Triton Technologies

Palos Verdes Institute of Technology
PVIT.org

Technical Report
Underwater ROV: *Typhoon*

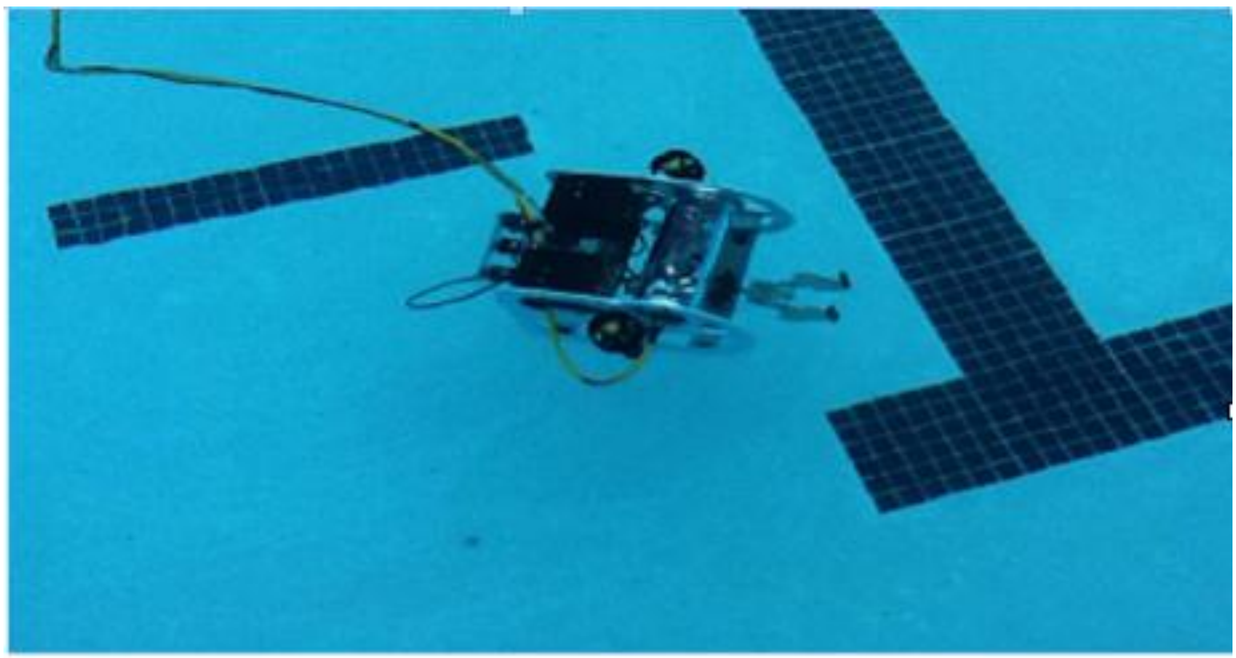

Photo credit: Liz Bacalja

Palos Verdes High School, 600 Cloyden Road, Palos Verdes Estates, CA 90274
2012

Title Page: Team Members

Triton Technologies

Palos Verdes High School, Palos Verdes Estates, CA
Palos Verdes Institute of Technology

Photo credit: Ashley Overbeek

(Back row; left to right)

Michael Konrad	Class of 2013	2nd year CFO and Pilot
	Career goal:	Aerospace Engineer
Dennis Smalling	Class of 2015	1st year Assistant Parts Fabricator
	Career goal:	Seismologist
Scott MacDonald	Class of 2013	2nd year Lead Parts Fabricator
	Career goal:	Medical Doctor
Anthony Bacalja	Class of 2013	3rd year Lead Payload Designer
	Career goal:	Engineer
Mark Caropino	Class of 2015	1st year Payload Engineer
	Career goal:	Medical Doctor

(Front row; left to right)

Keith Kreiner	Class of 2013	3rd year CEO and Pilot
	Career goal:	Aerospace Engineer
Ryland Dreibelbis	Class of 2013	1st year Software Engineer
	Career goal:	Engineer
Stevie Lillington	Class of 2013	1st year Navigational Engineer
	Career goal:	US Naval Submariner
JJ Kuwata	Class of 2013	3rd year COO and Chief Engineer
	Career goal:	Ocean Lifeguard and Medical Doctor

Mentors: Liz Bacalja, Kurt Kreiner, John Kuwata, MD, and Graham Robertson

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Abstract

This year, our remotely operated vehicle (ROV) team was tasked with being able to survey a shipwreck including measuring the ship's length and orientation on the seafloor. Other tasks include identifying whether objects are metal and part of the wreck site or not. This information will be recorded on a map along with the ship's length and orientation. We will recover endangered corals, and simulate drilling a hole through the ship's hull and retrieving a sample to determine if it is fuel oil. Our ROV is able to complete these missions through the use of the tools specifically designed for each task. Our pneumatic claw has the ability to attach the lift tube to the ship's mast and retrieve coral samples. A neutron backscatter device and ultrasonic thickness sensor have been built into the claw. We are able to acquire and store the fuel oil sample on the ROV. Our ROV's thrusters with microprocessor controlled motor control allow for rapid and precise movement underwater. We expect to complete each task within the allotted time.

Complete, intact vehicle photo of *Typhoon*

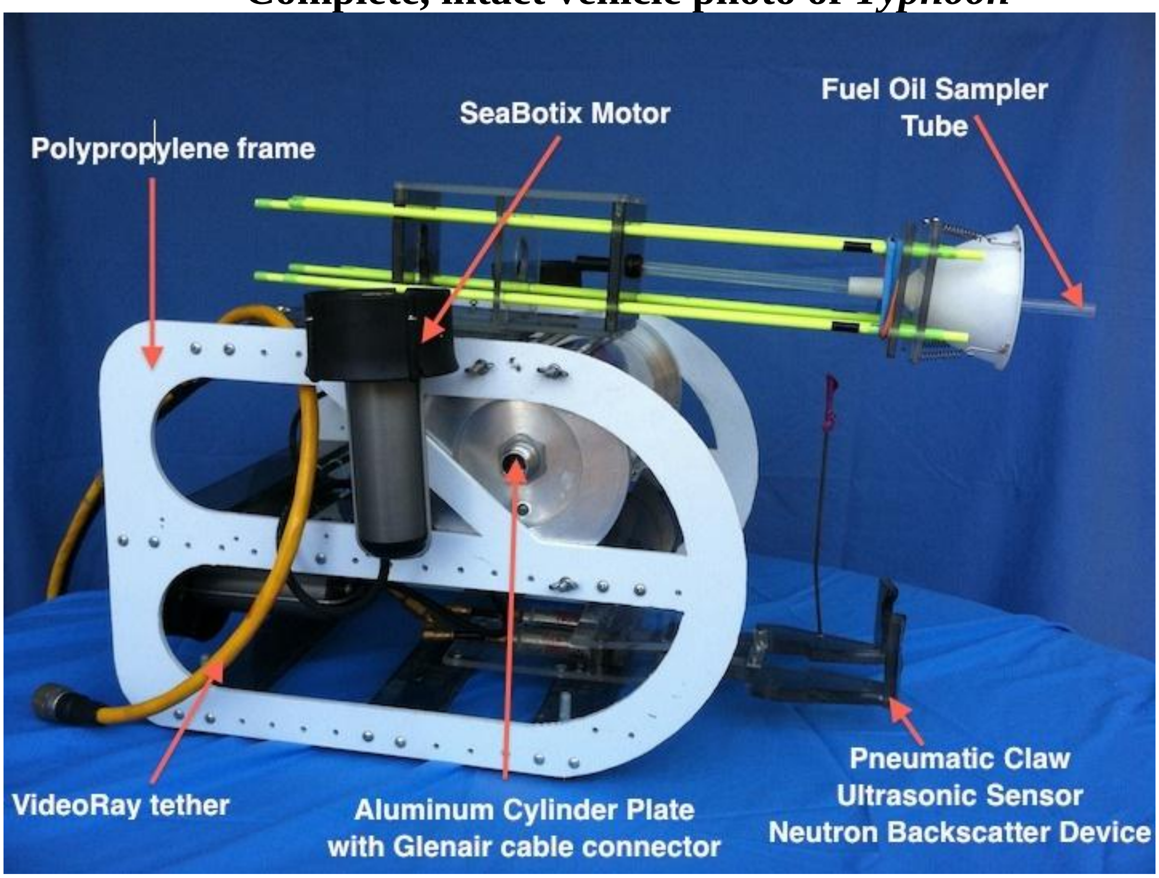


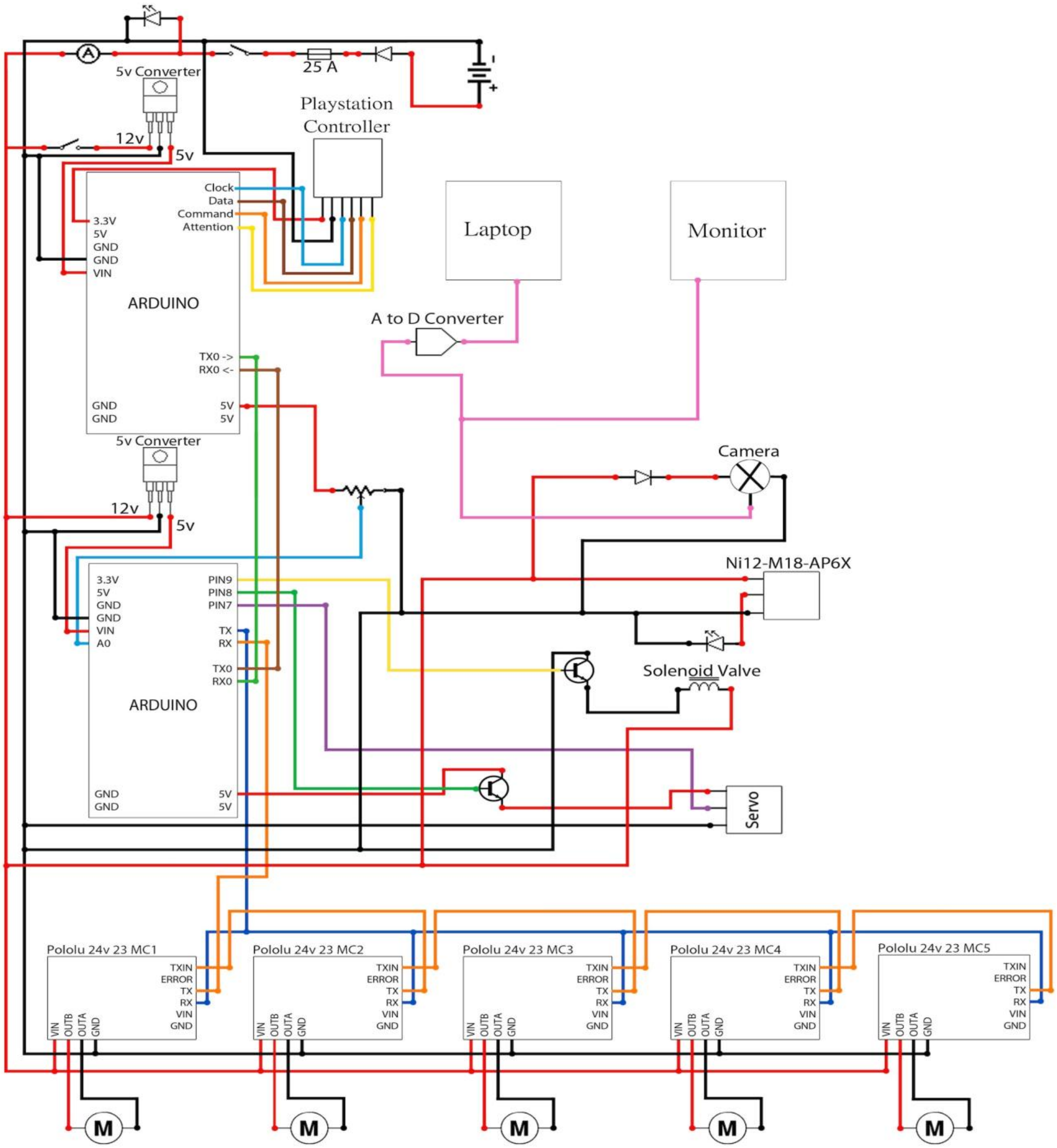
Photo credit: JH Kuwata

Expense Sheet

System	Description	Notes	Donated	Purchased
Claw				
	Lexan	Donated by the Bacalja family	$10.00	
	Acrylic	Donated by the Bacalja family	$10.00	
	Brass fittings	Donated by the Bacalja family	$30.00	
	Tubing	Donated by the Bacalja family	$5.00	
Waterproof Tube				
	Aluminum			$50.00
	Acrylic			$23.00
Oil Sampler				
	Fiberglass rods	Donated by the Bacalja family	$20.00	
	Acrylic	Donated by the Bacalja family	$20.00	
	60mL syringes x 3	Donated by the Kuwata family	$6.00	
	Brass fittings	Donated by the Bacalja family	$30.00	
Controls				
	Pelican case	Donated by the Kreitzman family	$100.00	
	Monitor			$154.00
	PS2 Controller	Donated by the Kuwata family	$40.00	
Tether				
	8 wire tether x 150 ft	Donated by Video Ray	$200.00	
	8 pin underwater connector	Donated by Glenair	Unknown	
Sensors				
	Inductive sensor	Donated by the Bacalja family	$110.00	
Onboard electronics				
	Arduino Mega 2560, r3 x 4			$260.00
	Polulu motor controllers x 6			$360.00
	SeaBotix motors x 6	10% subsidized by SeaBotix	$300.00	$2,700.00
	Camera			$50.00
	Servo			$16.00
	Lynx motion cable			$ 9.00
Frame				
	Polypropylene			$50.00
Totals			$881.00	$3,672.00

Items purchased through the generosity of the Peninsula Education Foundation, Palos Verdes High School Booster Club, ROV parents, Boeing Corporation, and Raytheon Corporation. We fundraised a total of $3,672 in order to purchase parts and received an additional $881 in donated parts from Video Ray, SeaBotix, Glenair, the Bacalja family, and the Kuwata family.

Electrical Schematic



M = SeaBotix Motors
N12-M18-AP6X = Turck Inductive Proximity Switch
A to D converter = Analog to Digital converter
Arduino = Arduino Mega 2560 rev. 3

Design Rationale / Vehicle Systems

Inspiration

First, our team researched the design of commercially available ROV's and discovered a common theme in the overall form: they generally consisted of two side panels with interconnecting struts providing structural support. The SeaBotix Model LBV600-6 and Model LBV300 as well as the SAAB Seaeye Falcon and Seaeye Falcon DR provided clear examples of simple designs creating successful commercial ROV's.

Materials

Another unifying trend was that most commercial ROV's that are rated for less than 100 meters, used some type of plastic as the primary frame material. To aid in our decision making processes, we created an empirical list of the density, mass, strengths, hardness and costs of different types of materials.

Material	Density	Total Mass	Tensile Strength	Impact Strength	Hardness	Price	Dimensions
Polypropylene	0.8996 g/mL	1476.376g	3,900 PSI	0.9-6.0 ft. lb/in		2($18.71)	3/8" X 12" X 24"
PVC Foam	0.0368 g/mL	60.394g	45 PSI	Poor		2($6.67)	3/8" X 18" X 24"
Acrylic	1.348 g/mL	1474.844g	6,100 PSI	15.0 ft. lb/in		2($32.18)	¼" X 12" X 24"
Al 6061	2.70 g/mL	2245.09g	35,000 PSI		95 Brinell	2($58.60)	0.19" X 12" X 24"
Al 6061	2.70 g/mL	2954.066g	40,000 PSI		95 Brinell	$155.80	¼" X 24" X 24"
Polystyrene	1.041 g/mL	1138.956g	2,400 PSI	2.1-3.3 ft. lb/in		$97.87	¼" X 40" X 72"
Lexan	1.190 g/mL	1952.966g	9,800 PSI	15.0 ft. lb/in		Free	?

Chart comparing the density, mass, strength, hardness, price, and commonly available dimensions of the various materials

Material	Mass	Volume	Total Force	Foam Req. (0.5 g/mL)
Polypropylene	1476.376	1641.148mL	-1.6165N	NA
PVC Foam	60.394	1641.148mL	-15.5072N	NA
Acrylic	1474.844g	1094.099mL	3.735N	761.468mL
Al 6061	2245.09g	831.515mL	13.867N	2827.115mL
Al 6061	2954.066g	1094.099mL	18.246N	3719.878mL
Polystyrene	1138.956g	1094.099mL	0.431N	87.870mL
Lexan	1952.966g	1641.148mL	3.149N	641.998mL

Chart comparing the mass, volume, buoyancy, and compensating buoyancy of the various materials

Our team selected polypropylene because it was positively buoyant, and our laser cutter could cut it. It is strong and inexpensive. We had thought of expanded PVC, but it gives off toxic fumes when cut with the laser. We then created a CAD design using AutoCAD and cut it out on our laser cutter.

ROV assembly, AB & JJ

Photo credit: Liz Bacalja

Electronics

For ideas we turned to the technical reports of last year's successful teams. One key difference between this year's design and last year's design is that we migrated from analog to digital. We chose the Pololu Simple Motor Controller because it is rated at 24 volts and 23 amps. Arduino Mega 2560's were selected as the microcontroller because they used a relatively simple language, they had a larger number of analog, digital and serial pins, and there were several open source libraries available for our use. This is further discussed under the Control section below.

Onboard Electronics

The cylinder proved a superior shape to house our onboard electronics because it has only 2 sealing ends. The side plates were machined from aluminum and made watertight with o-rings. One aluminum plate connects to the tether using the Glenair cable connector while the other plate has waterproof pins that are connected to the 5 SeaBotix motors, solenoid and metal detector. Each individual pin is sealed with Teflon tape, threaded pipe sealant and an o-ring.

Laser cut acrylic board to hold Arduino Mega microprocessor, Pololu motor controllers, servo and camera.

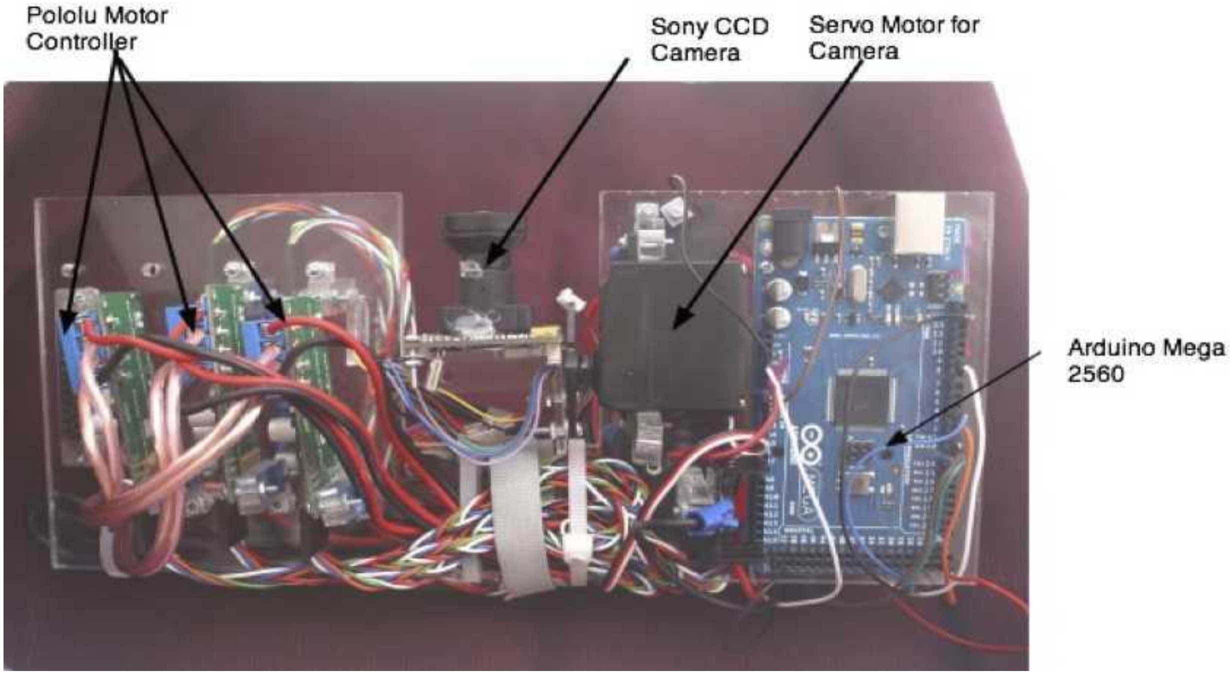


Photo credit: JH Kuwata

Tether

We opted for the thinnest tether possible to minimize its affects on the ROV's movement. To this end, we used a VideoRay negative tether with eight conductors, two of which are large gauge to minimize voltage drop. The tether attaches to the aluminum plate on the cylinder using the Glenair waterproof, double o-ring connector. The tether allows the onboard Arduino Mega to communicate with the Arduino Mega, on deck, in the control box. A pneumatic line is attached to the tether to power the claw and the fuel oil sampler. Originally 2 separate pneumatic lines were used but in the interest of a more flexible tether they were consolidated into 1 line through the use of an onboard solenoid to switch between the claw and fuel oil sampler.

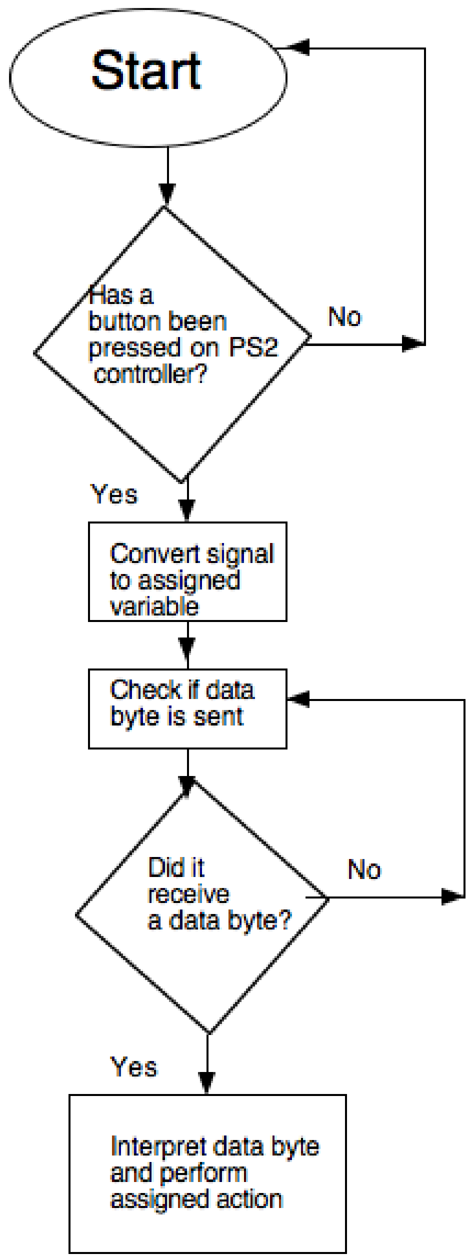
Motors

We selected SeaBotix motors because last year's bilge pump motors proved unable to endure prolonged exposure to water despite our efforts at waterproofing. The SeaBotix motors were also selected for their strength, pulling 14N of force at 12V, 1.5A. Another motivating factor was SeaBotix's 4,000 hour guaranteed runtime at a depth of 500 meters, well beyond our needs for the ROV. We see this as a long-term investment as succeeding ROV teams in later years will be able to use them. The *Typhoon* utilizes 2 vertical motors, 2 horizontal motors, and 1 lateral, strafing motor.

Software Control

Our team opted for a PlayStation2 (PS2) controller because of its intuitive nature and existing open source libraries. The Arduino program uses Bill Porter's PS2 Arduino library to interpret data from the PS2 controller. The data is then converted into data bytes and sent through 2 serial wires to the onboard Arduino using the EasyTransfer Arduino library. The Arduino mega was programmed to use these data bytes to provide both variable speed and bi-directional motor control. When the motors were given full power the camera would temporarily blank out as the system's current dipped. We used the Pololu simple motor controller software to decrease the rate of acceleration from instant on to 5% increments every millisecond. This prevented the dip in current flow to the camera so that it would not blank out.

Software Flow Chart



Sensors

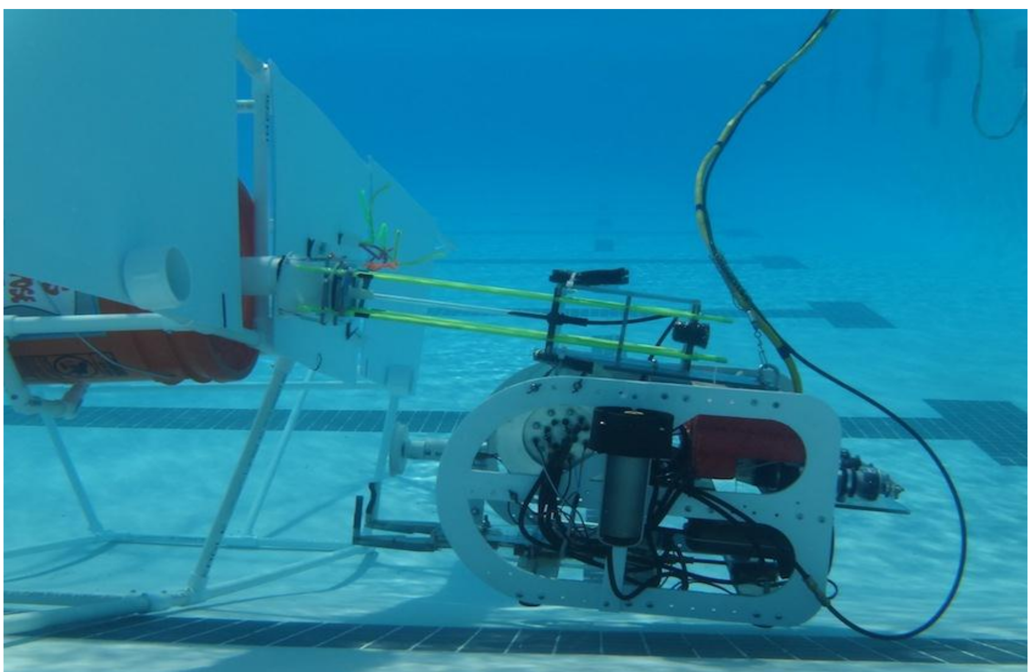
The primary sensor utilized in the ROV is the camera. We used a 1/3" Sony Super HAD CCD 600TVL PCB camera because of its compact size, high definition, and its ability to stream live video to the monitor in our control box. The camera allows us to accurately maneuver the ROV as well as detect and observe any objects encountered by the ROV. The camera is mounted on a servo-controlled board to allow the camera angle to be tilted 60 degrees upward and downward from the horizontal position. This allows it to look upward to see the tip of the fuel oil sampler so that it can be inserted into the fuel tank. It can look forward for steering, manipulating the claw, reading the compass, and positioning the ultrasonic sensor and backscatter device. It can look downward at the LED for the metal detector to determine if debris is metal from the shipwreck or rocks, and it can look at the overall debris location within the grid.

We used a Turck inductive proximity sensor to identify metallic debris. It was placed to the right of the claw so that its sensing surface was only a few cm from the bottom of the ROV. It was powered by 12V and its circuit was wired so that in the presence of a ferrous containing material it would light up an LED mounted on the back surface of the claw. This LED was positioned so that the camera could see both the LED and the tip of the metal detector at the same time. In this way we could identify which debris pile we were surveying.

We used an automobile compass to measure the ship's orientation on the seafloor. It was positioned far enough away from our motors and electronics to prevent magnetic interference. We are able to read the compass by using our onboard camera.

We used the camera to measure the ship's length. A screen shot of the ship was made. This analog image was converted to a digital image using the analog to digital converter in our camcorder. The digital image was then enlarged several fold using Photoshop which made measurement easier. We used a Photoshop tool to measure the width of the 1/2" PVC pipe on the photo that was sticking up from the bow/stern of the ship. We had measured the outside diameter of several pieces of 1/2" PVC pipe and found it to be 21.35mm. We then measured the ship's length in the photo between the half waypoints of the vertical PVC pipes at the bow and stern. We then solved for the length of the ship:

$$\frac{21.35mm}{half\ inch\ pvc\ measured\ in\ photo} = \frac{(X\ ship\ length)}{ship\ length\ measured\ in\ photo};\ Ship\ length\ in\ mm\ is\ converted\ to\ cm.$$



Typhoon taking a sample of fuel oil from the sunken ship. Photo credit: Mark Caropino

Challenges

Technical

One of the greatest technical challenges we faced was the waterproofing of the housing for electrical components. Upon initial testing, we found that the tube housing the micro controllers and motor controllers had a leak from one of the electrical pins to the motors. The holes for the pins had been drilled and tapped. Although the pins screwed down snugly they were the source of the leaks. We initially tried gasket sealant around the pins, but they continued to leak. We next tried Teflon tape and threaded pipe sealant. This helped but they still leaked. Finally, we added o-rings to the Teflon and pipe sealant and this stopped the leaks. This took multiple attempts before we were certain they were watertight. The tube was felt to be waterproofed and ready to house electronics.

Another challenge that we needed to overcome was programming. When we began we had very limited knowledge of how to program and we taught ourselves through trial and error. Each time we tried to use a new library we had to learn new functions and how they were utilized. It took many smaller Arduino test programs before we could begin to manipulate the program at will. It was a painful process, but we persevered because the ROV would not function without it. Eventually, we had the final program compiled and running. It finally became easier to add or change the program by manipulating the code. Over 100 hours of time has been spent on the programming alone.

Not Technical

The PVIT team had limited funding and this year it was felt more poignantly than ever. In the past we have used bilge pumps to propel our ROV, but this time we felt that we needed an upgrade. Last year the motors failed at unpredictable, and at the most devastating times. They did not always fail during practice but one failed during the regional competition and one failed at the International competition.

We chose to buy 6 SeaBotix motors, costing us around $3000. These are high quality motors and will be able to be reused in future years but some of the PVIT engineering club members were not happy with us using so much of their money. To make up for the deficit, we decided to raise money for ourselves. Team parents donated $100 each. We also wrote a grant proposal to Raytheon and were given $1025. We designed polo shirts for our engineering club and made a small profit on each. After all this fundraising we were able to pay for our new motors which are very effective and a great investment for future teams.

Troubleshooting Techniques

Pneumatic System Problem

1. Check that the compressor is charged
2. Check that the main hose is connected to the compressor
3. Check that the regulator is not closed
4. Check that the valve to the payload tool is working correctly
5. Check for air leaks in the airline to the rover

Motor Controller Problem

1. Turn power off, wait 10 seconds, turn back on. This resets the motor controller boards.
2. Check the status LEDs on each of the motor controller boards
3. Check if the plugs are adequately attached to each Pololu controller
4. Check if the RX and TX wires are properly plugged into each Arduino
5. Check to see 12V is being produced from MATE battery

Electronic Problem

1.Check master power supply and make sure it is providing 12V
2.Check that the main power cables are connected with the correct polarity
3.Check on/off switch
4.Check 25A fuse
5.Turn power off, wait 10 seconds, turn back on
6.Check to see if any plugs within the control system are not attached properly
7.Check for stray wires that should be connected
8.Check for any wires producing shorts
9.Check continuity of tether conductors
10.Check continuity of all plugs

Testing:

With the fuel oil sampler, it originally had a yoke surrounding the acrylic tube because we thought it would direct the tube into the fuel oil hole. After testing, we found that the ROV had incredible precise control, so we decided that we did not need the yoke so we removed it.

When one of our motors was not working, we made sure our power source was disconnected then proceeded to search for a broken connection or a loose wire. None were found so we proceeded to remove the motor to be replaced. Once the new motor was installed, we reconnected everything and it worked.

Payload Tool Description

We have two pneumatic payload tools: a claw and a fuel oil sampler. The claw was cut from sheets of Lexan. Two Bimba 041 spring return cylinders are used to power it. The claw is to be used to transport coral, and attach the lifter bag to the mast via a carabineer. Also incorporated into the claw are the two simulated sensors, the ultrasonic thickness gauges sensor, and neutron backscatter device.

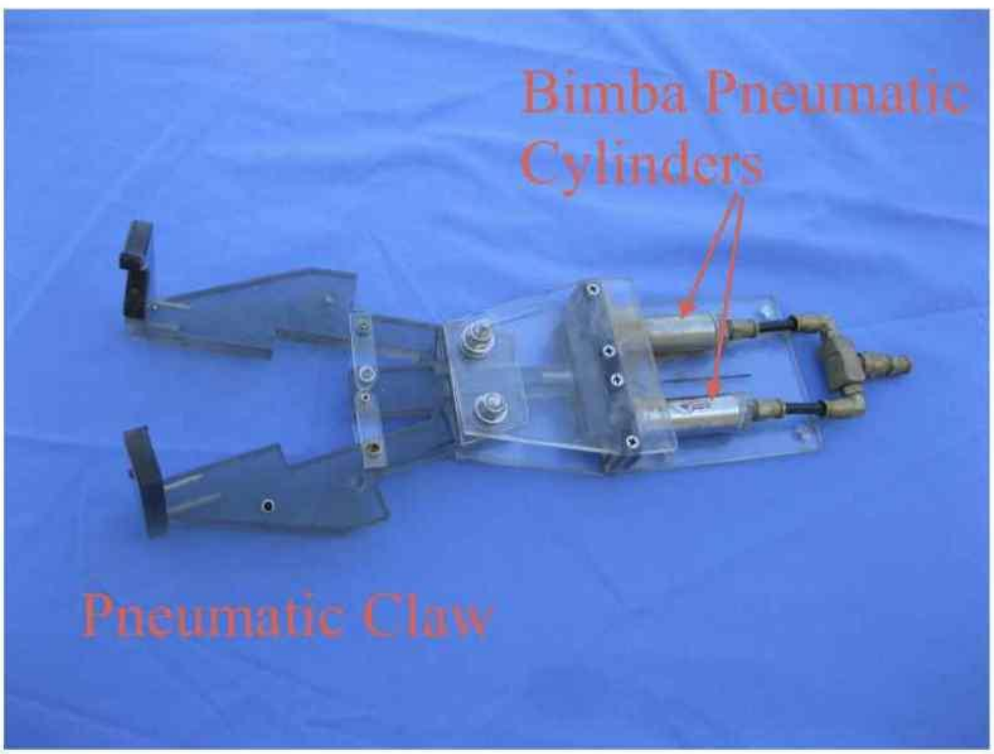


Photo credit: Liz Bacalja

Our other payload tool is our fuel oil sampler, which has an acrylic tube that sticks out the front containing long flexible tubing connected to two 60ml syringes. The air system is triggered by a pneumatic valve which causes a third 60ml syringe to fill with air which pushes out the plungers on the two other 60ml syringes, thus suctioning a sample of 120ml from the fuel tank. The sampler is built out of Lexan and acrylic.

Syringes to sample fuel oil mixture

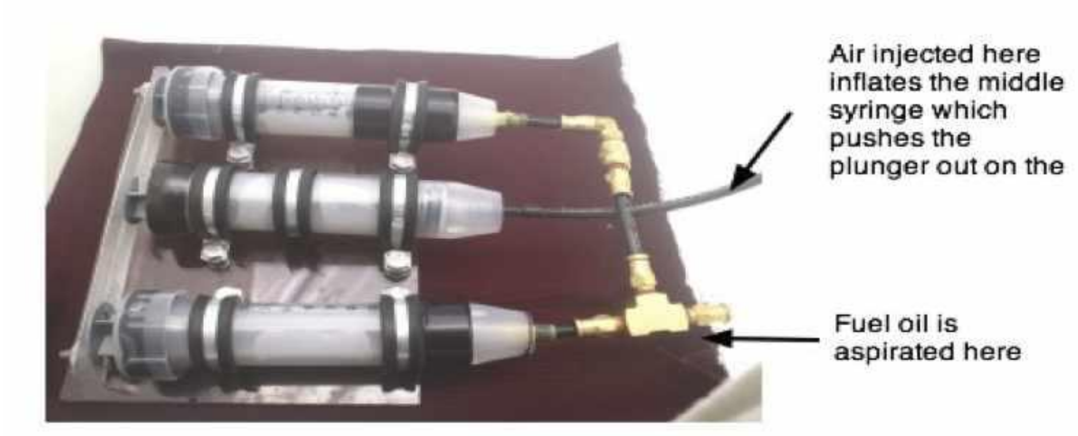


Photo credit: Liz Bacalja

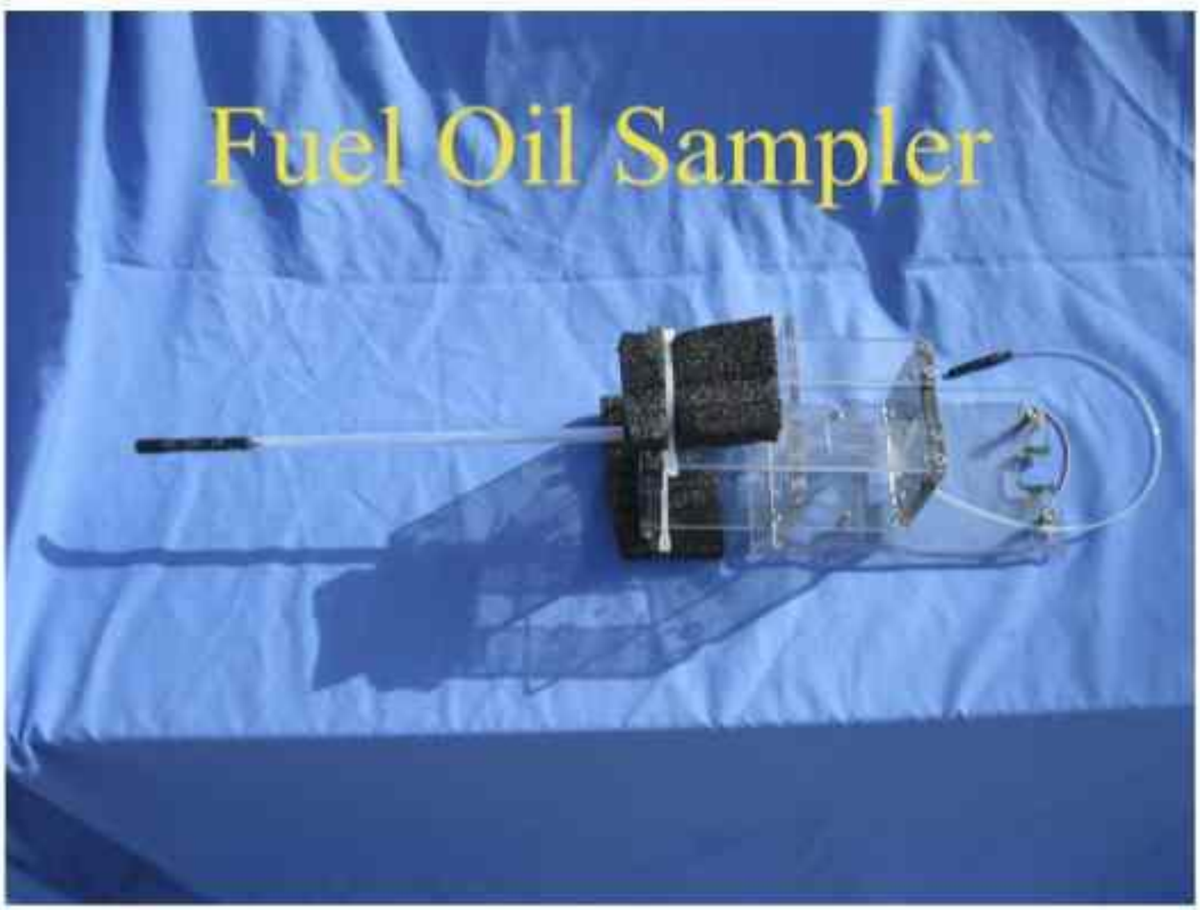


Photo credit: Liz Bacalja

Safety Precautions

Safety was taken into account as we planned and put together the ROV. Included in our circuitry is a 25-amp fuse placed immediately after the positive banana plug, which will blow if the ROV short-circuits. This precaution will prevent damage to any downstream components. We added a diode to the positive power line so we would never damage polarity sensitive electronics. Also, if there is an electrical malfunction the motor controllers are programmed to enter the “safe start mode” which stops all current flow to each motor controller. To reset the motor controllers the power must be turned on and off. Plastic kort nozzles surround each propeller on the ROV to prevent injury and to prevent any undesired objects from getting entangled in the propellers. There is also a warning sticker on each propeller. Lastly, we included an interwoven steel wire mesh around the tether between the ROV and the control box, which operates on the “Chinese Finger Trap” mechanism. This steel mesh is connected to the ROV by a carabineer. Any tension on the tether is then transferred from the Kevlar lined tether to the steel mesh to the ROV and not to the more fragile tether ROV electrical connector.

The team’s safety engineer developed a safety checklist, which is used each time before the ROV is put into the water.

Future Improvement

One system that we will improve will be in our command and control systems. This year we learned to program the Arduino Mega 2560, an inexpensive microprocessor that is cross platform compatible (Windows, Macintosh, Linux). Although it is a simple language, for us beginners it took hours of programming, compiling and testing before we developed the final program we are using today. Next year, we would like to add a graphical user interface to display voltage, current draw per motor, compass headings, and depth. We will look into using LabView or Python for this. We would like to program the ROV so that it would hover in one spot using 3 axis accelerometer data and depth data to control the ROV motors.

Lessons Learned

After having worked with the same team for two years, our company has improved enormously in both our knowledge of constructing a capable ROV and our knowledge of each other and our capabilities. There are several areas we improved:

1. We learned AutoCAD as freshmen. We applied that knowledge as juniors to laser cut the polypropylene frame, printed circuit board holder and acrylic camera servo mount.
2. We went beyond the PVC tubing of the two previous years to actually choose a material and a design, which are optimal for an ROV.
3. We learned to program the Arduino microprocessors and to use serial communication.
4. Last year, we experienced a downfall due to unpredictable bilge motor failure. This year, our SeaBotix motors are more powerful, more efficient, and less likely to fail. Although it was financially difficult to obtain the SeaBotix motors, we feel that the benefits far exceed the costs.

Another important issue our team had to face was how we would work together and if we would take in new teammates and/or if other teammates left. Regrettably, we did lose two teammates from last year; however, in their place we added four completely new recruits to the ROV team plus we had the leader of last year's other ROV team join our company. Based on each team member's skill set, we appointed each to a specific task and, as a team, worked to complete our ROV.

Reflections

Scott MacDonald

As a second-year ROV team member, I feel that I understand the tasks before the team better and know what to expect at this year's competition. This year, I had to ask myself "What can I do to improve the team this year and make sure we win the competition." Due to the fact that we were in the international competition last year, the task of constructing an ROV for the mission was much less daunting. I found that my knowledge of ROV's made it easier for me to aid the team in finding solutions to the problems and tasks that we would be faced with. In addition to helping find solutions to each task, this year I was able to learn very basic programming, which could be of use to the company should a programming issue arise at the competition. I feel that this year, our ROV will undoubtedly do well in the international competition.

Dennis Smalling

As this was my first year in the group I was focused on learning rather than leading. I learned valuable skills such as soldering and programming and also less tangible lessons such as teamwork. This year's competition has given me ample opportunities to advance my engineering knowledge and skills. I am glad to have been involved in the building of our ROV and hope to continue to be a part of this team next year.

Ryland Dreibelbis

Working on the ROV, I have improved my skills in working with a group and earned valuable engineering experience. I hope to pursue engineering when I go to college, and by working on the ROV, I have learned more about the field than I have in three years of engineering classes at my high school. I learned the essentials of programming, which has piqued my interest in computer science. The sense of accomplishment that comes from the final result of weeks and weeks of work is a feeling well worth the effort.

Mark Caropino

I learned that it takes a lot of people to do one project, everyone is important, and if one person doesn't pull their weight, it will take longer to do one part. I also learned that it is hard to get everyone on the team together for a meeting.

Stevie Lillington

This project taught me the valuable principles of teamwork and organization. Throughout our assembly process, I learned that every teammate is valuable in accomplishing a task. As the newest member of the team, I was introduced to the ROV and its design as well as its functions. Overall, I have become a better, more disciplined worker as a result of this project.

Anthony Bacalja

Freshman year, we used the previous year's ROV frame and I was head of tool design, earning our team 2^{nd} in regionals. Sophomore year, as co-leader, I helped design the frame and wired the motors. This year as Lead Payload Designer, I developed and fabricated the claw, which was inspired by a model I viewed on the Internet. The yoke for our fuel oil sampler was originally a modification of our water sampler from last year but, after testing, it was revised to a simpler tube. The sampler, instead of being powered by an electric pump, is connected to two 60ml syringes, which are driven by one 60ml syringe filled with compressed air. This idea was influenced by viewing other water samplers at last year's international competition in Houston. This is my first time working with pneumatics and I have grown to enjoy working with this system. At the start of the year I decided to learn how to use pneumatics and to utilize the knowledge for the rover's payload tools. I'd like to continue to develop payload tools for future ROVs.

Keith Kreiner

This is my third year leading an ROV team and leadership has taught me how to stay organized and keep others on task. Also this was my first year learning to program Arduinos and using programmable motor controllers. My greatest achievement was completing the waterproof tube that houses the onboard electronics. I learned a great deal about the difficulties of systems integration and look forward to leading the team again next year.

J.J. Kuwata

This is my third year participating in the MATE competition. I was part of the ROV team my freshman year, lead a separate ROV team last year that came in third at regionals and co-lead the ROV team this year. This year I learned how to control the Pololu motor controllers with the Arduino library NewSoftSerial. I learned and became quite familiar with the PlayStation2 (PS2) library that lets a programmer use the digital signals from a PS2 controller to control thruster motor speed and direction. I learned how to communicate between two Arduino's with the Arduino library called EasyTransfer, which lets me send signals by way of 2 wires. I used AutoCAD to design the entire electrical system. From there I used my Photoshop skills to convert my AutoCAD drawings into a 2D image that is then used to laser cut polypropylene and acrylic. I then reassembled the laser cut pieces in 3D to form the ROV frame, servo camera mount and prototype board to hold the microprocessor and motor controllers. I have learned to think ahead when I am soldering components so that they take as little real estate on the proto boards as possible. This allowed me to add more electrical components, as we needed. I also found that the best way to waterproof any seal is to use a combination of Teflon tape and o-rings. The most important lesson I learned is that if I work12 hours or more on the software or hardware I need to take a break and stop for the day. After 12 hours my efficiency and my ability to troubleshoot drops dramatically making the electrical control system seem like an unsolvable problem. I look forward to participating on next year's ROV team and incorporating more microprocessor control of things like hover and auto-depth.

Michael Konrad

Throughout the course of my second year competing in the MATE ROV competition I augmented my technical skill set with the ability to write budget proposals and organize written reports. As CFO I was charged with fundraising, allocating those funds, seeking donations, preparing the specs sheet, compiling the technical report, and organizing the poster board. These tasks have given me insight into the bureaucratic processes of a corporation. My greatest achievement was receiving a perfect score on the regional competition poster board.

Teamwork

Starting immediately after last year's international competition we began organizing our team structure and the delegation of tasks. We elected a CEO, CFO, and COO in order to effectively oversee our recently expanded staff. We devised three categories: electrical, mechanical and business. Under electrical we included the onboard Arduino control system and the topside Arduino control box. For mechanical we developed the ROV frame and payload tools. For the business side we developed the budget, the technical report and poster board.

Our restructured team agreed on a tentative schedule for the upcoming year, with the primary goal being an operational ROV at least 3 months before the regional competition. Various deadlines were drafted to meet our goal, every month we expected to complete another subsystem. This allowed us sufficient time to develop the payload tools, practice running the 2 mission tasks, and compile the technical report. Weekly meetings were held to encourage cooperation and integration between the 3 sections of the company and to ensure each team member's ideas were equally received. All team members were assigned a primary focus, electrical, mechanical, or business as well as a team leader to report to. The technical report was divided by section and assigned to individual members, then compiled by the CFO.

Acknowledgments

Triton Technologies thanks Palos Verdes High School for the use of the Palos Verdes Institute of Technology (PVIT) Room, PVIT tools, and the pool outside of regular school hours. We are grateful to Graham Robertson for sustaining the PVIT program. We thank Mr. Marshall and Mr. Alvarez for their suggestions about programming strategies and techniques for the Arduino. We also thank all the parents for their donations of time, money, and materials that helped the ROV team to succeed. Thank you to the Kuwata family for letting us have meetings in their home, building in their shop and for buoyancy testing in their pool. Thank you to the Kreiner family for letting us meet at their home.

A heartfelt thank you to our team mentors, Mr. Kreiner and Dr. Kuwata. While they were there to provide technical guidance, they also showed extreme patience in letting us fail, and then encouraging us to come up with other possible solutions for the problems we faced. We appreciate Mrs. Kuwata and Mrs. Kreiner who fed us snacks. Thank you to SeaBotix for a generous discount of their motors.

An extra special thank you to Mrs. Bacalja for keeping us organized and on task. Without Mrs. B we would have missed every deadline and would not have even made it to regionals. Mrs. B helped ease tensions whenever they developed and provided encouragement when things looked beyond repair. End of story.

Lastly, we thank the MATE Center in Monterey, in addition to the Mate Southern California ROV Fly-off supporters: Long Beach City College, Southwest Fisheries Science Center, MTS-San Diego. We also thank the Palos Verdes Peninsula Unified School District, Palos Verdes High School Booster Club, Peninsula Education Foundation, Boeing, and Raytheon for their financial support.

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Photo Credit

Liz Bacalja & JH.Kuwata: photos of the ROV and tools,

Mark Caropino: underwater photography

Ashley Overbeek: team photo