Sunk Robotics

Matthew Harris - CEO, Software Engineer, Sophomore

Noah Gibson - CFO, Float Technician, Sophomore

Zachary Bertocchi - CSO, Outreach Executive, Sophomore

Joseph Campbell - Software Engineer, Freshman

Aaron BenDaniel - Hardware Engineer, Freshman

Grace Kallberg - Fundraising Executive, Gripper Technician, Junior

Francisco Soto-Ortiz - Float Technician, Sophomore

Benjamin Wirz - Hardware Technician, Sophomore

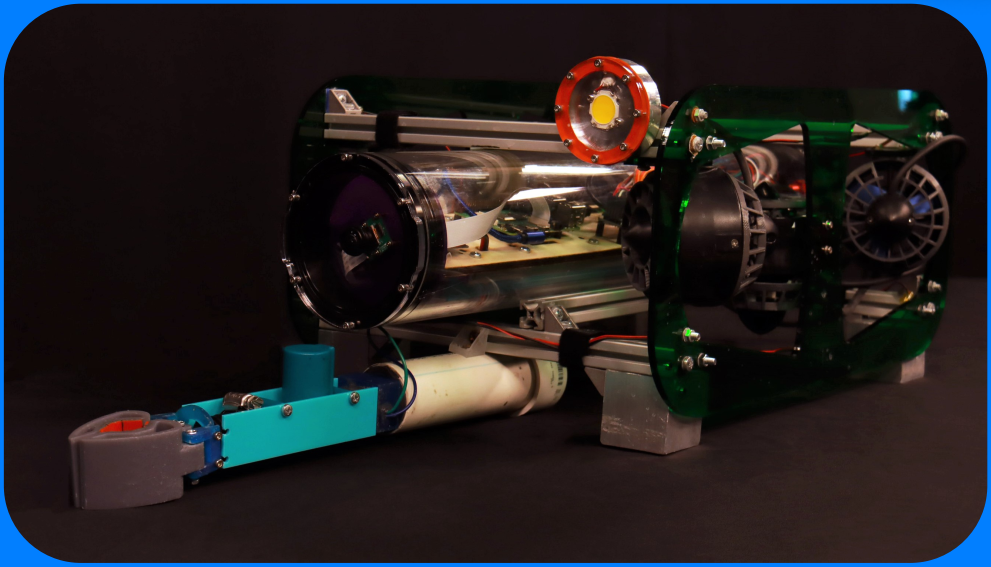
Christopher Hunt - Aquatic Technician, Senior

Samuel Christy - Mentor, MVTHS Instructor

Noah Lewkowitz - Mentor, MVTHS Instructor

Medford Vocational Technical High School

Medford, Massachusetts, United States



STEVE ROV

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Potential Clients

The STEVE Model from Sunk Robotics is designed to aid in the sustainability of the world and the oceans through its ability to conduct ecological operations as well as repair technology that combats climate change, such as offshore wind turbines.

The skillset of the robot would allow for our potential clients to include government agencies attempting to handle ecological crises and companies operating offshore windmills.

Management and Team Roles

The Sunk Robotics team has employed the skills of members from the *Programming and Web Development* vocational shop, the *Robotics and Engineering* vocational shop, and the standard high school. We have divided our Sunk Robotics team into individual subteams working on different subsystems of the robot.

In order to keep all of the small teams at the maximum productivity and ensure that there was no duplication of efforts, we had bi-weekly meetings. During these meetings, we made sure that everyone had something to do and that no one was in need of assistance, as well as caught everyone up on how every part of the ROV was working in case someone would not be able to come to later sessions. We utilized *Discord* as a way to organize communication while keeping all team members informed.

Caption: Joseph Campbell speaking at Bi-Weekly Meeting

Our Team is Made up of The Following Individuals:

- **Matthew Harris** - Programming and Web Development Shop - Sophomore
- **Noah Gibson** - Programming and Web Development Shop - Sophomore
- **Zachary Bertocchi** - Robotics and Engineering Shop - Sophomore
- **Joseph Campbell** - Robotics and Engineering Shop - Freshmen
- **Aaron BenDaniel** - Robotics and Engineering Shop - Freshmen
- **Grace Kallberg** - Robotics and Engineering Shop - Junior
- **Francisco Soto-Ortiz** - Robotics and Engineering Shop - Sophomore
- **Benjamin Wirz** - Medford High School - Freshmen
- **Christopher Hunt -** Robotics and Engineering Shop - Senior

Our Team was Supervised by the Following Individuals:

- **Samuel Christy** - Robotics and Engineering - Vocational Teacher
- **Noah Lewkowitz** - Robotics and Engineering - Vocational Teacher

Roles:

CEO - Matthew Harris
CFO- Noah Gibson
Government Affairs - Zachary Bertocchi
Electrical Project Lead - Joseph Campbell
CAD Project Lead - Aaron BenDaniel
Research and Engagement - Francisco Soto-Ortiz
Research and Development - Benjamin Wirz
Outreach and Fundraising Executive - Grace Kallberg

The Subteams throughout the building of the Sunk Robotics STEVE ROV included.

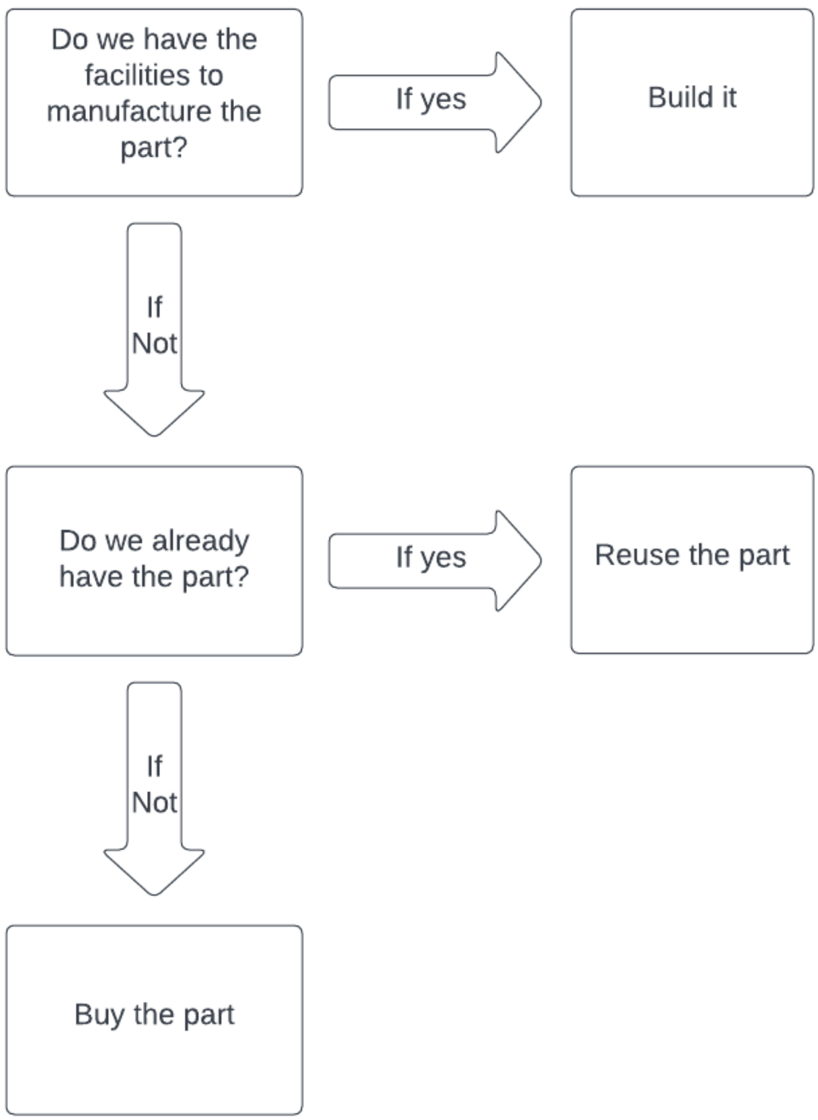
- Camera (Matthew Harris, Joseph Campbell, Aaron BenDaniel)
- Sensors (Joseph Campbell, Matthew Harris, Zachary Bertocchi)
- Wiring (Aaron BenDaniel, Joseph Campbell, Matthew Harris, Ben Wirz, Zachary Bertocchi, Francisco Soto-Ortiz, Noah Gibson)
- Internal board (Aaron BenDaniel, Zachary Bertocchi)
- Motor setup (Chris Hunt, Ben Wirz, Francisco Soto-Ortiz)
- Motor Control (Matthew Harris, Joseph Campbell)
- Web Client (Matthew Harris, Noah Gibson)
- Internal Server (Matthew Harris, Joseph Campbell)
- Lights (Aaron BenDaniel, Ben Wirz)
- Gripper (Ben Wirz, Grace Kallberg)

Abstract

Sunk Robotics is a company based in Medford, Massachusetts. Our team is made up of 10 students, including 2 *MVTHS Programming and Web Development* students, 7 *MVTHS Robotics & Engineering* students, and one *Medford High School* student. Using our team's combined skills, Sunk Robotics has dedicated its time and resources towards engineering and developing an ROV capable enough to perform in the MATE ROV Competition. This year Sunk Robotics has attended the MATE ROV competition New England regional for the first time and won first overall, and will be competing in the MATE World Championship. During the 2019-2020 school year, we made our first attempt at the competition, but the team's efforts were put to a complete halt due to the COVID-19 pandemic that swept the world. Per the *Massachusetts Department of Public Health* and *Department of Elementary and Secondary Education*, schools were closed for a large portion of the school year, leaving us unable to assemble a team and compete in the 2021 MATE ROV competition. This year with many combined efforts, we were able to put together a team of students to assemble the STEVE ROV and compete in this year's competition. The Sunk Robotics team has faced many challenges, the biggest one being that most of us are new to this. With the help of our mentors and fellow students we have made an ROV that we can confidently say we are proud of. While we did buy some fundamental parts such as our T100 & T200 motors, O-ring flanges, Raspberry Pi, etc, we, at Sunk Robotics take pride in the fact that much of the STEVE ROV was designed and manufactured by students using the tools and resources that we have here at *Medford Vocational Technical High School*.

Build, Reuse, Buy Philosophy

Sunk Robotics and our STEVE ROV's core philosophy is sustainability. We highly value reusing and recycling parts. A large majority of Sunk's STEVE ROV consists of parts made locally and resourcefully in the Medford Vocational Technical High School Robotics and Engineering shop. There are some situations where we may have to buy certain parts for the ROV. For example, if there is a part that we do not have the ability or time to produce, then we may have to purchase whatever it is that we need.



System Integration Diagram

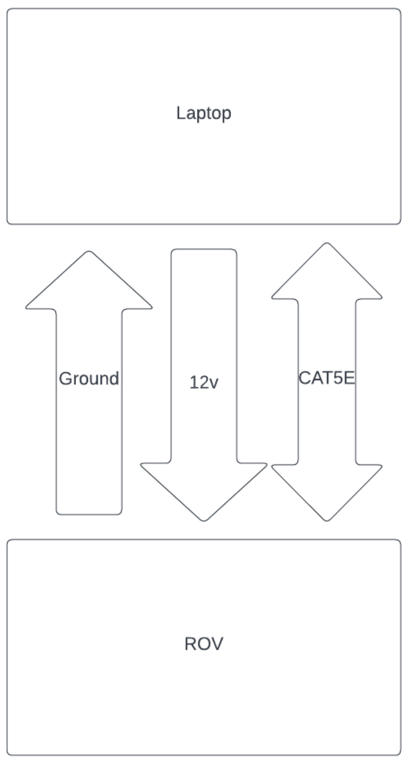
The STEVE ROV frame was designed in the *Robotics & Engineering* shop here at *Medford Vocational Technical High School*. The frame is made up of two side panels made out of green 6mm acrylic. Both side panels are connected using a structure constructed using four *80/20® modular T-slotted profiles*. The ROV also uses two *80/20® T-slotted profiles* to easily access and secure the enclosure.

The electronics tray is made of 6mm inch wood. Components on the electronics tray were loosely 3D modeled and arranged in CAD in order to make sure everything would fit properly and screw holes were placed correctly. Our 10cm acrylic enclosure for the electronics tray was cut here in the shop using one of our chop saws. The STEVE ROV enclosure uses two *Blue Robotics 4" Series O-Ring Flanges* to seal off the enclosure. Mounted on top of our seals are clear acrylic end caps cut using our laser cutters. Both STEVE's electronics board and side panels were also made here in the shop using our *Epilog Laser* laser cutters.

Tether

The tether is a vital part of the ROV. The ROV's operation depends on it, and so does the maneuverability. For this reason, we decided to cut down on as many cables as possible, leaving us with one CAT5E cable and one 16 gauge zip wire for power and ground. The floatation devices on the tether are designed to give it enough buoyancy to still float but not enough to make it more difficult to maneuver.

The tether guide is made out of a 3D printer filament roll. It sits over a base with the same inner diameter keeping it on the base. When the ROV is moving away, it pulls the tether out. When the ROV is returning, the tether manager turns the handle which retracts the tether and makes sure the tether gets stored properly and does not get tangled.



Buoyancy

Buoyancy is a crucial aspect of any submersible vehicle. If STEVE is too buoyant or too dense, valuable current and attention will have to be diverted from other areas in order to keep it above or below the water. Because of this we have taken great care to ensure that STEVE is neutrally buoyant or at least very close to it.

Neutral buoyancy is when the mass of the water displaced by our ROV and the mass of the ROV are equal. Our electronics enclosure is relatively light, but displaces a high volume of water. In order to cancel this out, using our drop saw we cut four 5x5x5 cm aluminum cubes. The cubes act as weights, or as we affectionately call them, “inverse buoyancy modules (IBMs)”.

We sized our inverse buoyancy models in order to make this equation true.

$$Volume\ of\ the\ ROV\ in\ m^3 * 997 = Mass\ of\ ROV\ in\ Kilograms$$

However we are still human so we cannot cut our cubes with perfect accuracy, consequently we found that our ROV had a slight negative buoyancy. To counteract this we cut small pieces of pool noodles and placed them on the sides of our ROV. We then slowly removed material from said pool noodle until there was not any noticeable drift upward or downward.

Propulsion

The STEVE ROV uses two *Blue Robotics T100 thrusters* to move vertically in the water. Another four *Blue Robotics T200 thrusters* work together to move the ROV on the X and Y-axis. When completing tasks, the combination of motors allows our Sunk Robotics ROV pilot to control the ROV vertically as well as horizontally. Our Blue Robotics thrusters are fairly powerful but perform with some limitations in order to comply with MATE safety regulations.

Each thruster is controlled by the Arduino through an ESC. The Arduino takes serial input from the Raspberry Pi. The user puts inputs into the system through a Logitech Game Controller.

Caption: Matthew Harris working on Thrusters

To power the Thrusters, we used Bullet Connectors. We made this choice so that we could quickly connect and disconnect the Thrusters from the ESCs. There was, however, a downside, bullet connectors require a lot of soldering on their own. They tend to break off without proper care as well increasing the amount of soldering necessary to maintain a secure connection.

Gripper

The manipulator is one of the most important components of the Sunk Robotics STEVE ROV. It is crucial for the completion of most tasks assigned to us. We based the function of the STEVE Manipulating Claw off of the Newton Subsea Gripper made by *Blue Robotic 6s*.

The manipulator has two primary functions; grabbing and spinning.

The grabbing function is powered by a 12V DC gear motor. The motor spins a threaded rod, pushing a smooth rod through a seal and into the claw. The claw then rotates open. When the motor direction is reversed, the smooth rod is pulled and the claw closes. The claw is a custom design that was cut on a water jet cutting machine. Both of the rods and the connector between them were cut to size and threaded / tapped as needed. The connector between the smooth rod and the claw is a custom 3D printed design.

The Spinning function is powered by a second 12V DC gear motor. It spins the entire structure of the grabbing function through a custom 3D printed part that connects the front of one motor to the end of another. This function allows us to be more precise when grabbing by allowing the arm to work at an angle.

The arm is housed in several custom resin printed parts with seals between them. The rod seal and the rotary shaft seal were bought, but the circular seals between the pieces of the housing were custom designed and laser cut. This housing design allows the motors and other water sensitive parts of the design to keep dry while preserving the functionality of the manipulator.

We have a Dual H Bridge connecting our gripper to the power terminal and the Arduino Uno. Due to our actuator being designed to work with a car battery, it operates at 12 volts with no need for conversion.

We have taken great care to place our gripper in a location where it will be easily visible to the camera. This is so it can be operated more effectively and make it so that objects can be simply placed into its claw.

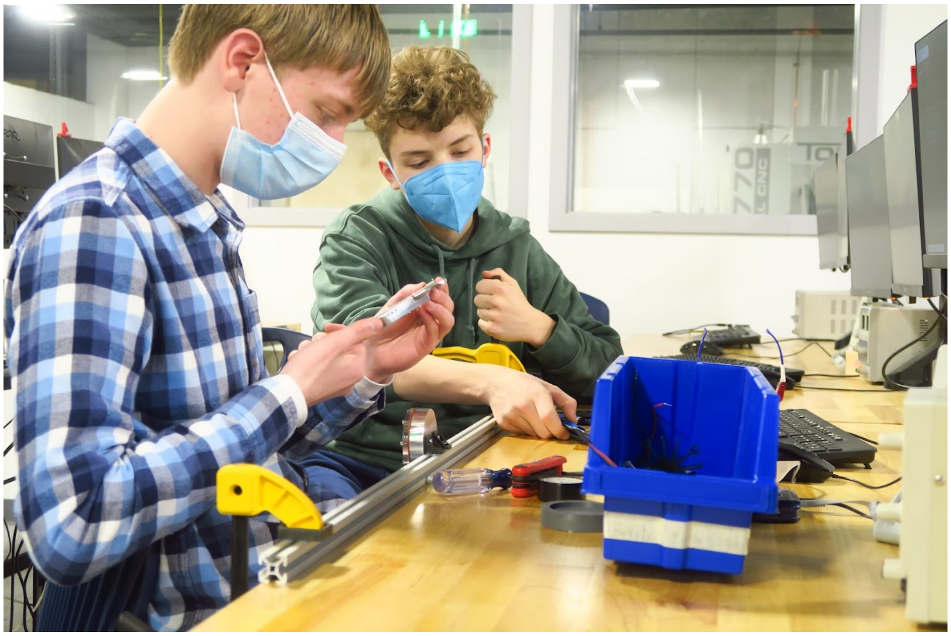
Caption: Grace Kallberg working on gripper

Cameras

To successfully navigate and complete tasks underwater, the ROV pilot must be able to properly observe their surroundings. Sunk Robotics's STEVE ROV uses two cameras: one front-facing camera and one downward-facing camera. The front-facing camera is a Raspberry Pi camera module, which is connected to the Raspberry Pi via a ribbon cable. The front-facing camera offers higher frame rates and lower latency in order to make navigation easier. The bottom camera is a Razer Kiyo X webcam, which is connected via USB. The bottom camera is outfitted with a fisheye lens, which offers a wide field of view to aid with positioning and finding objects. The camera software receives an MJPEG stream directly from each camera and serves them to the web client with minimal processing, resulting in very low latency and CPU utilization.

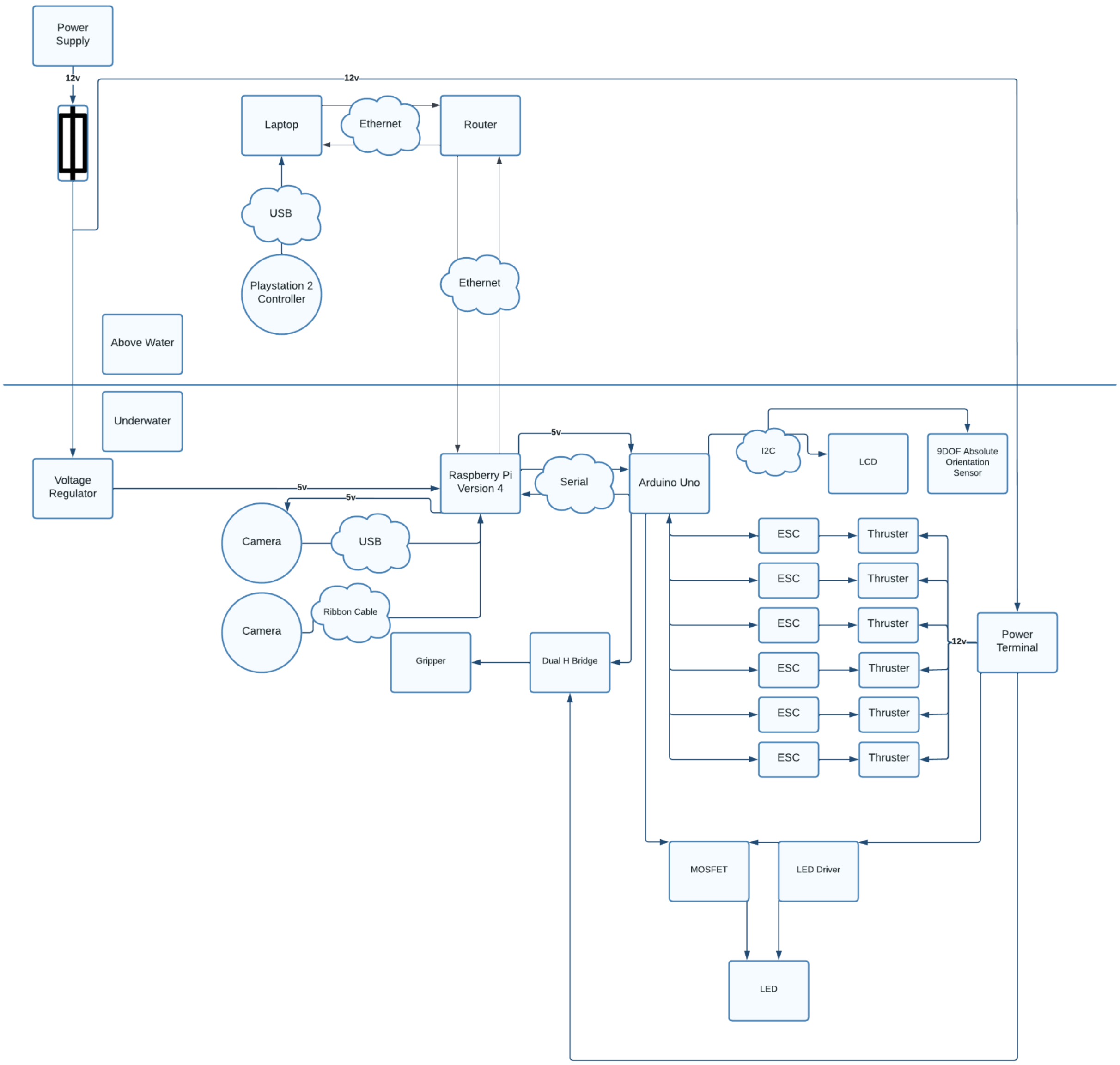
Lighting

Proper lighting is vital to using cameras. A *3W 900mA LED* driven by a 12V (Input) *900mA DC LED Driver* and controlled by the Arduino using a MOSFET is used to provide adequate lighting. A water-proof housing was designed in CAD and machined with a *Series 3 PCNC 1100 Personal Tormach Milling Machine*. A front cover was laser cut using our *Epilog Laser Cutter*. The cover is made of 6mm clear acrylic and fastened using m3 screws. A silicone gasket was also laser cut and is in between the cover and the metal housing along the edge. Only one hole goes from the exterior to the interior in order to allow the power wires through. The hole was water-proofed with *JB Weld Marine Adhesive*. The housing, which was machined out of aluminum, also doubles as a heat sink for the LED. The LED outputs a substantial amount of heat and is dissipated into the housing and into the surrounding water. A custom PCB was milled with our *Bantam Tools Desktop PCB Milling Machine*. The PCB connects the MOSFET, Arduino, LED, and LED Driver together without creating a tangle of wires and insecure solder points.



Caption: Aaron BenDaniel and Ben Wirz working on a mounting solution for the lights

System Integration Diagram



Safety

Task	Hazard	Solution
Testing in a pool	Potential slip hazard due to water on the floor.	Being careful as well as keeping safety equipment and first aid near at all times.
Putting robot in the water	Falling into pool	Have lifeguard and be careful
Working with thrusters	Phalanges getting injured	Have motor shrouds and no fingers in thrusters
Working with electrical equipment	Electrical hazards	Leave power off while working and place a fuse inline with power. Use Anderson Power Pole connectors to ensure a safe connection.
Losing	Fighting each other/Violence	Everyone keeps their hands to themselves
Being near water	SHARKS! (unlikely)	Keep some of those barrels from 'Jaws' around
Using a tether	Potential trip hazard due to cable on the floor.	The tether is attached to a spool to prevent unnecessary length reducing the overall opportunity to trip over it.
Using heavy machinery such as drills, chop saws, etc.	Have the potential to damage hearing as well as injure	Wearing headphones when using machinery and being safe such as not wearing gloves when using the drill. Being OSHA certified

Sitting down and working hours at a time.	Bad for posture and could cause pain.	Try to maintain good posture when working.

Error Detection and Recovery

In order to detect problems aboard a Sunk Robotics vessel before catastrophic failure, we have made sure that the pilot will be aware of most problems that could afflict the S.T.E.V.E. ROV.

One of the most common and destructive problems that can occur in a submersible electronic device is a simple leak. In order to detect an intrusion of water before it damages our electronics, we have placed cameras in optimal possessions to allow for the pilot to detect any intrusions. In the event of a leak, the ROV Pilot will be able to see the water respond to the situation accordingly.

A simple yet effective solution to any current overloads is a fuse. This will stop us from melting any expensive components by first sacrificing the incredibly inexpensive component, the fuse. We have placed a 25 Amp fuse in series with our power supply on land. If there is an electrical problem onboard, it will quickly cut power to the ROV, stopping any further damage happening aboard.

Navigation System

In order to be able to effectively navigate in the pool we have used an *Adafruit BNO055 Absolute Orientation Sensor.* The sensor allows for us to monitor the movement and location of our ROV as it moves through the water. It also allows us to detect abnormalities in our Euler angles that signal a problem in our ROV such as a tangled tether.

A feature that we hope to finish before the World Championship is the ability to track the ROV through the pool on a photomosaic acting as a map. We will use our *Adafruit BNO055 Absolute Orientation Sensor*'s Accelerometer and Gyroscope to map where we are relative to a starting point. We would track where we are going using what angle we are traveling at and our velocity which will be calculated based on the time traveled and previous acceleration values.

Trade Offs

When faced with trade offs between power consumption, cost, performance, and mission requirements we have attempted to keep an even balance. We have been able to keep the total cost of our ROV at a reasonable level while also having sufficient performance. We have, admittedly gotten less practice than we'd hoped with piloting the ROV due to our lack of regular access to our high school's pool.

One major trade off we have had to make was between speed and power consumption. Our ROV was able to easily use 50 amps before we limited the speed of the motors. We had to make the choice that the S in STEVE does not stand for "Speed Demon". We were able to limit the amount of power that we are sending to our ROV by putting a cap on the maximum value that we can send to our ESCs in software. This immediately fixed the problem.

Challenges

Throughout the building of the ROV, we have encountered many roadblocks. Many of them coming from the fact that the majority of the team members of Sunk Robotics are underclassmen and have never participated in an ROV-related competition. As we were constructing the ROV, many of us here at Sunk Robotics were in the midst of learning about different aspects of robot construction.

One of the earliest and most persistent challenges was getting code to work for the camera. It was an absolute necessity for it to have low latency and high quality. After many months of coding, we transitioned to web sockets being transmitted to a web client. We went through five editions of code that needed to be gutted throughout the build process.

More generally, all our programmers were used to working with higher levels of abstraction. As a software team, we learned the wonders of the C Programming Language. Most of our interfacing with our hardware was done through an Arduino where we could not reasonably use a high-level programming language such as Python.

A constant struggle that we will certainly address next year was the use of bullet connectors. Quite frankly, bullet connectors are of suboptimal durability. They would often disconnect from their wires and need to be resoldered.

A significant amount of time was dedicated towards ensuring proper water resistance. The discovery of leaks and their subsequent correction was most time-consuming. Wet-link penetrators needed to be re-installed and sealed many times over the course of the construction of the ROV.

During the early design stages of the internal electronics, the required components often changed, and the support board would need to be remade to secure them. Many internal systems went through multiple versions before we could settle on one which we believed was optimal. For each revision, the board would need to be remade and reassembled.

What We Learned

During the construction of the ROV, we learned the many struggles of designing and building such a complex system. Next year, we will make many changes with the additional time we will have. Some of these will include finding a different method of connecting our motors and motor drivers. Our current solution, bullet connectors, is, to put it lightly, subpar. Another solution will need to be developed for the next competition. We also learned a lot about making and sealing water-tight enclosures, and this will allow us to refine our methods for faster and better construction of water-tight vessels. The MATE ROV competition has been most educational, and all our team members have become far more experienced in constructing remotely operated vehicles.

During the regional competition we learned that navigation is one of the most important functions of the ROV. We learned that we absolutely needed to add a second camera, a gyroscope, magnetometer, and an accelerometer. During both of our attempts during the regionals, the biggest problem we had was locating different challenges in the pool. It is far too easy to get disoriented in the pool using only one camera.

Float

We went through several iterations of buoyancy engines before landing on the one we decided to use. Originally, we planned to use 6v air pumps to pump air into the balloon. However, after realizing that it would require some kind of valve to release the pressure in the balloon. The valves on hand were slow and used 12 volts, twice as many volts as our battery pack was capable of holding.

The syringe made more sense, especially because we could duplicate the mechanism for the gripper with little modification. The motor spins a long threaded cylinder that causes a small nut to move along it. The nut is linked to the base of the syringe via a plate. As the motor rotates, the syringe gets pushed up. It takes on the surrounding water as ballast, causing it to sink. The syringe chamber is only 350ml, meaning that the amount of buoyant force is small and would easily be nullified by a small amount of weight. To compensate, the float is designed to be neutrally buoyant allowing it to be carried upwards despite a small amount of buoyant force. We originally intended the mechanism to be pneumatically powered and use the syringe to push air into a balloon. However, we decided against it because balloons are not environmentally friendly.

The body of the float is designed to be pyramidal incase of any imbalances or water currents that would otherwise cause it to tip over if it was a different shape. The pyramid's wide base allows it to remain upright most of the time. It also reduced the difficulty of manufacturing because all sides of a pyramid are two dimensional and can be cut in shops easily. It also meant that mounting electronics would not be that difficult.

Finances

While building the Sunk Robotics STEVE ROV, we saved much of the cost incurred by other teams through the fabrication of most of our components. We made heavy use of our *Epilog Laser FusionPro* laser cutter, our *Tormach CNC Machines*, our *Fusion 3 410 3D printers*, our *Bantam Desktop PCB Milling Machines*, and our *Formlabs 3 Resin 3D Printers*. This has also had the added benefit that we can fix most of our parts in-house. However, there are some things that we simply do not have the facilities to make, such as computers, motors, and cameras.

Date	Type	Category	Expense	Description	Sources/Notes	Amount (USD)	Running Balance (USD)
December 2019	Re-used	Hardware	Blue Robotics T100 Thruster	A Thruster to propel ROV	2 of the Thrusters on ROV	$200.00	$200
November 2021	Purchased	Hardware	Blue Robotics T200 Thruster	A Thruster to propel ROV	4 of the Thrusters on ROV	$676.00	$876
November 2021	Purchased	Electronics	Blue Robotics Basic ESCs	Used to control thrusters	6 used to control Thrusters	$216.00	$1,092
October 2019	Re-used	Hardware	4" Acrylic Tube	Housing for electronics	1, Used to keep electronics dry	$201.66	$1,294
October 2019	Re-used	Hardware	O-Ring Flange	Cap housing for electronics	1, Used to keep electronics dry	$58.00	$1,352
March 2021	Re-used	Sensors	Cameras	To provide visuals	2, Used to provide visuals	$80.00	$1,432
N/A	Re-used	Parts	PVC Pipe	Housing for various parts	Used for building components	$6.00	$1,438
N/A	Re-used	Parts	Aluminum	For making power terminals	Used for building components	$5.00	$1,443
N/A	Re-used	Parts	3D Printing Resin	For making gripper	Used for building components	$20.00	$1,463
N/A	Re-used	Parts	PLA 3D Printing Filament	For making thruster covers and other things	Used for building components	$10.00	$1,473
N/A	Re-used	Parts	Acrylic Sheets	For making frame	Used for building components	$20.00	$1,493
October 2021	Purchased	Electronics	Arduino Uno	Controlling ESCs and interfacing with Sensors	Used for interfacing with different components	$23.00	$1,516
October 2021	Purchased	Electronics	Raspberry Pi 4	To communicate with surface	Used for interfacing with computers on the surface	$35.00	$1,551
October 2019	Re-used	Sensors	SainSmart Water Sensor	Detect aquatic intrustions	Notify pilot of leaks	$9.00	$1,560

February 2021	Purchased	Electronics	Voltage Regulator	Control voltage output to RPI		$4.98	$1,565
February 2021	Purchased	Electronics	Power Cable	Deliver power to ROV	35 Feet long	$48.00	$1,613
February 2021	Purchased	Electronics	Anderson Powerpole Connector	Deliver power to ROV from power supply		$1.20	$1,614
N/A	Re-used	Electronics	Ethernet Cable	Send data to and from ROV	35 Feet long	$12.00	$1,626
Februrary 2018	Re-used	Electronics	LCD Screen	Allows for quick troubleshooting		$12.00	$1,638
N/A	Purchased	Parts	Wood	Used to manufacture STEVE Electronics Board	Used for builfing components	$5.00	$1,643
October 2019	Re-used	Hardware	80/20® Bars	Provide structural support	6 rods in total	$25.00	$1,668
October 2019	Re-used	Hardware	80/20® Mounts	Mount thrusters to 80/20 rods	16 L-Brackets	$10.00	$1,678
N/A	Re-used	Parts	Fasteners	Connecting various components		$20.00	$1,698
January 2022	Purchased	Hardware	Blue Robotics Wetlink Penatrators	Allow for wires to go through cap without leakage		$228.00	$1,926
N/A	Parts Donated	Electronics	Logitech Dual Action Gamepad	Used to Pilot the ROV	donated a long time ago	$15.00	$1,941
N/A	Purchased	Parts	JB Weld	Sealing, and covering light on camera		$8.00	$1,949
N/A	Parts Donated	Parts	350mL Syringe	Used for buoyancy engine in float		$12.00	$1,961
May 2022		Hardware	Bno055 Absolute Orientation Sensor			$35.00	$1,996
May 2022		Hardware	Raspberry Pi Camera			$50.00	$2,046
March 2022	Re-used	Hardware	6v DC Motor	Used for buoyancy engine in float		$15.00	$2,061
March 2022	Re-used	Parts	Threaded Rod	Used for buoyancy engine in float		$2.00	$2,061
N/A		Electronics	Battery Pack	Used for buoyancy engine in float		$2.00	$2,065
April 2022		Hardware	Razer Kiyo X USB Camera	Bottom facing camera		$80.00	$2,145
	Cash Donated	General		Funds donated by Mide Technology Engineering Corporation		-$2,000.00	-$51

						Total Raised	$2,000
						Total Spent	$1,943
						Final Balance	$57

Travel Expenses

	9 Students	Additional amt for 3-4 Chaperones	Notes
Airfare	$10,800.00	$4,800	Roundtrip Boston MA - Long Beach CA; estimate $1200/person; including 4 chaperones
Checked Bags	$540	$180	estimate $30/bag each way
Hotel	$2,580	$2,580	6 rooms reserved as of 5/10 at $149/night; tax; 15%; estimate $172/night;
Rental Van	$1,025		United Vans - 12 Passenger - 5 day rental including insurance $30/day
Breakfasts	$540	$180	estimate $12/person/day for 5 days
Lunches	$675	$225	estimate $15/person/day for 5 days
Dinners	$1,350	$450	estimate $30/person/day for 5 days
Excursions	$450	$150	estimate $50/person/day for 5 days
Team Shirts	$450	$200	estimate $50/person/ for 2-3 shirts
TOTAL:	$18,410	$8,765	
COMBINED TOTAL:		**$27,175**	

Acknowledgments

Sunk Robotics would like to thank the following corporations not only for their financial help but also for providing our team with the tools and resources used to make the Sunk Robotics STEVE ROV. We are incredibly grateful and none of this would have been possible without the support and tools provided. Thank You.