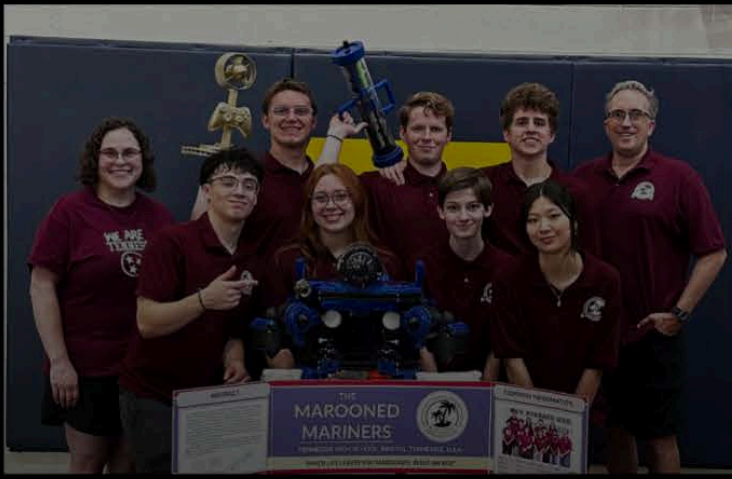




TECHNICAL DOCUMENT

THE MAROONED MARINERS 2026

Appalachian Highlands | Ranger Class | Tennessee High School |
Bristol, TN, U.S.A.

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ELECTRICAL & FLOAT:

*Composed of
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Left to Right, Back to Front: Luke Sah, Lily Chen, Luke Hicks, Galilee Sah, Moaaz Khalil, Cameron Bell, Noah Fernandez, Jose Vasquez, Dr Benji Lewis, Astraia Kudela, Aiden Bunning. **Not Pictured:** Alyssa Ison, Dominic Shipley, Chloe Whitt.



1.1 ABSTRACT

Based at Tennessee High School in Bristol, TN, the Marooned Mariners is a company that is composed of twelve members. The group is dedicated to the design, construction, and marketing of an ROV created to approach specific modern issues in a range of aquatic environments. For the 2026 year, these intended tasks reflect problems found along the coast of New Foundland and Labrador, Canada.

The team has approached these issues with the creation of two devices: an ROV and an autonomous float. These serve as the company's products and have been carefully curated in accordance with their intended environment and use. In general, these products have been designed in consideration for the needs and specifications of the Ranger Class for the 2026 MATE ROV Competition.

The ROV, named Thrudgelmir, has been expanded and improved with new features and modifications. Its design involves specific elements which reflect their use in the competition.

Due to the reuse of the ROV's structure from 2025, the name Thrudgelmir has been preserved. It is derived from Norse mythology, a theme chosen from Tennessee High's viking mascot, and is a six-headed giant that is noted for his swimming abilities. These features reflect the six thrusters of the ROV and its agile nature in the water, respectively.

In the production of the ROV and float, the team has worked to its goal of creating technological solutions that serve in improving aquatic environments and supporting a variety of ecosystems.



Figure 1, Team Photo: *Members and mentors of the team at the regional competition. (Courtesy of Alyssa Ison)*

1.2 COMPANY OVERVIEW

The company is composed of students at THS from 10th to 12th grade. These members have specialized in at

least one of five groups: mechanical, electrical, software, float, and marketing. However, these groups are non-restrictive



as members often collaborate and work in other fields.

In leadership, there are three positions with different responsibilities that contribute to creating a safe and productive working environment. Lily Chen and Luke Hicks are the Co-Chief Executive Officers (CEO) and are responsible for organizing and piloting team efforts. Aiden Bunning is the Chief Financial Officer (CFO) and is responsible for keeping track of company spending and leading fundraising efforts. Astraia Kudela is the Safety Officer and is primarily responsible for ensuring that all

work environments are safe prior, during, and after work.

Cameron Bell, a member of the mechanical team, is also the driver of the ROV during product demonstrations.

Each of the five groups is directed by a lead that is responsible for assigning tasks related to the goal of that branch of the company. These leads have been chosen based on experience and communication skills.

There are two mentors: Dr. Benji Lewis and Alyssa Ison. Both are teachers in the science department at Tennessee High School and offer unique advising.

1.3 PROJECT MANAGEMENT

The company has worked to manage the project of Thrudgelmir in a way that maximizes its resources and opportunities to create a vehicle that is effective and efficient. These efforts have also been made in consideration of natural impacts and competition requirements.

All monetary resources, such as grants and raised funds, have been primarily managed by the team's CFO, Aiden Bunning. For the purchasing of items, the team has a system for members to request an item; these requests include a provided cost, reason, and link. These items can then be bought by one of the team's mentors through a purchase order provided by Tennessee High.

All hardware is stored and organized in respective locations for efficient access. At the start of the year, the remaining and recycled items from the previous year, along with all tools, were accounted for during a reorganization process. Members have access to these resources when they are needed.

The team has also established consistent procedures to keep an updated and successful work environment. This includes an attendance sheet, where all members log the time they spend in scheduled meetings, and check-in meetings. At every meeting, each of the groups is responsible for recording notes on the work completed during that time.



The scheduling process for meetings is completed by the mentors weekly. These plans are completed in consideration of members' schedules and the time till competition with progressive increases in frequency and duration.

The structure of the company also assists in solving possible operation problems. If a member has a question or concern, they can seek guidance from the lead of their group. If needed, an inquiry can continue up to the CEOs and mentors.

PROJECT TIMELINE

An important part of the team's management efforts has been the establishment of a timeline. The members

of leadership sit down every month to plan and develop a general task timeline and adjust when needed. This involves the division of work across the months of August through June in consideration of the championship taking place in late June. These divisions include project planning, vehicle design, vehicle construction, project testing, outreach, fundraising, and document writing, as seen in **Figure 2**.

Through this timeline, there is a progressive shift from design to testing. During the period of various tests, the team worked with prototypes and final products while making necessary changes.

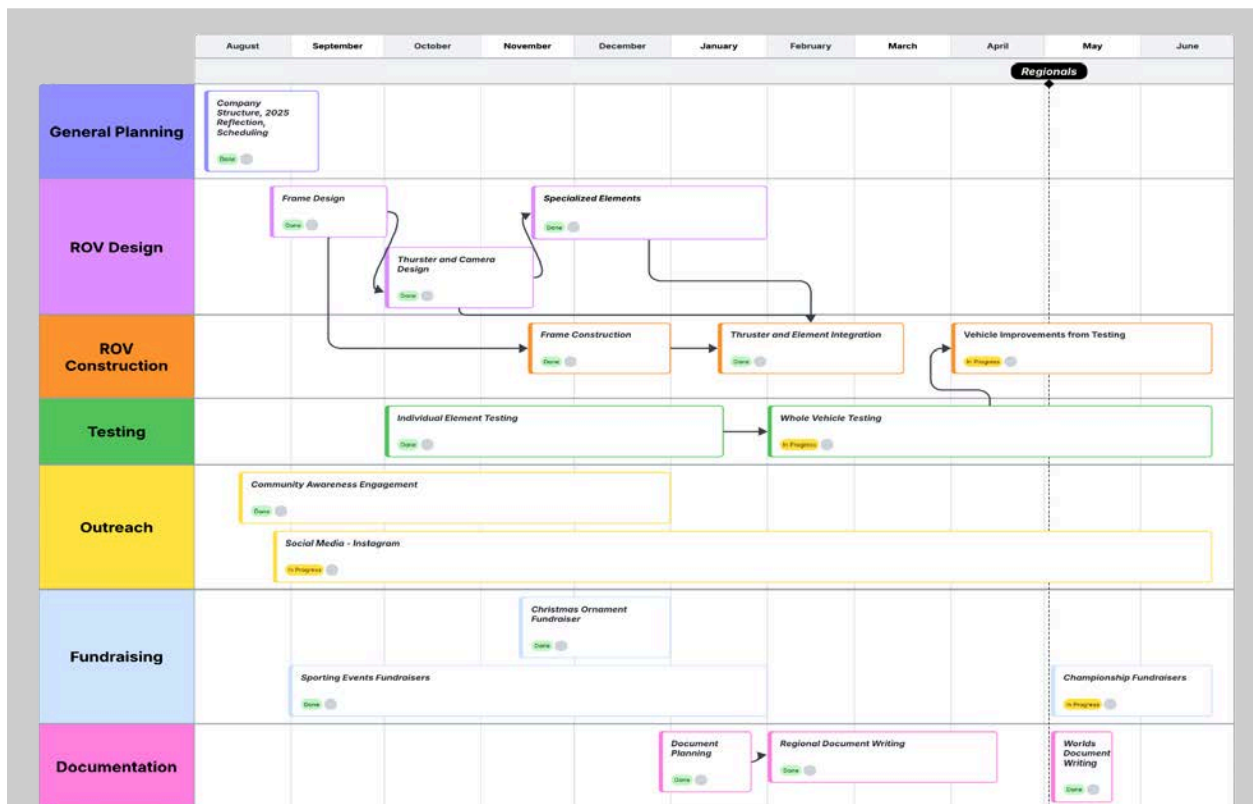


Figure 2, 2026 Timeline: Gantt chart of projects throughout the year. (Aiden Bunning)



2.1 SAFETY OVERVIEW

During the process of designing, constructing, and testing the vehicle products of the Marooned Mariners, it has been a priority of the team to make sure that all involved members are as safe as possible. The team Safety Officer, Astraia Kudela, has had the responsibility to ensure this is the case through a series of protocols and design adjustments on the ROV.

SAFETY IN VEHICLE DESIGN

Through the design of Thrudgelmir, safety for those involved has been a top priority. This includes thruster shrouds designed in accordance with IP-20 standards to decrease the risk of thruster-based harm.

Additionally, the team ensured that all connection points of the frame have been filed down to a smooth edge, decreasing the risk of a cut or scratch.

There have also been safety precautions in the electrical systems. This involved the waterproofing of all cameras and electrical components using epoxy. This provides a sealed casing that blocks water from interacting with the exposed components. For the full load amps, the total amperage of the ROV system is measured to be at 23.68. This is limited to be below 25A by a fuse.

For task 2.4, the rope being used is an orange and yellow pattern to be easily visible to all personnel, in or out of the water. This level of visibility helps the driver not get tangled during demonstration and possibly result in other safety issues.

In approach to task 2.5, the team has a potentially dangerous rotating task specific tool, the x-wing, on the ROV. To emphasize possible hazards, it was printed with a bright orange PETG and labeled.

The tether also poses a potential risk. To minimize tripping hazards and issues in transportation, straps were added to the cart to hold it in place.

SAFETY IN DAILY OPERATION

Daily, the team has the goal of ensuring the safety of all nearby persons. The team utilizes curated room divisions, safetyware, and a safety checklist to make this the case.

To approach potential hazards of tools and workspace conflicts, the team has divided its space based on work type. One section has been defined as having a focus on higher intensity mechanical and electrical work. This section, in itself, has also been divided with an area dedicated to hands-on mechanical work, such as the assembly of the ROV, and another that is primarily meant for electrical work, such as soldering and control box design.



The other area is reserved for members working on less intensive projects with non-dangerous work. This includes the work of the marketing team and CAD designing. This division ensures that possible hazards from specific projects are contained and do not pose a risk to others.

Outside of passive precautions, there are also active precautions. Daily, the

team ensures to follow the safety checklist: this has been established so all members approach work carefully, are aware of nearby work, and are wearing the proper gear with the necessary training.

While precautions cannot purely prevent a chance of injury, the team works consistently to implement all possible safety efforts.

2.2 SAFETY CHECKLIST

To ensure that all personnel involved in the construction and operation of the ROV are at a low risk of harm, the Marooned Mariners have developed two safety checklists. One list is used during standard, landside work on the vehicle, and the other is used when operating the vehicle for landside or in-the-pool tests.

When using these lists, if one of the safety criteria is not fulfilled, the Safety Officer is responsible for assessing changes that can be made to fulfill it.

WORK SAFETY CHECKLIST

To safely proceed with standard operations of construction, **all** of the following criteria must be met:

- ☐ All involved and nearby personnel are aware of any possible hazards in the workplace. This includes, but is not limited to, sharp objects, live power, and moving parts.

- ☐ Those working with tools are knowledgeable about all functions and possible dangers. Additionally, they are informed about the proper reaction to an injury.
- ☐ The work area is clear from any possible obstacles or additional hazards. The following criteria must be met:
 - ☐ Power cords are placed in such a way to minimize obstruction and the risk of tripping.
 - ☐ Work is being completed in its respective area with consideration for others on different projects.
- ☐ During potentially hazardous work, there is someone else present, particularly a mentor if possible.
- ☐ All personnel involved and nearby are wearing proper protective



attire. This includes safety glasses, closed-toed shoes, no loose clothing, and gloves when necessary.

- ☐ Before and after work is completed, involved members wash and dry their hands.

TESTING SAFETY CHECKLIST

To safely proceed with standard testing and vehicle operation, **all** of the following criteria must be met:

- ☐ Before the vehicle and related components are transported, they are secured to decrease the risk of falling or serving as a hazard to personnel.
- ☐ All members involved or nearby through the testing process are aware of any possible pool-side hazards. This includes, but is not limited to, tethers, power cables, or props.
- ☐ All vehicle pieces are confirmed as secure and watertight prior to being submerged in the water. This should

be regularly checked through the testing process.

- ☐ All electrical components on the vehicle and in the electrical box are functioning properly prior to transport or being submerged.
- ☐ The pool-side components have been set-up in an orderly manner to decrease possible risks.
- ☐ During the process of deploying and retrieving the vehicles, involved members are careful and conscious to pose little risk of damage to the vehicles or harm to members.
- ☐ Through operation, the tether is monitored by a member of the team as their sole responsibility to ensure entanglement and possible strain issues do not occur.
- ☐ All personnel involved and nearby are wearing proper protective attire. This includes safety glasses, closed-toed shoes, no loose clothing, and gloves when necessary.
- ☐ Before and after testing, involved members wash and dry their hands.

3.1 ROV OVERVIEW

Thrudgelmir was started for the 2025 competition. This original design involved a larger frame, different tools, and different placements for features such as the claw, cameras, and thrusters.

This year, the design of the vehicle has been modified to better approach the new issues while also accounting for the determined improvements from last year's successes and struggles.

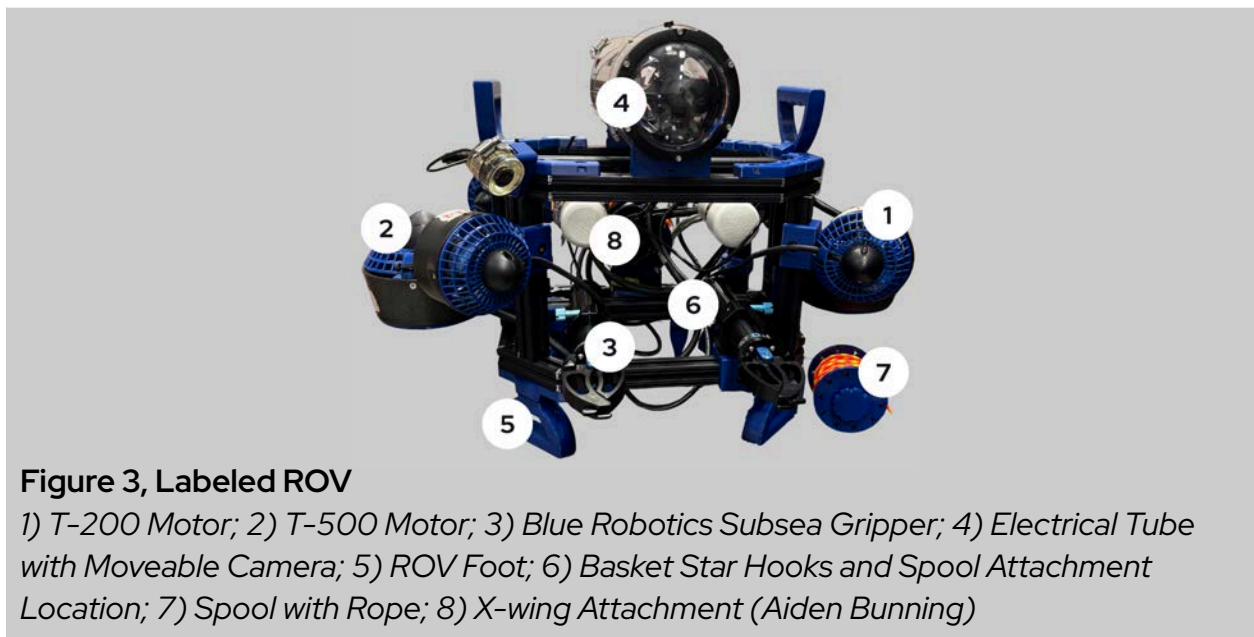


The 2026 ROV is composed of an aluminum frame with four T-200 and two T-500 thrusters. To perform the intended tasks, there are features such as two claws, three analog cameras, a panning Blue Robotics Low-Light HD Camera, and specialized elements for unique tasks.

At the top of the vehicle, there is a water-tight acrylic tube that holds a depth sensor and the panning camera.

Thrudglemir is powered through a tether that is linked to an electrical control box onshore. This box utilizes displays for the ROV's cameras and switches for control of the vehicle's power.

Overall, Thrudgelmir has been created to achieve the company's goal with considerations of making the most effective and efficient ROV possible.



3.2 ROV STRUCTURE

In the design of the ROV, the underlying structure has been a primary focus to ensure that the ROV is strong while also being agile and lightweight.

VEHICLE FRAME

The ROV features a structure that has been designed in the shape of an octagonal prism. This choice of shape has

been based on the capabilities of the thrusters (see 3.4).

The frame, by itself, has the dimensions of 36.68 x 29.06 x 22.86 cm.

The dimensions were decreased this year from the previous version of Thrudgelmir. This choice comes from a few key advantages: a decrease in weight



and improved mobility. However, this choice has posed a disadvantage of the compact nature of the vehicle's interior. This has led to some degree of restrictions on the placement of interior tools.

The choice to continue with the T-slot aluminum in a thin structure, which does not reflect a compromise in strength, results in a more hydrodynamic and lightweight structure. The 1" T-slot, specifically, was chosen for its compatibility with various forms of custom brackets and mounts.

BRACKETS AND MOUNTS

The frame has been connected structurally through custom brackets that have been designed through CAD software and printed. These brackets were all printed from PETG (see 3.9).

While these brackets generally follow a similar design to those from last year, they have been updated with a new feature: a drainage hole. This allows for water to drain out of the open spaces, such as the bolt holes, and decreases rust.

The brackets on the bottom of the frame have also been designed to serve another purpose: feet for landside resting and to protect against impacts with the ground when submerged. These feet were added this year in response to the planned tool placements on the bottom of the frame.

Also, mounts have been designed for elements such as thrusters and claws. While using some ideas from last year, there have been changes to improve durability and decrease resource use.

The analog cameras have also all been attached with custom mounts. For flexibility throughout use, these mounts have been designed with a ball and socket joint that can be adjusted by hand throughout the product demonstration.

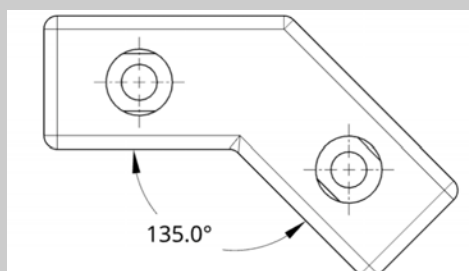


Figure 5, Bracket: A CAD drawing of a bracket designed by Dominic Shipley. (Aiden Bunning)

ADDITIONAL ELEMENTS

Beyond the primary framework, there are additional structural pieces.

On top of the frame, there is a watertight enclosure that serves as the primary electrical housing on the vehicle itself. This is an acrylic tube that has a diameter of 4.75 inches, or 12.065 cm. Including the dome, the tube has a length of 14.5 inches, or 36.83 cm.

This tube serves as the home for the panning camera and a depth sensor.



The structure also plays a major part in providing buoyancy.

Additionally, for easy handling in and out of the water and on land, there are

handles on either side of the top of the frame. These have been custom designed to be a perfect fit with the deployer's hand.

3.3 SPECIALIZED TOOLS AND PAYLOAD

In the design of the ROV, there are many specialized tools that serve to complete specific tasks. Most of these features have been designed by the team in response to the MATE competition.

BLUE ROBOTICS CLAWS

For general use through a variety of tasks, namely 1.1, there are two Blue Robotics Newton Subsea Grippers on the front of the ROV.

In previous years, the team has used one claw as the primary tool through all tasks. With specialization for tasks, an additional claw was determined to be beneficial. Particularly, the claws assist in the collection of coral species.

These claws have been placed in two key positions for the best approach in these intended tasks. These positions, as seen in 3.1, allow for access to any props in front of the vehicle.

BASKET STAR HOOKS

In a specific approach to task 1.1, the team has designed a 3D printed three-pronged hook that attaches to the bottom frame. This is a part of a new compatibility system on the ROV. The two

hooks can be screwed on and off based on need.

The hook has the intention of picking up an O-ball basket star with the vehicle descending upon it, inserting the hook, and rising to the surface with the basket star sample.

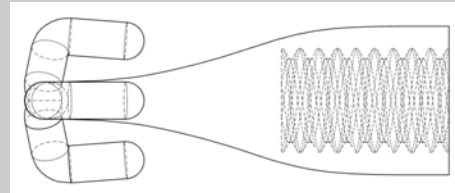


Figure 6, Hook: *The hook with the interior thread outlined, which was designed by Dominic Shipley and Cameron Bell. (Aiden Bunning)*

ROPE AND SPOOL

Another task-oriented tool is a spool with a rope for task 2.4. This assists in attaching a line to a buoy anchor.

This is an attachable piece that holds the rope to ensure that it is not entangled during ROV motion.

For the rope itself, a braided paracord was chosen so that it is water resistant and adds little weight to the ROV.





Figure 7, Spool: *The spool was designed to be removable by Astraia Kudela and Chloe Whitt. (Chloe Whitt)*

GEARBOX AND X-WING

Additionally, an attachment was designed to complete task 2.5. The task asks for the ROV to remove biofouling from the subsea observatory. This involves the rotation of a prop.

In response, the team has designed a four-pronged x-wing adapter. It is attached to a stripped down T-200 motor that is controlled from the landside control box.

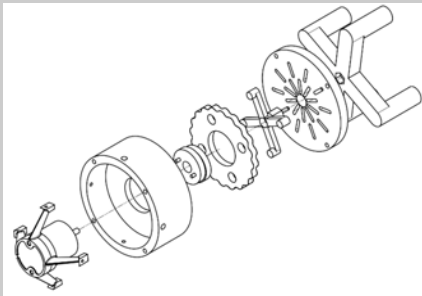


Figure 8, Gearbox and X-wing: *The tool, depicted in its multiple parts, was designed by Dominic Shipley and Cameron Bell. (Dominic Shipley)*

This motor was not powerful enough to rotate the task 2.5 wheel. To

increase the torque and slow down the motion, a cycloidal gearbox was designed and 3D printed. Multiple gear ratios and tolerances were tested before the final device was successfully employed.

CAMERAS

Across the vehicle, there are three analog cameras and one panning camera that all serve as views into unique perspectives for driving and tool usage. Two of the analog cameras are to be used at any given time.

One camera is on the bottom of the frame in reflection of task 1.3. This will allow the driver of the vehicle to gain information and create the necessary video for the transect over the coral garden. This camera will also offer a view of the basket star hooks and spool for proper alignment.

The other used camera has been placed on the back of the vehicle in a way that offers a view of the x-wing attachment that is connected to the back of the frame.

The third analog camera has been added to the vehicle as a spare. The mount allows for the camera to be placed at any location along the frame.

The panning camera, a Blue Robotics HD Camera, sits in the front of the watertight enclosure. This camera, which has the ability to be moved automatically from the controller, provides



a view of the landscape in front of the vehicle, particularly providing an advantageous look at the claws.

SENSORS

To gather other pieces of necessary information, the team has added a depth and pressure sensor. This is a Blue Robotics piece that has been placed at the rear of the enclosure.

3.4 PROPULSION

The ROV is propelled through a combination of six thrusters. Their placement serves to maximize thrust for efficiency in water mobility based on vector thrusting.

These thrusters are from Blue Robotics and have all been reused this year in a very similar approach to last year.

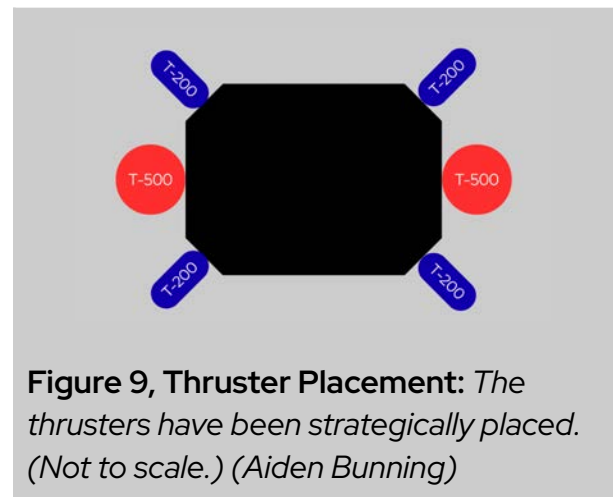
There are four T-200 thrusters placed at the angled parts of the frame for horizontal movement.

There are two T-500 thrusters that are placed on the left and right sides in an orientation for vertical thrust.

The horizontal thrusters have been placed at a 45 degree angle from the front of the vehicle. This allows for all thrusters to contribute when moving in any direction. This results in an increase in thrust and more efficient rotation.

The sensor was added to provide an improved idea of where the ROV is in the pool at any moment. Additionally, the sensor can assist in the measuring of heights. With the ability to measure depth, the vehicle can then move along the height of an item and record the change.

With only two vertical thrusters, the T-500s allow for greater power in this direction.



Alongside these choices, there are also many trade-off considerations. For example, the addition of the T-500s for powerful vertical thrust has resulted in a significant addition of weight. Given the mission requirements, the weight addition has been determined justifiable.



The motors have also been a large factor in the cost of the vehicle. However,

all six have been reused from previous years.

3.5 TETHER AND ELECTRICAL SOURCING

Thrudgelmir is electrically connected to its landside equipment through a tether. This tether has been designed to work in both directions: electricity is sent to the vehicle and information is returned.

The tether is 50' long, or about 15.24 meters. It is composed of five cables. There are four 12-core cables where most electronics are connected. This includes the claws, standard cameras, and thrusters. This year, an ethernet cable was added for the panning camera and the pressure sensor, which are both located in the enclosure; as a result, the ethernet cable is directly directed from the tether to the back of the tube.

The entire system is electrically connected to a landside power box.

For the total vehicle system, there is a measured full load amperage, in water, of 23.68 A. The software limits this to 20 A. *View 3.7 for more software information.*

TETHER MANAGEMENT

The team, for the safety of all members and to protect electrical components, has established a set of

tether management protocol and elements. These points have been highlighted:

On-Deck Advisor

During the product demonstration, an on-deck member will be responsible for handling the tether at the side of the pool.

Tether Awareness

The tether is to be on a side of the deck that has been agreed upon.

Strain Relief

A system of tether strain relief was designed and installed by the team. Its design uses a slight "S" curve to latch onto the ROV's tether securely.



Figure 10, ROV-Side Strain Relief: *The strain relief design on the ROV by Cameron Bell. (Aiden Bunning)*



3.6 LAND-SIDE EQUIPMENT

On the pool side, there are additional elements that serve as the control center for the vehicle and related elements.

The primary land-side element for the ROV is the control box. Built upon the structure of previous years, the box serves a few primary purposes: directing electricals, controlling basics, and sending signals.

Inside the box, similar controllers are lined up together for convenient access and organizations. This includes groups such as thrusters and cameras.

The system is based upon an Arduino Mega 2560 as a microcontroller. The Arduino is responsible for sending signals in response to actions from the controller.

The ROV is controlled by a PlayStation 2 remote controller. The device serves as the input for the thrusters and the claws. The control box features a Bluetooth dongle that serves as the connection to the controller.

With the information from the controller, the Arduino sends signals through the electronic speed controllers (ESCs) to the ROV. Here, the thrusters then move appropriately to the controls.

The box also features four displays that are linked to the cameras on the vehicle. Two of these displays are to be used at any given time with the remainders serving as a back-up if necessary.

The controls directly integrated into the box include the power for the entire system.

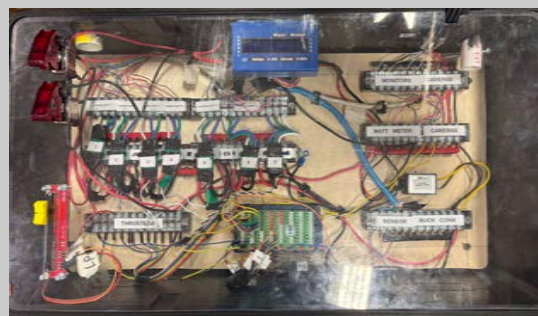


Figure 11, Control Box: *The team's wiring in the control box. (Aiden Bunning)*

3.7 SOFTWARE AND SYSTEMS

Behind the physical tools and structure of the ROV is a system of software that serves to guide the vehicle in autonomous manners in addition to

translating between the operated controls and vehicle actions.

The control systems of the vehicle have been designed to serve as a



connection between the PS2 controller and the Arduino in the control box. It is based on software and C++ code.

To read and interpret the inputs from the controller, the team is using the PS2x_lib.h and Servo.h libraries. The controller has analog outputs that allow for direct communication with the Arduino.

Operator performance was improved with the use of the controller with code set into the joysticks and buttons. The intuitive controls have allowed for clear use by members of the team, specifically the driver.

Outside of the controller, there are additional inputs from controls in the electrical box.

The code features advantages such as the particular intuitive aspect of the remote use, but also has disadvantages of a lower speed than some other programs.

When determining the needs for the control system, the team considered the individual elements and their

requirements. With constant reference to the competition manual, the team worked to plan and write the code. Throughout the process, the work was documented at the top and verified with the leads through means of testing.

SYSTEMS APPROACH

In the design of vehicle and related control systems, the team has approached the issue holistically. This has involved a constant consideration of all aspects of the design to ensure that there is a smooth blend.

With the subgroup structure of the team, innovations in software, mechanics, and electricals were able to occur simultaneously. This has allowed for development that easily works together in a coordinated manner.

The system of the vehicle has been considered as a single entity that works for a unified goal at a time.

3.8 WATERPROOFING AND BUOYANCY

With the ROV being used in aquatic environments, there are other important factors like waterproofing and buoyancy.

WATER PROOFING

For the electrical connections and general elements, waterproofing is a necessary step.

At wire connection points, the solder area has been covered with epoxy. To do so, the team used two 1.5" x 3.5" PVC tubes with endcaps that have been filled with epoxy, protecting the connections placed inside.

The analog cameras have also been waterproofed. With the choice to reuse



these cameras, the epoxy coverings were added years prior and have previously proven their durability. This epoxy surrounds the camera within the defining edges of an acrylic tube.

BUOYANCY

The buoyancy of the vehicle has been a major factor in its design.

The watertight electrical enclosure has been the primary source of buoyancy.

The remainder was added with the addition of high density. The use of foam has been one that easily allows for slight adjustments.

It was determined that the weight of the ROV was 5.97 kg in water. This number was the base for determining the amount of foam in addition to the tube.

3.9 RESOURCE CHOICES AND ENGINEERING APPROACH

Behind all design choices for the vehicle was a system of approaches to ensure that all resources were maximized with the best possible product.

RESOURCE CHOICES

The team has worked to determine the proper materials across the vehicle through the consideration of many factors.

The main resource choices are outlined below:

PETG Filament

For all 3D printed items, PETG (polyethylene terephthalate) was chosen for being durable, easily printable, and recyclable.

Aluminum T-Slot

The aluminum was chosen for the frame as it is relatively lightweight. Additionally, the specific t-slot allows for compatibility.

Acrylic

For the watertight tube, acrylic was chosen as it is lightweight, transparent for the camera, and generally durable.

The process of particularly choosing a resource was based on a few factors: weight, cost, durability, buoyancy, and other potential needs. For a single choice, the team compiled a list of choices and then worked to weigh the factors.

When first assessing the ROV, there were many important decisions to be made. Of these was the decision of what items should be reused or replaced. The considerations have been highlighted below:

1. Ask Questions

What is the intended use of the



item/element?

How did the current element, if there is one, perform previously?

Are there any different requirements for this part this year?

2. Consider Value

What is the value of the current part?

What is the cost/effort of the intended new element?

3. Make Decision

Given the answers to the previous questions, the decision is considered with all factors weighed.

If the previous element was sufficient prior, then the item may be reused. Conversely, an unsuccessful element would likely be replaced. If the performance was lower than intended, it is considered if there is a way to improve that same element.

All reused items have been applicable to the mission requirements for this year. This includes the thrusters, one of the claws, and some of the cameras.

Another important consideration is the decision of whether an element should be purchased or designed by the team.

1. Ask Questions

What is the cost of a purchased part?

How long would it take to design it?

How complex would it be to design the element?

2. Consider Value

Would the time required to design a part justify it?

What is the cost of a new element?

3. Make Decision

Given the answers to the previous questions, the decision is considered with all factors weighed.

If a part would be very complex and time consuming, this element likely would be purchased. For example, the claws were purchased. However, if the cost of a new item is too high given the budget, this would most likely result in a custom design.

ENGINEERING APPROACH

In the designing, constructing, and testing of the ROV, the approach of the team has directly reflected general engineering ideas and procedures.

The engineering approach of the team has been outlined below:

1. DETERMINE MISSION AND GOALS

The first part of the Marooned Mariner's approach, in reflection of the engineering cycle, was the determination of the goals for the year. This was the general mission of creating an ROV to compete in the MATE competition. This also included specific goals like to increase both media presence and the variety of tasks that the vehicle can perform.

2. BRAINSTORM AND PLAN

After agreement over the mission, the team began to brainstorm solutions to reach these goals.

The means of brainstorming is based around sessions for idea collecting that took place when the majority of



members were present, especially subgroup leads. Here, everyone could offer their input into a list over an issue.

3. NARROWING DOWN SOLUTIONS

Members looked through all of the ideas and condensed them down to the best options for that goal. One was selected as the most promising solution; the other ideas were kept as alternatives.

This process of selecting the most prospective idea and comparing alternatives involved assessing many factors of all the options. These included size, time, material usage, and cost.

4. PROTOTYPE, TEST, IMPROVE

With a promising solution, the team invested time and resources into drafts and prototypes for this design. See 5.1 for more testing and assessment information.

5. INTEGRATE AND REFLECT

After creating a finalized element, it was integrated into the vehicle. Here, the

team had a chance to reflect on the process of this particular part. Any possible lessons could then be applied to other designs.

Throughout this approach, the team strives for innovation that allows for improved effectiveness, heightened efficiency, and decreased cost.

The design of the vehicle has continued to evolve throughout the year in response to the competition. At the start, the team based plans on last year's requirements. As more information was released from MATE, designs were adapted for competition requirements. This included the addition of elements like the basket star hooks and x-wing.

Reducing the cost of the vehicle has also been a consideration during the design process. A primary means of doing so has been the decision to design and 3D print most brackets and mounts.

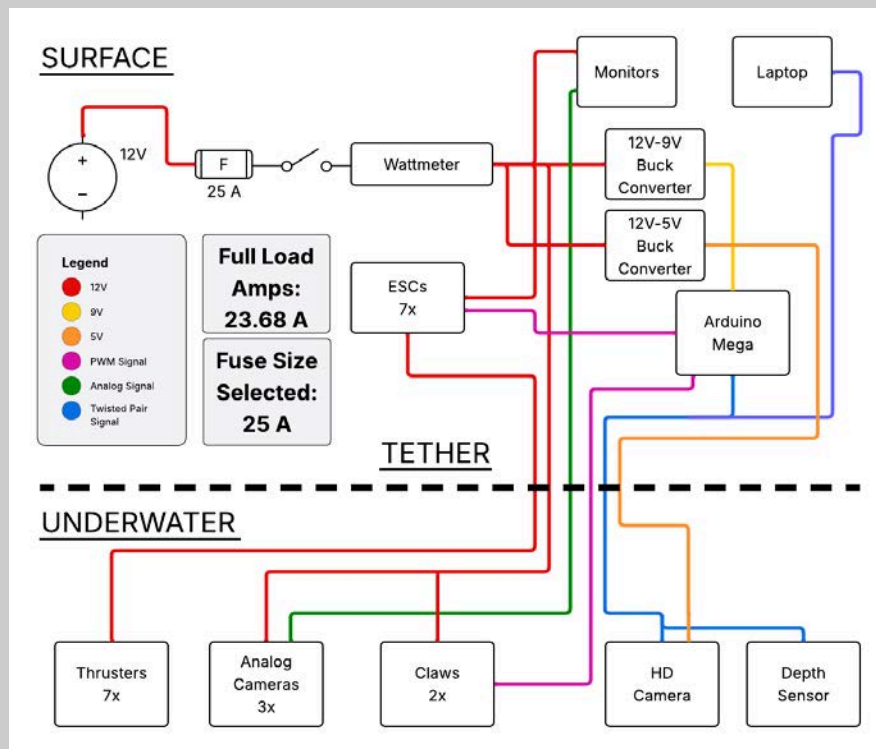
4.1 SYSTEM INTEGRATION

A System Integration Diagram has been created to reflect the electrical set up of the ROV and its connected components. These components have been divided into two major categories: on

the surface and below the water. Additionally, specific types of connections and voltages have been color coded.

This diagram can be found below.





5.1 TESTING AND TROUBLESHOOTING

During the process of producing the ROV and adjacent features, testing has been a primary piece to ensure that all products are as effective as possible.

Overall, the team has put its products through at least 20 hours of testing in all aspects, including poolside practices and stress testing.

Early landside testing offered opportunities for improvements in the designs of individual elements.

This involved the use of prototypes and followed the testing methodology seen below:

1. Review Design in CAD

After an element has been designed, other members in the same subgroup review the part.

2. Print and Test Prototype

After any recommended changes, the part is printed at a low infill and is tested for its needs. It is accounted for that there is decreased strength.

3. Assess Tests and Move Forward

Following the tests, members can determine if any changes need to be made. If so, the process is repeated. If the tests are satisfactory, then the part can be printed at a greater infill in the necessary quantity.



A direct example of this testing is in the basket star hook. The tool went through multiple designs. These changes include a switch from four prongs to three. The screw system was also adjusted following printed prototypes.

When testing the whole ROV, a specific process has also been established. This methodology has been outlined below:

1. Set Up and Review Safety

All needed equipment and elements are set up. Following this, the operation safety checklist is considered for a safe testing site.

2. Power Up and Test

The necessary elements are powered up and are checked for proper function with additional safety considerations. Following this, the ROV undergoes necessary drive throughs.

3. Assess Tests and Move Forward

Following the tests, members can determine if any changes need to be made. If so, the process is repeated. If the tests are satisfactory, then the team can move onto another element or task.

Most general functions of the ROV follow this testing methodology, often all tested at the same time. This includes electrical, thruster, and claw functions.

The complete vehicle testing, when possible given waterproofing restrictions, took place in the pool. This allowed for a more comprehensive idea of how the vehicle was functioning in its intended environment and possible improvements.

TROUBLESHOOTING

Problems are an often occurrence when dealing with complex hardware and software. In response, the team has a standardized troubleshooting procedure.

However, this approach must be flexible as issues can greatly vary.

The guidelines for this process have been outlined below:

1. Identify the Issue

Identify the problem and record a general description of the occurrence.

2. Determine Possible Source

Predict a possible cause for the issue.

3. Test Source and Assess

*Test ways of addressing and solving the source. If the problem is fixed, then the process is completed. If this is not the case, restart the process at **step 2**.*

This process can be used in many instances. Particularly, this approach was beneficial during work on the electrical and software systems of the vehicle.

6.1 PROJECT BUDGET

An important part of managing the project is establishing a budget. This plan

was created upon the initial ideas of the team and the expenses of previous years.



Throughout the year, the team has referred to the budget to ensure that each purchase follows in line with the intended spending in that category and for the overall project. If a category starts getting

close to surpassing the budget, new considerations are made for ways to decrease spending.

This budget for the 2025-2026 year is outlined below.

Time Period:	2026 Competition Year: 8/4/25 - 6/27/26			
Anticipated Income:				
Category:		Description:	Amount:	Budgeted:
Team Fundraisers		3D Printed Sales	\$,1500.00	\$1,500.00
2026 Engineering Grant		From BTES	\$2,000.00	\$2,000.00
Donations, Sponsors, Funds		Community Funding	\$20,000.00	\$20,000.00
Total:			\$23,500.00	\$23,500.00
Expenses:				
Category:	Source:	Description	Amount:	Budgeted:
Mechanical	Purchase	Filament, ROV Tube	\$700.00	\$700.00
Mechanical	Reuse	Motors, Frame	\$3,000.00	\$0.00
Electrical	Purchase	Tether, Camera	\$1,000.00	\$1,000.00
Electrical	Reuse	Control Box, Cameras	\$750.00	\$0.00
Special Elements	Purchase	Float, 2nd Claw	\$1,000.00	\$1,000.00
Special Elements	Reuse	Claw, Controller	\$1,000.00	\$0.00
General	Purchase	Shirts, Mark. Materials	\$300.00	\$300.00
Travel/Lodging	Purchase	World Championship	\$21,000.00	\$21,000.00
Total Vehicle:			\$7,450.00	\$2,700.00
Total Expenditure:			\$28,750.00	\$24,000.00



6.2 PROJECT FUNDING AND ACCOUNTING

Throughout the year, the company has kept a precise record of all income and expenses. This has then offered a chance for a budget variance analysis.

There have been two primary sources of funding for the team's projects: fundraisers and grants.

The fundraisers of the team include the sale of student designed 3D printed items. These sales were based on the team's presence at THS events and holiday fundraisers with seasonal items.

The team received the "2025-26 Engineering & Robotics Grant for Tennessee Schools" from Bristol Tennessee Essential Services (BTES). This was administered through the Bristol Chamber of Commerce for the amount of \$2000.00. All purchases were restricted to only planned items.

The total income of the team has been recorded in the table:

Category:	Description:	Amount:	Budgeted:
Team Fundraisers	3D Printed Sales	\$2,856.00	\$1,500.00
2026 Engineering Grant	From BTES	\$2,000.00	\$2,000.00
Donations and Sponsors	Community Funding	\$10,000.00	\$20,000.00
Championship Funding CTE	For Travel Expenses	\$11,800.00	
Total:		\$26,386.00	\$23,500.00

The accounting record of the team can be viewed in the table on **page 24**.

There was a total of \$7029.80 worth of material used with \$6688.62 on the ROV itself. Of this amount, \$5552.78 was from reused materials. \$1477.02 was spent on new materials.

Accounting for the sources of income, there can be a determined balance of the team of \$2,359.65 when including all reused items. However, when looking at the money spent the team has a balance of \$7,903.43. This money, while not being accounted for spending yet, can be reserved for any additional travel expenses and unexpected materials costs.



Date:	Category:	#:	Expense/Item:	Type:	Description:	Source:	Amount:	Balance:
8/4/25	Funding	-	Starting Amount	Re-used	Remainder from 2025	--	(+) \$733.45	(+) \$733.45
8/20/25	Hardware	2	T-200s	Re-used	ROV Thrusters	Blue Robotics	\$1,580.00	\$946.55
8/20/25	Hardware	4	T-200s	Re-used	ROV Thrusters	Blue Robotics	\$920.00	\$796.55
8/20/25	Electrical	1	Scow Terminal Block	Re-used	For Arduino Mega	Amazon	\$32.00	\$1,796.55
8/20/25	Electrical	3	Waterproof Ad Converter	Re-used	For Electricals	Amazon	\$40.47	\$1,839.02
8/20/25	Electrical	2	600 V 15A Scow Terminal	Re-used	For Control Box	Amazon	\$25.98	\$1,865.00
8/20/25	Hardware	1	25 Tia Mounts (100 pc)	Re-used	General Use	Amazon	\$9.99	\$1,874.99
8/20/25	Electrical	1	12 Gauge Wire	Re-used	For Electricals	Amazon	\$29.99	\$1,904.98
8/20/25	Electrical	1	Mini Breadboard Kit	Re-used	For Arduino Mega	Amazon	\$6.98	\$1,911.96
8/20/25	Electrical	1	22 AWG 12 Conductor Shielded Cable	Re-used	For Electricals	Amazon	\$295.00	\$2,206.96
8/20/25	Electrical	4	7" LCD	Re-used	For Control Box	Amazon	\$23.98	\$2,230.94
8/20/25	Hardware	1	100 ft Braided Slewring	Re-used	For Tether	Amazon	\$22.99	\$2,253.93
8/20/25	Electrical	1	9V Battery Snap Connector (20 pc)	Re-used	General Use	Amazon	\$5.99	\$2,259.92
8/20/25	Hardware	1	8 in. Plastic Test Tubes (50 pc)	Re-used	For Waterproofing	Amazon	\$9.98	\$2,269.90
8/20/25	Hardware	1	Arduino Nano Terminal Adapter (3 pc)	Re-used	For Arduino Mega	Amazon	\$8.79	\$2,278.69
8/20/25	Hardware	1	West System 105A Epoxy Bundle	Re-used	For Waterproofing	Amazon	\$104.47	\$2,483.16
8/20/25	Hardware	1	Polycarbonate Sheet	Re-used	For Control Box	Lowes	\$40.00	\$2,523.16
8/20/25	Hardware	1	Wood Backing	Re-used	For Control Box	Lowes	\$5.00	\$2,538.16
8/20/25	Electrical	1	Crimp Terminals (540 pc)	Re-used	For Control Box	Amazon	\$9.78	\$2,558.94
8/20/25	Electrical	1	Shrink Tubing Kit	Re-used	For Control Box	Amazon	\$1.99	\$2,568.93
8/20/25	Hardware	1	Potentiometer Kit (60 pc)	Re-used	For Control Box	Amazon	\$13.99	\$2,582.92
8/20/25	Electrical	1	Toggle Switch with Safety Cover	Re-used	For Control Box	Amazon	\$9.99	\$2,592.91
8/20/25	Electrical	1	Banana to Banana Plug Test Leads (5 pc)	Re-used	For Electricals	Amazon	\$2.99	\$2,605.90
8/20/25	Hardware	1	Male Adapter Clip (22 pc)	Re-used	For Electricals	Amazon	\$7.29	\$2,623.99
8/20/25	Electrical	1	Fuse Holder (10 pc) + Fuses (50 pc)	Re-used	For Electricals	Amazon	\$2.99	\$2,626.98
8/20/25	Hardware	1	Rare Earth Magnets (5 pc)	Re-used	General Use	Amazon	\$1.99	\$2,638.97
8/20/25	Hardware	4	T-Dot Aluminum	Re-used	For Frame	Granger	\$201.00	\$2,839.97
8/20/25	Hardware	4	BHSCS and T-Nut	Re-used	For Frame	Granger	\$46.04	\$2,886.01
8/20/25	Hardware	30	Inside-Corner Bracket	Re-used	For Frame	Granger	\$245.40	\$3,131.41
8/20/25	Hardware	4	Drop-In T-Nut	Re-used	For Frame	Granger	\$80.64	\$3,212.05
8/20/25	Hardware	2	Newton Subsea Gripper	Re-used	For ROV Function	Blue Robotics	\$1,380.00	\$4,592.05
8/20/25	Hardware	15	End Feed Nut and Screw	Re-used	For Frame	McMasterCarr	\$60.00	\$4,542.05
8/20/25	Hardware	6	Drop-In Ball Nut and Thread Button Head	Re-used	For Frame	McMasterCarr	\$32.64	\$4,578.89
8/20/25	Hardware	4	Corner Brackets	Re-used	For Frame	McMasterCarr	\$38.84	\$4,617.73
8/20/25	Hardware	3	Fitting for Drilling Water	Re-used	For Float	McMasterCarr	\$6.97	\$4,624.70
8/20/25	Hardware	1	Nylon Plastic Tubing (100')	Re-used	For Float	McMasterCarr	\$37.00	\$4,661.70
8/20/25	Hardware	4	Tube Fitting for Air	Re-used	For Float	McMasterCarr	\$9.36	\$4,671.06
8/20/25	Hardware	2	Fitting for Drilling Water (P-to-Connect)	Re-used	For Float	McMasterCarr	\$4.58	\$4,675.64
8/20/25	Hardware	1	Tube Stock	Re-used	For Float	Granger	\$82.62	\$4,758.26
8/20/25	Hardware	2	Switch	Re-used	For Float	Blue Robotics	\$50.00	\$4,808.26
8/20/25	Hardware	1	Burn O-Ring 3-1/4" (25 pc)	Re-used	For Float	Amazon	\$1.17	\$4,809.43

9/9/25	Hardware	1	Camera Tilt System with Mount	Purchase	For ROV Function	Blue Robotics	\$66.00	\$4,885.43
9/9/25	Hardware	1	Low-Light HD USB Camera	Purchase	For ROV Function	Blue Robotics	\$14.40	\$5,019.73
9/9/25	Electrical	1	Electronica Tray, Terminal Block	Purchase	For Electricals	Blue Robotics	\$142.24	\$5,197.97
9/9/25	Hardware	1	Waterlight Enclosure	Purchase	For Electrical Tube	Blue Robotics	\$257.60	\$5,418.57
9/9/25	Hardware	1	End Cap (Model 1)	Purchase	For Electrical Tube	Blue Robotics	\$47.04	\$5,465.61
9/9/25	Hardware	1	O-ring Seal (Model 1)	Purchase	For Electrical Tube	Blue Robotics	\$56.00	\$5,521.61
9/9/25	Hardware	1	End Cap (Model 2)	Purchase	For Electrical Tube	Blue Robotics	\$40.32	\$5,561.93
9/9/25	Hardware	1	O-ring Seal (Model 2)	Purchase	For Electrical Tube	Blue Robotics	\$56.00	\$5,617.93
9/9/25	Hardware	1	Pressure Relief Valve	Purchase	For Float	Blue Robotics	\$35.84	\$5,653.77
9/9/25	Hardware	1	Fast-Response Temperature Sensor (°C)	Purchase	For Float	Blue Robotics	\$76.00	\$5,729.77
9/9/25	Hardware	1	Depth and Pressure Sensors	Purchase	For ROV Function	Blue Robotics	\$80.00	\$5,809.77
9/9/25	Hardware	2	Drop-In T-Nut	Purchase	For Frame	Granger	\$4.86	\$5,814.63
9/9/25	Hardware	2	Slide-In T-Nut	Purchase	For Frame	Granger	\$9.98	\$5,824.61
9/9/25	Hardware	1	50mm Linear Actuator	Purchase	For Float	Actuonix	\$100.93	\$5,925.54
1/29/26	Hardware	1	8in Velcro Strap	Purchase	For Tether Mount	Amazon	\$10.09	\$5,935.63
1/29/26	Prop	2	O-Hall	Purchase	For Competition Props	Amazon	\$9.48	\$5,945.11
1/29/26	Hardware	3	Overture PETG Filament	Purchase	For Custom Hardware	Amazon	\$50.97	\$6,034.08
2/4/26	Electrical	1	Tenaya Connectors	Purchase	For Float	Amazon	\$8.69	\$6,042.77
2/4/26	Electrical	1	9.6V Batteries (2 pc)	Purchase	For Float	Amazon	\$29.99	\$6,072.76
2/19/26	Electrical	1	Cat 6 Ethernet Cable (500')	Purchase	For Tether	Amazon	\$149.99	\$6,222.75
2/19/26	Electrical	2	USB - USB-C Cable	Purchase	For Float Connection	Amazon	\$5.98	\$6,233.73
2/19/26	Hardware	1	Resound S50	Purchase	For ROV Function	Amazon	\$12.34	\$6,250.07
3/4/26	Hardware	1	L-Flower Carabiner	Purchase	For ROV Function	Amazon	\$9.99	\$6,260.06
3/4/26	Hardware	1	USB 2.0 Female Plug	Purchase	For Electricals	Amazon	\$10.39	\$6,270.45
3/4/26	Electrical	1	Arduino Nano 33 IoT	Purchase	For Float	Amazon	\$24.90	\$6,295.35
4/1/26	Funding	1	3D Printed Fundraisers	Funds Donated	Company Fundraisers	Community	\$2,866.00	\$3,440.35
4/1/26	Funding	1	Engineering Grant	Funds Donated	Grant for Robotics	BTES	\$2,000.00	\$5,440.35
5/15/26	Travel	9	World Championship Plane Tickets	Purchase	To YYY from CLT	AirCanada	\$10,800.00	\$12,240.35
5/15/26	Travel	6	World Championship Hotel Room	Purchase	For 5 Nights	Munsey Properties	\$5,400.00	\$17,640.35
5/15/26	Food	1	World Championship Team Food	Purchase	For 8 Members	Varies	\$1,800.00	\$19,440.35
5/19/26	Funding	1	Championship Funding CTE	Funds Donated	Alotted Travel Funds	Tennessee High	\$1,800.00	\$17,640.35
5/19/26	Funding	1	Additional Sponsorships and Fundraising	Funds Donated	For Travel	Local Businesses	\$10,000.00	(+) \$2,359.65
							Total of Revised Items:	\$5,552.78
							Total of New Items:	\$1,477.02
							Total of Used on Vehicle Items:	\$7,029.80
							Total of Travel Expenses:	\$19,000.00
							Total of 2026 Expenses (New Items, Travel, Etc.):	\$30,477.02
							Total of All Expenses (New Items, Revised Items, Travel, Etc.):	\$25,029.80
							Total of Income, Donations, and Carried Over Funds:	\$27,389.45
							Final Balance:	(+) \$2,359.65

7.1 SOURCES AND ACKNOWLEDGEMENTS

Through the process of designing, constructing, and testing the ROV and float, the team has gained guidance and support from many other organizations and members of the community. The

Marooned Mariners, in a reflection of gratitude and a desire to provide credit, has created the following lists of sources and acknowledgements.

SOURCES AND REFERENCES

MATE ROV COMPETITION WEBSITE

<https://materovcompetition.org/>

-Accessed Aug. 28th

EASTMAN ENGINEERS

Visited THS Feb 26th.

TEAM MENTORS

Starting Aug. 4th

BLUEROBOTICS

<https://bluerobotics.com/> -Accessed

Sept. 12th

STREAMWORKS ADVANCED ROBOTICS WORKSHOP

-Accessed Aug. 29th

ARDUINO FORUMS

<https://forum.arduino.cc/> -Accessed Sept.

15th

MATE FORUM

<https://materovcomp.discourse.group/>

-Accessed Sept 28th.

BLUEROBOTICS FORUM

<https://discuss.bluerobotics.com/>

-Accessed Sept. 28th



ACKNOWLEDGEMENTS

MATE ROV COMPETITION

The Marooned Mariners would like to show their gratitude to the MATE ROV Competition for organizing the event and providing the educational opportunity to all members of the team.

TENNESSEE HIGH SCHOOL

The team is thankful for the support from Tennessee High School, the school from which the Marooned Mariners operate. Specifically, the Career and Technical Education department of the school has provided many opportunities and benefits to the team, such as \$11,800.00 for travel to the World Championship.

BRISTOL TENNESSEE ESSENTIAL SERVICES

For the engineering grant, the Marooned Mariners would like to provide a special thanks to the Bristol Tennessee Essential Services.

BRISTOL CHAMBER OF COMMERCE

The team would like to provide an acknowledgement to the support provided by the Bristol Chamber of Commerce for administering the engineering grant provided by BTES.

BELIEVE IN BRISTOL

The Marooned Mariners are thankful for the outreach opportunities and community support that has been provided by Believe in Bristol this year.

THE BRISTOL COMMUNITY

For providing support during fundraising events, the team would like to offer their appreciation to the Bristol community.

TEAM MENTORS

The members of the Marooned Mariners would like to provide their gratitude for the mentors of the team, Dr. Benji Lewis and Alyssa Ison, for their constant support and dedication to the team.

