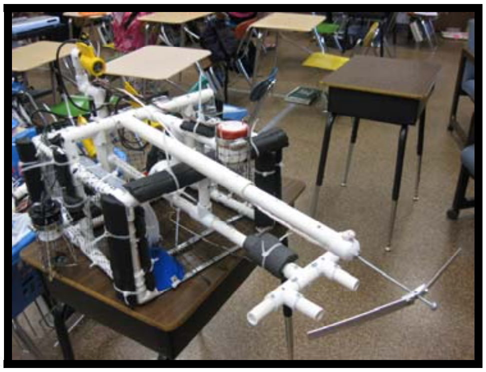
Socastee High School SEAL Team

Myrtle Beach, South Carolina



Members:

Meg Oshima – Engineer, Marine Science, 2011

Brian Nguyen – Engineer, Marine Science, 2011

Kirtan Patel – Engineer, Biochemistry, 2011

Matt Ives – Engineer, Aerospace Engineer, 2011

Cody Edgar – Engineer, Computer Engineer, 2011

Kyle Beale – Engineer, Electrical Engineer, 2012

Peter Straus – Engineer, Education, 2012

Stephanie Hetzer – Pilot, International Affairs, 2012

Instructors:

Chris Weeks

Shannon Stone

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Abstract

Described within the following technical report are the design, construction, and implementation of Socastee High School's 2011 ROV being entered into the MATE ROV competition in Myrtle Beach, South Carolina. The design and construction of this ROV was carried out by a team of eight high school seniors and juniors while being overviewed and sponsored by two mentors that work within the science department at Socastee High School. The creation process spanned over the course of five months beginning in January with the designing of the machine. The missions by which the ROV was designed and constructed around were based on ones which marine scientists would likely encounter during the Deep Water Horizon Incident. The missions include; removing the damaged riser pipe, capping the oil well, obtaining water samples and measuring depth, and collecting biological samples. The final ROV includes six bilge pumps and three cameras. Four of the five bilge pumps are fixed with 55 mm propellers used to control the movement of the vehicle, while one is fixed with a 40 mm propeller. Wire hangers protrude from the front of the ROV to collect biological samples, while a prong extends out the front of the ROV to turn the wheel. A Johnson bilge pump near the back of the ROV pumps water into a platypus bag for water sampling, and a harpoon extends out the front to pull the U-bolt. Water depth is taken using a depth gauge placed in the center of the ROV.

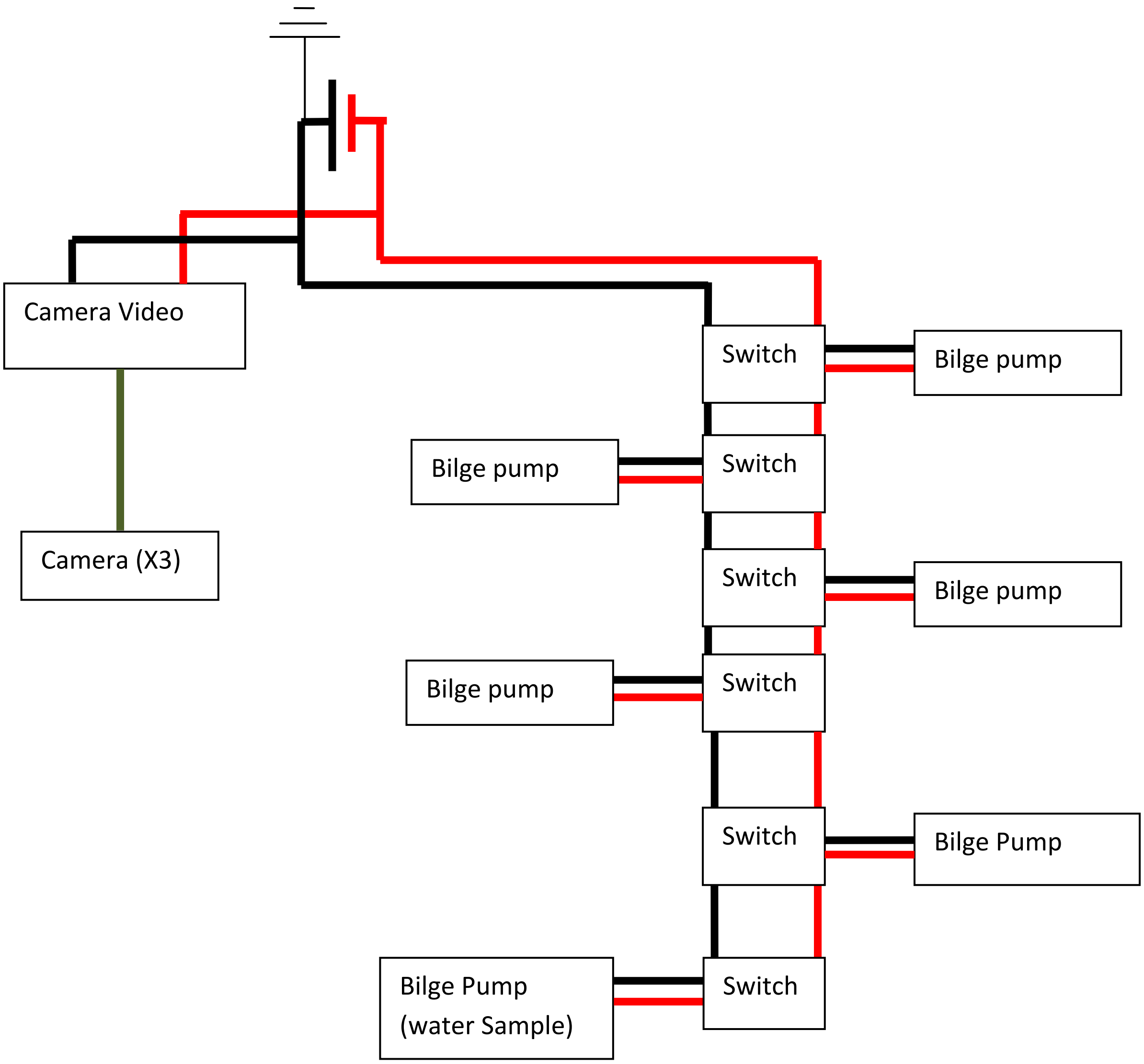
Budget/Expense Sheet

Item	Unit Price (US$)	Quantity	Cost (US$)
Propeller Blades	$8.20	5	$41.00*
Tether 600ft. 18 gauge	$48.00	1	$48.00*
Thruster Couplings	$1.95	5	$9.75*
Control Box	$4.50	2	$9.00*
Switches	$2.00	6	$12.00*
Bilge Pumps	$25.00	6	$150.00*
Cameras/Monitors	$100.00	3	$300.00*
Surfboard Foam Scraps	$0.00	1	$0.00*
Platypus Bag	$20.00	1	$20.00*
Funnel	$1.00	1	$1.00*
Mesh Netting	$4.00	1	$4.00*
Clothes Hangers	$0.15	10	$1.50*
Aluminum Flat Bar	$1.95	1	$1.95*
Magnets	$0.00	2	$0.00*
PVC pipe	$2.00	1	$2.00*
PVC fittings	$0.45	34	$15.30*
Drywall Anchor w/ Fittings	$1.00	1	$1.00*
Threaded Rod	$1.50	1	$1.50*
Plastic Tubing	$0.50	2	$1.00*
		Total	**$619.00**

**Donated*

Total Expenses after Donations $**0.00**

Electrical Schematic



Design Rationale

Frame: PVC piping was chosen as the frame because it is a light weight material, cheap to purchase in large amounts, and easy to shape. Pre-made corner pieces of different angles made the fabrication of the ROV easier. Also, the PVC piping was chosen because it can be easily cut into different shapes to create the optimal frame for the ROV to best accomplish all of the missions. Finding a suitable frame proved a problem for the turning of the valve. Our plan is to barrel roll the ROV to complete the task, but in order to do this we had to mound all of our propulsion on the same plane and everything around one axis in order for the ROV to roll properly.

Buoyancy: In order to make our ROV neutrally buoyant we added strips of surfboard foam. At first we attempted to use water bottles but they did not easily mount to the sides of the ROV. The water bottles were also difficult for adjusting buoyancy, and compressed at depths below 12 feet. We decided on surfboard foam because it does not compress and so would be better suited for the depths we must reach this year. It was critical to make sure that as the ROV descended, the buoyancy did not change. Through trial and error, we figured out the placement of the foam that would make the ROV both balanced and neutral. Most of the foam is located on the side posts with only a little on top because we needed it to be able to barrel roll. More foam on top makes the ROV more stable and less likely to roll. We also wanted to maintain stability, while still being able to barrel roll so we had to be very careful about where we put the foam. Once we had the foam placed in the correct locations, we painted it with an oil based paint to prevent it from water logging and losing buoyancy.

Tether: Speaker wire was used for our tether because different gauges are readily available, which allowed us to control the power flow to each of our motors. We used 18 gauge wire because it was thinner than 16 gauge wire which made our tether a neater and more manageable size, and it gave us more pounds of thrust than 20 gauge wire (which only gives 1 pound of thrust over a 100ft tether). The speaker wire was also chosen because we could purchase it at a very low price compared to other wiring. The tether consists of a braid of the four wires leading to the four main bilge pumps, three camera wires, and two other wires for the water sampling bilge pump and bow bilge pump. On top of all these wires are foam pieces which we zip tied in place to make the tether neutrally buoyant.

Propulsion: Five bilge pumps were used as thrusters to move the ROV: two for moving forward, backward, left and right, two for moving up, down, and to roll the ROV to turn the shut off valve, as well as one located out front that controls attitude so the ROV can dive to scoop up objects such as the sea cucumbers or glass sponges. These pumps were chosen because they were already waterproofed, easy to wire, and were relatively cheap. The first four pumps mentioned had a forward thrust of 1.8 pounds and a backward thrust of 1.4 pounds. The attitude pump has a smaller forward and backward thrust of 1.5 and 1.2 pounds so it can have less of a chance of flipping the ROV over. Prop diameter for the main four pumps is 55mm each. The prop on the attitude pump was is 40mm long so it would not be as powerful as the others. The props themselves are boat props to achieve the maximum thrust through water. The props maximum amp draw is 6amps; in total there are 24amps when all four motors are run at once, which is still in our safe zone.

Cameras:

> **Camera 1** is positioned at the top, rear of the ROV. It provides an elevated view of the ROV with the front portion of the ROV visible to provide a visual reference. This camera is primarily used for open water driving, not during completion of the tasks because it allows for the best spatial awareness but does not give a view of the majority of components on the ROV.
>
> **Camera 2** is positioned on the left side of the ROV, giving a view of the specimen basket, hook, depth gage, and bow extension beam (tasked with turning of shut off valve). It will be used for the majority of tasks.
>
> **Camera 3** is positioned on the right side of the ROV giving a view of the water sampling device as well as the bottom of the ROV where we will approach the water sampling area. This is the main purpose of this camera, but it may also serve to help spot obstacles or objectives below the ROV.

Water Sampler: A sixth bilge pump has been added to the ROV in order to collect the water sample. The bilge pump has a funnel mounted flush to the bottom of the ROV with a hose connecting to the intake of the pump. On the output of the pump is a platypus bag connected by another hose. The pilot, using Camera 3, lowers the ROV onto the water sampling tube and into the mouth of the funnel. The bilge pump is then turned on and the contents of the water sample flow through the hoses into the platypus bag.

Harpoon: The harpoon was constructed by drilling a hole through a PVC cap and sliding a threaded rod through. The rod was held in place by the use of two washers and lock nuts tightened to each side of the cap. The cap was placed into a PVC pipe with a magnet taped to the inside of the opposite end of the pipe. A drywall anchor was screwed onto the top of the exposed part of the bolt and aluminum bars were added to each side of the drywall anchor to widen its overall reach. The drywall anchor was held in place by the use of nuts on each side. Loc-tite was used to ensure stability. Another piece of PVC was attached to the ROV with a magnet tapped to the inside. We slid a bigger piece of PVC pipe over the smaller one and secured to it the ROV. The harpoon slides into the bigger PVC and the magnets connect. The magnets hold the harpoon in place while performing other tasks. When the harpoon is pushed through the U-bolt, the bars are pushed back until it completely passes the U-bolt. The ROV is then able to back up and the harpoon will lock in place.

Troubleshooting

One of our biggest issues while building the ROV was having to wait for parts; particularly the couplings needed to mount the boat props to the bilge pumps. They were ordered and put on hold. At this point we needed to test a lot of what we designed in the water in conjunction with our currently incomplete propulsion. This put us behind our building schedule. Finding effective mounts for the propulsion was another major problem because we had to make sure they would not get caught in the net under the ROV but yet centered enough to balance the ROV's directional movements. Mounting the cameras provided another challenge. We wanted the fewest number of cameras necessary to give us clear views of all the ROV's tools. The final placement included moving many of the tools to the front and adding extra infrastructure in order to fit all of the tools into the camera angles. Overall, the biggest problem we faced was maintaining the building schedule we set. Each time a deadline arrived, something would set it back. Whether it was waiting for parts or figuring out something we planned would not work.

Lessons Learned

We learned about real life applications of robot technology, design, and the construction of electronic and mechanical tools from scratch. One interesting lesson we learned was how much equipment we could find in objects laying around that no one uses anymore. We learned to use simple parts to create working designs. One of our most important lessons was not to wait so long or rely so much on a single component, or the ROV becomes that much harder to build. Lastly, most members of our team were new this year and learned that building an operational ROV takes much more time and hard work than originally thought.

Future Improvements

If this ROV had to be built again, we would probably make it a little bigger in order to fit all of the components such as cameras and motors, with more free space left over on the ROV. In the future, we will also try to have more people working on the ROV so it could be built faster and have better ideas on the project.

Personal Reflections:

Meg Oshima

My experience in working with the ROV has helped prepare me for my future in the marine sciences. Figuring out the solutions to the various problems we encountered challenged my problem solving skills and helped me further my abilities. Working with a larger team this year has helped me learn to take a bunch of different ideas and create one or two really good ideas. This year I have further developed my appreciation for teamwork and my fellow teammates.

Brian Nguyen

Being part of Socastee's ROV team has given me an opportunity to further extend my knowledge in regards to hydro technology. In working with others, I have learned the importance of team work. Furthermore, working on the ROV has put me out of my comfort zone in that I have experienced working with tools and performing task I would have never seen myself doing before, such as soldering.

Matt Ives

This project gave me a lot of new experiences. It gave me the opportunity to work on projects I don't normally undertake in designing, wiring, and troubleshooting our ROV platform. The difficulties that were presented included everything from camera mounting to buoyancy and pushed my ability to solve problems. I was able to learn new skills such as soldering and planning the details that go into creating a remotely piloted vehicle. Overall the project was one big challenge. It made me think above all else, but also forced me to better manage my schedule around designing, building, tweaking, and finishing the ROV. The long process that was the multitude of problems served to increase my knowledge, increase my patience, and think my way through the design.

Kyle Beale

I joined ROV because I always was interested in robotics from when I was younger, so I continued to follow that interest. I love working with wires and building new things and ROV let me do both these things so it was perfect for me. Building the ROV was a lot of fun for me and it taught me how to think in different ways to be able to design a certain part. It also taught me new skills like how to use the dremel tool.

Stephanie Hetzer

This is my second year doing ROV and I am loving this year just as much as the first. I had no real experience with engineering before I joined the team last year but this experience has really helped me to broaden my knowledge. We had a great team last year and an equally great team this year, I've just had so much fun working with all of them, especially since most of them are people I wouldn't meet through my normal school day. Though engineering is not my focus for the future I feel I've gained so much through joining ROV and I hope the tradition continues for many more years.

Peter Straus

I have been honored with the privilege to be on the Socastee High School ROV team. It has been a wonderful experience to work on a project with a small, select group of the smartest people in the school, especially when I learn something completely foreign to me in the process. Building this ROV has gotten me out of my comfort zone and learn skills I may be able to apply in life one day, especially critical thinking. Discovering what can be done with PVC pipe, a couple cameras, and a few pumps and props has been an enlightening experience and forces us to improvise solutions to the problems presented to us in the competition. Learning how to think was probably the greatest lesson I will get out of projects such as building this ROV.

Kirtan Patel

This is my second year working on the ROV and I have learned to appreciate the amount of time and effort everyone has put into successfully creating this ROV. I enjoy working in teams and especially on hands on projects and this experience has allowed me to do both. Throughout this experience I have learned how to overcome many problems and think outside the box which will help me in many other real life situations that I may experience in the future. The project has further enhanced my appreciation for people who do this for a living while also opening my eyes up to the various opportunities there are available for me in the future and I have greatly enjoyed this experience.

Cody Edgar

Being part of the ROV team at Socastee has been an extremely gratifying experience. I had hoped to do it last year, but missed my opportunity and was very disappointed. Missing out on my chances last year, however, made the experience that much better this year. All of the team members are easy to work with, and care as much about this team as I do. They all have worked so hard for this team, and knowing that my teammates are just as dedicated as I am is an inspiring feeling. I have always hoped to become involved in engineering, and helping to build the ROV gave me some first-hand experience with this type of work. Now, having done some engineering work, I am more excited than ever to work on engineering in college and eventually have a career in it. Joining ROV was one of the best decisions I have ever made, and I hope to be involved in similar programs once I enter college.

Acknowledgements:

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References

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