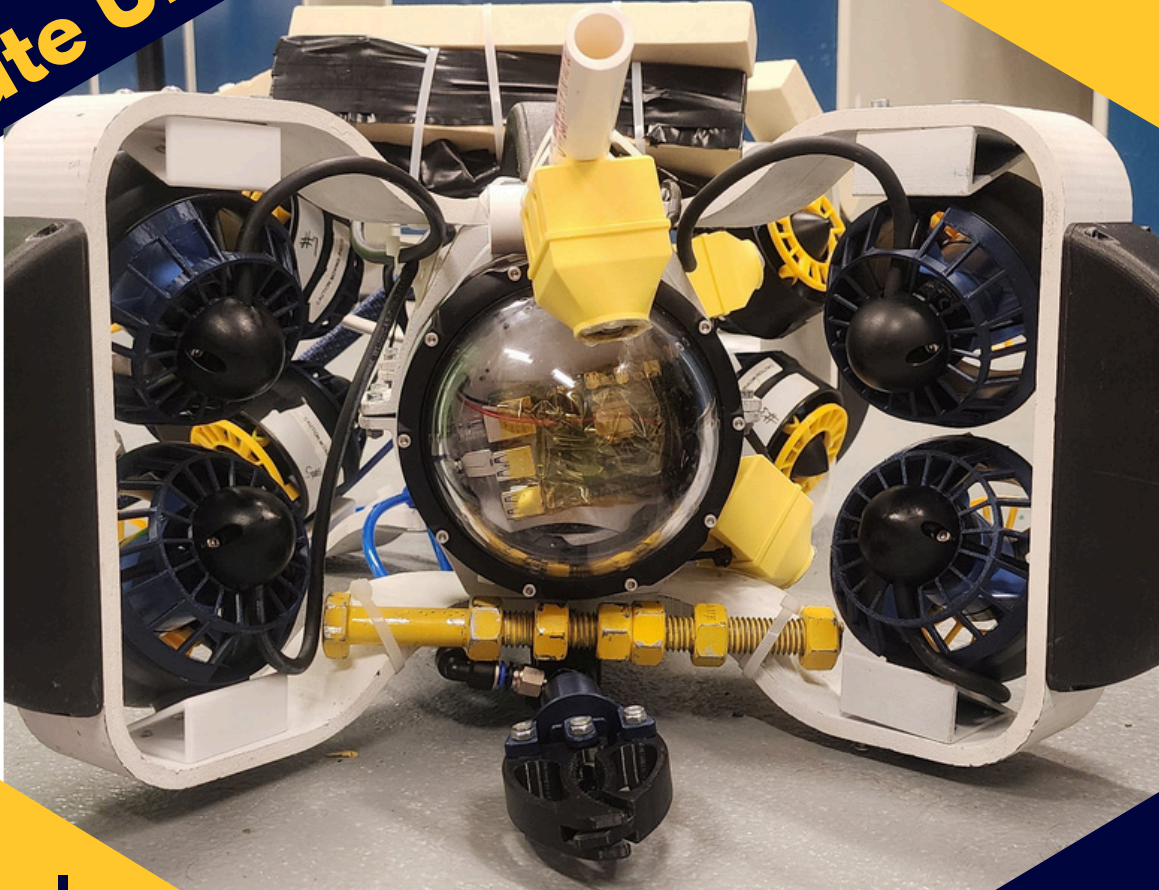


**East Tennessee
State University**

**EXPLORER Class
Johnson City, Tennessee,
United States
Buccaneers**

2026

ROV



Technical Documentation

**Pearson Mills, CEO
Samuel Deaton, COO
Brandon Bartley, Software
Kytric Brownlee, Mechanical
Shaye Etheridge, Software
Patrick Lanham, Mechanical
Riley Mars, Float
Luke Seal, Hardware/Pilot
Noah Shelton, Float
Matthew Smith, Safety
Yosr Souf, Hardware**

**Mentors
Leslie Hollenbeck
B Dye
Betsy Cunningham**



Abstract

The Buccaneers, or Bucs, of East Tennessee State University are an underwater robotics company hailing from Johnson City, Tennessee. The twelve-member company is situated in a region known for its extraordinary freshwater biodiversity and close proximity to hydroelectric infrastructure, the Buccaneers are uniquely positioned and motivated to engage with real-world aquatic challenges, ranging from ecosystem monitoring to sustainable energy initiatives. Founded in 2020, the Buccaneers have developed a strong foundation in underwater robotics, encouraging sustainability and ingenuity. With backgrounds spanning biology, computer science, engineering technologies, and environmental health, each member of the Bucs brings an interdisciplinary approach to the design and deployment of marine technology. In response to this year’s request for proposals, the Buccaneers are proud to present *Theseus*, a versatile and high-performance Remotely Operated Vehicle (ROV) engineered to address the challenges of coral species, icebergs, and offshore oil platforms. *Theseus* features a custom 3D-printed frame designed for modularity and strength, an eight-thruster vectored configuration for omnidirectional control, and a newly developed topside control system to enhance pilot feedback and mission efficiency. Each subsystem was the result of the cumulation of years of experience, extensive testing, and a focus on dependability and serviceability. This document details the Buccaneers' design and development process, including overviews of ROV systems, teamwork, safety, and accounting.



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Teamwork and Project Management

Company Overview

The East Tennessee State University Buccaneers are a highly experienced underwater robotics company dedicated to the efficient completion of the design and construction of *Theseus*. The company is comprised of twelve undergraduate students, each with a unique skillset. This led to the natural delegation of tasks to each member. This logical organization guided new members to their department. The company's departments include mechanical, hardware, software, and float.

With the largest member base in the company's history, the Buccaneers were able to promote greater specialization, allowing members to focus more deeply on their respective disciplines. Instead of one member having to tend to many parts of the development, a member could focus specifically on pneumatics or supplemental devices, for example. This structure refined design and construction processes, improved collaboration, and ultimately enhanced the company's overall efficiency and innovation.

The company is led by two positions. The first is the Chief Executive Officer (CEO), which manages the finances and coordinates with sponsors and the University. The Chief Operations Officer (COO) oversees the development of the ROV and its systems. The COO makes decisions within the logistical bounds set forth by the CEO.

Name	Position	Year	MATE Exp.	Field of Study
Pearson Mills	CEO	Sr.	8	Biology
Samuel Deaton	COO	Jr.	8	Computing
Brandon Bartley	Hardware	Jr.	1	Computing
Burak Baskir	Software	Fr.	1	Computing
Kytric Brownlee	Mechanical	Sr.	1	Engineering Technologies
Shaye Etheridge	Software	Fr.	1	Computing
Patrick Lanham	Mechanical	So.	2	Engineering Technologies
Riley Mars	Software	Fr.	4	Computing
Luke Seal	Hardware	Jr.	2	Computing
Matthew Smith	Safety	Jr.	7	Environmental Health
Yosr Souf	Hardware	Jr.	1	Computing
Noah Shelton	Float	Jr.	2	Computing

Table 1: Buccaneers' company information.

Scheduling

To ensure that the company would operate at optimal efficiency, the Buccaneers implemented a schedule at the beginning of each semester. To determine the best meeting dates and times, a survey was distributed where members selected times when they would be available to meet. As the season progressed, meeting frequency increased to ensure completion of the ROV.

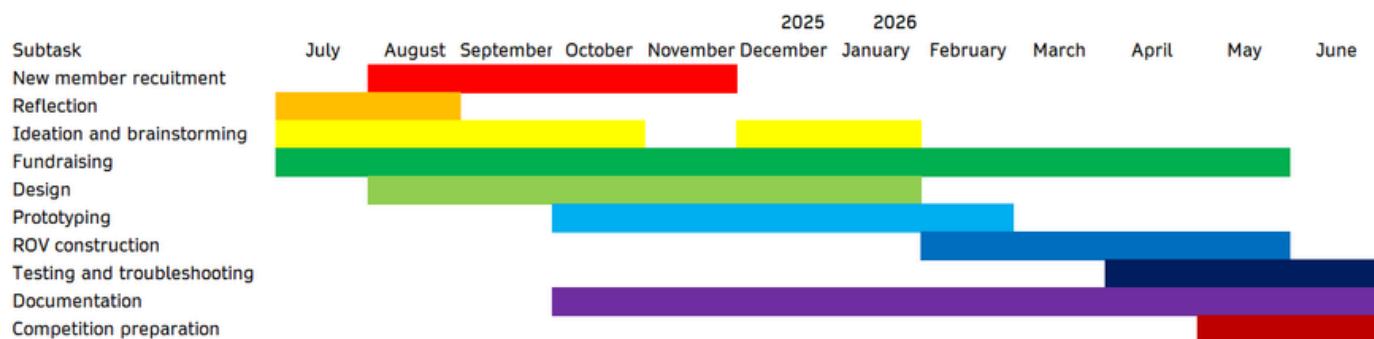


Figure 1: Buccaneers 2025-2026 schedule..

As shown in Figure 1, the season began with recruiting new members and researching and developing the general design of *Theseus*. Once MATE mission specifications were released in late 2025, further development began to ensure that *Theseus* would be fully capable of completing every mission with success. Upon fabrication of the ROV, in-water testing and troubleshooting began.

Resources, Procedures, and Protocols

In the day-to-day operations of the company, the Buccaneers employed various methods to ensure their success. To determine the design of the ROV for the year, company members would meet and brainstorm ideas. Cost-benefit analyses were conducted for multiple components and members would discuss what would be best for the design.

The Buccaneers meet at East Tennessee State University's Valleybrook campus. The company has a designated workspace and access to tools and materials. The workspace is available to company members whenever they need it for their projects. The Valleybrook campus also houses a small indoor above-ground pool used for thruster and control system testing.

To communicate online, Discord was used.

Discord was selected for the instant sharing of ideas, pictures, and meeting plans. If any member was unable to attend, a rough update of progress would be shared. Also used was Microsoft OneDrive and SharePoint for technical documentation and file storage. Autodesk Fusion and Onshape were used as computer-aided design (CAD) software.

This year, the Buccaneers implemented Trello, a project management platform, to improve task organization and workflow. Trello allowed the company to organize assignments on lists and boards, making responsibilities clear to all members. By adopting Trello, the Buccaneers were able to promote accountability and streamline communication.

To improve manufacturing efficiency and reduce dependence on external fabrication, the Buccaneers invested in two new 3D printers. These purchases allowed multiple components to be produced simultaneously, reducing turnaround time and improving the company's ability to quickly prototype and iterate designs.

The company also acquired organized tool storage systems and dedicated electrical troubleshooting equipment, improving equipment accountability and reducing time lost locating tools and diagnosing faults.

Design Rationale

Engineering Design Process and Problem Solving

Throughout the development of *Theseus*, the Buccaneers were guided by the engineering design process, from identifying problems to the final product at the MATE ROV World Championship. The company followed the process found in Table 2 to address past faults in every subsystem, particularly in the context of MATE missions.

Table 2: Engineering Design Process followed.

1. Identify problem	The company examined the requirements of the MATE ROV Competition for 2026 and looked at how previous systems had resulted.
2. Research issue and study solutions	The company investigated why the issue had occurred and how the issue could be addressed at its root cause. Alternatives to previous designs were studied using data and trade studies.
3. Select solution	The solution that fared the best during research was selected and was purchased or constructed, depending on the component.
4. Build prototype	The prototype was assembled to meet the requirements to solve the original issue.
5. Test and evaluate prototype	Company members test the proposed solution either as an individual component or as part of the ROV. The design is analyzed to see whether it adequately addresses the problem in its current state.
6. Improve or redesign if necessary	If the design is unsatisfactory or does not meet the requirements of the company, the design is improved or altered.

Innovation

Year after year, the Buccaneers have become more focused on maintaining a balance between innovation and not reinventing the wheel. Countless methods in the field of underwater robotics are now tried and true. However, the Bucs know that this does not mean that there is no room for innovation and improvement.

The Bucs' *Theseus* features several design elements that are not too common in the MATE ROV Competition. This year, the company is debuting a frame material new to the Bucs. This improvement has made for a lighter, more durable structure. Another major upgrade is the implementation of custom printed circuit boards across the ROV. This has allowed for increased power efficiency and fine-tuning to meet the requirements of the competition. Yet another innovation is the creation of a multi-axis manipulator, allowing dexterity that the Bucs have never had before.

Vehicle Philosophy

The Buccaneers' ROV this year is named *Theseus* after the philosophical paradox known as the "Ship of Theseus". Much like the thought experiment, the company redesigned and improved nearly every subsystem and component from the previous ROV while retaining the same overall look as well as the experience and knowledge gained from past designs. The name *Theseus* reflects the Buccaneers' philosophy of continuous refinement and iterative innovation.

	PETG-rCFo8	PC
Impact Resistance	Moderate	High
Cost	Moderate	High
Equilibrium Water Absorption	Moderate	Low
Tensile strength (MPa)	59.8 (X-Y), 41.1 (Z)	53.4 (X-Y), 41.4 (Z)
Bending strength (MPa)	94.6 (X-Y)	81.3 (X-Y)

Table 3: Comparison of PETG-rCFo8 and polycarbonate.

Vehicle Structure

The structure of *Theseus* is constructed from polycarbonate filament from Polymaker. The company's previous ROV design used Polymaker's PETG-rCFo8. The shift in filaments used resulted in the polycarbonate filament having a lower moisture absorption compared to PETG-rCFo8. This is vital for lengthy in-water testing and operation. Minimal absorption allows for consistent buoyancy, long-term durability, and dimensional stability. Per the technical data sheet of each filament, polycarbonate has an equilibrium water absorption of 0.25%, while PETG-rCFo8 has a value of 0.55%. A material with a high equilibrium absorption can expand, warp, or soften, significantly impacting the operation of the ROV (SpecialChem).

The density of materials was also a consideration when selecting the frame material of *Theseus*. According to the technical data sheets, polycarbonate has a density of 1.19 g/cm³. For PETG-rCFo8, the density is listed as 1.30 g/cm³. For every liter of printed material, the product will weigh 110 g less, directly reducing thrust requirements and increasing payload capacity.

One benefit of using PETG-rCFo8 was its ease of printing. PETG-rCFo8 produces fewer toxic fumes in printing than polycarbonate. Additionally, polycarbonate requires the use of a more advanced printer. To protect company members, the polycarbonate printer is housed in a fume hood and only operated while members are not present. Upon completion of printing, polycarbonate is much safer than PETG-rCFo8, as the PETG-rCFo8 would produce microsplinters if sanded or worn, posing a potential hazard to members.

Theseus features the same robust design as last year, utilizing the watertight enclosure to attach the front and rear components. This reduces unnecessary mass and simplifies construction, since the enclosure itself functions as a structural element. The structure of the ROV is mounted to the enclosure via 3D-printed enclosure mounts. The company had reiterated this design because of its hydrodynamic symmetry and convenient mounting angles for vectored thrusters, as well as the modularity it allows for the installation of additional equipment.

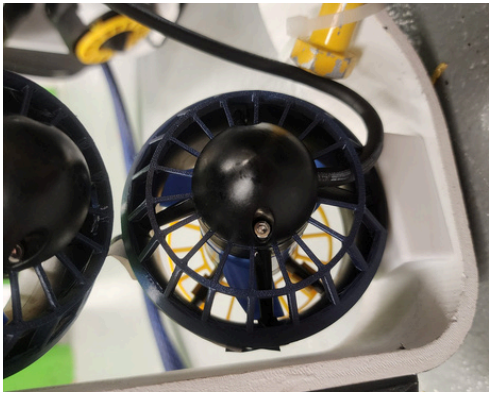


Figure 2: Thruster fitted with 3D-printed guards. Credit: Pearson Mills.

Propulsion

Theseus is propelled by eight T200 thrusters from Blue Robotics. As with previous designs, T200 thrusters were selected for their high thrust capability, compatibility with the existing control system, and known reliability. Additionally, the thrusters have their own electronic speed controllers designed specifically for their operation, from Blue Robotics. Each thruster is mounted in a corner of the ROV's structure, pointed at a 45° angle. This angle provides omnidirectional movement and allows for a stronger up and down thrust, as every thruster can contribute to movement in any direction. Mounting the thrusters within the frame of the ROV protects the thrusters from being bumped during operation and transportation. Moreover, locating the thrusters closer to the ROV's center of mass naturally reduces the necessary torque for rotating, allowing for more precise control in piloting.

The front and rear thrusters are both directed towards a point behind and in front of the ROV, respectively. This configuration allows for high maneuverability and thrust efficiency. When moving in any direction, every thruster can contribute to the propulsion of *Theseus*.

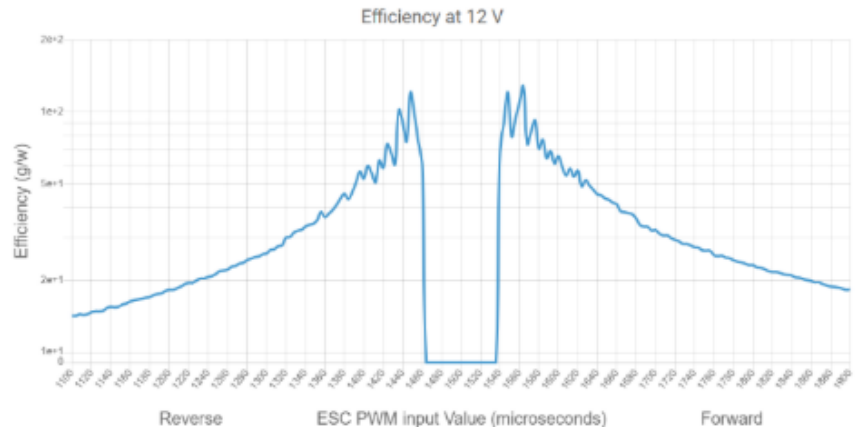


Figure 3: Graph showing power efficiency of T200 Thruster at 12 Volts. Credit: Blue Robotics.

Distributing the power between eight thrusters also allows for operation at the most optimal range on the efficiency graph (Figure 3). For example, if only two thrusters were used to ascend or descend, their power usage would be less efficient, because they would be operating at higher PWMs (Pulse Width Modulation). When power is distributed among eight thrusters, power can be used at its maximum efficiency.

Furthermore, if a thruster fails, the remaining thrusters can compensate for it, a feature not as strong in a six-thruster configuration. When carrying a heavy load, power can be increased to the front thrusters, allowing the ROV to stay level as it is piloted. Each thruster is fitted with 3D-printed thruster guards to ensure the safety of operators and to prevent outside interference with the propellers (Figure 2). The guards meet IP-20 standards, keeping objects greater than 12.5 mm from reaching the propellers.

Figure 4: Blue Robotics T200 thruster. Credit: Blue Robotics.



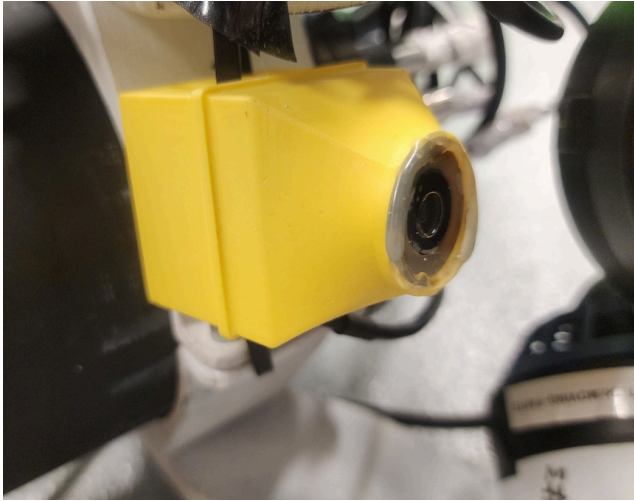


Figure 5: Camera in custom mount

Vision

Theseus is fitted with four Arducam cameras, which were selected for their low cost and high quality. Each camera is positioned to allow for maximum functionality in completing the mission tasks set forth by MATE. The camera housed in the clear dome of the electronics enclosure functions as the main view used for driving the ROV. Other cameras are located on custom-designed mounts which allow the cameras to be moved around for each product demonstration. Cameras can be facing downwards for Task 1.3 Fly a transect over the coral garden and Task 2.1 Mitigate invasive species, upwards to view the tether, and forwards for missions such as Task 1.1 Collect species from the coral garden and transporting the eDNA sensors in Task 2.5. The custom-designed mounts are designed to incorporate waterproofing the cameras and to allow for rapid repositioning of the cameras. The construction of the custom mounts allowed the Bucs to fit the cameras to the requirements of the MATE missions.

Buoyancy

Through measurements, calculations, and testing, *Theseus* has achieved near-neutral buoyancy. Buoyancy considerations played a critical role throughout the design process and significantly shaped the ROV's configuration and component placement. *Theseus* was constructed to be symmetrical, in shape, size, and mass.

To calculate the needed upward buoyant force to counteract the weight of *Theseus*, the weight of the ROV was measured in air and in water. Using these measurements, the volume and density of the ROV were determined. With these values and the known density of water, the Archimedes' Principle was applied to calculate the buoyant force of *Theseus*.

These calculations informed the selection and placement of Subsea R-3312 syntactic buoyancy foam, a closed-cell foam specifically designed for underwater applications. The foam was strategically positioned to achieve near-neutral buoyancy and to maintain balance in all axes.

In addition to buoyancy, the locations of thrusters, watertight enclosures, and internal electronics were carefully planned to maintain both vertical and horizontal stability. The result is an ROV that remains balanced in water, requires minimal pilot compensation, and performs reliably in all mission scenarios.

Control System

The Calypso Control System (CCS) was designed in-house to control and manage the ROV while maximizing pilot situational awareness and subsystem integration. Control system requirements were established through analysis of the mission tasks and identification of the information, controls, and feedback necessary for effective ROV piloting. Particular emphasis was placed on subsystem monitoring, rapid fault identification, and intuitive pilot interaction.

The CCS uses a graphic user interface (GUI) that separates camera feeds, sensor monitoring, warning systems, and controller inputs into independent subsystems. This design simplified troubleshooting, improved maintainability, and allowed components of the software to be iteratively refined.

Multiple gauges and camera feeds allow pilots to monitor several critical data points simultaneously during mission execution. Safety systems, including leak sensors and current sensors, feature dedicated visual warning indicators capable of rapidly alerting pilots to abnormal conditions. To further improve operator awareness, the CCS incorporates haptic feedback through a Logitech Rumblepad 2 controller, ensuring pilots receive tactile alerts even when focused on mission tasks or camera feeds. Software functionality and interface layout were continuously evaluated during pool testing to verify system reliability, usability, and subsystem integration.

Software and Sensor Integration

To control the movement of *Theseus*, the pilots use a Logitech Rumblepad 2 and a Logitech G Extreme 3D Pro. This provides precise control of the omnidirectional movement that is possible with the thruster positions.

The Raspberry Pi 5 on the surface runs on custom code written in C#, C++, and Assembly to optimize the controller inputs. The custom GUI, known as the Calypso Control System, uses C# to handle the visual elements, while C++ handles controller inputs, modes, and sensors. Assembly was implemented for calculating thruster vectors. The inputs reach the ROV in less than 32 milliseconds, allowing for near instantaneous response time. This is of utmost importance when piloting the ROV during time-sensitive missions, as well as allowing for quick corrections in the event of changing conditions.

The propulsion system interprets the joystick inputs and calculates the percentage of movement. This is then used in combination with precalculated vectors to provide data for the thrusters. Using precalculated vectors reduces the time it takes to calculate vectors every time, which helps to achieve the quick response time. Because each input is a separate vector, they can be added together for multiple movements. Having the additional buttons and joysticks on the Logitech G Extreme 3D Pro allows for individual buttons for starting missions as well as full tilt controls with the joystick.

Several driver-assist modes were incorporated to improve ROV control and pilot performance. Precision Mode limits thruster output to allow accurate fine-movement control during delicate tasks. Turbo Mode increases the maximum allowable thrust output for rapid traversal and heavy-object manipulation. Hover Mode uses feedback from onboard sensors to maintain depth and automatically compensate for changing payload conditions. Tilt Lock uses data from the gyroscope and accelerometer to stabilize ROV orientation and maintain a desired pitch and roll angle during operation. To improve operational safety, Safe Mode can be enabled while the ROV is being handled poolside. In this mode, propulsion commands are blocked from reaching the vehicle, preventing unintended thruster activation during maintenance, deployment, or recovery.

Tether

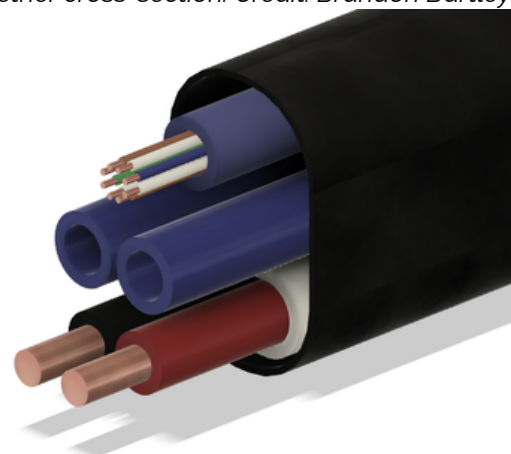
Providing power, signal, and pneumatics to *Theseus* is the tether. The tether measures 30.5 meters in length and is roughly 1.9 cm in diameter. The tether contains power wires that carry 48 volts, air inlet and outlet lines to the pneumatic piston on the ROV, and an ethernet cable for communication. In past seasons, the tether has only been around 15 meters. Lengthening the tether this year provides assurance that the tether can be reused year after year because it is capable of reaching the farthest missions. A tether management protocol is included in the JSEA, which details safety measures taken during transportation, setup, deployment, and operation of the ROV.

Watertight Enclosures

The electronics of *Theseus* are housed within a Blue Robotics watertight enclosure and a modified McMaster-Carr submersible enclosure. The Blue Robotics enclosure is aluminum, has a diameter of 13 cm, and a length of 30 cm. The enclosure's durable aluminum body allows the electronics to stay cool by quickly adjusting to the water temperature. This means that the enclosure serves as a heat sink, transferring the heat created by the electronics to the water.

The wires enter and exit the enclosure through a rear end cap that features 26 M10 penetrator holes. This high-capacity end cap was selected for its ability to accept a large number of wires, which is vital for the use of eight thrusters and three cameras. Furthermore, more components can easily be added to the ROV's design in the future, such as additional cameras or manipulators. The caps can lock to the enclosure tube via a locking cord, further enhancing the enclosure's ability to remain watertight. The locking component also prevents the electronics from rotating, reducing the likelihood of any internal damage.

Figure 6: Tether cross-section. Credit: Brandon Bartley



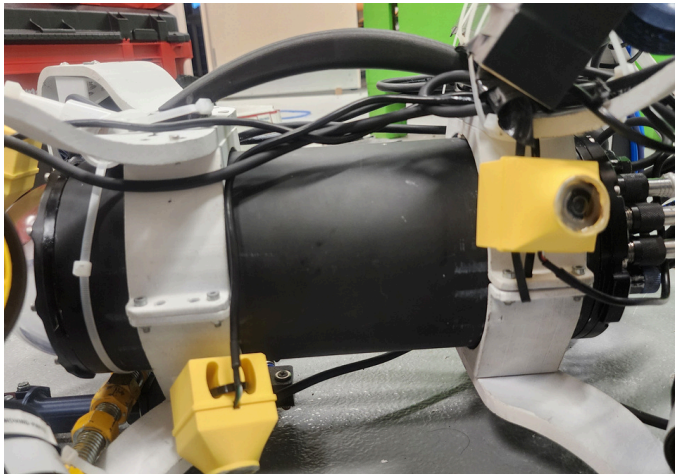


Figure 7: Aluminum watertight enclosure on Theseus.

The secondary enclosure is made of polycarbonate and is rectangular. It measures 8.9 x 15.9 x 6.0 cm. This enclosure was added to house the electronics of the primary manipulator, as these components could not be integrated into the main aluminum capsule due to space constraints. While it does not offer the same thermal conductivity or pressure resistance as aluminum, it is suitable for housing smaller components and provides visibility into the enclosure's interior for monitoring through its clear lift-off cover. This enclosure had eight M10 holes added aftermarket to send power to the ESCs of the thrusters.

A benefit of separating electronics into multiple enclosures comes in leak protection. If a leak begins in one enclosure, only a portion of electronics are at risk. This can be likened to watertight bulkheads in ships, preventing water from spreading throughout the base of the ship. Both enclosures house desiccant gel packs that absorb any moisture that may seep in.

Electronic Speed Controllers

To ensure maximum system reliability and preparation time, the thrusters of *Theseus* use industry-standard Blue Robotics Electronic Speed Controllers (ESCs). While custom field-oriented control (FOC) motor controllers were evaluated for their theoretical efficiency gains, the Buccaneers prioritized the proven solution that has provided stability and success in the past. The choice of Blue Robotics ESCs allows for seamless integration into the control software, ensuring predictability during operation. By opting for the reliable, well-documented ESC platform over experimental custom circuitry, the company was able to significantly compress the development cycle, as members were able to focus on improving other aspects of the ROV.

Figure 8: Blue Robotics Electronic Speed Controller, measuring 32 x 17 mm.
Credit: Blue Robotics.



Penetrators

Theseus features a combination of Blue Robotics WetLink penetrators and Blue Trail Engineering Cobalt Connectors. The permanent connections into the electronics enclosures use WetLink penetrators, while connections that may need to be removed use Cobalt connectors.

Connections for power and cameras are removable within a few seconds. While Cobalt Connectors are less affordable, they do provide higher serviceability. Table 4 shows information examined by the Buccaneers when considering the two options.

Table 4: Enclosure connection analysis.

	WetLink Penetrator	Cobalt Connector
Modularity	Low	High
Reliability	High	High
Cost	Low	High
Quality	Low	High
Simplicity	High	Low

Pneumatic Manipulator

For the first time ever, the Buccaneers are harnessing the power of pneumatics. One of the manipulators is opened and closed using pneumatics, creating a fast and powerful mechanism. Compared to an electric manipulator, this manipulator has faster actuation, a higher force-to-weight ratio, and eliminates the possibility of water interfering with electronics.

To control the opening and closing, a pilot presses a switch on the 5-way, 2-position pneumatic solenoid. Having this switch isolated from the rest of the system allows pilots to maintain control even if communication or power is lost. Furthermore, the pneumatic manipulator reduces the number of wires and hardware required on the ROV as only two air lines are required.

The pneumatic system of *Theseus* contains multiple safety features, as well. At the attachment to the air supply, there is a pressure relief valve and pressure regulator, which keeps air pressure from exceeding the MATE limit of 40 psi. Additionally, all fittings and tubing are rated for pressures in excess of 100 psi, as required by MATE.

Primary Manipulator

What gives the primary manipulator of *Theseus* its dexterous control is five NEMA 17 stepper motors. Inspired by the ROV featured in the 2026 Explorer Mission Fly Through, the manipulator is a multi-axis articulated arm designed to provide precise and versatile object manipulation. The independently controlled joints allow the arm to achieve multiple degrees of freedom, enabling *Theseus* to accurately position tools and retrieve mission objects in confined or complex environments. There is no mission that *Theseus* is unable to complete as the manipulator is able to move in any direction needed.

As the stepper motors did not come pre-waterproofed, they had to be waterproofed in-house. This process involved filling the stator with epoxy, which protects the electrical components of the motor from water. The rotor remains exposed to water, posing no risk as it contains no electronics.

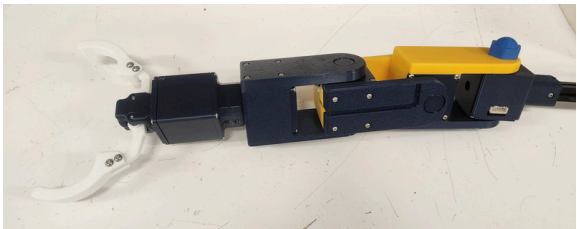


Figure 9: Multi-axis manipulator.

Build vs. Buy, New vs. Used

Before making the final decision on any subsystem of *Theseus*, the company evaluated whether it would be best to build, buy, or reuse the component based on performance, manufacturability, cost, and mission requirements. If the Bucs desired the component to be customized or easily produced, they would design and construct what they needed. Commercially available parts were selected when their reliability and performance outweighed the benefits of in-house construction. Existing components from previous ROVs were reused when testing and evaluation determined that they still met or exceeded company and mission requirements.

Component	Reasoning
Camera mounts	Increased modularity
Frame	Higher impact resistance, lower equilibrium water absorption

Table 5.1: New, built components..

Component	Reasoning
Cameras	Compatibility with mounts and software
Stepper motors	Required for newly designed manipulator
Pneumatic system	Required for pneumatic-powered manipulator
Power converters	Better meets size requirements within electronics enclosure and higher efficiency

Table 5.2: New, purchased components.

Component	Reasoning
T200 thrusters	Meets requirements for thrust capabilities and reliability
Float body	Enclosure from previous ROV meets requirements for body of float
Electronics enclosure	Meets requirements for size and dependability

Table 5.3: Reused, purchased components.

Component	Reasoning
Thruster mounts	Thrusters are mounted at same angle as previous year
Handle	Meets requirements for strength and structure
Enclosure mount	Meets requirements for strength and structure

Table 5.4: Reused, built components.

Testing and Troubleshooting

Throughout the construction and development of *Theseus*, all mechanical, electrical, and software subsystems underwent thorough testing and validation to ensure reliability and mission readiness. Testing occurred continuously throughout the design process, allowing the Buccaneers to identify design limitations, refine subsystem integration, and verify operational performance prior to in-pool testing.

Waterproofing verification was conducted using a vacuum-testing procedure on all watertight enclosures. A vacuum pump was connected to each enclosure through a pressure relief valve to create negative pressure within the housing. If the enclosure maintained vacuum pressure for a minimum of fifteen minutes, it was approved for in-water operation. Any measurable pressure loss indicated a potential leak, prompting inspection of penetrators, seals, O-rings, and enclosure interfaces. This troubleshooting and retesting process continued until each enclosure consistently maintained a reliable seal.

In addition to subsystem-specific testing, *Theseus* underwent pool trials to evaluate maneuverability, control responsiveness, buoyancy stability, manipulator functionality, and sensor integration under realistic mission conditions. These testing procedures allowed the Buccaneers to continuously refine vehicle performance and improve operational reliability throughout the year.

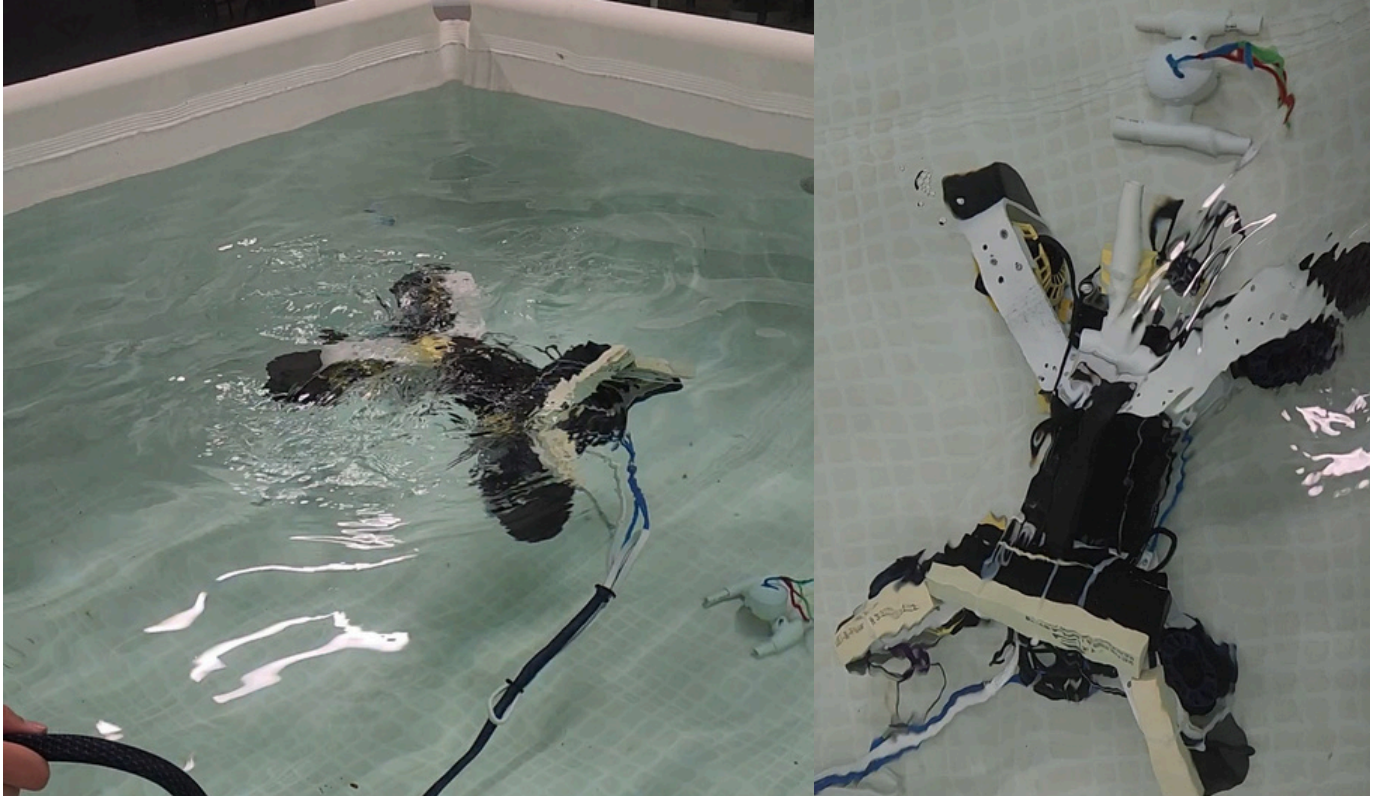


Figure 10: ROV during in-pool testing.

Safety

The Buccaneers uphold strict safety standards throughout every ROV development, deployment, and operation. These standards aim to protect company members and their surroundings through safety practices of members and preventative measures taken through safety features present on *Theseus*. The Bucs believe that prioritizing safety enhances workplace efficiency and improves company morale.

Personnel Safety

All company members undergo safety training of potential hazards and are informed of emergency situations. This includes multiple members which have completed OSHA certification to ensure workplace safety. Before construction of the ROV, all members are informed of proper safety protocols and of available personal protective equipment (PPE), including safety glasses, masks, gloves, and ear protection. Additionally, members were required to remove jewelry, wear closed-toe shoes, and tie back long hair before entering the workspace. The workspace of the Buccaneers has an emergency eyewash station, two fume hoods, a fire extinguisher, and a first aid kit.

Equipment Safety

A major part of the design of *Theseus* was the inclusion of various vehicle safety features, including electrical, mechanical, and software-based safety measures. These all ensure the lowest chance of personal harm or machine damage.



Figure 11: Company member wearing safety glasses and gloves when soldering.

In terms of electrical safety, *Theseus* is protected by a 30-amp fuse to prevent unsafe shorts that could harm the electrical components or members of the team. This is an inline fuse that is housed within 30 centimeters of the power supply connection. The surface-side control box contains an emergency stop switch so that in the case of a short, fire, or any other electrical issue that may damage electronics, a company member is able to instantly prevent power from reaching the ROV.

Mechanical safety measures include the reduction of sharp edges, securing the frame, utilizing tether thimbles and strain/abrasion protection at key places of possible movement. The thrusters are equipped with 3D-printed propeller guards that prevent any outside contact with the propellers.

There are also multiple software-based safety measures that have been included to provide yet another line of defense. Leak sensors within the electronics enclosure allow the company to identify when a possible short could arise due to water leakage. When the sensor identifies a leak, the Raspberry Pi Pico will notify the Raspberry Pi 5 and return the signal to the surface to be viewed via a custom GUI. To prevent unnecessary damage, the power output by the thrusters is reduced by a code multiplier in the PWM output signals. Because of the eight-thruster configuration of *Theseus*, the power requirements can be greatly reduced, allowing for safer operation.

Operational Safety

During the operation of *Theseus*, the Buccaneers adhere to a strict set of protocols to ensure the safe handling of the vehicle. For example, before *Theseus* is deployed, the team follows a "Pre-Flight Checklist." This checklist consists of multiple steps including testing subsystems and ensuring that all company members are prepared before deploying the ROV (Appendix E). The Buccaneers also observe operational safety measures that are outlined in the Jobsite Safety and Environment Analysis. These measures ensure avoidance of the risk of injury and damage to individuals or the ROV.

Accounting

To effectively manage the development of *Theseus*, the Buccaneers established a comprehensive budget at the beginning of the season. This proactive approach ensured that the company could make informed financial decisions throughout the design and construction stages while maintaining focus on innovation and mission readiness.

Working within the financial guidelines of the University, the Buccaneers compiled a comprehensive list of projected expenditures to request. This included ROV components, tools, and testing equipment. Through this process, the company received substantial support from the University's Student Government Association, which served as the company's primary internal funding source. In addition to university funding, the company secured multiple external sponsorships. These partnerships allowed the Buccaneers more room for innovation and strengthened relationships with industry and community.

From the beginning, the company emphasized responsible spending and cost-effectiveness. Careful budgeting and ongoing accounting allowed the company to prioritize critical upgrades and strategically reuse proven components from previous ROVs, while still maintaining financial flexibility for unforeseen needs. This approach ensured financial stability for the Buccaneers while supporting the development of *Theseus*.

We would not be here without any of our sponsors!
The Buccaneers would like to thank the sponsors below.



STUDENT GOVERNMENT
ASSOCIATION

EAST TENNESSEE STATE UNIVERSITY



ETSU Research
CORPORATION

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Glass Industries



STREAMWORKS



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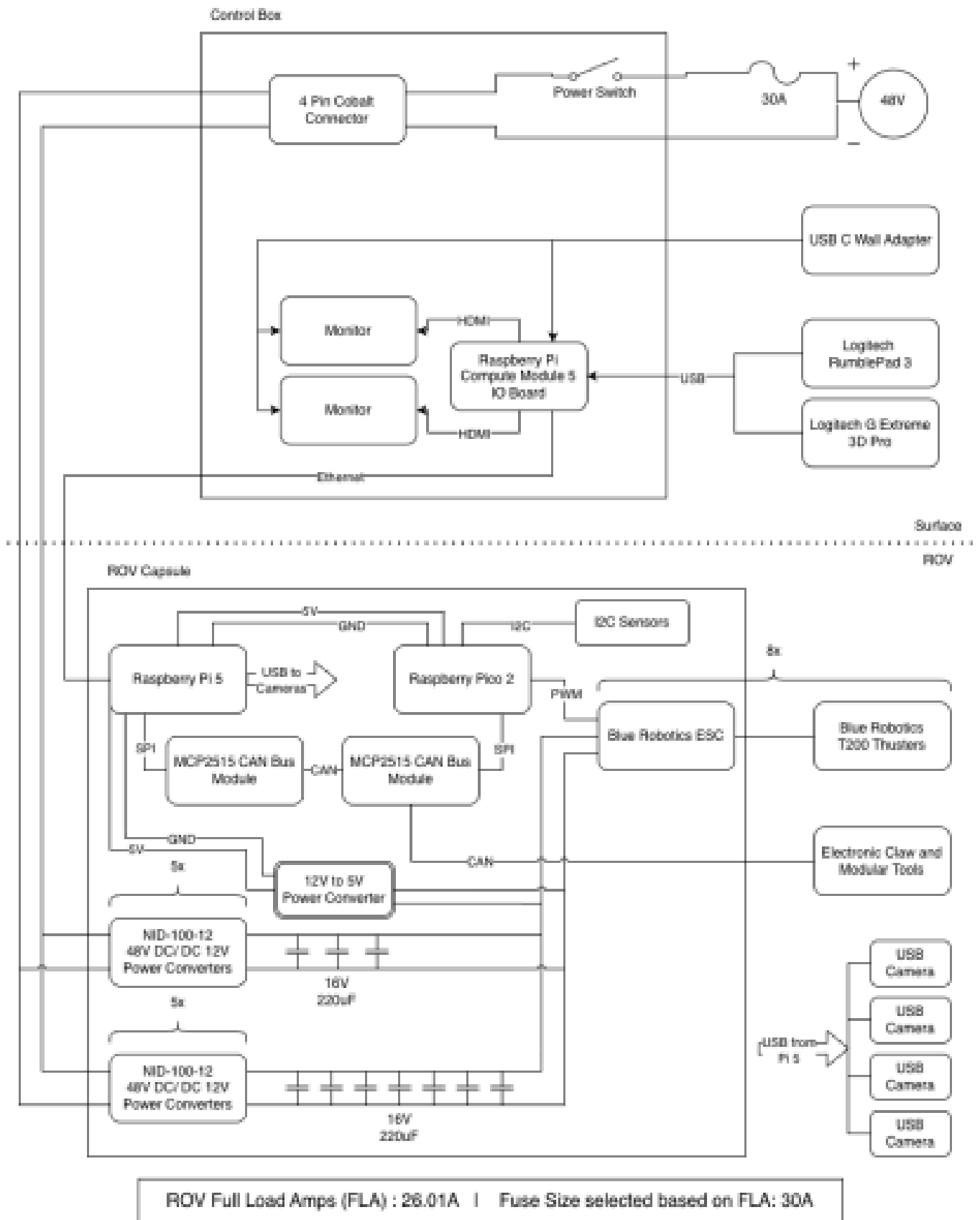
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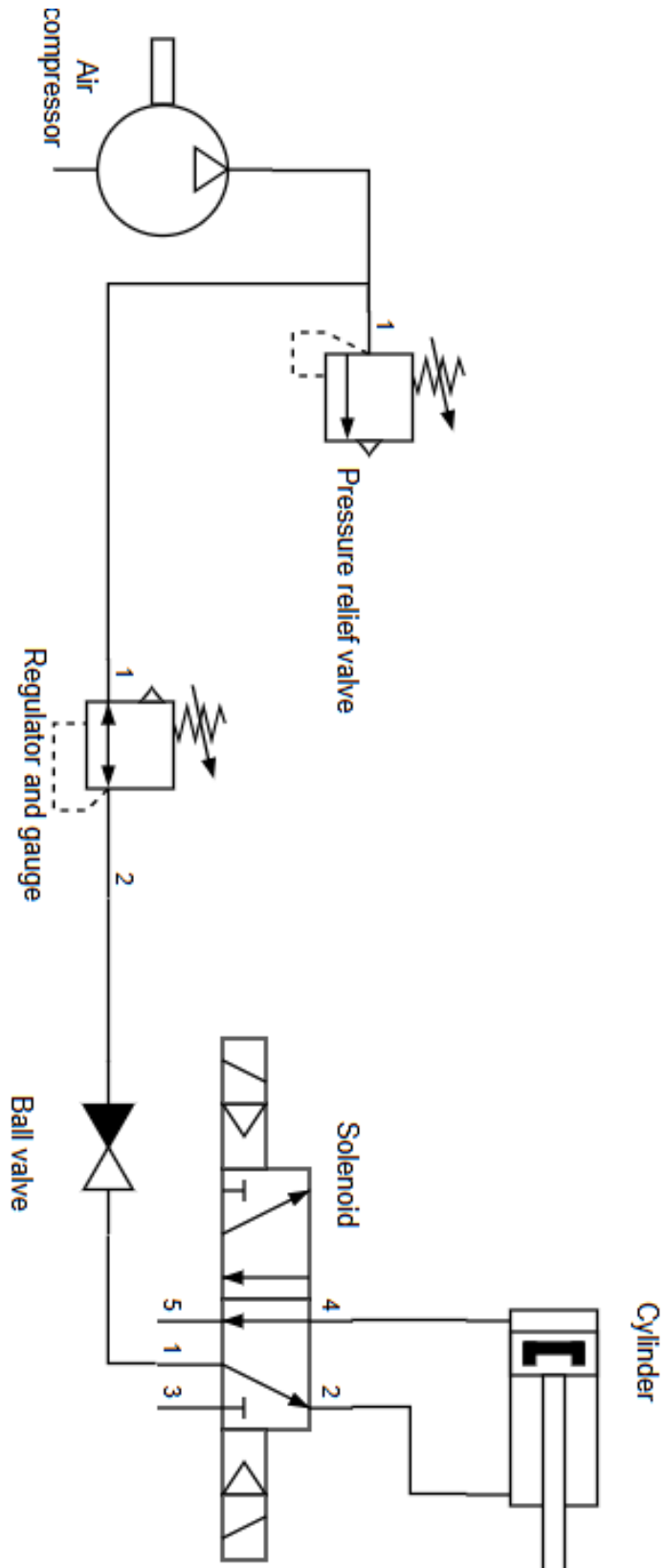
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Appendix A



Appendix B



Appendix C

Category	Type	Expense	Amount	Reporting Period
Frame	Donated	Frame filament	\$ 70.00	From: 01 July 2025 To: 30 June 2026
Thrusters	Reused	T200 Thrusters	\$ 2,064.00	
Tether	Purchased	Wire, ethernet, tubing	\$ 100.00	
Penetrators	Reused	Blue Robotics WetLink	\$ 150.00	
Penetrators	Purchased	BTE Cobalt connectors	\$ 250.00	
Enclosure	Reused	Aluminum watertight enclosure	\$ 634.00	
Control Box	Purchased	Milwaukee Packout case	\$ 85.00	
Raspberry Pi	Reused	Pico, Pi 5	\$ 168.00	
Cameras	Purchased	USB cameras	\$ 280.00	
Pneumatics	Purchased	Tubing, solenoid, piston	\$ 170.00	
Gripper	Purchased	NEMA 17 stepper motors	\$ 170.00	
Monitors	Purchased	Topside monitor	\$ 60.16	
Controllers	Reused	Logitech controllers	\$ 70.00	
ESCs	Reused	Blue Robotics ESCs	\$ 360.00	
Buoyancy	Reused	Subsea R-3312	\$ 48.00	
Total (ROV)			\$ 4,679.16	
Travel				
Hotel Lodging	Purchased	6 nights, 3 rooms	\$ 5,100.00	
Airfare	Purchased	Flights to and from St. John's	\$ 3,600.00	
MATE ROV Registration	Purchased	EXPLORER registration	\$ 650.00	
Total (Travel)			\$ 9,350.00	
Grand Total			\$ 14,029.16	

Appendix D

Budget

School Name: East Tennessee State University

Reporting Period

From: 01 July 2025

To: 30 June 2026

Income Source	Amount
Student Government Fund	\$ 8,960.00
Tennessee Machine Tool	\$ 250.00
Cardinal Glass	\$ 500.00
Elevate Gym	\$ 250.00
United Steelworkers	\$ 250.00
Streamworks	\$ 1,000.00
Polymaker	\$ 200.00
Applied Industrial Technologies	\$ 250.00
ETSU Research Corp	\$ 8,700.00

Expense	Category	Description/Examples	Projected Cost	Budgeted Value
Hardware	Purchased	Enclosure, fasteners	\$ 800.00	\$ 800.00
Hardware	Re-used	Enclosure, thrusters	\$ 2,500.00	-
Hardware	Donation	Polymaker filament	\$ 200.00	-
Electronics	Purchased	PI 5, PCBs	\$ 800.00	\$ 800.00
Electronics	Re-used	ESCs, monitor	\$ 1,000.00	-
Sensors	Re-used	Bar02, Celsius	\$ 200.00	\$ 200.00
Travel	Purchased	Lodging, rental car to MI	\$ 10,000.00	\$ 10,000.00
General	Purchased	Team Shirts	\$ 500.00	\$ 500.00
Total Income			\$	20,360.00
Total Expenses			\$	12,300.00
Total Expenses (with re-used/donations)			\$	16,000.00
Remaining Amount			\$	8,060.00



Preflight Prep

1. Connect to power
2. Notify team members power has been connected
3. Flip on power
4. Pilot call out "Power on"
5. Team member place ROV in water
6. Team member calls out "hands-off"
7. Initiate Motor test
8. Pilot drive Forward
9. Pilot Turn Right
10. Pilot Turn Left
11. Pilot Lift Down
12. Pilot Lift Up
13. Pilot Drive Back
14. Pilot call out "Motor Test Complete"
15. Visual systems Check
16. CEO asks teammates if systems are ready to go
17. When all confirmed, CEO says "mission launch"