HMS SeaBots

Maureen Barrett

Harrington Middle School

MATE ROV Competition Project Report

514 Mt Laurel Rd, Mt Laurel, NJ 08054

Ganesh Premarajah, CEO, Electrical Engineer
Sanjana Jampana, CEO, Ocean Engineer
Antonios Nitsolas, CFO, Mechanical Engineer
Jackson Bauer, Head of Research and Development, Electrical Engineer, Pilot
Darrell (A.J.) Byes, Head of Fundraising, Marketing, and Media Outreach, Ocean Engineer
Daniel Coleman, Head of Government and Regulatory Affairs, Mechanical Engineer
Kyle Bauer, Head of Systems engineering, testing, and operations, Pilot
Jonathan Procopio, Sales Engineer
Zack Levitt, Electrical Engineer
Hollyanne Clemence, Mechanical Engineer
Brian D'Auria, Mechanical Engineer
Jason Jetter, Mechanical Engineer
Thomas Keane, Mechanical Engineer

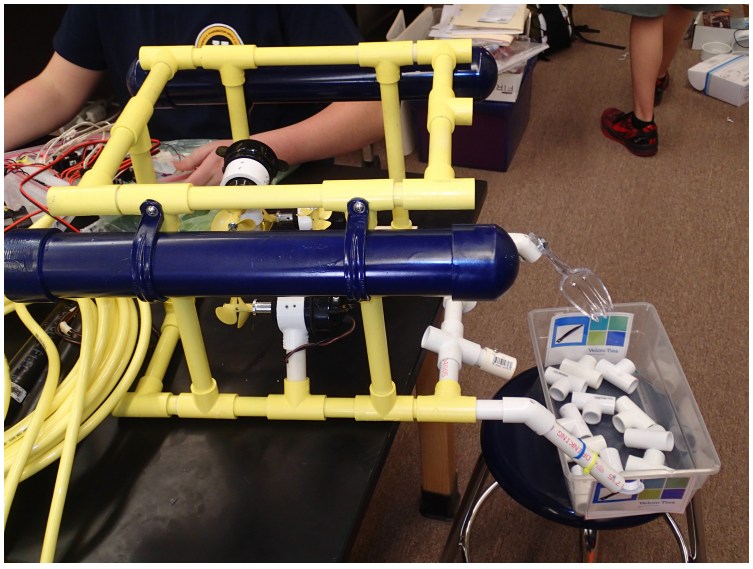


Table of Contents

Page number(s)	Page description
3	Abstract
3	Design Rationale
4	Teamwork
4	Troubleshooting Techniques
5	Safety
5	Lesson Learned - Center of Gravity
5 - 6	Lesson Learned - Buoyancy
6	Systems Integration Diagram
6	Fluid Power Diagram
7	Budget
8	Future Improvements
9	Our Leaders
9	Reflections
10	Acknowledgements
10	References

Abstract

The HMS SeaBots, established in 2014, travel around the world to aid underwater operations that require Remotely Operated Vehicles. Some of these operations include explorations, retrievals, and repairs. Our company motto is, “There’s no limit on how innovative we can get with our ROVs!” Our engineers are highly qualified and well trained. We always follow the engineering design process because we know that using it will create a smoother building process and a better ROV for our clients. We guarantee satisfaction! Our team delivers high quality products on time or your money back! The HMS SeaBots create ROVs that will complete any mission that is deep, dark, and dangerous in the most efficient and effective way. You can ALWAYS count on the SeaBots to get the job done!

Design Rationale

We looked at three things while deciding the overall ROV design: functionality, serviceability, and aesthetics. In terms of functionality, we did many things to ensure that our orthogonal (ortho) triggerfish could be the best it could be. We used the “measure twice cut once” motto to make sure our frame was properly built. Our Electrical Engineers worked extremely hard to wire the tether, thrusters, and control box so the ROV would function properly. We were also able to easily service and troubleshoot our ROV because our design allowed us to remove the thrusters and take apart the frame with ease. For aesthetics, we decided to paint the ROV frame blue and gold to represent our school colors.

The ortho design for our Triggerfish ROV helps us maneuver through the water with ease. Part of this is due to our four-motor design. Two of the thrusters are used for going back and forth and left and right, the third thruster is used for side-to-side motion (crab), and the last one is used for vertical movement (up and down).

The capped PVC tubes located on the top two outer sides of our ROV help us control our buoyancy. The key to maneuverability is to be neutrally buoyant. We have achieved the perfect combination of floats and ballast to maneuver the ROV gracefully through the water. This will help insure success mission completion. We are also using neutrally buoyant tether. This tether will reduce drag and also help our “tether managers” manage the tether more efficiently and effectively during the missions.

We attached a water hydraulic manipulator arm to our ROV. The arm will allow us to complete some of the pool tasks. The arm is designed to pick up various objects on the pool floor and carry them to their destination.

All engineers have to make compromises to fit the needs of their goals. They call these compromises “design tradeoffs.” One design tradeoff we encountered was adding a fourth thruster to our ROV design. This was a design tradeoff because we knew that adding a fourth thruster would add more weight. However, this fourth thruster will give us more maneuverability in the water and allow us to crab sideways. We feel this added movement would help us be successful in the water.

Teamwork

At HMS SeaBots, we have our employees gain skills that they won't gain with other companies. One of the biggest skills we teach is teamwork. Michael Jordan once said, "Talent wins games, but teamwork and intelligence wins championships." We teach this skill to our engineers because it allows them to build upon what they already know. Also, our engineers get to combine their ideas to build a better ROV for our clients. Like Michael Jordan, we have the intelligence pre-built in our great employees, and we teach the skill of working in a team.

We teach this skill to our workers in many different ways. Most of the time, we split our employees into groups. Electrical Engineers work on the control boxes, mechanical engineers design our frames, and Sales Engineers are on the phone negotiating contracts. Working together as a whole helps each individual team accomplish what we have to do and gives us an ROV that can complete any mission without any limitations.

Another way we teach teamwork is through presentations. At our presentation meetings, we work as a team, giving each person a role to speak on their expertise. Even the person with the most expertise may have an issue with his/her presentation. This can include, the usual "ummms" and sometimes stage fright. This can also include some issues with their data (our workers would quickly jump in and fix the discrepancies). Receiving productive feedback from colleagues helps us get rid of any negative issues. We don't just make great ROVs, we also make great presentations also. Our teamwork has led the HMS SeaBots to great success.

Troubleshooting Techniques

The Triggerfish ROV control box was a bit challenging for us. We started the control box by taping all the components on a labeled piece of paper. We then followed the directions on the Power Point from the MATE website, and soldered all the pieces onto the four printed circuit boards. But as we began work on the control box assembly, we ran into some issues. The first of our issues began right after we finished all the soldering: two of the circuit boards just didn't work. The problem with them was that a couple of the components were facing the wrong way on the board! We used the solder sucker to remove them and resolder them in place. Unfortunately, our mistakes had ruined one of the circuit boards. We had to solder a jumper to fix our mistakes. After getting all the circuit boards to work, we had to remove the potentiometers and replace them with joysticks. Finally, we had gotten all of the correct components onto the circuit boards. Next we wanted to attach the strain relief for the tether to the control box, so we drilled a hole to put in the tether holder. But we soon found out that none of our drill bits were big enough to create a large enough hole to fit the tether holder. To work around this issue, we drilled as big of a hole as we could, then we took a Dremel and put a sanding piece on it and sanded around the hole to make it bigger. We made it big enough to fit the tether strain relief piece. On a more positive side of all of this, we got through it all and we made our very own Harrington Middle School Triggerfish ROV.

Safety First!

At HMS SeaBots, we always take every single necessary precaution to make our ROV safe. We want safe products and healthy people! ROVs can have some safety issues that might cause a short circuit and blow a fuse. Batteries can also cause shocks. One of the main precautions we take is taking our ROV and going through the MATE safety checklist with it. We find this checklist is a great way to ensure we are producing a safe ROV. Another precaution we take is installing an in-line fuse built into our control boxes. In the case of too much amperage going to a part of the ROV, the fuse would blow, and our ROV would remain unscathed except for the fact that we would have to replace the fuse and find the problem. The next step we take in keeping safe is by using propeller shrouds on our thrusters. Shrouding helps the ROV by blocking foreign objects that might try to damage the propellers. If a propeller gets damaged in the water, it would make it difficult to pilot the ROV back home. All in all, Harrington SeaBots try to make the safest ROV in the safest working environment or our clients and our team!

Lesson Learned - Center of Gravity

According to a physics website, the center of gravity is the point in which the resultant torque due to gravity forces vanish. Near the surface of the earth, where the gravity acts downward as a parallel force field, the center of gravity and the center of mass are the same. Center of gravity is the position where both sides are equal. For example, if there was a 1 kilogram weight on both sides of a scale, assuming that they are both 3 inches apart the center of gravity would be exactly in the middle, (0), or the fulcrum. If there is a bigger weight (5kg) on one side closer towards the center of the scale than a 4 kilogram weight the center of gravity would be toward the smaller weight, because the distance is not equal balancing out the weights.

We build our ROVs keeping center of gravity in mind. We pride ourselves on building ROVs that are perfectly balanced and do not tip to one side. If our ROV tilts to one side, it will have a hard time completing a mission and will cost both the clients and us money. So we try to diminish the problem and take precaution to ensure that our ROVs are centered and well balanced. This is why our ROVs are well built, fast, and reliable.

Lesson Learned - Buoyancy

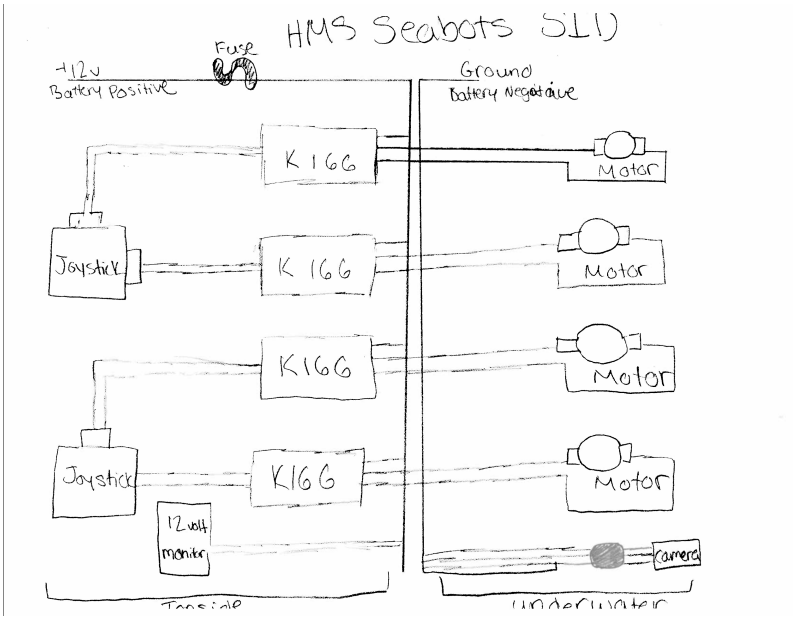
Buoyancy is the power to float or sink in a liquid. The key to buoyancy is the density of the object. To find the density of an object is to find the mass and divide it by the volume and you will get the density of the object. The density of fresh water is 1.00g/mL. There are three types of buoyancy.

- Positive Buoyancy- The object will float in the liquid; for example for an R.O.V to have positive buoyancy it needs to have a density less than 1.00g/mL to float in fresh water.
- Negative Buoyancy- The object will sink in the liquid; for example for an R.O.V to have negative buoyancy it needs to have a density more than 1.00g/mL to sink in fresh water.
- Neutral Buoyancy- The object will neither float or sink in the liquid: for example for an R.O.V to have neutral buoyancy it needs to have a density exactly 1.00g/mL to not sink or float in fresh water.

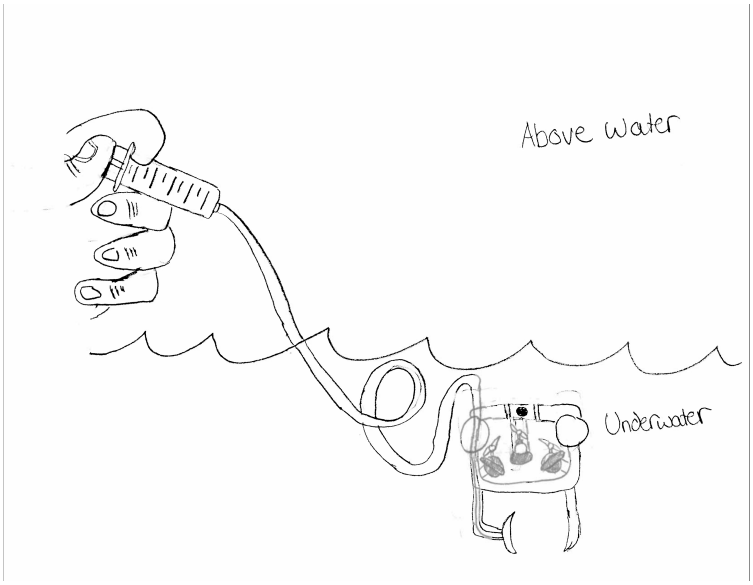
If you are looking for a company to help you with buoyancy HMS SeaBots is the best choice.

We are the perfect people to deal with buoyancy. We emphasize on giving our customers well-designed ROVs incorporating design methods such as this one. Our company's buoyancy tactics and strategic placing for weights and floats make us a good choice for your next mission.

Systems Integration Diagram



Fluid Power Diagram



Budget

Out of Pocket Expenses						
Item	Used For	Description	Cost/Each	Quantity	Cost/Total	Total Money Used
Syringes	Operation of the Manipulator Arm	Used to take oral medications	$1.00	3	$3.00	$3.00
Copper Piping (50 Ft)	Sending Fluid to Manipulator Arm	Water Line Piping	$36.89	2 Ft	$1.48	$4.48
Compression Tee	Building Manipulator Arm	Copper Pipe Tee	$5.98	1	$5.98	$10.46
Flexible Aquarium Tubing	Manipulator Arm	Flexible tubing used for home fish tanks	$34.02	1	$34.02	$44.48
Spray Paint	Coloring the Triggerfish ROV	Paint in aerosol form	$3.76	2	$7.52	$52.00
ABS Piping	Tether Housing	Holds the tether in place on the ROV	$3.57	1	$3.57	$55.57
PVC Hook	Used to pick up something in the pool	Hook that is used to hang PVC	$0.78	1	$0.78	$56.35
Pair of Tongs	Picking up things in the Pool	Regularly used to pick up food products	$1.99	1	$1.99	$58.34
CPVC	Manipulator Arm	Water Supply Piping	$5	1	$5	$63.34
Hook	Used to pick up something in the pool	Used to carry PVC	$1	1	$1	$64.34

Re-Used Expenses						
Item	Used For	Descriptions	Cost/Each	Quantity	Cost/Total	Total Money Used
PVC Piping	ROV Frame	Basic Plumbing Pipe that is Cut to Build Frame	$3.48	1	$3.48	$3.48
PVC Tees	Connecting PVC	Used to connect PVC Pipes	$0.48	23	$11.04	$14.52

Donations							
Item	Used For	Description	Cost/Each	Quantity	Cost/Total	Total Money Donated	Donated By:
M.A.T.E Triggerfish Kit	Miscellaneous Items	Items for Making the Triggerfish	$600.00	1	$600.00	$600.00	M.A.T.E. Center
TOTAL BUDGET							$678.86

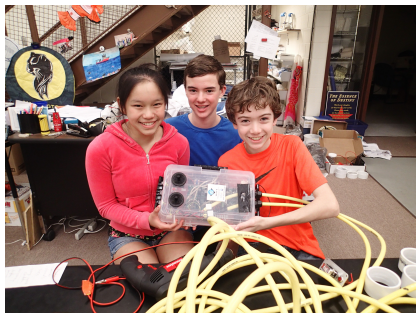
The Plan for the Future

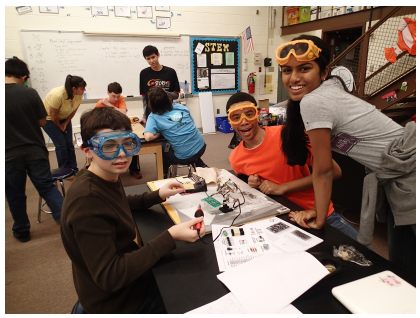
Since this was our first year competing in a MATE competition, we went with the standard Triggerfish Ortho design. As we built the ROV, we came together as a team to decide what we would want to do in the future for this design. Our team concluded that there were many upgrades that were necessary. Some of these adjustments included, making it able to help with recovery missions (such as the Malaysia Airlines Flight 370 retrieval mission), sleeker design, and also being able to help the army. Here are some modifications that we want to make in the future:

1. We need to improve the hydraulics and manipulator arms. We need to do a better job with these concepts on our next ROV. Everybody had ideas and wanted it done a certain way but couldn't put their ideas into motion. Fortunately one of our team members followed through and finished their idea. This was discussed as a group, and we concluded that we need to be more efficient in this area. After all, we pride ourselves in being ready at moment's notice, and nothing will stop us from getting the job done.

2. Also, a higher quality camera should be added to see more clearly in the water. Even though we already have a camera, we thought that we could add more cameras to obtain multiple views to get different perspectives in the water. This would help us to maneuver in the water better and see our surroundings. We thought we could add four cameras, one in front, the sides, and the rear. Having more eyes in the water can never be a bad thing.

3. This was our first year with MATE, so we thought that we could do a more sophisticated design in the future. This could help us get the judges' attention and show them that we mean business. Perhaps, we could add our logo onto the ROV. We decided Next year, we will create our own design and possibly improve maneuverability. We thought about one of the designs with a pointed front may help water move along the ROV frame and give us more speed and maneuverability.




HMS SeaBot Leadership

Ganesh Premarajah, CEO, Electrical Engineer

Job Description: Electrical Engineering

- Design entire control system for the underwater vehicle
- Control the use of power in the most efficient way
- Make use of resistors, diodes, capacitors, and circuit boards to make it able to push a button and make the vehicle go in the direction desired
- Design the charging system for the battery
- Design the delivery system for energy

- Make sure that the right voltage goes to the needed component
- Decide what type of battery is right for the system looking at how long the vehicle should run at a specific power
- Makes parts so that a new task can be attempted

I have the most awesome job in the world, and I look forward to coming to work every day! Collaborating with other HMS M.A.T.E engineers, such as the MechEs, is a task that I really enjoy. In addition to my EE skills, electrical engineers must have the ability to work on a team.

Sanjana Jampana, CEO, Ocean Engineer

As an Ocean Engineer, I am responsible for understanding the natural components of the ocean. My position with the HMS Seabots includes working closely with the MechEs to carefully choose materials that will allow our ROVs to survive the ocean environment. First, I have to deal with pressure, and a lot of it! I design the control housing so that is not damaged at any depth. I must design the ballast and flotation in a way that they will survive the ocean's natural atmosphere. I work to solve problems in the mechanical aspect, but I do not do exactly what the Mech Es do; I focus on the ocean's unforgiving environment and research accordingly. Positioning the motors is another task, and I strive to have these motors positioned so that the ROV is as maneuverable as possible. These are just a few of the responsibilities that HMS SeaBots engineers have in order to create amazing ROVs!

Looking Back…

"Working with the HMS Seabots has really helped me increase my knowledge of engineering and allowed me to learn how to work with and manage a team!" -Ganesh Premarajah

"Working with the HMS Seabots has helped me understand things in real life." -A.J. Byes

"Working with the HMS Seabots has helped me draw things from a whole different perspective, 3-D!" -Thomas Keane

"Working with the HMS Seabots has helped me learn how to solder components on to PCBs." -Zack Levitt

"During my tenure at the company, I had a great time working with my coworkers, putting my best foot forward, and getting the report and ROV done with great quality!" -Sanjana Jampana

Acknowledgements

The HMS SeaBots have received a lot of help from people and organizations outside of the company. A person who gave us a lot of help would be Mr. Levitt. Mr.Levitt, a computer technician who knows a lot about electronics (and Zack's Dad!), has helped our company a lot with the control box. Also, a thanks also goes out to the M.A.T.E. Center, which generously donated a MATE Triggerfish kit to our company. Video Ray has helped by donating 100 feet of neutrally buoyant tether. Mount Laurel Board of Education also gets thanks for their commitment to our HMS SeaBot after school program. And last but not least, thank you to our parents/guardians who often had to pick us up at school after long company meetings!

Thank you to our sponsors:

References

"MATE - Marine Advanced Technology Education :: TriggerFish." ***MATE - Marine Advanced Technology Education :: TriggerFish Instructions Page 1.*** **Marine Advanced Technology Education, n.d. Web. 05 May 2014. <http://www.marinetech.org/triggerfish-instructions-and-curriculum/>.**

Moore, Steven W., Harry Bohm, and Vickie Jensen. ***Underwater Robotics: Science, Design & Fabrication*****. Monterey, CA: Marine Advanced Technology Education (MATE) Center, 2010. Print.**