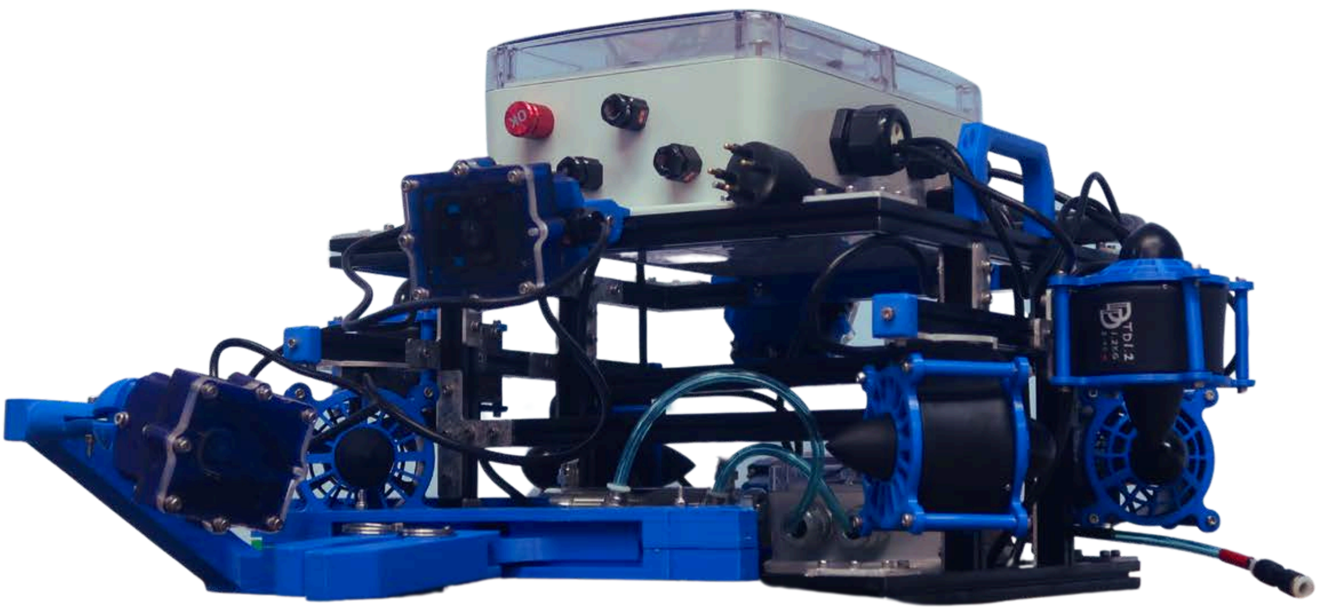
TECHNICAL DOCUMENTATION 2025

GENESEAS

ST. FRANCIS HIGH SCHOOL
SACRAMENTO, CA USA



EXECUTIVE LEADERSHIP TEAM:
KINNERA TIRUMALA '25 (CEO)
ALYSSA RENOMERON '25 (SOFTWARE)
YOGJA SINGLA '26 (MECHANICAL)

MECHANICAL:
ISABELLA RAMOS '25 (LEAD)
KATIE KOO '27
MINNA BRINDLE '27

ELECTRICAL:
LAILA SHAMSHAD '26 (LEAD)
DAR EUGENIO '25

SOFTWARE:
GABBY ROSARIO '25 (LEAD)
SONA PRASAD '26
ANGELYN GONZALES '27

TOOLS:
AZUL KUPPERMAN '25 (LEAD)
ELIZA YEE '25
GRACE CHAVEZ '25
KATE HWANG '27

COACHES:
MARCUS GRINDSTAFF
SIENA MAROIS
KITARA CRAIN
DEAN EUGENIO
MAURICE VELANDIA
GORDON SYLIN

TABLE OF CONTENTS

01 ABSTRACT

Geneseas is an underwater robotics company based in Sacramento, California. Composed of 15 highly-skilled female engineers, *Geneseas* creates advanced technology to solve complex global issues and restore ocean health.

Andromeda, *Geneseas'* sixth-generation ROV, is our newest and most technically advanced product. Andromeda was engineered through meticulous planning, prototyping, testing, and analysis, resulting in a custom-built ROV that is tailored to meet the United Nations Sustainable Development Goals (UN SDG), and complete the challenges outlined in the 2025 Marine Advanced Technology Educate (MATE) Request for Proposal (RFP). Andromeda's advancements include the addition of custom camera USB hubs, a dynamic vision system with measurement and modeling, plus streamlined electronics for enhanced reliability, usability, and mission efficiency. Effortless control. Reliable performance.

This technical document details Andromeda's design and development process, and ROV capabilities. Andromeda's methodically engineered features allow it to support ocean biodiversity by identifying shipwrecks, replacing sacrificial anodes, managing jellyfish on offshore farms, and collecting data to monitor ocean health.

FIGURE 1. *GENESEAS* TEAM PHOTO

02 TEAMWORK & PROJECT MANAGEMENT

A. COMPANY PROFILE

Geneseas is a seven-year-old company located in Sacramento, California, that designs submersible robots to tackle climate change and its impact on marine ecosystems. The company's all-female workforce of 15 engineers is organized into five departments: mechanical, electrical, software, cameras, and tool development. These departments provide hands-on experience in programming, soldering, circuit board making, and computer-aided design (CAD).

Geneseas operates with a two-tier leadership structure consisting of the Functional Leadership Team (FLT) and the Executive Leadership Team (ELT). FLT leaders mentor and oversee departments, supporting employees and progress, while ELT drives overall program success. ELT and FLT form a unified leadership team to execute design reviews, oversee testing, and promote cross-department collaboration.

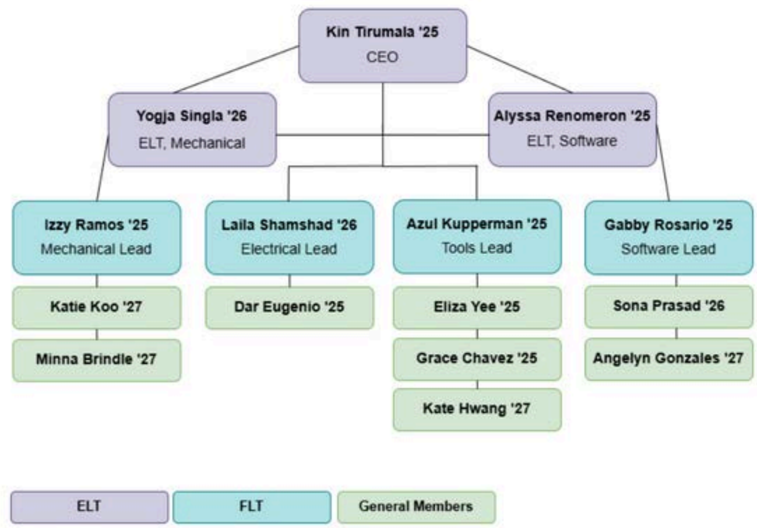


FIGURE 2. *GENESEAS* COMPANY ORG CHART

FIGURE 3. NEW MEMBERS PRESENTING THEIR ROV DURING MOCK COMPETITION

This year, *Geneseas* onboarded 18 new members who completed comprehensive training, concluding with a mock MATE Scout competition. They learned the ROV's five subsystems and gained skills in coding, computer aided design (CAD), and soldering while building teamwork and project management experience.

To support new members, *Geneseas* created a Navigator team, the Crocs, offering all 18 recruits opportunities to explore interests sparked during training. Guided by dedicated Navigator leaders and mentored by Ranger team members, the program builds engineering skills and curiosity while creating a pipeline of future *Geneseas* engineers to ensure team sustainability.

Geneseas' peer-to-peer and linear training system builds a solid foundation for long-term growth and success. This structure supports the efficient design, production, and iteration of innovative ROVs that protect global marine ecosystems while ensuring company sustainability.

B. PROJECT MANAGEMENT

Geneseas follows a comprehensive project management approach to effectively delegate department assignments and achieve key milestones. This system helps keep our objectives organized, on time, and on budget. Starting in September, the team met every Saturday to design, build, and test the ROV. In addition, the *Geneseas* leadership team meets for two hours every Tuesday to track progress, conduct design reviews, reallocate tasks, and refine plans for Saturday meetings. The ELT prepares and conducts a presentation with key daily objectives to kick off every Saturday meeting.

Using *Geneseas'* Project Management Tool (PMT), the leadership team creates project schedules at the beginning of every year. The PMT includes individual department timelines, meeting objectives, overall project deadlines, and links to other organizational tools. The team utilizes the PMT to assign and manage projects, set timelines, track progress, identify potential obstacles, and adjust the project plan. It ensured timely completion leading up to the initial in-pool test on December 7th and mission tools testing on February 22nd. Additionally, the team uses Google Workspace for meeting communications and file sharing, and Github for software updates and documentation.

The use of the PMT, weekly leadership meetings, and Saturday kick-off meetings facilitate the achievement of key design objectives and ensure structure in day-to-day operations.

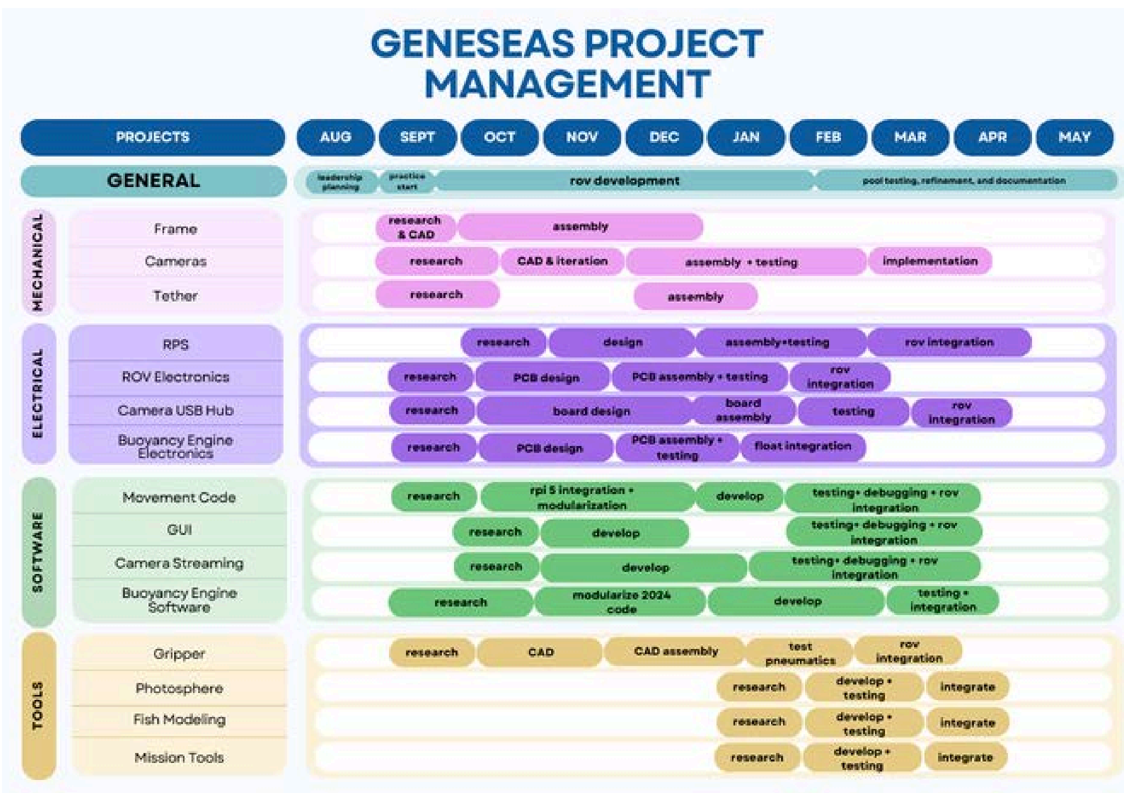


FIGURE 4. *GENESEAS* PROJECT MANAGEMENT GANTT CHART

03 DESIGN RATIONALE

Prior to beginning product development, *Geneseas'* leadership team met in August to create a comprehensive list of key design objectives for all components of our newest ROV, Andromeda.

Last year's design philosophy held an emphasis on customization, reliability, and serviceability. *Geneseas* further built off this philosophy with the addition of ease of operation in mind to produce a more user-friendly experience. *Geneseas'* has a new pilot this year, so improved ease of operation was essential to minimize the time required for our new pilot to learn how to efficiently and safely operate the ROV. These primary goals enable Andromeda to provide effortless control to pilot with confidence.

The leadership team then aimed to translate these goals into specific modifications that are outlined in the 2025 Design Decision Matrix (Figure 5):

2025 Key Design Objectives	Reliability	Serviceability	Ease of Operation	Plan for Implementation
Accurate measurement capabilities	✓		✓	Addition of a Intel(r) RealSense stereoscopic camera
Increase camera capacity and streaming quality, reduce lag	✓		✓	Designing a custom USB Hub and upgrade from Raspberry Pi 4 to 5
Ability to send more data packets efficiently	✓		✓	Adding additional Powerline Communication Wires through the tether
Reduce pinch points on ROV tools			✓	Designing a cover for the gripper's gears and safety reviews of all tools
Improve electronics management and neat wire connections	✓	✓	✓	Incorporating a larger electronics housing and building a new Remote Processing System
Allow for more iteration prior to manufacturing; save raw materials; allow for digital preview of the ROV	✓			Extensive use of CAD for prototyping main ROV and tools
Increased customization abilities of vision system, improved durability and easy assembly		✓	✓	Custom designing adjustable ball and socket camera mounts
Enable adjustable buoyancy and increased hydrodynamic efficiency		✓	✓	Implementing an adjustable vertical thruster bar and smaller ROV frame

FIGURE 5. *GENESEAS* DESIGN DECISION MATRIX

Creating a design decision matrix allowed *Geneseas* to carefully evaluate the benefits of each design implementation before putting them into effect and seeing which changes aligned most with our goals for 2025.

3.1 DESIGN EVOLUTION

Company members evaluated *Geneseas'* previous robot, Atolla, to determine what major improvements were needed to more effectively fulfill MATE's RFP. The most important goals were streamlining electronics systems, improving communication abilities, and maximizing camera efficiency.

The goal of constructing a more streamlined electronics system was met by replacing the previous electronics housing on the ROV with a larger one. This allowed for an orderly layout of electrical components, which also reduced the risk of short circuits and increased serviceability. Communication was improved by running two dedicated powerline communication wires through the power allowed for data to be sent more reliably.

Andromeda's camera system was made more efficient by the design of a custom camera USB hub. This allowed *Geneseas* to increase camera capacity from four cameras to eight. *Geneseas* also expanded the vision system by equipping Andromeda with an additional RealSense stereoscopic camera. Our streamlined electronics system, enhanced communication abilities, and improved vision system delivers safe and serviceable ROV systems without compromising efficiency.

A. *GENESEAS* DESIGN METHODOLOGY

Geneseas' design methodology (Figure 6) is rooted in rapid prototyping, iteration, rigorous testing, and cross-team collaboration to ensure successful ROV production and advancement. Throughout the design process, employees developed multiple prototypes, conducted design reviews, and performed iterative modifications to ensure our objectives were met and exceeded.

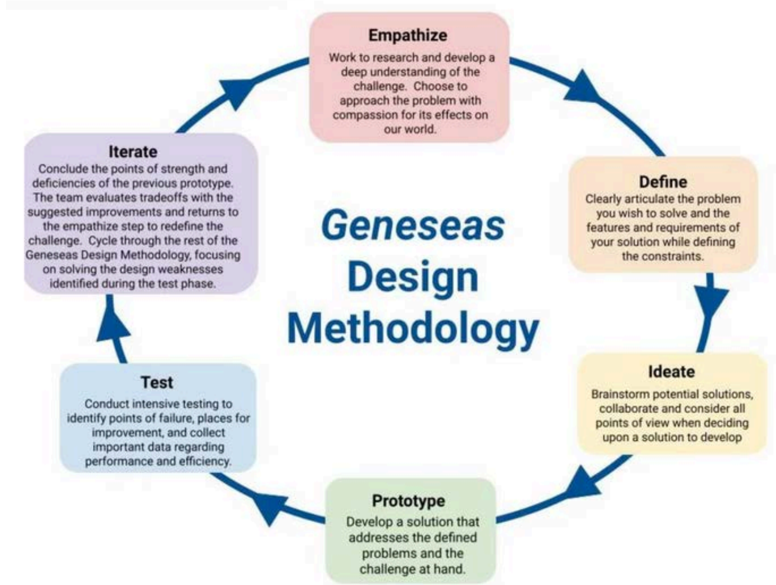


FIGURE 6. *GENESEAS* DESIGN METHODOLOGY

Peer reviews, pilot feedback, and overall ROV efficiency are especially considered during *Geneseas'* design processes. The leadership team meets weekly to review design progress and exchange feedback regarding all components of the ROV. During these meetings the team determines necessary improvements and strategies for developing the next iterations. Design feedback from all members are welcomed and considered. This collaborative approach delivers a highly specialized ROV, engineered to solve mission tasks highlighted in MATE's RFP, all while meeting the key design objectives of serviceability and ease of operation.

The success of *Geneseas'* design methodology is founded on understanding the problem at hand. Company members thoroughly research and understand the issues impacting global aquatic ecosystems, such as global warming and lake acidification. By understanding the strains present on marine life, employees are able to effectively identify the problem, parameters, and constraints of the task at hand before the first stage in the design process, where employees collaborate to find solutions.

3.2 VEHICLE STRUCTURE AND SYSTEMS

A. FRAME

Geneseas introduced a notable change to Andromeda's frame by decreasing its length by 17 mm, its width by 6 mm, and its depth by 50 mm from last year's design. This allows for easy transportation, enhanced maneuverability, and improved speed in the water. The ROV features adjustable thruster placement that aligns the centers of thrust and buoyancy closer to the ROV's core, offering our pilot increased underwater stability. This improvement results in a hydrodynamic product that is more serviceable and efficient, allowing for smooth operation in marine environments.

Geneseas redesigned Andromeda's frame by reducing its size to fit in a carry-on suitcase with minimal disassembly, facilitating easier transportation. Additionally, this size change allows for better maneuverability and increased speed underwater. Adjustable thruster placement aligns thrust and buoyancy centers for greater underwater stability, resulting in a more hydrodynamic, efficient, and serviceable ROV.

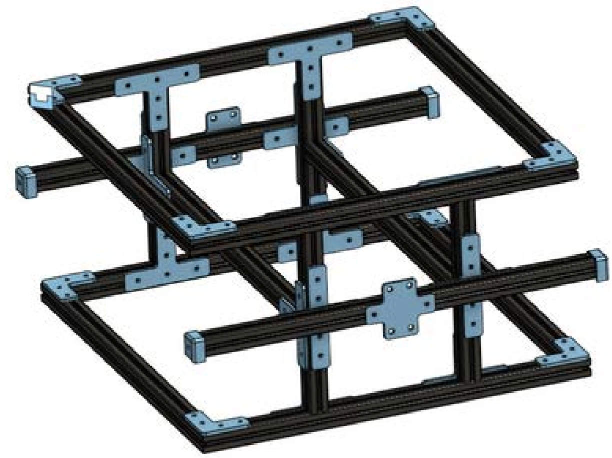


FIGURE 7. ANDROMEDA'S FRAME

The rectangular frame measures 305 x 305 x 203 mm and is built from 15 x 15 mm extruded aluminum T-slot rails with channels for easy attachment of tools, cameras, and thrusters. Custom L-, T-, and cross-shaped brackets join the rails.

Geneseas used Onshape's CAD software to design and improve the frame before manufacturing. This allowed for the significant decrease of the frame size and the strategic placement of the upsized electronics housing, six thrusters, six cameras, two grippers, and tools.

Andromeda's frame is meticulously designed with safety as a top priority. It features four custom 3D-printed polycarbonate end caps that cover the cut edges of the aluminum, protecting employees during operation and maintenance. Two durable polycarbonate handles mounted on top allow for easy retrieval, placement, and transport of the ROV.

B. ELECTRONICS HOUSING

Andromeda features an upgraded Polycase electronics housing designed for durability with minimal risk of corrosion or leaks. This year, the depth was increased by 25.4mm for improved wire management and accessibility.

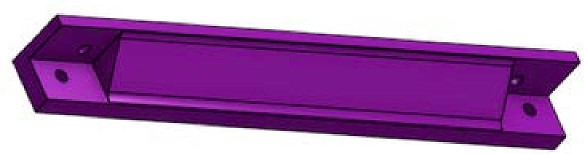


FIGURE 8. ELECTRONICS HOUSING MOUNT CAD

The larger size increased pressure on the housing when submerged, causing lid distortion. To solve this, *Geneseas* 3D-printed a supportive arch structure integrated with custom mounts that organizes electrical components, reduces wire strain, and improves serviceability.

C. PROPULSION

Geneseas retained Andromeda's six-thruster configuration from previous years, using reliable, cost-effective Diamond Dynamics thrusters with new design enhancements. Three thruster pairs rotate in opposite directions to prevent counteracting forces.

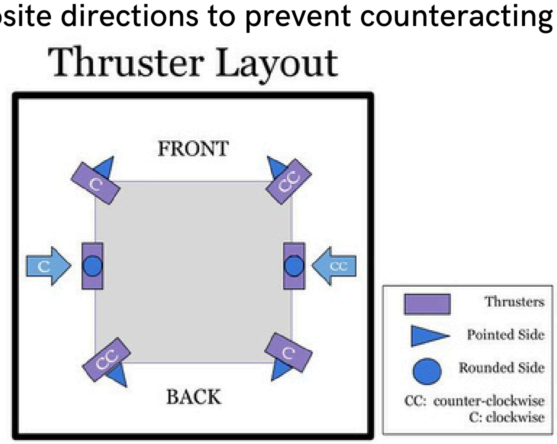


FIGURE 9. THRUSTER DIAGRAM

Four horizontal thrusters enable smooth lateral movement and rotation. They are mounted in pairs at each end of two adjustable bars for precise placement and improved stability. Two vertical thrusters are centered on each bar for efficient vertical motion.

The adjustable system aligns the center of thrust, minimizing pitch and roll for greater stability. The thrusters are angled at 45° to divert thrust away from the electronics housing, enhancing hydrodynamic performance.

D. BUOYANCY AND BALLAST

In its final design, Andromeda is neutrally buoyant, providing optimal pilot ability. Initially, Andromeda's large electronics housing resulted in significant positive buoyancy as expected based on the initial calculations. In order to correct for this, *Geneseas* first made the ROV negatively buoyant by adding 2.26 kilograms of weight to the ROV. Utilizing a hanging scale, *Geneseas* was able to calculate how much weight needed to be removed to achieve neutral buoyancy. After initial testing, *Geneseas* removed 0.86 kilograms resulting in a net addition of 1.4 kilograms using using aluminum bars and achieving neutral buoyancy.

ROV Weight in Water	Added Weight	Net Buoyancy
+ 1.4 kg	2 x 0.7 kg brass bars = -1.4 kg	+ 1.4 - 1.4 = 0 kg

FIGURE 10. BUOYANCY CALCULATIONS

The tether can also impact buoyancy. To counter this, *Geneseas* added an adjustable buoyancy system using two water bottles attached along the length of the tether. The deck crew can adjust water levels in the bottles to fine-tune buoyancy, minimizing tether impact and improving ROV stability. This approach reflects *Geneseas'* practical and effective method for refining ROV buoyancy and optimizing Andromeda's performance in aquatic environments.

E. SUBMERSIBLE CONNECTORS

Andromeda's rectangular electronics housing features 13 submersible connectors across all four sides of the housing. (Figure 11)

Each of Andromeda's camera housings uses a WetLink penetrator to securely connect camera wiring to the electronics housing, ensuring leak prevention and reliable connections. The pneumatic solenoid housing features eight McMaster-Carr cord grips, allowing pneumatic lines to supply pressure to both grippers without additional connections as gripper count increases. These waterproof, serviceable cord grips connect directly to the two pneumatic lines in the tether.

Quantity	Type	Use
10	Wetlink Penetrators	Thrusters, Grippers, pH Sensor, Peristaltic Pump
2	4-Wire Connector	Cameras
1	Vacuum Plug	Pressure Testing
8	Mc-Master Carr Cord Grips	Pneumatics Housing

FIGURE 11. SUBMERSIBLE CONNECTORS CHART

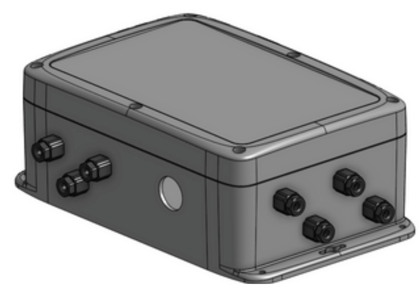


FIGURE 12. ELECTRONICS HOUSING CAD

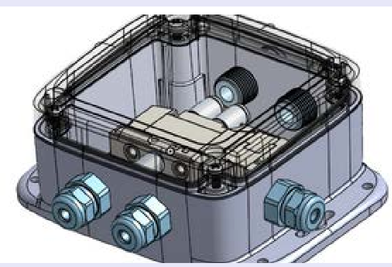


FIGURE 13. PNEUMATICS HOUSING CAD

Andromeda also includes a wet-mateable four-pin SubConn power connector that delivers power to the ROV. Combined with Anderson connectors, these components ensure safe storage, transport, and protection of RPS systems.

3.3 ELECTRICAL AND CONTROL SYSTEMS

A. ROV ELECTRONICS

Andromeda's electronics system (Figure 14) is designed for serviceability and reliability with a modular setup using four circuit boards: a custom Raspberry Pi Hat printed circuit board (PCB), a custom USB hub, a Raspberry Pi 5, and a Powerline Communications (PCB) Board.

Geneseas continued using powerline communications, enabling ethernet and TCP/IP through a single wet-mateable connector. This reduces the number of connections, eliminates corrosion of electrical connections, streamlines the RPS, and improves ROV handling and operation.

Andromeda's 3rd generation bottom-side Raspberry Pi Hat PCB (Figure 14) provides an updated layout for more streamlined wiring and features an added crystal for more precise PWM control. The PCB houses a thruster driver microcontroller, six solid-state relays for mission tools, a 12V to 5V converter, and screw terminals for thruster connections -- preventing shorts and enhancing serviceability. Capacitors protect against voltage spikes when thrusters engage. This compact board also supports future electronics expansion.

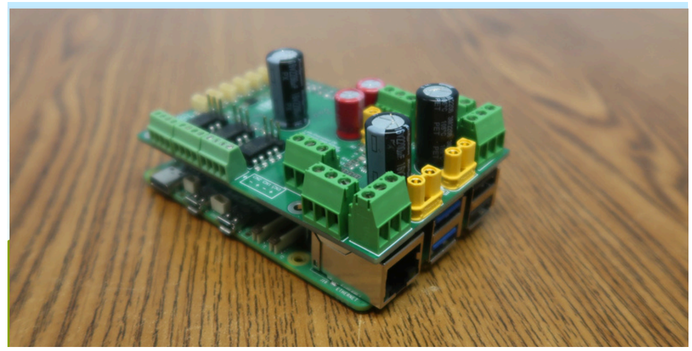


FIGURE 14. CUSTOM BOTTOM-SIDE PCB

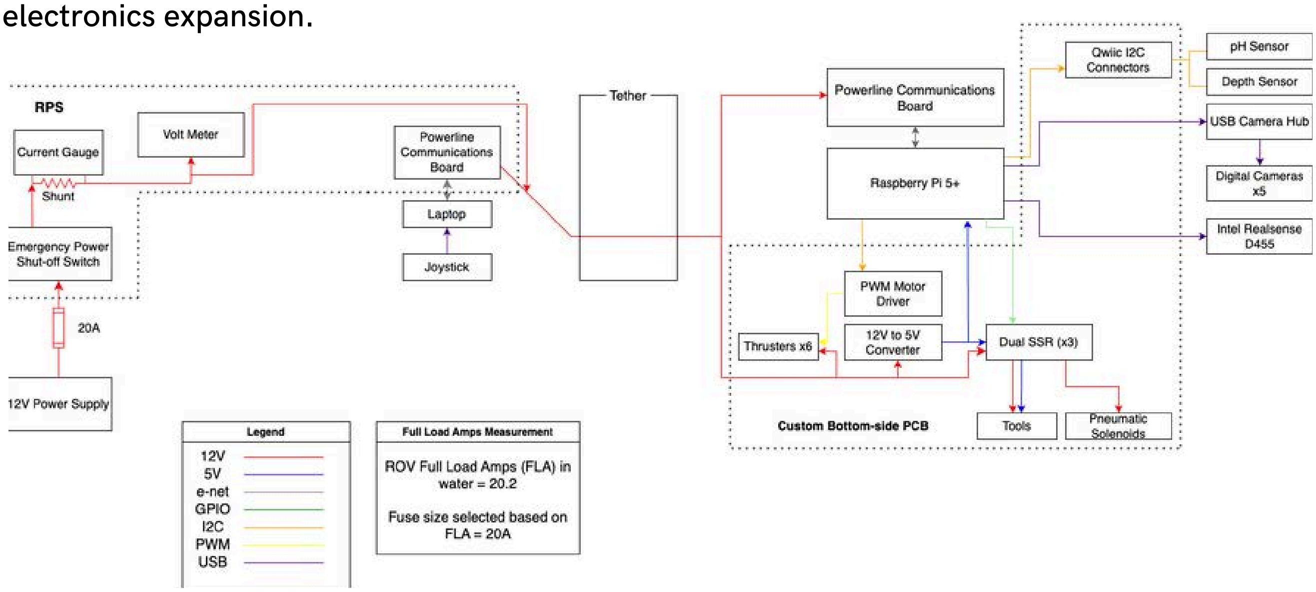


FIGURE 15. ELECTRONICS SID

B. CAMERA USB HUB

This year, Geneseas designed a new, custom USB hub to support eight cameras, simplify wiring, eliminate lag, and improve troubleshooting. Since the Raspberry Pi supports only four USB connections, the hub doubles the capacity and resolves last year's issues with camera lag and random failures that required full system restarts. Further, the screw terminal attachments for the downstream USB ports make wiring cameras easier and requires far less space than traditional USB connectors.

The custom hub includes GPIO controlled relays that allow individual cameras to be power cycled, eliminating the need to reboot the entire system. The hub significantly reduces debugging time, improving mission efficiency and serviceability.

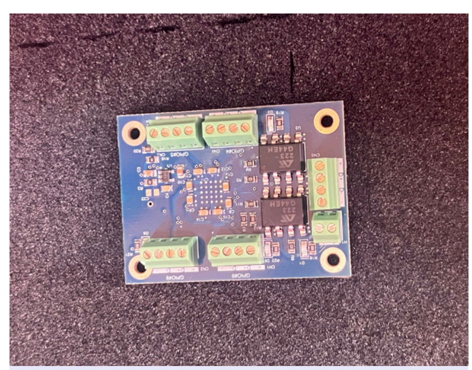


FIGURE 16. CAMERA USB HUB

C. RPS

Geneseas employees updated the Remote Piloting System (RPS) to streamline electronics, reducing its size by 39% to 22 cm by 30 cm—small enough to fit in a backpack. The team selected an enclosure that weighs only 2KG, resulting in a 36% reduction in weight. This significant reduction in size and weight allows for easier transport and faster setup at mission sites.

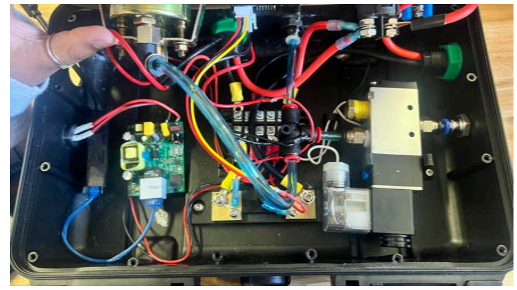


FIGURE 17. RPS ELECTRONICS

Further reducing complexity and increasing functionality, gripper controls were moved from dedicated buttons and are now available to the pilot on their joystick and the co-pilot via keyboard buttons.

Geneseas selected smaller components—including the pressure regulator, power switch, voltmeter, and ammeter to fit the downsized RPS box. The result is a streamlined, compact RPS that allows faster setup and easier operation.

After selecting the new box and components and developing a top-side SID, *Geneseas* designed the RPS structure and layout (Figure 17). Using Onshape CAD, the team created the top control panel, which was laser cut for assembly. By consolidating key components into a compact system, the deck crew can set up and operate the ROV efficiently.

D. TETHER

Andromeda's 15.24-meter tether consists of four 10-gauge silicone power lines—two for power, two for PLC—and two pneumatic lines for the grippers: one for pressure and one vent.

To accommodate the deeper competition pool, the tether was extended by 3 meters for improved reach and maneuverability.

The tether is protected by durable woven nylon sheathing with strain relief at both ends. Its bright, neon yellow color enhances visibility, protects against abrasion, and maintains flexibility.

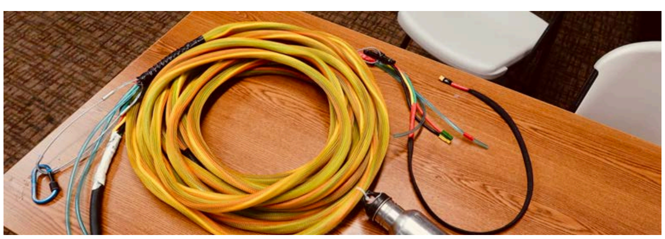


FIGURE 18. ANDROMEDA'S TETHER

Calculation Factors	2025 Tether	2024 Tether
Current	25 A	25 A
Wire	10 AWG	10 AWG
Wire length	50 ft	40 ft
Wire type	Stranded silicone power wire	
Resistance per feet	0.000999 Ω	0.000999 Ω
Resistance per side	0.04995 Ω	0.03996 Ω
Voltage drop on power side	1.24875 V	0.999 V
Voltage drop on return side	1.24875 V	0.999 V
Total Voltage Drop	2.4975 V	1.998 V
Voltage Difference ('25-'24)	0.4995 V	

FIGURE 19. VOLTAGE DROP CALCULATIONS

To maintain neutral buoyancy and prevent entanglement, two water bottles are attached. One empty bottle near the ROV provides positive buoyancy, keeping the tether trailing directly above the vehicle. Even with the tether extension, the voltage drop remains minimal at 2.5V, and the ROV receives over 9.5V to power all systems efficiently. The *Geneseas* tether manager is responsible for handling, maintaining, and storing the tether during missions. During setup, they uncoil the tether, connect it to the RPS and ROV — starting with strain relief — and manage slack as needed for smooth ROV movement. While in operation, the tether manager maintains contact with the tether, preventing sudden movements to ensure safety. After the mission, they retrieve the ROV, disconnect the tether, coil it properly, and store it securely in the tether bag.

E. TOP-SIDE AND BOTTOM-SIDE SOFTWARE

Andromeda's software, programmed in Python, enables seamless communication between the topside laptop and the ROV's bottom-side Raspberry Pi 5 — an upgrade from the Pi 4 for improved camera and network performance. The Pi 5's 2.4 GHz CPU eliminates previous camera lag and low streaming resolution.

The bottom-side software receives joystick and keyboard inputs from the topside laptop via TCP/IP to control thrusters and grippers.

Geneseas used PyQt5 to develop two camera GUIs and a GUI overlay for efficient operation. One GUI displays six live camera feeds, while the second allows switching between cameras. The overlay shows pH sensor data for saltwater testing and humidity readings from a newly added leak sensor, addressing prior water intrusion issues.

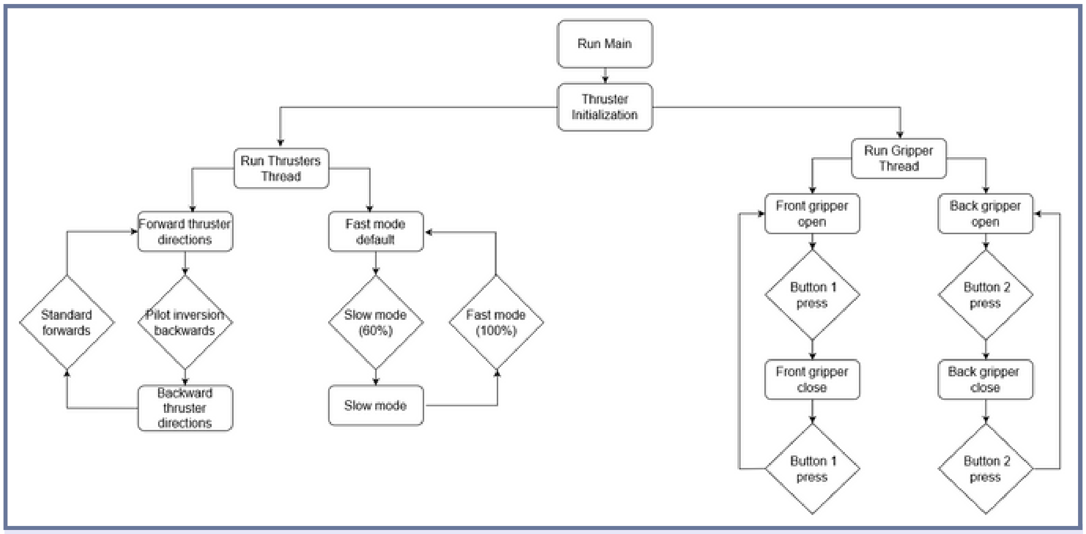


FIGURE 20. BOTTOM-SIDE SOFTWARE FLOWCHART

F. THRUSTERS

Andromeda's thrusters are designed for maximum stability and smooth operation. *Geneseas* integrated three communication types: joystick control, gripper functions, and camera streaming. Joystick inputs are processed by a Raspberry Pi 5, which applies a dead zone for neutral positioning and converts signals to PWM for the ESCs.

Features include fast and slow modes for precision, propeller inversion for counter-rotation, and adjustments for 45° thruster angles and asymmetric water resistance. Pilot inversion controls allow easier navigation when operating backward. *Geneseas* also added static and dynamic power limiting for stable voltage, consistent power, and integrated lateral thruster movement to support the side gripper.

The thruster management code is modular, with each processing step in separate functions operating on a thruster array. This design allows quick, low-risk adjustments—moving thrusters requires updating only the array to maintain proper performance.

Geneseas also integrated an Inertial Measurement Unit (IMU) for autonomous stabilization. The IMU records movement data, and the software uses accelerometer readings to calculate velocity and real-time position. This data powers PID controllers, enabling stable mid-water tasks and smoother navigation.

3.4 PAYLOAD AND TOOLS

A. DIGITAL CAMERA SYSTEM

Geneseas' Andromeda utilizes a fully digital camera system to relay a camera stream in real-time to the pilot. This highly optimized camera system is capable of relaying low-latency, high resolution footage from the robot directly to the topside system for pilot navigation and image processing.

The fourth-generation camera system improved upon the third generation's high serviceability. This year's cameras feature custom lenses, resin printed enclosures, and field replaceable wiring enabling all operators to quickly and safely repair vision.

Andromeda's digital field cameras, including the built-in MJPEG streaming software, provide low-latency video. At 800x600 resolution, the average video latency is 127 ms, and each fisheye camera provides a 170° field of view (FOV). Higher resolution, narrower FOV, camera rotation, focus, buffers and basic image adjustment can all be provided through command-line configuration options.

Andromeda is equipped with six digital cameras, each serving a specific function for mission tasks and navigation. A front-mounted navigation camera provides the pilot with a wide view of the mission area. Two rear cameras, mounted on the top and bottom bars at 0° and 45° angles, support navigation and capture a 360° photosphere of the surroundings. This setup enables pilot inversion, allowing controls to switch forward, reverse, or sideways via software for smooth handling in any direction.

Extended adjustable mounts hold two gripper cameras — one focused on the front gripper and the other on the side gripper — giving the pilot clear views during operations. *Geneseas* designed these custom-built mounts using a ball-and-socket joint, which allow the gripper cameras to be maneuvered in all directions. The socket extends out from the frame of the ROV and to the side of the gripper. The ball joint is then placed inside the socket, and can be adjusted to the pilot's preferred angle. A screw then tightens the grip of the socket around the ball joint, firmly holding the camera in place.

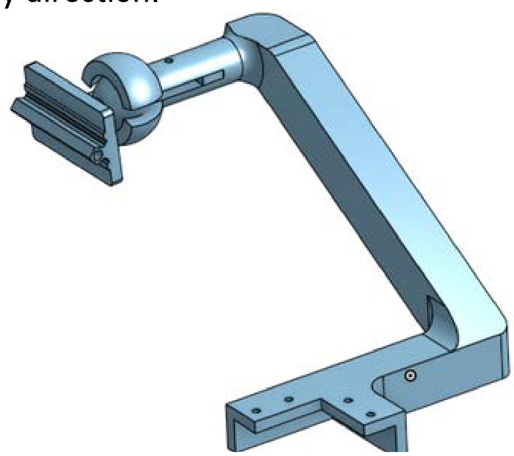


FIGURE 21. CAMERA MOUNT CAD

Geneseas also integrated an Intel RealSense camera mounted on the back of the ROV, providing precise measurements during missions. Chosen for its accuracy, high-resolution footage, and strong processing capabilities, the RealSense enhances mission performance.

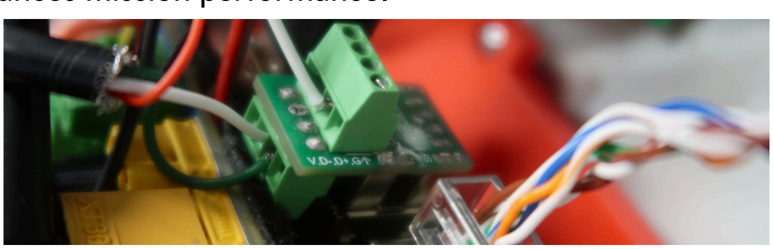


FIGURE 22. CAMERA USB BREAKOUT BOARD

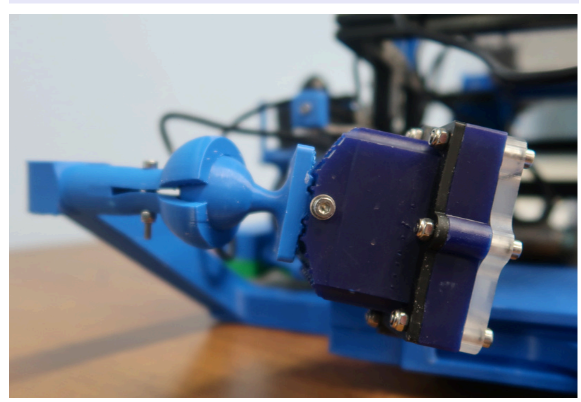


FIGURE 23. CAMERA MOUNT

All six of Andromeda's camera housings were custom-designed and resin-printed, creating waterproof, serviceable enclosures that minimize leakage risk. Each camera housing includes a WetLink penetrator to secure waterproof connections to the electronics housing.

B. GRIPPER

Andromeda features two pneumatically actuated, parallel jaw grippers that use rack and pinion systems for actuation: the front gripper and the side gripper. Both grippers were designed in Onshape CAD (Figures 26 and 28), and use 3D printed parts, allowing for several rapid prototypes enabling testing and iteration.

The front gripper (Figure 27) has two moving gripper jaws that converge in the center of the gripper. This gripper is used when it is optimal to align an object in the center between the gripper jaws. Both jaws move toward the center and grip the object. The front gripper consists of two linear racks acting as jaws on the same plane, operated by two gears acting as pinions.

The side gripper (Figure 29) has one static jaw and one moving jaw. This is ideal when the pilot needs to pick up an object without risk of moving the object. This gripper uses a single rack and pinion system, saving space on the side of the ROV.

Both grippers are fully shrouded to ensure there are no pinch-point in the rack and pinion system.

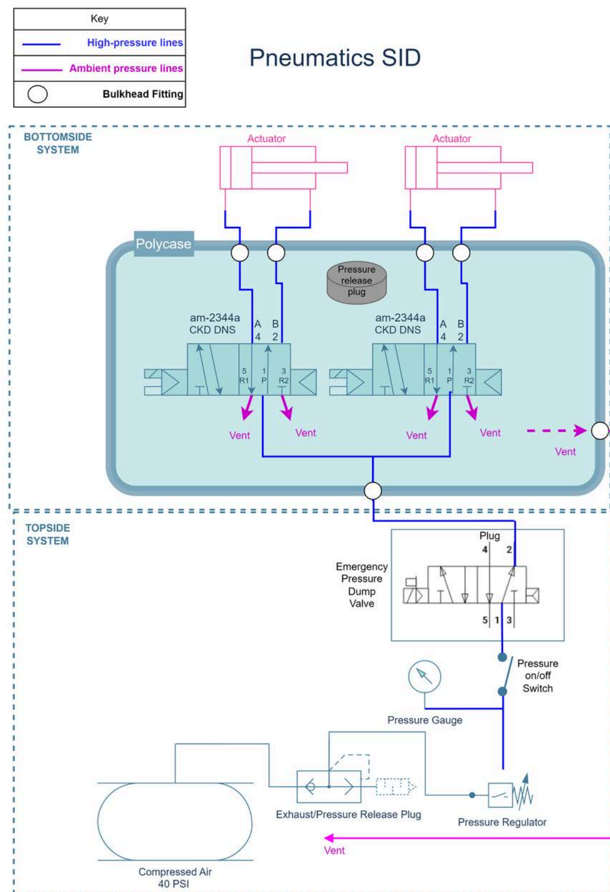


FIGURE 24. PNEUMATICS SID

Factor	Piston Type: Single Action	Piston Type: Dual Action	Factor	Solenoids Location: Topside	Solenoids Location: Bottomside
Size	Same	Same	Robot Weight	None added	Adds 45g per gripper
Rust	Likely to Rust	Not Likely to Rust	Rust	Will Not Rust	Rust if not enclosed
Cost	Initially Less $	Less $ Long Term	# Control Signals	0 in RPS	1 GND, 2 Control
# Pneumatics Lines	1 per piston	2 per piston	# Pneumatics Lines	2 per solenoid	1 down tether
End Decision	**Dual Action**		**End Decision**	**Bottomside**	

FIGURE 25. GRIPPER PARTS DECISION MATRIX

The grippers are actuated using dual-action pneumatic actuators connected to the pneumatic housing. Solenoids, controlled by signals from the Raspberry PI regulate airflow to each piston. The grippers also feature interchangeable jaws for mission-specific tasks and new pinch-free encasements for operator safety.

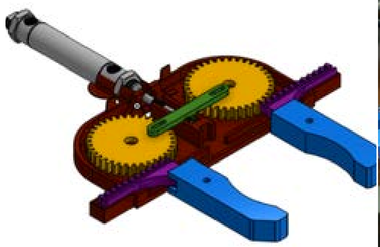


FIGURE 26.FRONT GRIPPER CAD

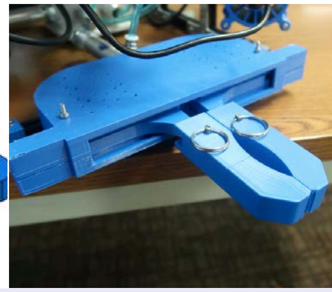


FIGURE 27.FRONT PRINTED GRIPPER

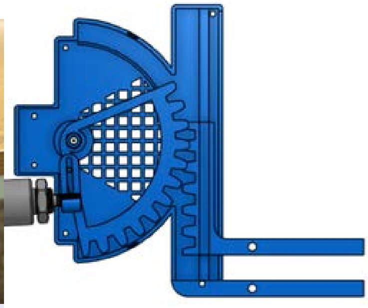


FIGURE 28.SIDE GRIPPER CAD

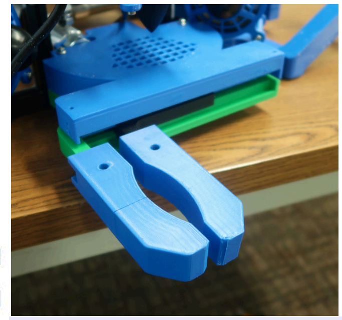


FIGURE 29.SIDE PRINTED GRIPPER

C. PHOTOSPHERE

Andromeda's photosphere tool develops a 360° photosphere image of the shipwreck area. The *Geneseas's* software team created a Python program to take screenshots of the shipwreck from two mission specific cameras. These cameras are mounted at the back on the top and bottom bars of Andromeda's frame. The top camera is mounted at a 45° angle and the bottom camera at a 0° angle to account for the top and bottom halves of the photosphere.

Once the pilot lands in the given photo area, the pilot slowly rotates and takes screenshots of the shipwreck area. Screenshots taken are processed into PTGui to make the initial photosphere image. The operation manager examines the 360° image and fixes discrepancies by adding additional control points for a seamless 360° photosphere. PTGui was chosen for its photo stitching capabilities, quick processing, and cost-effectiveness.

D. FISH MODELING

Geneseas utilizes a combination of Tkinter, PyQT5, and Python widget animation components to successfully record and animate data of carp movement throughout five regions in the course of ten years.

To complete this task, *Geneseas* coded a user-friendly table interface capable of recording carp data. *Geneseas* chose to input data in the form of a GUI widget table (Figure 30), visually similar to the form of the given data sheet, to enable seamless data entry.

After inputting all necessary data, the data is coded into a two-dimensional array and the user can immediately begin the animation through the click of a widget button. As the region data is processed into two-dimensional arrays, pixels of the region map are set to a color indicating the carp population's presence in a particular year.

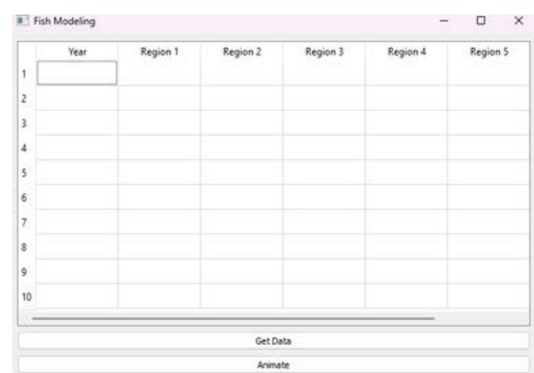


FIGURE 30. FISH MODELING GUI

E. PERISTALTIC PUMP/ PH SENSOR

The peristaltic pump (Figure 32) and pH sensor are part of a water quality test system. pH is measured in situ while dissolved CO2 is measured once the sample is recovered. A peristaltic pump was chosen to ensure the sample is fully isolated from the pump motor and mechanisms, eliminating the possibility of contamination. The pump consists of a flexible tube and rollers that displace water by squeezing and releasing pressure along the length of the tube. Andromeda's front gripper holds a pointed metal straw to puncture the plastic cling wrap. This straw is connected to the peristaltic pump using silicone tubing. The straw is surrounded by a 3D printed cone to align the straw with the ¾ inch coupling on top of the collection area.

Once the plastic cling wrap is punctured, the peristaltic pump is able to pump the water sample to a bottle connected to Andromeda. The pH sensor is inside of this collection bag. This efficient tool is able to quickly and accurately collect a water sample and measure the pH resulting in a manageable task for the pilot and can be installed and removed from the ROV with a single connector.

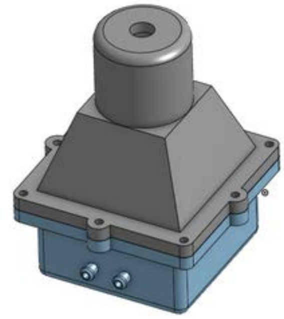


FIGURE 31. PERISTALTIC PUMP CAD

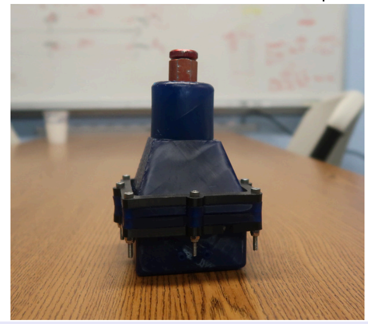


FIGURE 32. PRINTED PERISTALTIC PUMP ENCLOSURE

F. JELLYFISH COLLECTOR

Andromeda's jellyfish collector (Figure 33) is designed to retrieve and transport a medusa stage jelly while being submerged in water. The Geneseas mechanical team developed the tool in Onshape, testing multiple prototypes before finalizing the design. The tool is a gripper attachment with a bucket-like scoop, mounted at the end of the gripper for easy installation and removal. The initial prototype featured two bucket-like props, one on each half of the gripper, which would close around the jellyfish and lift it to the surface. However, this design struggled to retain enough water around the jellyfish when lifted out of the water. To solve this issue, the team created a second prototype with a single-bucket mechanism that scoops the jelly from below.

FIGURE 33. PRINTED JELLYFISH COLLECTOR

This design allows the ROV to maintain water around the jelly while bringing it to the surface. The tool consists of a square-based scoop measuring 150 mm by 150 mm, with a height of 55 cm and an infill depth of 3 mm. The gripper attachment is 83 mm by 26.5 mm and includes two 5.5 mm holes positioned 7.25 mm from the top for secure mounting. The attachment mechanism uses quick-release pins similar to those in adjustable tables or chairs, ensuring a stable and reliable connection between the gripper and the tool.

G. EPOXY PATCH TOOL

Geneseas' epoxy patch tool (Figure 35) is designed to assist the pilot in mitigating corrosion of the offshore wind farm by applying an underwater epoxy patch. Consisting of two textured gripper attachments with a flat, 50 mm by 60 mm board, the tool allows the ROV to securely grab the epoxy patch while keeping the material taut. Star-shaped holes allow water to pass through the tool to minimize water resistance and maximize ROV speed and efficiency. Once the upper velcro has been attached, the pilot can use the flat board to press the bottom of the epoxy patch onto the corroded area.

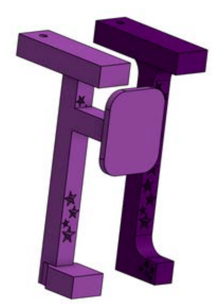


FIGURE 34. EPOXY PATCH TOOL CAD

FIGURE 35. PRINTED EPOXY PATCH TOOL

H. FISH COLLECTION TOOL

To collect fish species underneath the solar panel array, *Geneseas* designed a vertical scooping mechanism that easily attaches to the main gripper. It was 3D printed using durable polycarbonate and

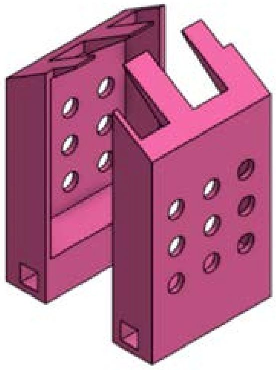


FIGURE 36.FISH COLLECTION TOOL CAD

FIGURE 37.HOOK CAD

features holes to allow water to pass through the tool and reduce drag. The tool protrudes 15 cm up from the gripper to allow easy access to the fish species. When the gripper closes, two compartments are able to fully capture up to four fish at once, allowing for secure retrieval to the surface.

I. HOOK TOOL

In order to collect polyp stage jellies from midwater, *Geneseas* created the hook tool (Figure 37). The hook was designed using the CAD software, Onshape, and was 3D printed using polycarbonate material. It is 7.5 cm tall and easily attaches and detaches from the gripper. The hook was made with ultimate precision in mind to allow the pilot to grab multiple jellies at once. *Geneseas* employees tested and designed multiple iterations of the tool to provide the most effective results.

04 BUOYANCY ENGINE

FIGURE 38. COMPLETED FLOAT

Geneseas' updated vertical profiling float, Asteria, uses a buoyancy engine and depth sensor to autonomously perform depth-controlled vertical profiles, collect data, and output results. This year's float retains the Raspberry Pi Zero and wifi based web-page control system while upgrading control systems to support precise depth control and reducing power consumption. Lessons from last year's design led to upgrading from a geared DC motor to a PWM-controlled continuous rotation servo for greater efficiency and reliability. Asteria's system consists of a 500 mL syringe and a lead screw mechanism driven by the servo motor to adjust buoyancy by drawing in or expelling water. Aluminum dowels create the buoyancy engine's minimal frame providing structural integrity. Lead screw rotations are counted using a switch connected to a GPIO on the Raspberry Pi, enabling precise buoyancy control and the required depth-hold function.

At the start of each mission, Asteria remains at the surface and streams a control webpage over a closed WiFi network to a deck device. This user-friendly interface allows real-time monitoring and control without specialized software. Pressing the 'DIVE' button triggers water intake, decreasing buoyancy and initiating data collection with a Blue Robotics Bar02 pressure sensor, recording pressure, depth, and time.

As Asteria approaches 2.5 meters depth, a PID algorithm begins increasing Asteria's buoyancy by expelling water. The PID algorithm is tuned to hold Asteria precisely 2.5 meters below the surface. The PWM-controlled continuous rotation servo provides very precise buoyancy control ensuring no deviation from the allowable depth range.

At the surface, the antenna transmits pressure and depth data with UTC timestamps, displaying it on the web page alongside a depth-versus-time graph. This process is repeated twice.

Asteria's electronics are built around a custom circular PCB (Figure 39) and a Raspberry Pi Zero, creating a compact and efficient processing system optimized for the cylindrical tube. The PCB acts as a Pi "hat" with a 2x20 header for seamless integration. Three dedicated LEDs provide clear status indicators—one for buoyancy engine activation, one for motor operation, and one for low battery warnings—improving safety and allowing surface monitoring of the buoyancy system. Lessons from previous designs informed these improvements, resulting in a more effective and user-friendly system. For serviceability, the battery system is housed in a separate, watertight compartment near the base for easy replacement. A pressure release plug prevents buildup, ensuring safe operation.

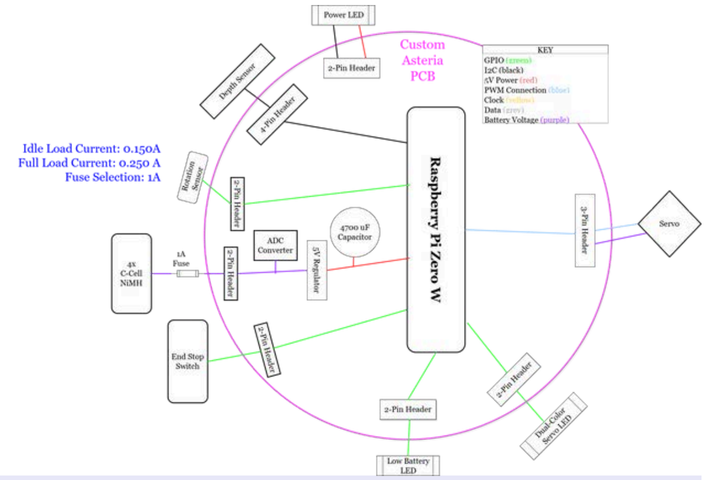


FIGURE 39. BUOYANCY ENGINE PCB

Combined with enhanced buoyancy control and real-time data transmission, Asteria's refined design ensures reliable, safe, autonomous vertical profiling and accurate underwater data collection.

05 BUILD VS. BUY, NEW VS. USED

Geneseas evaluated each ROV component—whether to build, buy, or reuse—using a decision matrix (Figure 40) to balance affordability, sustainability, and reliability.

This process led to developing a custom USB hub for the camera system. While the 2024 camera setup performed well, it lacked the flexibility needed for safer, easier operation. For 2025, *Geneseas* built a new USB hub that expanded camera streams capacity from four to eight and added individual camera power cycling via the command line, giving pilots more control and reliability over Andromeda's dynamic vision system.

To further improve ease of operation and setup, *Geneseas* upgraded to Raspberry Pi 5 boards, tested and debugged for higher bandwidth to support the expanded vision system. Combined with an updated tether with dedicated powerline communication wires, tests confirmed more stable, high-resolution camera streams. Integrated with powerline communications (PLC) and the custom USB hub, these upgrades resolve past connectivity issues, delivering a more reliable, user-friendly piloting experience.

Geneseas prioritizes mission requirements and operator safety when deciding whether to build or buy components. The 2025 gripper redesign reflects this approach—engineered for greater serviceability, reliability, and safety while meeting mission objectives. The result is a corrosion-resistant, pinch-point-free, and adaptable gripper capable of tasks ranging from applying epoxy patches to replacing sacrificial anodes.

For components like thrusters and the RPS, *Geneseas* reviewed the RFP and evaluated reuse options.

Parts were repurchased if testing confirmed they met mission needs. The thrusters, proven reliable through characterization, were reused and reprogrammed for improved maneuverability. These sourcing decisions ensure Andromeda is a functional, practical, and cost-effective ROV designed to protect marine ecosystems.

Component Name	Build		Reuse		Buy		End Decision
	Pros	Cons	Pros	Cons	Pros	Cons	
Thrusters	High level of customization	Potential waterproofing and functionality challenges	Saves money; thrusters are reliable	Would have to remove from the old ROV. We prefer to keep our previous designs intact to use them for other functions.	Ensures reliability from purchasing a new, off-the-shelf thruster model that has already proven reliable; new thrusters ensure longevity of thrusters and we do not have to disassemble older ROVs.	Spending money	Repurchase
Gripper	Highly customizable with control over all aspects, less expensive, can be built off of frameworks of previous grippers	Difficult, time consuming	Saves money	Inability to make desired modifications and improvements	Fast turnaround	Lack of specialization and inability to engineer a custom manipulator	Build
Camera Enclosures and Electronics System	Can maufacture compact and custom enclosures and electronics system well-suited to our specific cameras and 2025 ROV design	Have to dedicate time to testing the reliability and underwater durability of camera enclosures and to design and outsource custom PCBs	Saves money	Cameras cannot be reused from previous ROVs; risks unreliable electronics	Accessibility and fast turnaround	Large and not specialized to 2025 design objectives	Build
USB hub	Highly customizable with control of power to cameras; streamlines software	Difficult, time consuming	N/A	N/A	Fast turnaround with buying an off-the-shelf product	No customizability and inability to work with 2025 design objectives	Build
Communication (Ethernet) System	Large variety in designs to develop electronics meeting *Geneseas'* 2025 design objectives with an increased data sending ability	Issues with reliability	Simple and straightforward ethernet connections	Previous system has reliabiity issues and sends less data down the tether; contributed to previous bandwidth	Reliable Powerline Communications Board that's industry tested by professional companies	High Cost	Buy
RPS	Ability to custom-engineer a topside control system for the new ROV	High cost with few additional benefits	Saves money, materials, and time due to similar base that is easily modifiable to the new design	Larger and takes up a significant chunk of space; unnecessary buttons	Not an option because there are no off-the-shelf RPS models with capabilities suiting our team		Build

FIGURE 40. BUILD VS. REUSE VS. BUY DECISION MATRIX

06 TESTING AND TROUBLESHOOTING

At *Geneseas*, safety is the top priority. Every system on Andromeda is rigorously tested before in-pool use to ensure safety, reliability, and mission readiness.

Geneseas follows a two-step testing process with continuous iteration. Tools are first dry-tested to identify design flaws and verify reliability, then tested in water, where pilots provide feedback for performance improvements. On-site 3D printers enable rapid redesigns and specialized tool development for each task.

Movement code and software are debugged outside of practice sessions using compact, portable test benches. The software team locates errors with line-by-line print statements, corrects issues, and tests components individually before re-running programs for optimization. This process ensures the pilot trains with reliable, bug-free code, making pool tests more efficient.

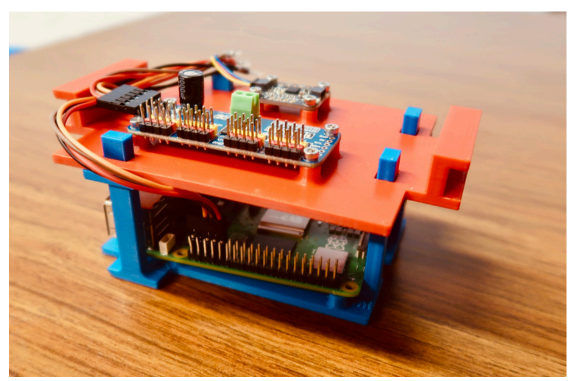


FIGURE 41. TEST BENCH

Before water testing, all six thrusters are calibrated to synchronize startup and optimize movement software. This minimizes setup time and ensures smooth operation.

To maintain camera reliability, *Geneseas* developed a custom bash script that monitors camera functionality and allows quick restarts of cameras or thrusters if failures occur mid-mission. Additionally, Andromeda's electrical and solenoid housings undergo a 10-minute vacuum test at 10 psi to ensure watertight integrity before every pool test.

07 SAFETY

A. SAFETY PHILOSOPHY

Geneseas is committed to prioritizing safety at every stage of development, testing, and operation. The team implements rigorous safety standards that exceed requirements and integrates innovative safety measures while following established guidelines.

All employees complete comprehensive safety training covering lifting techniques, electrical safety, tool use, hazardous materials handling, and maintaining a clean workspace.

Safety is embedded in Andromeda's design, with features that protect both operators and equipment. For *Geneseas,* safety is not just a policy but a core value guiding every decision and action.

B. LAB PROTOCOLS

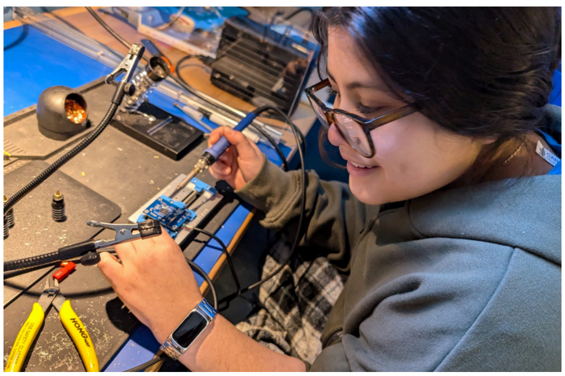


FIGURE 42. *GENESEAS* MEMBER SOLDERING

Geneseas prioritizes safety in all lab and field operations. Team members wear closed-toed shoes, tie back hair, and use personal protective equipment (PPE) like goggles, gloves, masks, and ear protection when machining, soldering, or working on the ROV.

New employees receive hands-on safety training from mentors, with a focus on proper machinery use and hazard awareness. A tool labeling system indicates which equipment can be used independently and which requires supervision, ensuring safe operation.

ROV water tests follow a detailed safety checklist and Job Safety Analysis (JSA). The pilot, co-pilot, and safety manager enforce protocols, including keeping electrical equipment dry and using clear communication between the pilot and tether manager. A specialized call-and-response system alerts the deck crew when the ROV is powered on or off, reducing injury risk. Before and after each test, the team inspects the ROV to confirm proper maintenance and safety compliance. All electrical equipment, including the RPS and laptop, is placed on elevated surfaces to avoid water exposure.

FIGURE 43. *GENESEAS* MEMBER DRILLING

In the lab, a chemical fume hood minimizes fume exposure during soldering. Team members are responsible for proper waste disposal and returning tools after use, maintaining a safe, organized workspace. These protocols ensure a consistent culture of safety and help prevent potential hazards.

C. VEHICLE SAFETY FEATURES

Andromeda incorporates several safety features that reflect *Geneseas'* commitment to safe design and operation.

All components and wires are carefully organized and labeled to ensure easy inspection, maintenance, and troubleshooting. Each sub-team is responsible for upholding strict safety standards, enhancing the overall safety of the ROV and its systems.

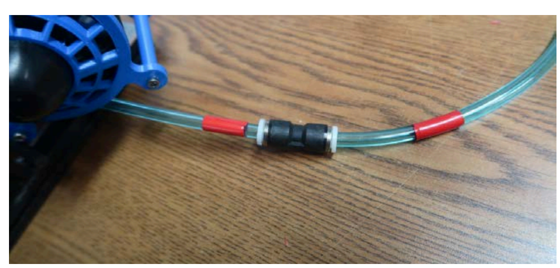


FIGURE 44. LABELED PNEUMATICS

During a safety review, *Geneseas* identified a potential pinch hazard with many rack-and-pinion gripper designs. As a result, Andromeda's gripper features shrouded rack-and-pinion mechanisms.

These integrated safety measures in both the ROV and RPS help prevent accidents, reduce the risk of injury, and enable quick responses to potential hazards.

D. OPERATIONS AND SAFETY CHECKLIST

Geneseas develops comprehensive operational and safety checklists (Appendix D) to protect employees, customers, and bystanders during launch, operation, and retrieval. This structured approach reinforces the importance of strict safety protocols, ensuring safer operations and reducing risks throughout every mission phase.

08 BUDGET AND COST ACCOUNTING

Geneseas funds its operations through school support, student contributions, and fundraising efforts. To maximize resources, the team prepares a detailed budget and Profit & Loss (P&L) analysis for Andromeda's development. The P&L includes non-recurring engineering (NRE) costs—factoring in market-rate labor over a one-year period—unit production costs and revenue estimates based on market prices. The complete budget can be found in Appendix C. Additionally, research and development (R&D) costs were estimated to be $172,800 USD based on the 3840 labor hours *Geneseas* employees spend in research and development per unit. Future income and development costs are projected using historical data and market trends to ensure long-term financial sustainability. The project is expected to break even after selling approximately 75 units in the first year (see Appendix B for full details).

A competitive pricing analysis evaluated manufacturing costs, market demand, and competitor positioning. A comparison table outlines *Geneseas'* products against key competitors to guide pricing and maximize profitability. Based on this analysis, Andromeda's price range is set between $7000 and $9000 per unit, with an initial price of $8000 USD.

Geneseas also conducted thorough build vs. buy assessments to balance reliability and cost-effectiveness, prioritizing the reuse of existing components wherever possible to further improve cost efficiency.

09 CONCLUSION

A. ACKNOWLEDGEMENTS

Geneseas would like to express our appreciation and gratitude for the opportunity to participate in the MATE program. Thank you to MATE, the Marine Technology Society—sponsor of the 2025 competition—along with MATE II, the National Science Foundation, Oceaneering International, Ocean Infinity, and Reach the World for supporting this incredible educational experience.

- We gratefully acknowledge the following contributors to our success:
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- Jesuit High School - for pool and laboratory space.
- Industry Partners — Tyler Schilling, Schilling Robotics, Nauticus Robotics, NASA, Green Circuits, Bay Area Circuits, and The Aerospace Museum of California — for inspiring us and showing real-world applications of our work.
- Michelle Menza, Kitara Crain, Cheryl Kiyama, and Siena Marois — for being inspiring role models and empowering us to be "Women who change the world."

- St. Francis Coaches — Marcus Grindstaff, Kitara Crain, Dean Eugenio, Siena Marois, Karen Jones, Maurice Velandia, Jay Isaacs, Michael Sharp, and Steve and Cheryl Kiyama — for your time, knowledge, dedication, and mentorship. Your support creates a team environment focused on learning, growth, and fun.
- Our families — for your unwavering encouragement and support.

Thank you all for helping make this learning opportunity possible.

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10 APPENDICES

APPENDIX A. LABOR COSTS

Staff	Salary and Benefits (USD)	Cost per Hour in USD	# of Employees	Fixed Cost (USD)	Hours per Unit	Cost per Unit in USD	
Electrical Engineer	$94,500.00	$47.25			8	$378.00	
Software Engineer	$94,500.00	$47.25			8	$378.00	
Mechanical Engineer	$94,500.00	$47.25			8	$378.00	
Administrative	$52,500.00	$26.25	1	$52,500.00		$0.00	
Customer Support	$47,250.00	$23.63	1	$47,250.00		$0.00	
Sales	$31,500.00	$15.75	1	$31,500.00		$0.00	Commission
	$414,750.00			**$131,250.00**	**Fixed**	**$1,134.00**	**Variable**

APPENDIX B. PROFIT AND LOSS

PROFIT & LOSS (Annual)									
Price of Unit	$8,000								
	Year 1	Year 2 (Varying Quantity Sold)							
# of Units Sold	**0**	**1**	**50**	**100**	**200**	**300**	**400**		
Revenue	$0.00	$8,000.00	$400,000.00	$800,000.00	$1,600,000.00	$2,400,000.00	$3,200,000.00		
COGS - Materials	$0.00	$2,774.09	$138,704.50	$277,409.00	$554,818.00	$832,227.00	$1,109,636.00		
COGS - Labor	$0.00	$1,134.00	$56,700.00	$113,400.00	$226,800.00	$340,200.00	$453,600.00		
Gross Income	$0.00	$4,091.91	$204,595.50	$409,191.00	$818,382.00	$1,227,573.00	$1,636,764.00		$0.00
R & D (prior to production)	$172,800.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
NRE - Materials	$3,758.40	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
Fixed Labor	$0.00	$131,250.00	$131,250.00	$131,250.00	$131,250.00	$131,250.00	$131,250.00		
Total Expense	$176,558.40	$131,250.00	$131,250.00	$131,250.00	$131,250.00	$131,250.00	$131,250.00		
Profit	-$175,019.00	-$43,769.00	$87,481.00	$218,731.00	$349,981.00	$481,231.00	$612,481.00		
Net of Investment		-$218,788.00	-$87,538.00	$43,712.00	$174,962.00	$306,212.00	$437,462.00		

APPENDIX C. BUDGET

	Type	Cost for Development in USD	Unit Cost per ROV in USD
Raspberry Pi 5	Purchased	$60.99	$60.99
Motors	Purchased	$21.36	$21.36
Joystick	Reused		$40.00
Cameras	Purchased	$370.31	$370.31
Real Sense Camera	Purchased	$180.00	$180.00
Pneumatics Box	Reused		$21.70
Electronics Enclosure	Purchased	$49.20	$49.20
RPS Box	Purchased	$25.99	$25.99
Sleeving	Purchased	$60.09	$60.09
3D Printer Resin	Purchased	$354.00	$118.00
Polycarbonate Filament	Donated	$155	$155
T-Slot Nuts	Purchased	$52.60	$52.60
ROV PCB Components	Purchased	$63.32	$63.32
USB Hub Components	Purchased	$40	$40
Cord Grip Fittings	Purchased	$69.56	$69.56
Pneumatic Pistons	Purchased	$65.86	$65.86
Pneumatic Tubing	Purchased	$21.99	$21.99
Aluminum Rail	Purchased	$74.50	$74.50
Frame Brackets	Purchased	$65.11	$65.11
Buoyancy Engine Tube and Syringe	Reused		$80.76
Power Wire	Purchased	$164	$164
Blue Robotics Wet Link Penetrators	Purchased	$114	$114
Power Connectors	Purchased	$186	$186
Pneumatic Solenoids	Purchased	$59.00	$59.00
IMU	Purchased	$14.99	$0.00
Thrusters	Purchased	$384	$384
Various Consumables < $20 each	Purchased	$230.50	$230.50
Additional NRE components	Purchased	$875.55	$0.00
		$3,758.40	**$2,774.09**

Regionals Competition Travel Expenses	Based on 2024 Actuals
Hotel * 4 rooms , 1 Night	$2,430
Car Transportation	Donated
Meals	$4,288.59
Total	**$6718.59 USD**

World Competition Travel Expenses	Based on 2024 Actuals
Hotel * rooms , Night	$5,007
Flights	$11,175.46
Car Transportation	$3,841.17
Meals	$3,230.00
Other	$1,387.50
Total	**$24,641.28 USD**

APPENDIX D. OPERATIONS AND SAFETY CHECKLIST

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 to 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
- ☐ Vacuum test electronics housing (see Vacuum Test below)
- ☐ Vacuum port is securely capped
- ☐ Thrusters are free from obstructions

Vacuum Test (Deck Crew)
- ☐ Verify electronics housing and CEH are properly sealed
- ☐ Connect vacuum pump to the electronics housing and CEH
- ☐ Vacuum down the electronics housing and CEH to ~10 Hg and verify they hold this pressure for 10 minutes
- ☐ Remove vacuum pump and securely cap vacuum port
- ☐ Return vacuum hand pump to case

Power-Up (Pilot, Co-pilot, and Deck Crew)
- ☐ Verify RPS is receiving 12V nominal
- ☐ Control computers up and running
- ☐ Ensure deck 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 Below)

Inspect and Test Pneumatic System (Pilot, Copilot)
- ☐ Verify all pneumatics 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 pneumatics 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 Deck Crew)
- ☐ Deck crew members handling ROV call out, "hands on!"
- ☐ Carefully place ROV in the water
- ☐ Check for bubbles
- ☐ Visually inspect for water leaks
- ☐ If there are large bubbles, pull to surface immediately and proceed with Leak Detection Protocol
- ☐ If no issues are detected call out, "prepare to launch"
- ☐ Deck crew members handling ROV remove their hands from the vehicle and call out, "hands off!"
- ☐ Co-pilot calls out "thrusters engaged" and pilot begins mission

ROV Retrieval (Pilot, Co-pilot, and Deck Crew)
- ☐ The pilot calls out, "ROV surfacing"
- ☐ Deck crew calls out, "ROV on surface. Disable thrusters"
- ☐ Co-pilot calls out, "thrusters disabled"
- ☐ Deck Crew call out, "hands on," and remove ROV from 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 Deck 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.

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.

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 hazards
- ☐ Check electrical cords and correct any electrical hazards
- ☐ Check supplies and organize a shopping list if anything is needed for repair or upkeep.
- ☐ Verify 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