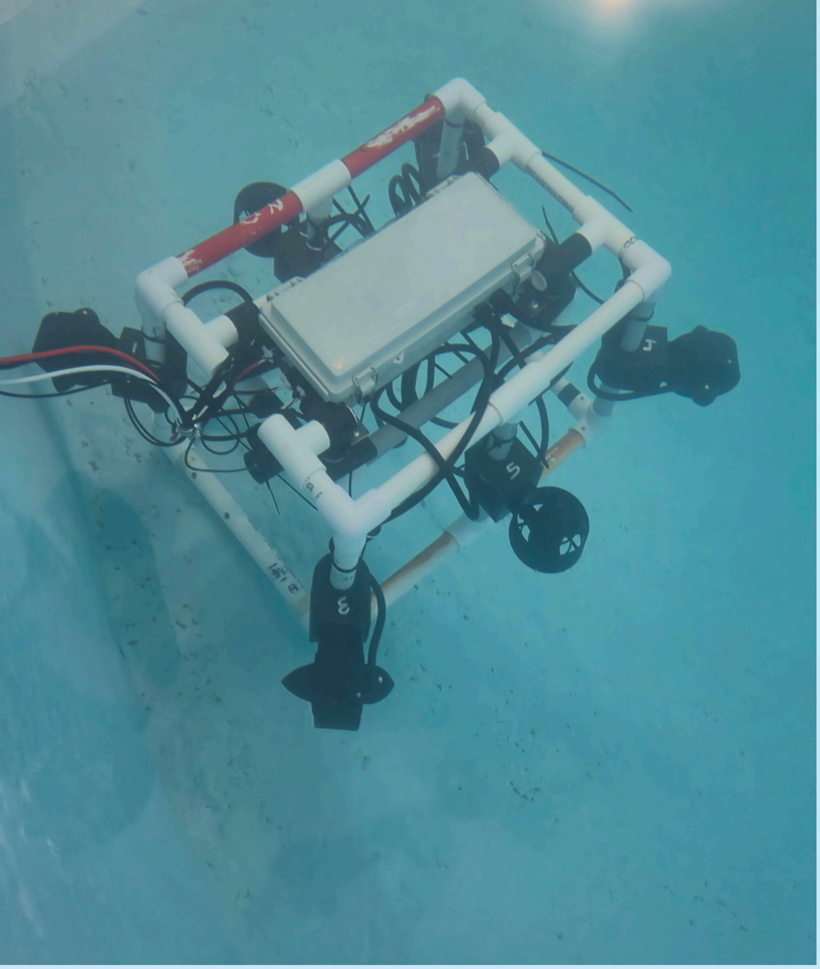

Technical Documentation 2025

Company Members

Priyanshu Gunput	CEO	First year
Abbey Bryden	CFO	First Year
Corbin Rideout	Pilot	First Year
Ben Ross	Deck Manager	First Year
Evan Scott	Mechanical Engineer	First Year
Lucas Buckle	Tether Manager	First Year
John Nsionu	Lead Electrical Engineer	Third Year
Aaron Kutin	Electrical Engineer	Third Year
Satyam Kalra	Electrical Engineer	First Year
Kirandeep Kaur	Technical Writer	First Year
Sanchit Mehta	Technical Writer	First Year

Mentors

Thomas Young
Anthony Randell
Michaela Barnes
Jamie Brake
Alaina Mejia

ABSTRACT

Western Wave is a company based in Corner Brook, Newfoundland and Labrador, Canada. For the 2025 MATE Request for Proposal, Western Wave designed a Remotely Operated Vehicle (ROV) to meet the proposal requirements. The ROV, Tsunami, was designed to be cost-effective, reliable, and maneuverable. Tsunami is equipped with two ice fishing cameras and a pneumatic claw to complete several mission tasks. The claw was designed in Fusion 360 and then 3D printed out of PLA, which is eco-friendly, durable, and cost efficient. Western Wave also 3D printed the motor mounts, and camera mounts to reduce costs of buying new materials to use as mounting for our components. Safety was critical for Western Wave. Safety procedures were implemented and were made sure to be strictly followed by all employees. Western Wave spent over 1500 hours per member to construct a high performance, durable ROV with the user in mind.

Figure 1: Western Wave Robotics Company Photo, Michaela Barnes 2025

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1.0 INTRODUCTION

This is the first year Western Wave will be competing in the MATE ROV Competition. We are a team of students from Memorial University of Newfoundland (Grenfell Campus) and College of the North Atlantic (CNA) in Corner Brook, Newfoundland and Labrador, Canada.

The 2025 MATE ROV Competition challenges teams to develop underwater ROVs capable of conducting critical tasks in the Thunder Bay National Marine Sanctuary in Lake Huron. The cold, fresh water of Lake Huron allows for preservation of shipwrecks, but it also creates difficulties for divers and equipment due to low temperatures, limited visibility, and complex underwater terrain. Human divers face significant risks in this environment, including potential disorientation in cluttered wrecks, dangerous currents, and the physical stress of extended exposure to cold water. ROVs offer a safe, efficient, and repeatable way to access and study these underwater heritage sites without disturbing them.

Our ROV, Tsunami, was designed with these challenges in mind. It is lightweight, modular, and easy to modify for future missions. As Western Wave's first ROV, we focused on a balance of functionality and adaptability, allowing us to meet the specific needs of this years MATE Request for Proposal while preparing for future competition and real-world applications. Working together to navigate this learning curve has been an incredible experience for our team.

1.1 Company Structure

During the initial stages of Western Wave's project, company members started with general roles such as designing the frame, budgeting for the company, and researching about the competition until a foundation was built. Everyone was then able to gain enough experience with multiple responsibilities to aid in the process of Tsunami's construction, fundraising efforts, coding, prop designing and project management. The Chief Executive Officer (Priyanshu Gunput) was chosen for his leadership, adaptability, and experience and provided overall direction and managed our company structure and strategy. The Chief Financial Officer (Abbey Bryden) handled the orders for materials and kept track of the cost accounting. The team leads for mechanical design and electrical engineering were chosen based on what they were most skilled at and managed the tasks for their divisions and ensured progress for each step was communicated for a smooth integration. The pilot operated Tsunami and prepared for the mission tasks. Our technical writers prepared all technical documentation required for this project. *Figure 2* shows Western Wave's company roles tree.

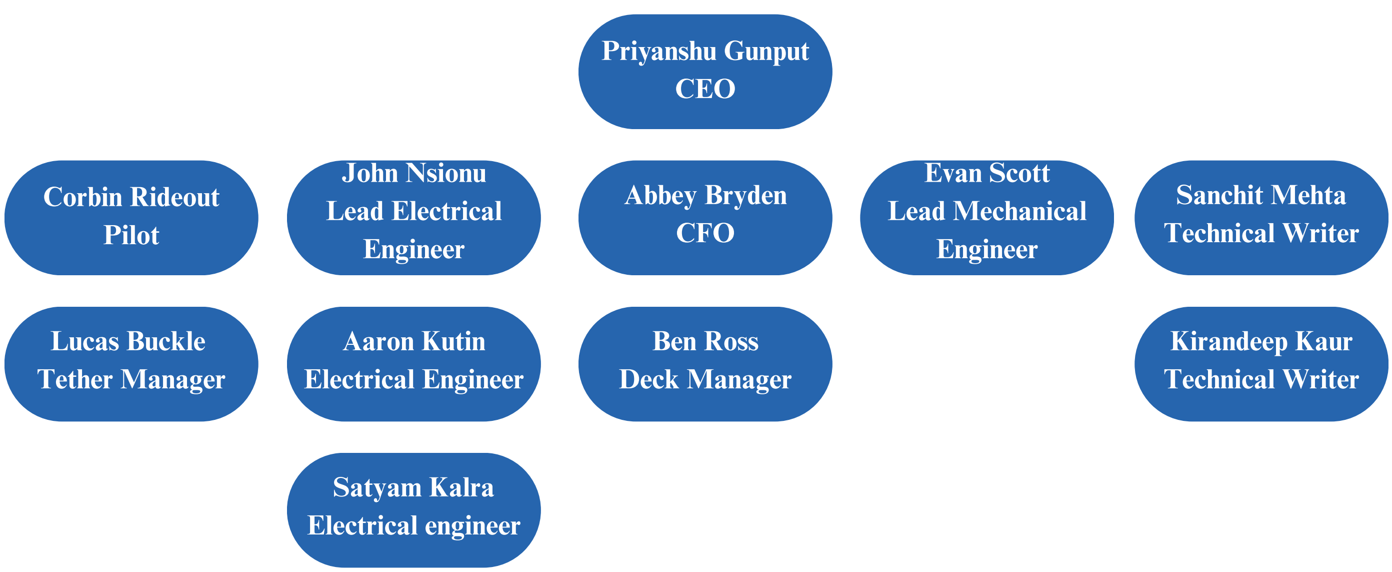

Figure 2: Western Wave Organizational Chart, Priyanshu Gunput 2025

1.2 Company Organization

Western Wave was subdivided into specialized departments to complete the companies plan for the project. Each team member were chosen to join specific departments based on what they were most skilled at and based on prior experience. Our departments were: mechanical design, electrical, finance, and administration

MECHANICAL DESIGN

Our mechanical design team was responsible for the brain-storming, prototyping, and construction of our ROV. They created a variety of designs and chose the optimal solution. This also included constructing any props and fixing any mechanical issues that arose.

ELECTRICAL

Our electrical team was responsible for our electrical systems on the ROV. This included power distribution to the systems, implementing the control board, tether, and creating the code for our thrusters. They ran tests and ensured all systems operated safely.

FINANCE

Our finance team was responsible for the teams fundraising efforts. This included brainstorming ideas to raise money for our teams expenses and finding possible sponsors. They led local fundraisers in our community.

ADMINISTRATION

Our administration team was responsible for ensuring projects were being met, government and regulatory affairs, community outreach and marketing

2.0 MECHANICAL DESIGN

2.1 Design Rationale

Tsunami was engineered with three key principles in mind: cost-effectiveness, operational efficiency, and field serviceability. This was Western Wave's first Remotely Operated Vehicle (ROV), so during our design process it was essential that we met our design goals of being easily interchangeable, maneuverable, and reliable and meet and exceed all requirements for the request proposal. One of our first major design choices was selecting PVC over high-density polyethylene (HDPE) for the frame. PVC offered a more affordable and readily available solution, reducing both cost and downtime during development. Tsunami has the dimension of 31cm x 41cm x 31cm and weighs 7.56kg. For propulsion, we selected pre-waterproofed, budget-friendly motors, which minimized the need for additional sealing and reduced system complexity. Similarly, ice fishing cameras were chosen due to their built-in waterproofing, durability and high resolution. A six-thruster configuration was implemented to allow sway, enhancing maneuverability in confined underwater environments. This configuration will also allow the ROV to tilt up for the 360 photosphere task as well as spinning 90 degrees for removing and inserting the sacrificial anode.

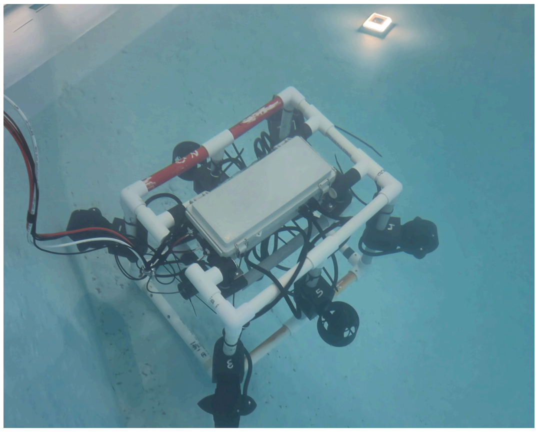

Figure 3: Tsunami ROV, Corbin Rideout 2025

2.2 Design Process

Western Wave's initial stage of the design process was brainstorming and sketching prototypes for the ROV. It was established that we needed a design that would be simple to construct and modify The team was left with multiple ideas for the shape of the frame such as a rectangle frame, and a triangular frame and it was decided that a rectangle frame would allow for adaptations as we moved forward in the design process.

An effective method used continuously was a decision matrix (*Table 1*). The team needed to decide on a material for the frame. PVC, high density polyethylene (HDPE), and Teflon (PFTE) were thoroughly considered. The cost of PVC was $4.99 per meter and available locally. The cost of HDPE was approximately $115.00 per meter and would need to be ordered online and due to the team being located on an island, shipping times increase drastically. And the cost of Teflon (PTFE) was going to be approximately $15.06 per Kilogram and would also need to be ordered. Because of these deciding factors, the frame would be constructed with PVC.

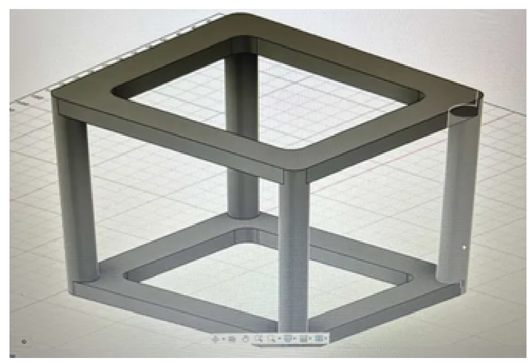

Figure 4: ROV frame in Fusion 360, Priyanshu Gunput 2025

Table 1: Decision Matrix for Frame Material, Priyanshu Gunput 2025

Material	Availability	Cost (CAD)
PVC	Local	$4.99/m
HDPE	Order Online	$115/m
PTFE	Order Online	$15.06/kg*

*Cost of material was measured by weight

Thrusters

Thrusters were another components that was evaluated in a decision matrix. Multiple options were considered. The T200 was valued at $307.35 per thruster. The ApisQueen U2 Mini was valued at $44.69. The DIAMONDDYNAMICS was valued at $108.19. Cost was a big deciding factor for the thrusters due to the company's budget as well as having spare thrusters in the event a replacement was needed during the testing stages. The price of the ApisQueen U2 Mini allowed for spares without affecting our budget significantly. Thrust was also an important factor to make certain that Tsunami was able to retrieve objects and return to the surface, for example, the mission task that requires the ROV to retrieve a sacrificial anode and then to replace it. Due to the Apisqueen U2 Mini having more thrust (1.3 kg) than the other two thrusters (1.2 kg) which made them a suitable choice. *Table 2* below was used to aid in the selection process.

Table 2: Decision Matrix for Thrusters, Abbey Bryden 2025

Thruster	Thrust	Availability	Cost (CAD)
T200 Thruster	1.2 kg	Order Online	$307.35
ApisQueen U2 Mini	1.3 kg	Order Online	$44.69
DIAMONDDYNAMICS Thrust	1.2 kg	Order Online	$108.19

2.3 Vehicle Systems

Pneumatics Systems

Western Wave's pneumatic system is crucial to Tsunami's operation. It provides compressed air to the claw and allows it to open and close. The main components for the pneumatics system are located in the topside control box. The system features a pressure release valve, emergency shut-off valve, and a pressure regulator which is set to 40 psi. It is connected to two tubes, 3.175mm and 6.35 mm diameters, rated at 800 kPa. The tubes run through the three stage switch rated at 793 kPa (115psi) to the tether, which connects to the double-acting cylinder rated at 1000 kPa (145 psi)

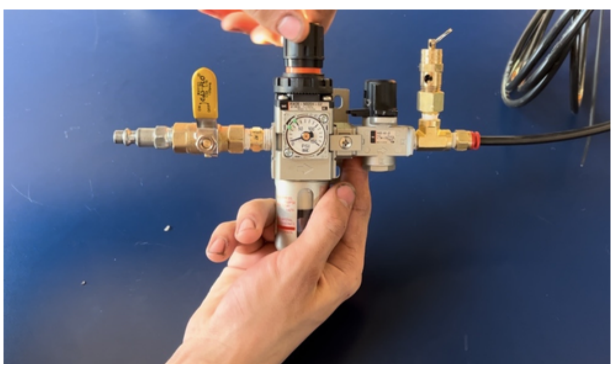

Figure 5: Pressure release valve, shut-off valve, and pressure regulator, Evan Scott 2025

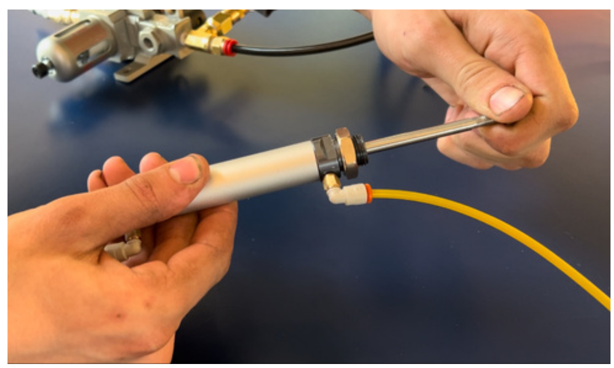

Figure 6: Double-acting cylinder, Evan Scott 2025

Electrical Systems

All electrical wiring going to Tsunami is powered by a 12-volt direct current (DC) power supply connected using Anderson power pole connectors. The foundation of electrical system is the main power board which is connected through the tether. all detailed System Integrated Diagrams (SID) can be found in Appendix A of the document.

Control System

Rather than developing a propriety control system, the control system for Tsunami consists of an Xbox controller which uses the joysticks to maneuver horizontally and vertically. The controller can be connected to any laptop which runs the code written by the electrical engineering team. For the pneumatic system that powers the claw, a 3-stage lever is used to open and close and is connected to the air compressor. Both camera displays are on two monitors provided with the cameras.

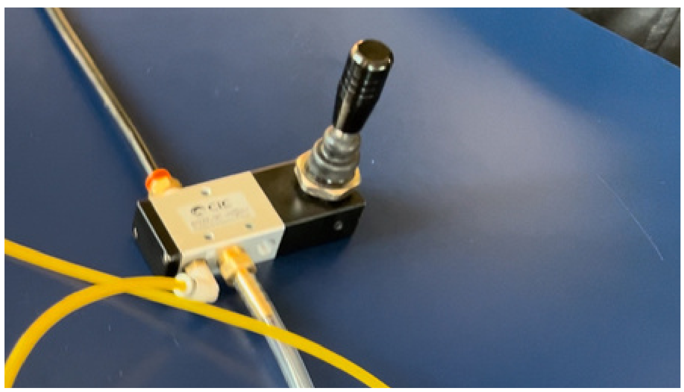

Figure 7: 3-stage lever for pneumatics, Evan Scott 2025

Propulsion

The propulsion system of Tsunami consists of six Apisqueen U2 Mini thrusters. These thrusters were chosen due to their budget-friendly cost. They are light weight, brushless motors with 1.3 kg thrust. Two thrusters were placed vertically in the middle of the ROV and the remaining four were placed at 45 degree angles at the corners. This configuration allows Tsunami to move vertically, horizontally, and sway. The motor mounts were 3D printed rather than bought.

Figure 8: Apisqueen U2 Mini, 2025

Buoyancy

Tsunami is neutrally buoyant in water. During initial tests, the team figured out that the ROV was slightly negatively buoyant. To increase buoyancy, high density foam was added to the top sides of the ROV. This helps with completing simpler tasks that do not require heavy objects to be brought to the surface. As for lifting heavier props, such as the sacrificial anode, a 16.0cm x 16.0cm "backpack" made of high density foam can be added to add additional buoyancy to the ROV.

2.4 Payloads and Tools

Camera

Western Wave repurposed underwater ice fishing cameras for Tsunami's camera system. Costing $78.19 CAD each, two cameras were installed on the front and back of the ROV. The camera mounts were 3D printed and engineered to simply mount the cameras to the ROV.

Figure 9: Tsunami's camera, Corbin Rideout 2025

Claw

Originally, Western Wave decided that a hook would be sufficient for the mission tasks. A hook would allow for a simple design that would not require any additional wiring or electrical system. As flight practices continued, it was decided that a claw would be better applicable to meet the needs of the request proposal. The claw was designed in Fusion 360 and 3D printed in-house. The claw is shaped to interlock and grip items to effectively replace the sacrificial anode onto the base of an offshore wind farm.

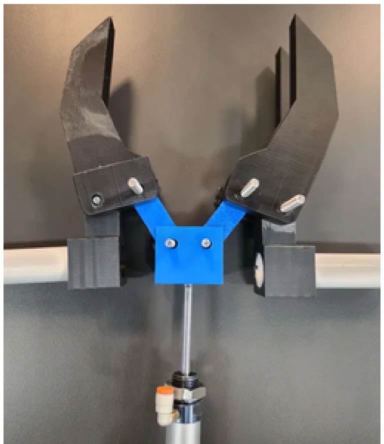

Figure 10: 3D printed claw, Priyanshu Gunput 25

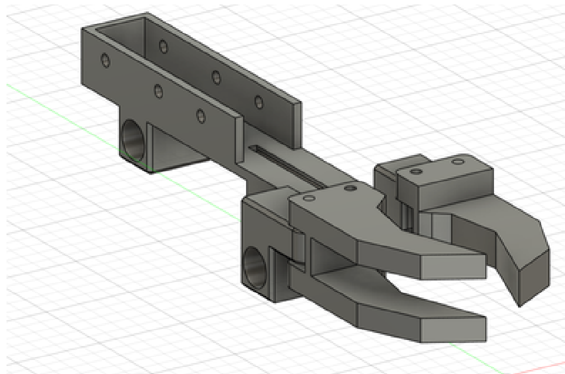

Figure 11: Rendering of claw, Priyanshu Gunput 2025

Jellyfish Catcher

One of the more difficult tasks is to retrieve the Medusa jellyfish, a tool was specifically designed to safely carry it. The tool is made using PVC, a 4 L measuring cup and electrical tape. As well as a 3d printed part that is attached to the PVC pipe that fits perfectly into the claw. It is also safe for the jellyfish as the claw is not directly holding the jellyfish, hurting it in the process.

Figure 12: Tool for medusa jellyfish, Corbin Rideout, 2025

Water Sampler

One of the tools that is required to for the mission tasks is a water sampler. The water sampler that the team has consist of two 100 ml syringes mounted to the side of ROV. One of the syringes is connected to another at the top which when closed opens the two syringes on the ROV, retrieving a water sample.

Figure 13: Tool for water samples, Priyanshu Gunput 2025

Build vs. Buy

Western Wave's goal was to construct an ROV that was high performance but also cost-effective. Build vs. buy were important considerations when purchasing the materials for Tsunami.

The PVC pipes used to construct the frame were repurposed rather than bought new from a hardware store, meeting the UN Sustainability goal of using ROV technology to address the challenges of climate change and foster a sustainable future. All of the thrusters on Tsunami are mounted by 3D printed motor mounts designed by Western Wave and printed in-house. The camera mounts and pneumatic claw were also designed and 3D printed locally. Tsunami's claw, is powered by a pneumatic system that was repurposed from one of the members as well as the Xbox controller used to pilot Tsunami was also repurposed by a member,

For the items that we did purchase new, research was done beforehand to ensure that the budget was being strictly followed.

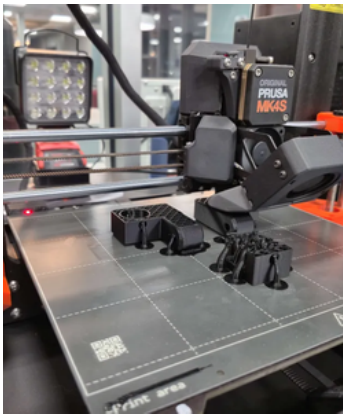

Figure 14: Printing parts for claw at CRI, Corbin Rideout 2025

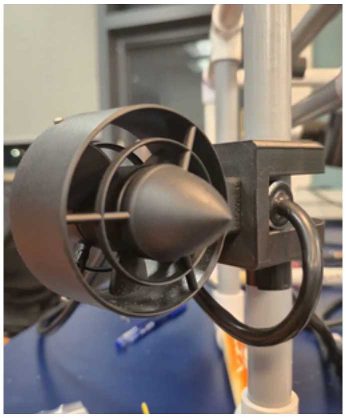

Figure 15: 3D printed motor mounts, Corbin Rideout 2025

3.0 ELECTRICAL

3.1 Electrical Systems

Overall System

The ROV's electrical systems consists of a laptop to send python code to the thrusters and an Xbox 360 controller to control the thruster movements using the joysticks, six thrusters, a transmitter for the cat6 Ethernet cable to transmit the python code to the receiver inside the enclosure. The code then gets sent through a USB type-c cable to the Arduino. The python code for the ROV is integrated through the pygame library and controller integration is sent through command prompt, to control the amount of input for the thrusters.

ROV Control Board

The onboard ROV control board consists of an Arduino which sends and receives lines of python code for the thrusters. The Arduino has a connected backboard which allows signal wires from the thrusters to connect with the systems.

Tether

The tether connects the top-side control system to Tsunami. Western Wave's tether is 15 meters and neutrally buoyant due to the pneumatic line that runs through it. It consists of one pair of 12 gauge copper wires, an ethernet cable, two camera lines, and a pneumatic line connecting to six motors and two cameras. The pneumatic lines have a diameter of 3.175 mm and 6.35 mm, which operate the claw. A protective covering keeps wiring and tubes safe from potential damage, and entanglements. Pool noodles are also placed 1 m apart to maintain a neutral buoyancy.

4.0 TESTING & TROUBLESHOOTING

Western Wave believes that testing and troubleshooting are crucial to creating a quality product. It is crucial that all components are tested prior to being put on the ROV. This helps to reduce the amount of troubleshooting and retesting needed to happen during valuable meeting and practice times.

Before the electrical systems were integrated on the Tsunami, the enclosure was tested to ensure it was water proof and no damage from water exposure could happen. The initial test revealed a leak. The team discovered that the seal on the enclosure was made out of foam, which could not hold up while fully submerged in water. The mechanical design team solved this issue buy sealing the enclosure with silicone. After this repair was completed and retested, it was confirmed that the enclosure was now fully waterproof.

Techniques that Western Wave used for troubleshooting:

- Check the connections and ensure that all cables and connectors are properly connected
- Test each component individually to isolate the problem, this reduces time spent troubleshooting
- Inspect the ROV for any physical damages
- Use diagnostic tools like a multimeter to check the voltage of electrical components
- Seek help from professional who are able to provide guidance

5.0 SAFETY

Safety is a top priority at Western Wave . All of our employees must follow company safety procedures to make sure nobody gets hurt. These procedures are reviewed at the beginning of meetings and prior to any tasks where there are safety risks. To ensure safety, employees must secure long hair, pull back sleeves, and wear personal protection equipment (PPE) when necessary. Supervision is required and no employee is allowed to operate equipment without a mentor present. It is also a company requirement that all employees who are operating equipment must be Workplace Hazardous Materials Information System (WHMIS) certified. Employees are encouraged to ask questions and speak up about any concerns about safety and procedures to promote a safe work environment for all. If there are any concerns, they are notified to the CEO and mentor(s).

Table 3: Checklist for PPE, Abbey Bryden 2025

PPE	Applicability
Eye Protection (i.e safety glasses)	Working in an area that involves particles, flying objects, or dust.
Hand Protection (i.e gloves)	Whenever there's a potential for hand or arm contact with energized parts
Ear Protection (i.e ear plugs)	Exposure to sounds above 85 dB

Along with company safety procedures, Tsunami was designed with safety as a top priority. The safety features include rounded edges on all parts of the ROV to prevent any injuries. For example, there were screws projecting from the ROVs electronic enclosure, this problem was solved by applying silicone over the screws to eliminate the sharp edges. A water proofed electronics enclosure keeps all electrical components sealed. Thrusters are waterproofed and shrouds are up to IP-20 standards. The tether is secured with top-side and bottom-side strain relief to prevent any strain.

To prevent any damage to the electrical components of Tsunami, Western Wave made sure all connecting wires are soldered. Company members also made sure that there are no exposed copper wires anywhere The 25 amp fuse placed within 30 cm of the positive end of the power supply ensures that there is no possibility power surge. While using Tsunami, no electrical components come into contact with water, and the Tether Manager keeps the tether from dragging on the ground.

Figure 16: Lead Electrical Engineer soldering wires, John Nsionu 2025

Figure 17: 25A Fuse, Abbey Bryden 2025

6.0 ACCOUNTING

6.1 Budget

Our budget was created during the preliminary stages of the project and kept into consideration throughout our design process and construction of Tsunami. A large portion of our budget was allocated for team travel due to being located in Newfoundland and Labrador, Canada. Our budget also consisted of construction materials for the ROV, materials & tools, and administration costs. Totaling our costs together, this made our budget $22,359.83 USD. See *Table 4* below for our itemized budget.

Table 4: Western Wave Budget (USD)

Western Wave Budget 2025 (USD)	
Item	**Cost**
ROV Construction	$3,606.42
Tools & Materials	$1,442.57
Administration	$1,081.93
Flights	$5,770.28
Accomodations	$8,655.42
Ground Travel	$1,803.21
TOTAL	$22,359.83

6.2 Cost Accounting

Table 5: Expenses, Abbey Bryden 2025

Western Wave Expenses 2025			
	Vendor	Date	Expenses (USD)
QTY 8 U2 Mini Thrusters	Underwaterthruster.com	2025-02-05	$ 378.59
PVC Fittings	Amazon	2025-02-18	$ 40.09
Camera	Amazon	2025-02-04	$ 56.79
Arduino Prototyping Kits	Amazon	2025-02-04	$ 52.03
Various ROV Components	Amazon	2025-02-18	$ 344.86
Duties for Thrusters	UPS	2025-02-19	$ 14.52
Cable Penetrators	Blue Robotics	2025-02-19	$ 156.77
Duties for Blue Robotics	UPS	2025-04-09	$ 55.63
10 ' of 1/5 inch pipe	Guillevin's	2025-03-17	$ 9.42
Electrical Tape, pegs, magnet	Canadian tire	2025-03-17	$ 13.21
Misc. Electrical components	Amazon	2025-03-19	$ 49.88
Misc. Electrical components	Amazon	2025-03-19	$ 55.13
Tote	Walmart	2025-03-17	$ 12.38
Calliper, Zips, Pliers	Canadian tire	2025-03-24	$ 28.91
New Penetrators	Blue Robotics	2025-04-01	$ 126.23
Duties for New Penetrators	DHL	2025-04-04	$ 19.55
Caliper (Exchanged)	Canadian tire	2025-04-07	$ 16.53
Hex keys, piston	Amazon	2025-04-08	$ 35.77
Marine Epoxy	Canadian Tire	2025-04-15	$ 12.39
New Larger Enclosure	Amazon	2025-04-18	$ 31.41
Regional Hotel 1	Holiday Inn St. John's	2025-05-03	$ 655.83
Regional Hotel 2	Holiday Inn St. John's	2025-05-03	$ 476.51
Regional Hotel 3	Holiday Inn St. John's	2025-05-03	$ 476.51
Regional Hotel 1 Adjustment	Holiday Inn St. John's	2025-05-12	-$ 70.75
QTY 3 U2 Mini Thrusters	Underwaterthruster.com	2025-05-12	$ 149.48
QTY 1 U2 Mini Thruster	Underwaterthruster.com	2025-03-12	$ 57.37
Spare Fuses	Canadian Tire	2025-05-12	$ 4.95
Gas Corner Brook	Ultramar	2025-05-01	$ 37.95
Gas Gander	Irving	2025-05-01	$ 48.43
Gas St. John's	Esso	2025-05-02	$ 21.57
Gas St. John's	Costco	2025-05-04	$ 46.40
Gas Gander	Irving	2025-05-04	$ 52.11
Rubber Self-Adhesive	Hancocks Woodwork	2025-05-07	$ 10.74
Caulking Sealant	Hancocks Woodwork	2025-05-10	$ 9.91
Caulking Sealant	Hancocks Woodwork	2025-05-09	$ 4.95
AIr Compressor + fittings	Princess Auto	2025-05-01	$ 271.51
Air fittings	Industrial Sales & Service	2025-05-13	$ 19.38
Gas Clarenville	North Atlantic	2025-04-30	$ 23.98
Gas St. John's	North Atlantic	2025-05-04	$ 32.08
Gas Gander	North Atlantic	2025-05-04	$ 31.98
Gas Deer Lake	North Atlantic	2025-05-04	$ 28.74
Team Registration	MATE	2025-05-12	$ 550.00
		Total Expenses (USD)	$ 4,449.72

7.0 ACKNOWLEDGMENTS

Western Wave would like to thank all of the organizations who supported our project. Thank you to MATE II and their sponsors for allowing us to have an opportunity to gain experience in project management, collaboration, mechanical design, and electronics. We would also like to thank Memorial University, College of the North Atlantic (CNA), Bryden & Associates CPA, Centre for Research & Innovation (CRI), and Navigate for sponsoring our team. A big thank you to Holiday Inn Express Deer Lake and Greenwood Inn & Suites in Corner Brook for providing us pool access to test and practice operating the ROV. As a first year team, we had to build the foundations and connections in our community to ensure Western Wave can continue to build and grow as a team for future students.

8.0 REFERENCES

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9.0 APPENDICES

9.1 Appendix A

Electrical System Integration Diagram (SID) displaying top-side and underwater components.

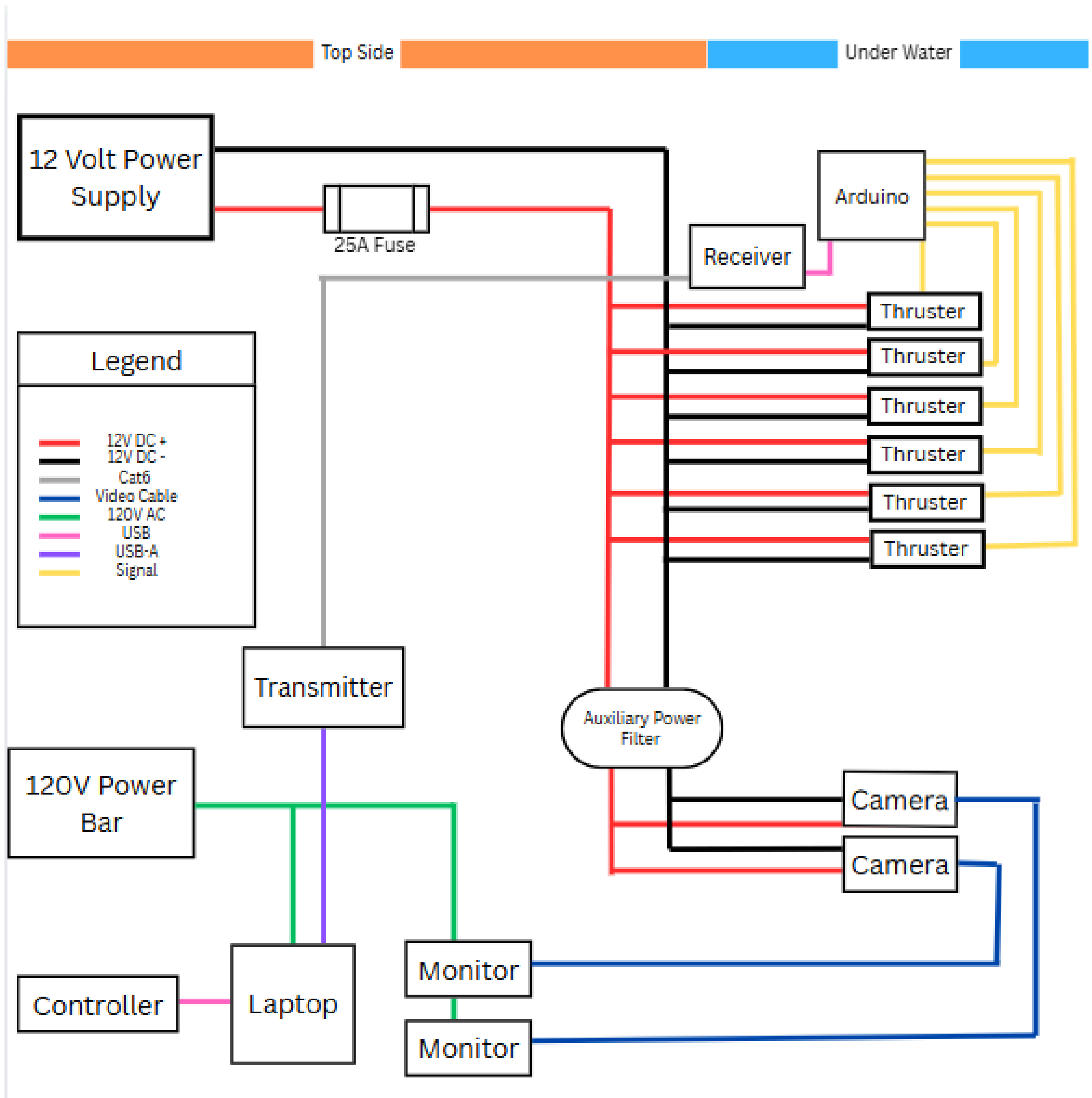

Figure 18: System Integration Diagram, Lucas Buckle 2025

System Integration Diagram of the pneumatic system used to power the claw for the ROV.

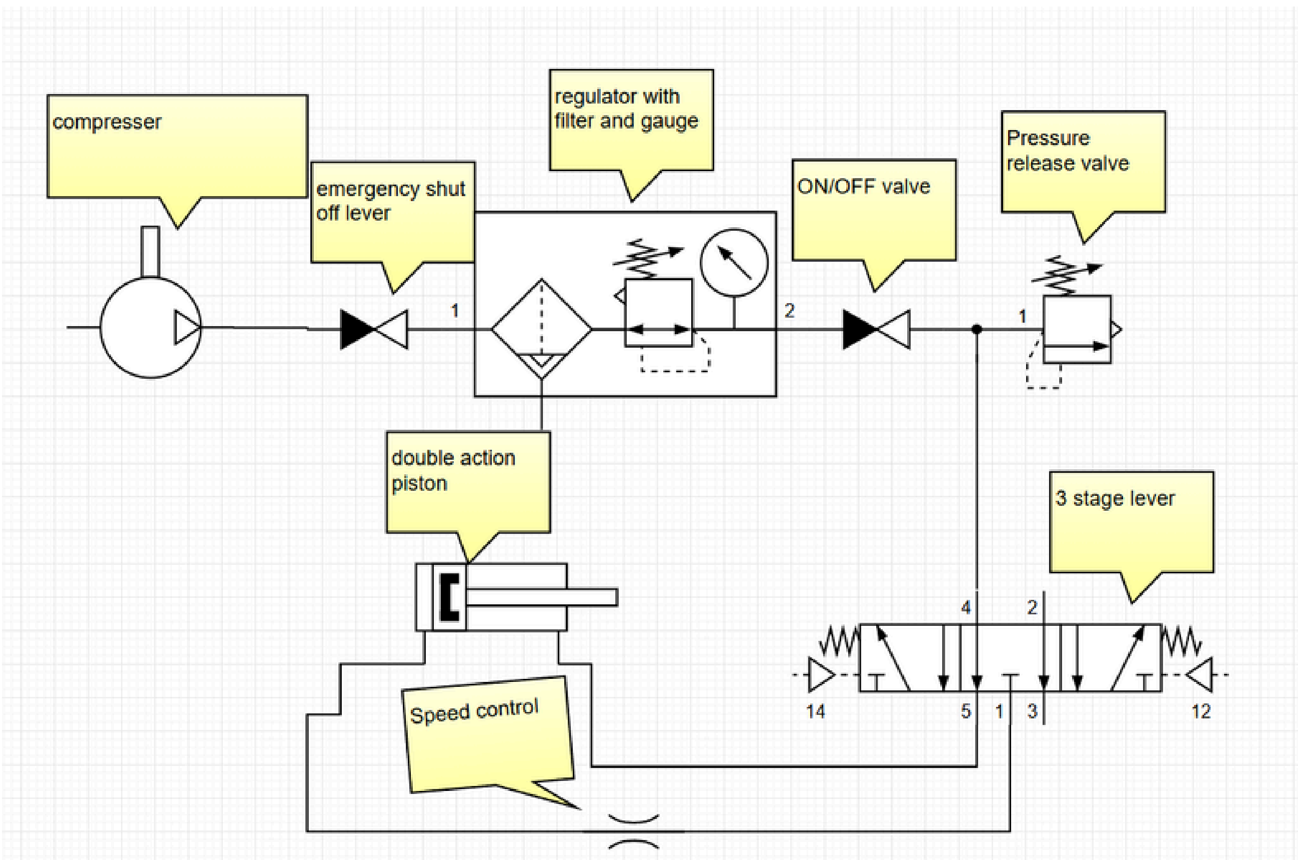

Figure 19: System Integration Diagram for pneumatics, Evan Scott 2025