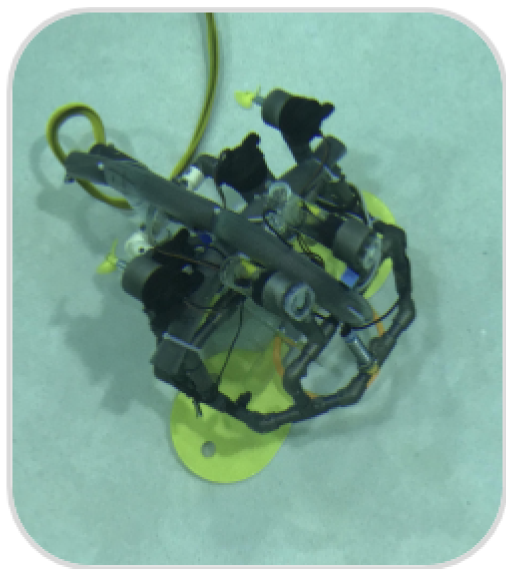
Patrick Henry
Community College
MHC After 3 &
Eastman Foundation
Martinsville, Virginia

Dasyatis



Team Members:

- Anika Banerjee - CEO/CFO
- Gabe Richardson - ROV Design
- Andrew Parikh - ROV Design
- Andres Lopes - Electronics
- Casey Richardson - Electronics
- Pedro Reyes - Electronics
- Dillon Nutter - Electronics
- Will Dehart - 3D Printing
- Keishawn Wray - Marketing
- Andrew Carter - Tether

Mentors:

David Dillard
Keith Newcomb
Christy Richardson

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Abstract

Our ROV has been designed to ensure public safety by way of dam inspection and repair. It was specifically built to be under 60 centimeters in length so that it is maneuverable enough to fully operate in the smallest crevices of the ocean. Temperature and metal sensors have been integrated into the design in order to help maintain healthy waterways as well as keep a balanced weight distribution for the vehicle. The ROV is also able to preserve the natural history of any underwater biome since it is built from materials that will not in any way alter the health of the ocean, even as they degrade. In order to build an ROV fully capable of accomplishing these tasks, the ten committed members of Dasyatis have spent nearly 80 hours designing this ROV to be adaptable to any possible situation, with unique qualities such as flexibility, speed, and endurance. Specifically constructed to meet the most restricted size and weight requirements, the final design is compact, yet functional, heavy-duty, and free-flowing. We plan to bring the ROV back to the surface after completion of each task.

Company Profile

Our company, Dasyatis, was founded in December of 2018 by the sponsorship of the Eastman Chemical Manufacturing Company. Dasyatis is a collaboration of three networking crews from local area schools including Bassett High School, Martinsville High School, and Carlisle School. Our crews' housing and assembly took place at the Patrick Henry Community College Manufacturing and Engineering Technology Complex in Martinsville, Virginia.

The Bassett Crew

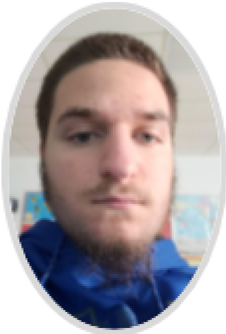
Pedro Reyes is a junior at Bassett High School and dual-enrolled at the Patrick Henry Community College Manufacturing and Engineering Technology Complex in Martinsville, Virginia. Pedro has assisted the team by building props and troubleshooting electrical soldering issues.

Keishawn Wray is a senior at Bassett High School, who has no previous experience with robotics or engineering. He lives in the Martinsville-Bassett area, and has two younger siblings. As part of the marketing and design team for Dasyatis, Keishawn has digitally created our logo through *Adobe Photoshop*, an application that he downloaded onto his smartphone.

Will Dehart is also a senior at Bassett High School and lives in Bassett, Virginia with his father and younger siblings. Will has always enjoyed working with computers and is a roller coaster enthusiast. He has been an active member of the MHC Youth Bowling League for five consecutive years. He has taken a two-year robotics class and is currently enrolled in an engineering class. Will has worked on the 3D-printing and Computer Numerical Controls for Dasyatis.

Dillon Nutter is a senior at Bassett High School who has taken two prior robotics courses before joining the team. He lives in Collinsville, Virginia, and has six siblings. Dylan enjoys building guitars and cars in his spare time. Dylan has worked hard to ensure our ROV is maneuverable and adaptable to several of our tasks and has helped solder electrical components.

The Martinsville Crew



Andrew Carter is a sophomore at Martinsville High School. He lives in Martinsville, Virginia, and has two younger siblings. Andrew enjoys engineering and math, as well as World War II history, making him an exceptional candidate to assist our the team. He has worked diligently on various aspects of the design process and has focused on ensuring the quality and maintenance of the ROV tethering system.

Andres Lopes is a sophomore at Martinsville High School. He has worked with Casey Richardson on the electrical assembly of the control system by soldering the all the various components of the circuit boards.

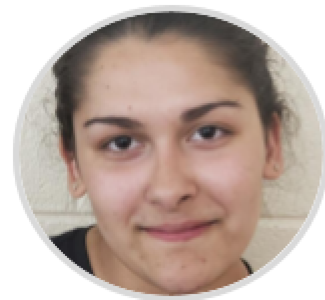
The Carlisle Crew

Casey Richardson is a freshman at Carlisle School, located in Axton, Virginia. He lives with his two brothers, Gabe and Owen, in Mayodan, North Carolina. Casey plays varsity baseball, and has no previous experience working with robotics or engineering, although he learned to solder quickly. Casey's precision and persistence have made him a great member of Dasyatis' design team. Casey has spent countless hours working with Andres Lopes to solder the main control board of the ROV.

Gabe Richardson, younger brother of Casey, is an eighth-grader at Carlisle School. Although Gabe has not taken any previous robotics courses, he has competed in the 2019 Virginia Cyber Robotic Coding Competition (CRCC). Gabe has been an extremely influential member of the Dasyatis design and build team for the primary ROV. Gabe's dedication, optimism, and unique ideas have made him an excellent teammate.

Andrew Parikh is a seventh-grader at Carlisle School. He plays for the school's junior varsity soccer team and enjoys working with all kinds of technology. Andrew also competed with Gabe in the 2019 Virginia CRCC Finals. Andrew has spent most of his time working with Gabe on the design and testing of the ROV.

Anika Banerjee is the CEO and CFO of Dasyatis. She lives with her three younger siblings in Collinsville, Virginia, and is a freshman at Carlisle School. Other than playing varsity volleyball, Anika enjoys reading books, listening to music, and creative writing. Anika has no previous experience with robotics or engineering, although she has taken several coding courses prior to joining the team.



The Coaches

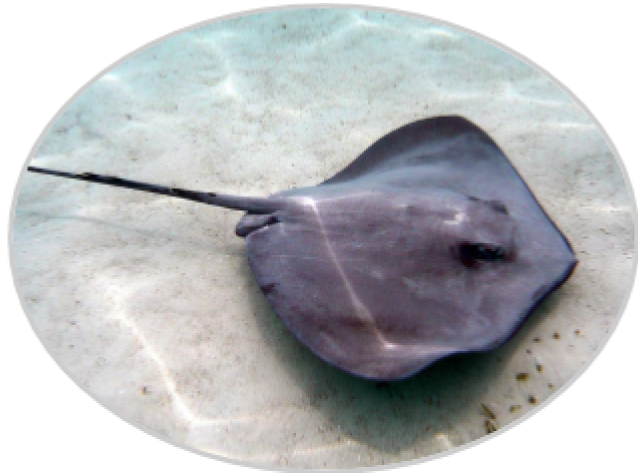
David Dillard, *Patrick Henry Community College* - Assistant Professor of General Engineering Technology

Keith Newcomb, *Patrick Henry Community College* - Adjunct CADD Instructor

Christy Richardson, *Carlisle School* - Upper School Chemistry/Physics Teacher

Design Rationale

Why "Dasyatis"?



The name **“Dasyatis”** is the genus of stingray and comes from a Latin translation meaning “rough” or “dense”. Stingrays tend to stay close to the surface of the ocean, going no deeper than one hundred meters, inhabiting muddy and sandy coastal waters. They can grow to be up to seventy-five centimeters in width and two-hundred and fifteen centimeters in length, depending on the species. Stingrays are typically grey or dark brown in color and often bury themselves into the shallow ocean floor as a form of camouflage.

Structural Inspiration

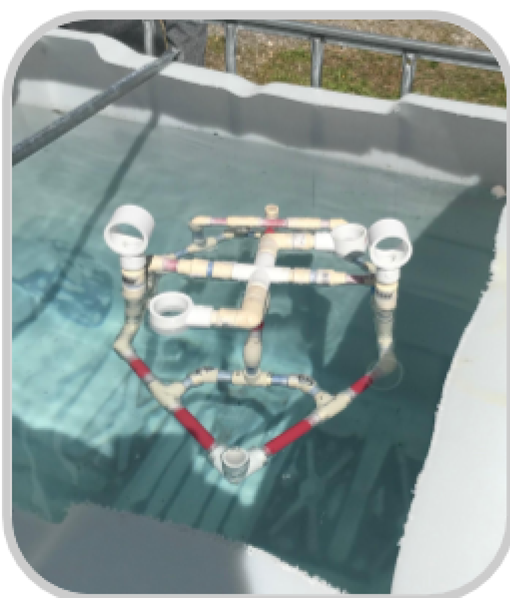
Much like a stingray, our ROV is able to glide through the water and stay low to the ocean floor due to its slightly negative buoyancy. The frame, length, and height of our primary ROV can easily be compared to a stingray, hence the team name, Dasyatis. The shape of our ROV is rounded at the front and pointed at the back. We decided on this shape so that our device would be able to break water with minimal drawback, causing water to flow around our ROV effortlessly.

Branding Ourselves

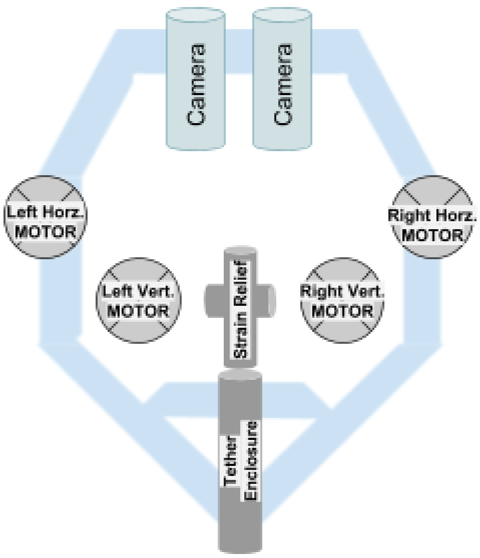
Our logo went through many modifications over the course of several weeks. We decided naturally to use a stingray since the symbolism could easily be carried over from the team name and ROV design. Keishawn created the logo himself using *Adobe Photoshop*. We believe this logo adds flare and a sense of differentiation.

Frame

Since our ROV is not the typical box shape, we hope that unique configuration will serve us well. At first, we built several of our prototypes using PVC (polyvinyl chloride) pipe. We knew that this material would have been way too heavy to keep building with, our ROV would perform better if we found a lighter, less dense material. We switched to a combination of PVC and PEX (cross-linked polyethylene) pipe as a more lightweight solution.



Propulsion



The final design of our ROV features four motors in mirroring positions on either side of the vehicle. Two of our motors face vertically, one up and one down, and the remaining two are placed horizontally, facing in the same direction. The reason for two of our motors facing the same way is because our ROV will mainly be driven forward, as opposed to side to side. Our unique motor placement easily serves the purpose of efficiency as well as maneuverability underwater.

We have used the four thruster motors from the Barracuda kit, purchased through the online SeaMATE store.

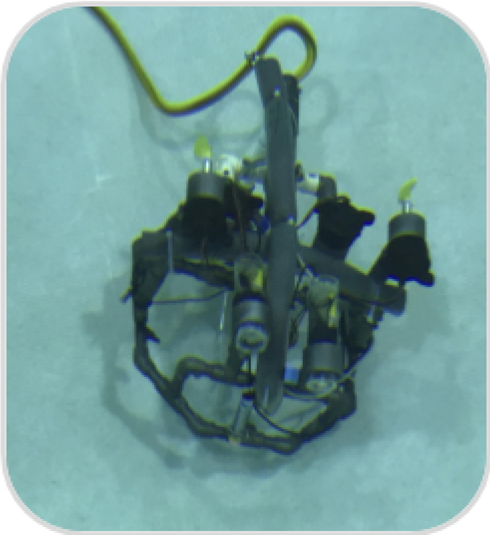
Video and Sensors

Our cameras both face forward, although at different angles. One camera is position to see in front of the ROV and the other is positioned downward to see the hook apparatus. These cameras appear to be the “eyes” of our ROV. The foam wrapped around the front of our vehicle holds the cameras in place, and can easily resemble a nose.

Our video system was purchased directly from the MATE store. We have used the “SeaMATE TriggerFish/Barracuda Video System Kit, which contains two cameras. The types of cameras listed in the kit are typically used for security purposes. They were waterproofed using the SeaMATE Camera Waterproofing System. Our color monitor was purchased from a hardware store. This type of monitor is typically used for cars, as a backup camera.

We have temperature and inductive sensors attached at the middle of our vehicle to allow us to gather ambient temperature data in the water and to detect metal objects for possible salvage inspection.

Tether



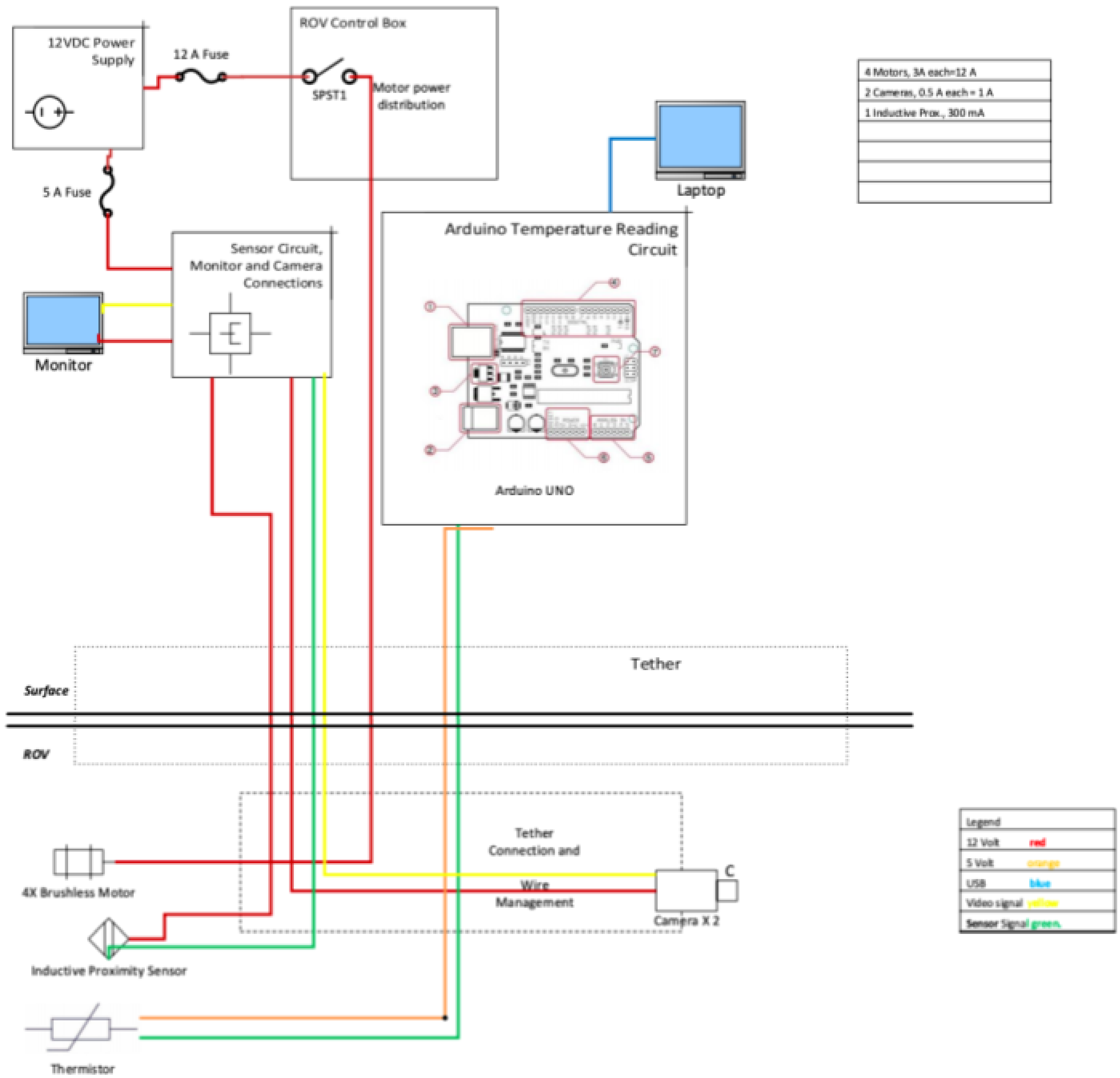
Our tether, included in the Barracuda ROV Kit, was also purchased from SeaMATE. It is 12.2 meters long, and includes a total of 13 wires. Eight of these are for our motors, two for each of the four. Three wires connect to our sensors, two inductive, and one temperature. The final two subjoin the cameras, one wire for each.

We reassembled the tether several times to include all of our wires. Because of this, we had to resolder multiple times, and color-coding our wires seemed like the best route. All of our live wires have been waterproofed using the SeaMATE Waterproofing Kit. We have also attached a strain relief to our ROV to relieve the stress of individual wires on the tether. Tether management was not an underlying issue for the team. After each use, we looped the tether and exposed wires to prevent tangling.

Control System

At the surface, our ROV runs solely from a 12VDC power supply. From this, two fuses, one 5 amp and one 12 amp, are attached. The 12 amp fuse powers the ROV control box, as well as the four motors underwater. All of the wires running from the surface to the ROV are waterproofed, and encased by the tether. The 5 amp fuse powers the sensor circuit, motor and camera connections, the monitor, the two cameras, as well as the inductive proximity sensor. The Arduino temperature reading circuit is powered by USB from a laptop. The thermistor runs through the Arduino.

Systems Integration Diagram



Safety

The team was consistent with safety precautions throughout the ROV's build and while testing. While soldering or using wire clippers, we always made sure to wear safety glasses, and other necessary protective equipment. Throughout the build process, the team typically worked in small groups, or with a partner, for peer checks without overcrowding. While soldering wires onto our control boards, we always used tools to hold objects in place rather than touching them with our hands to prevent injury and the transfer of unnecessary oils from our hands to the instruments.

Situations	Potential Hazards	Safety Protocols
1. Using manual/power tools *includes ratcheting pipe cutter, soldering iron, heat gun, screwdrivers, power drills, box cutters, wire strippers, etc.	1. Physical injuries ● Cuts ● Burns ● Broken/amputated appendages 2. Electrocution	1. Always use personal protective equipment, such as safety glasses and gloves, when working with any tools. 2. Ensure tools are used properly for intended purposes. 3. Make sure work area is neatly organized with unobstructed space to work safely. 4. Ensure power is off before working with electrical controls and rotating mechanisms.
2. Launching/Retrieval of the ROV	1. Slipping 2. Electrocution 3. Water damage 4. Trip hazards 5. Back strain	1. Always wear non-slip shoes with proper traction. 2. Ensure power is off before working with electrical controls and rotating mechanisms. 3. Ensure that all electrical components are properly waterproofed. 4. Avoid trip hazards by maintaining work area organization and proper tether management. 5. Ensure proper ergonomics and body alignment when lifting ROV.

Personal Protective Equipment (PPE)

- Safety glasses
- Gloves
- Flotation device (in/around pool)

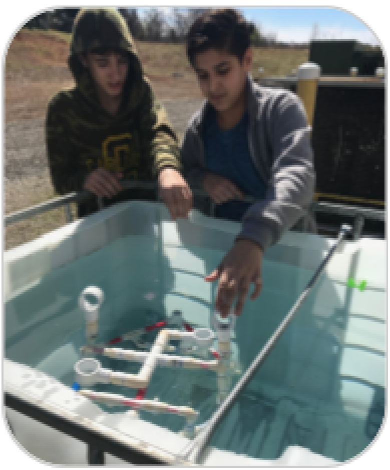
Individual Safety Protocols

- Proper clothing (covering legs, torso, and arms)
- Proper footwear (non-slip, closed-toed shoes)
- Long hair tied back

Testing and Troubleshooting

Structural Redesign

The construction of our ROV and circuit boards have been challenging for several reasons. One of the first conflicts we had to face was material choice. Originally, we built our ROV from standard PVC pipe, because it was convenient and easy to find. The facility we held practices at had plenty of it, so it was at no expense to us to use it. We soon realized that if we continued our build with only the PVC, we would surpass the weight restriction for the competition, and also limit maneuverability in the water. The team unanimously made the decision to change to PEX pipe, a significantly lighter material. This simple change drastically impacted the weight of our vehicle. And would help increase our speed and buoyancy in the water.



Electrical System Issues

During the assembly of our main control board, we came to the realization that the team did not have Anderson Powerpole crimpers. We tried many other wire crimpers, although none of them were the right sizes. Eventually, we decided to simply cut and solder the wires.

After completing the assembly of our Barracuda control board, we ran into a few technical issues. The first time we connected the board to a power box, the entire right side of the board refused to light up. With much inspection and analysis, it was clear that we were missing a fuse. Casey and Gabe had to adjust pieces, and re-solder, in order to fix this major issue.

Once we started flying in the water, we began having issues with the joysticks. They were being temperamental, and only functioning when the control box was completely level, and untouched. The team collectively decided that we were not going to continue with this control box, simply because it was unreliable and inconsistent. Therefore, our only option was to completely convert to another control system.

We had an untouched Pufferfish control board that we quickly assembled. This board worked much better than the Barracuda had. We took our ROV to the water yet again, and this time, we found our Pufferfish switches to be inverted. We did not have time to assemble another control board, so we simply learned to fly with these controls.

Originally, the team had planned to assemble a micro-ROV, although later decided against it due to time. With a team as small, and as divided as ours, after completing our second control board, assembling the tether became a first priority.

Logistics

Throughout our journey building our ROV, the team ultimately operated as two separate groups. We divided ourselves based on our schools. The members of Bassett and Martinsville High Schools worked together on tether management, prop building, and creation of the logo. Members from Carlisle School worked on the ROV's design and build, as well as all documentation for our work.

Communication was originally established through a website, Canvas, where team members could vote for a team name, create discussion posts, etc. Later on, we used text and email as an easier way to reach out to everyone.

Our team’s lack of experience with the MATE Robotics Competition encouraged us to reach out for help. Dennis Courtney, mentor for his team, R-Matey’s, visited us early on, to help us choose our roles. He also gave us an overview of the competition. A few weeks later, the R-Matey’s team drove to Patrick Henry Community College to give us helpful tips and inspiration for our design. They told us what to expect at the regional competition, and helped us create several groups within our team to divide the workload. That way, everyone would have a role.

Another design flaw was weight distribution. The first week of April, we put our ROV in a large body of water for the first time. After adding small rings of foam to achieve ideal buoyancy, we started flying. It wasn’t hard to notice that our ROV kept rolling to the right. We couldn’t figure out why, until we began drawing our design schematic. Although we had two motors on either side of the vehicle, they were not placed to mirror each other. One of the motors on the right was far too close to the camera, causing our ROV to be a lot heavier on the right. A few days of trial-and-error, we decided that the only way to fix this issue was to have the motors placed exactly opposite of each other.

After our first test flying in the water, we realized that our Barracuda control box was not very reliable. It only worked when the box was completely level. The team decided to switch to the Pufferfish control box, which we found to be a lot easier to operate.

The controls were inadvertently inverted, which caused a bit of confusion for the team when learning how to fly. However with the correction of the inverse controls the Pufferfish control box will be a much more reliable asset to use in competition.

Even with these technicalities resulting from the control box and ROV there were other issues such as the actual contributions and the ability to operate as a group. Whilst having three high schools would have more hands and the potential for new members our schedules are very contradicting resulting in incomplete meetings and confusion with specific jobs.

Future Improvements

Upon our first formal meeting, the members of Dasyatis ran into many conflicts. With a lot of us being from different schools, there was a lot of tension throughout the first few weeks. Grade level was also an issue for the team. Dasyatis contains students from seventh to twelfth grade, therefore many of the younger members had no experience working on collaborative group projects before joining the team.

It took the team a few weeks to decide on the roles of each member. We picked them based on personal strengths and weaknesses, not necessarily what each individual had wanted their role to be. Our mentors, Christy, Keith, and David, helped us choose our roles according to what they knew would benefit the team best. If we decide to enter the competition again next year, it is our assumption that team members will keep the same roles.

Along with tensions from seperate schools and members, there were also differentiating viewpoints on small decisions, such as the team name, or opinions on the design of the ROV. To solve this, we opened a canvas classroom where we could all sort of converse and share our separate topics on the ideas. But with the unreliable ability to login in to this canvas classroom we found that this would not work. However with the use of a website called “Survey Monkey” we were able to open anonymous polls resulting in the decision of most of our contradicting ideas.

Finance

Budget 2019

Company Name: Dasyatis						**Reporting Period**
Instructor/Sponsor: David Dillard						**From:** February 15, 2019
						To: April 27, 2019
Expenses						
Category	Item	Type*	Cost per Unit	Quantity	Projected Cost	Budgeted Cost
Hardware	SharkBite 1/2-in x 5ft PEX pipe	Purchased	$2.98	4	$11.92	$11.92
Hardware	SharkBite 3/4-in x 5ft PEX pipe	Purchased	$2.98	4	$11.92	$11.92
Hardware	PEX Coupling Joints	Purchased	$0.31	90	$27.90	$27.90
Hardware	SeaMATE Barracuda ROV Kit	Purchase	$900.00	1	$900.00	$900.00
Hardware	SeaMATE PufferFish ROV Kit	Re-Use	$200.00	1	$200.00	$200.00
Hardware	1/2-in PVC Cross	Purchase	$1.28	3	$3.84	$3.84
Hardware	2-in PVC Joint	Purchase	$0.50	10	$5.00	$5.00
Hardware	1/2-in PVC Joint	Purchase	$0.32	10	$3.20	$3.20
Hardware	SeaMATE TriggerFish/Barracuda Video System Kit (2 Cameras)	Purchase	$180.00	1	$180.00	$180.00
Hardware	PNP NO 18mm Screw	Purchase	$4.99	1	$4.99	$4.99
Hardware	DIGITEN Waterproof Inductance Proximity Sensor	Purchase	$6.99	1	$6.99	$6..99
Hardware	Drop Tank	Donation	$169.00	1	$169.00	$169.00
Hardware	10pcs Thermistor Waterproof Temperature Probe	Purchase	$9.99	1	$9.99	$9.99
Hardware	Hose Clam Worm Drive Kit	Purchase	$3.47	1	$3.47	$3.47
Hardware	Mini Fuses	Purchase	$17.97	1	$17.97	$17.97
Hardware	Metallic Grey Spray Paint	Purchase	$5.98	2	$11.96	$11.96
Hardware	Silicone	Purchase	$4.28	1	$4.28	$4.28
Hardware	Swivel Eye Bolt	Purchase	$2.58	1	$2.58	$2.58
Hardware	#6 1/2-in 100ct screws	Purchase	$4.98	1	$4.98	$4.98
Hardware	#8 1/2 in 100ct screws	Purchase	$5.98	1	$5.98	$5.98
Hardware	Johni-Ring Wax Gasket	Purchase	$1.78	1	$1.78	$1.78
						Total: $1,587.75

The Eastman Foundation generously sponsored the team with an initial $1500 to cover registration, control kit cost and build materials. The MHC After 3 program offered funding for transportation and lodging at the competitive events. Early on, we looked at the official documents from the top three winners of the 2018 MATE ROV Ranger Competition. Several teams used 3D printing for most of their framework. Their budget spreadsheets reflected these expenses. We knew that we were going to repurpose as many parts as we could from inexpensive materials that were readily available from spare parts donated to the team, and only purchased what was necessary. Our team ultimately decided against 3D printing pieces, although we had access to a printer, due to the projected cost of the filament. Purchasing PEX pipe to build our frame was still lightweight and hollow, also a more convenient way of addressing the build.

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Acknowledgments

Dasyatis would not be here without all of the organizations that have made it possible for us to compete. We would like to formally thank the Eastman Foundation, for their sponsorship, and MHC After 3 for additional funding. Many thanks to Connie Jones, of Bassett Furniture Company, for her generous donation of our drop tank, which was frequently used to test the buoyancy of our ROV. Also to the Patrick Henry Community College Manufacturing and Engineering Technology Complex, and to the Martinsville YMCA, for the use of their facilities. Thanks to Dennis Courtney, and to R-Matey's, for answering all of our questions, and sharing their competition experiences with the team. Also to Talmage Thomas, who cropped several pieces of metal for the team. These metal plates were used to smoothly integrate our hook apparatus to the main structure of the ROV. Also, a huge thank you to Marine Advanced Technology Education, Kingsport Aquatic Center, and Streamworks, for financing and supporting such a wonderful competition each year.