Aquabot Technicians

Foy H. Moody High School

Corpus Christi, Texas, USA

REDEMPTION

Elijah Euresti- CEO- '18

Shelby Rivera- COO/ Technical Documenter– '18

Anthony Escatiola- Mechanical Engineer/Safety Specialist – '18

Madelyn Perez- Technical Documenter- '18

Ariana Benavides- Display Board/Media Outreach– '18

Ramsey Tapia- CTO/Software Engineer- '19

Kisha Charles- Mentor

Ramsey Almaguer-Project Manager/Co-Pilot– '19

Nico Nieto- Software Engineer – '19

Julianna Gomez- CFO- '20

Matthew Cantu- Research and Development- '20

Matthew Rodriguez- Pilot/Electrical Engineer- '20

Mario Bayarena- Mentor

2017-2018

Aquabot Employees

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I.Introduction

A. Abstract

From the beginning, our oceans have been the largest surface portion of the Earth. The oceans have enormous areas of high pressures, temperatures, and density. Mankind has only scratched the surface of harnessing its great potential. The oceans' having such power lends to no discrimination of those who explore it by way of under and above the vast area. The earth's natural movement that creates earthquakes contributes to the unleashed power of tsunamis. The thousands of square miles between continents make for people of courage crossing it by ship or air vulnerable for losing their lives with its giant swells and deep crevices. Here at Aquabot Technicians we have made a product that will surpass any industry competitor by using a lifesaver approach. Our Remotely Operated Vehicle (ROV) "Redemption" can harness the ocean current strengths by efficiently installing Tidal generators to produce electrical power, position Ocean Bottom Seismometers for measuring earth movements and by recovering Airplanes that have succumb to the strength of the ocean's abyss.

B. Theme

ROV's are playing a major role in performing tasks that have been proven too dangerous for humans to complete. With continuous advancements in the electronic industry, ROVs are now capable of reaching extreme ocean depths in order to do difficult tasks, such as locating and retrieving debris from a crashed airplane. Specialized ROVs, similar to the one used by the National Marine Sanctuary Foundation (NMSF), can be utilized to monitor and keep a clean and contaminant free environment. Other ROVs can be customized to be compatible with an ocean bottom seismometer (OBS) or can be equipped to determine the optimal location for a tidal turbine, using tidal data and state of the art visuals. Aquabot Technician's newest design, *Redemption* is ready to dive in to any of these situations. *Redemption* is specifically constructed to satisfy the needs retaining to the Energy, Earthquakes, and Aircraft tasks proposed by the 2018 MATE request for proposal.

C. Description of Project Management

As a company, each employee gave their input in order to present an overall projected timeline to help employees work efficiently and in a timely manner by meeting deadlines and accomplishing assigned tasks and prototypes. The delineated spreadsheet listing below in ***Figure 1*** are the details of the tasks that needed to be completed along with a firm deadline. An accumulation of the ROV construction along with the mission accessories were prioritized on a calendar for employees to strive for each task completion. To ensure that each employee of Aquabot Technicians followed the instructed timeline, the company CEO implemented a system of weekly goals for each employee to accomplish to insure the overall monthly and yearly timelines were met.

Every week, each employee came up with a goal in their specialized area. The goal/s was to be completed and documented at the end of the week in our engineering notebooks. To evaluate progress, daily entries were documented and if needed were continued the following week. This delineated timeline allowed us to get our work done and innovate an ROV that met all requirements.

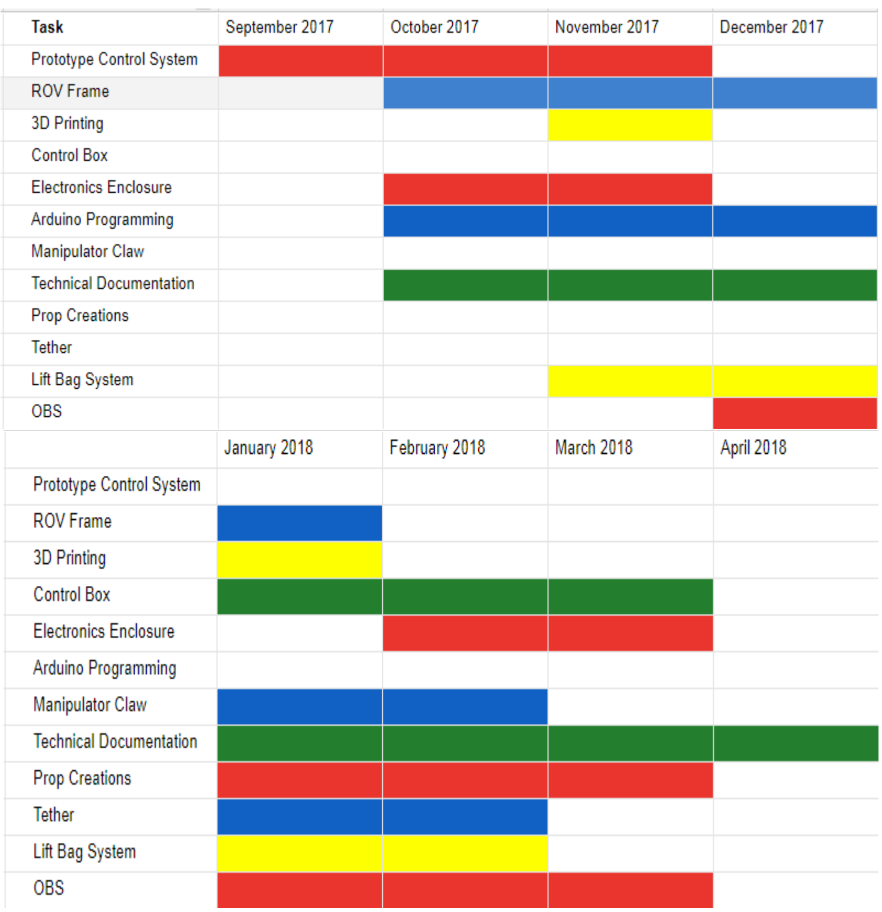


Figure 1: Company Project Timeline

D. Company Assignments

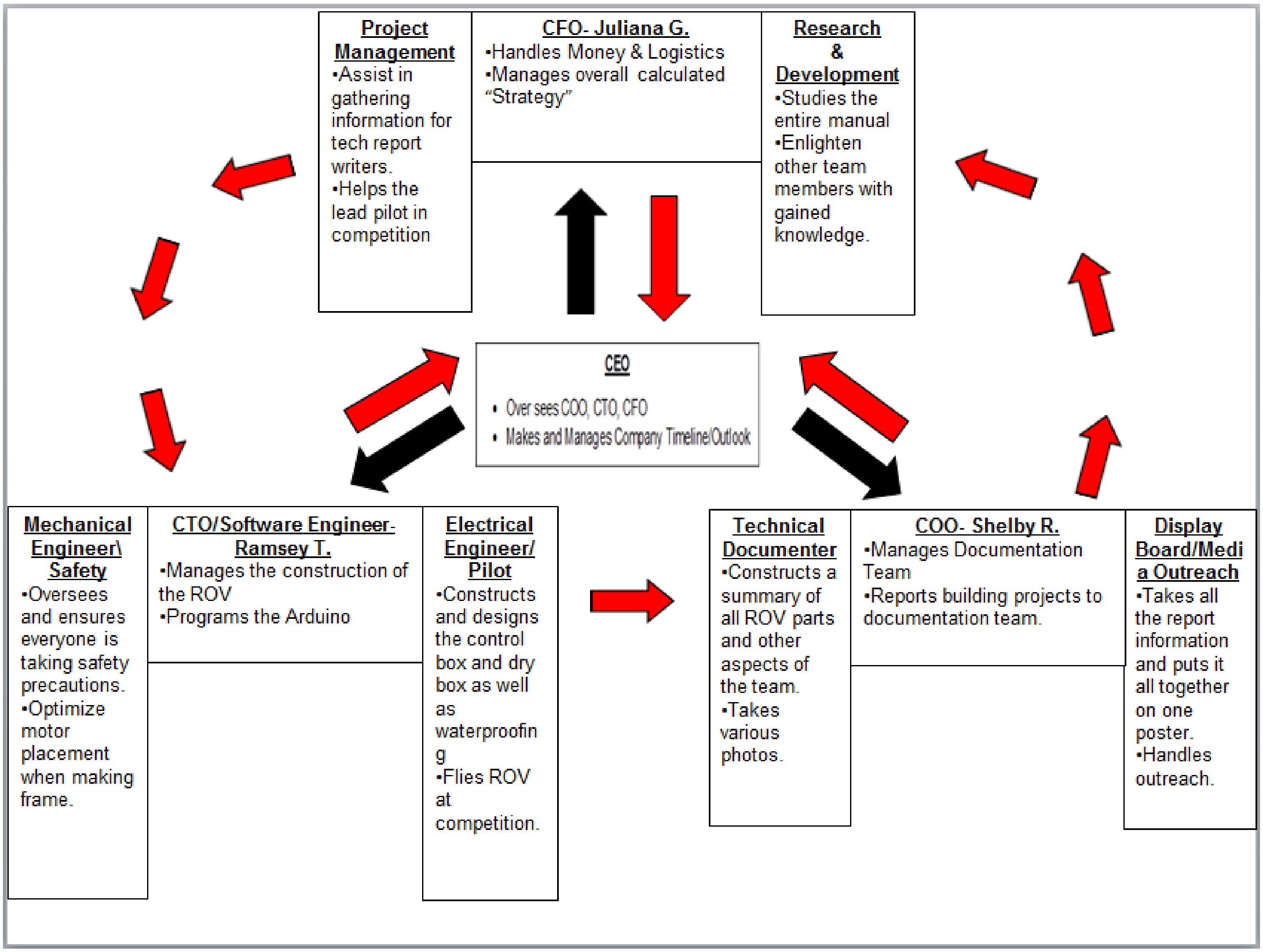


Figure 2: CEO Elijah Euresti during a weekly team meeting Picture by Val Cantu

II. Design Rationale

A. Design Process

Factors in mind when approaching the design process; the ROV is set to operate in a busy industry with specific constraints. With this in mind, Redemption has a compact hydrodynamic design, containing materials and different manufacturing techniques specific for Mission tasks. Also, Aquabot Technicians have stream-lined budgeting for a highly productive ROV at a reasonable cost for our clientele.

B. Design Evolution

Our company considered the design of the previous ROV, *Garibaldi*, which demonstrated positive attributes. The goal was to preserve its lightweight, compact and hydrodynamic nature. An evaluation of its weaknesses and a modification of its design was done to meet the challenges of the tasks. These features greatly boosted performance.

As seen in Introduction paragraph C, all departments could easily view the prototype design and suggest any beneficial modifications. Members of the company's different teams voiced their opinions and suggestions.

Mechanical Design

C. Frame

The company construction team created the final ROV frame after several design modifications to the *Garibaldi* prototype design. We made modifications based on several factors, including our electronics enclosure tube, the thrusters, and the overall size and weight of the ROV.

As the frame design was still in the prototype stage, we named her *Redemption*. Given this year's competition size restrictions and task constraints, the frame design came to fruition. Redemption's design had been altered repeatedly in order to meet the vision of Aquabot Technicians' construction team. The new design allowed for unique capabilities. Redemption's rectangular prism design, allows for exploration anywhere you could imagine underneath the sea. The electrical system is housed in an acrylic tube that is sealed and waterproofed in order to keep the surrounding environment and the ROV in top condition. To keep the dry box (acrylic tube) in place, we 3-D printed two 12.7cm x 5.7cm pieces, which were 1.9cm thick, with indentions that were a half of a circle with a radius of 5.7 centimeters. Our ROV is composed of 24 pieces of flat and angled aluminum and 30 machine bolts and nuts. We chose this type of frame because aluminum is strong, durable, and compact. The dimensions of Redemption are 35.6cm x 17.8cm x 17.8cm, with the "wings" of our ROV extending out 38.1 centimeters. Redemption's sleek and compact frame is designed specifically with our client's size constraints in mind. After all considerations, brainstorming on the placement of each component, Redemption was finished with a vibrant red to standout in the ocean. ***Figure 3***

D. Buoyancy

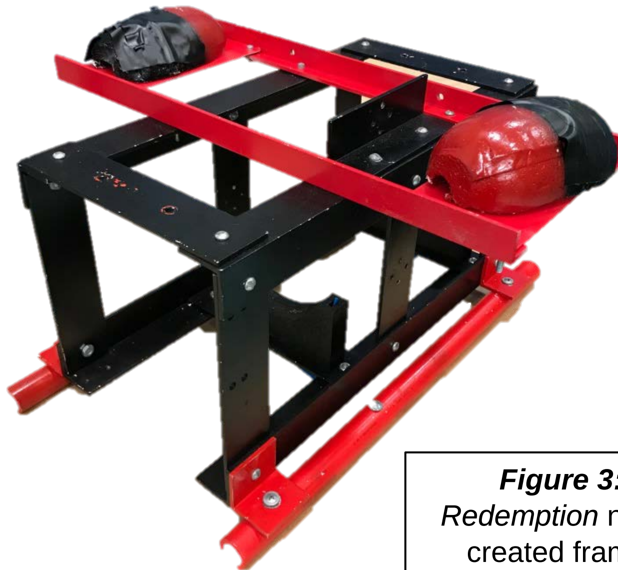


Figure 3:
Redemption newly created frame.

Buoyancy was easy to gauge because the ROV was negatively buoyant due to the weight of all of her components. This meant that all that was needed was to add buoyancy little by little until *Redemption* was slightly positively buoyant. After that was accomplished, we had noticed that the ROV would easily roll whenever the pilot gave her thrust. This was a result of her center of mass not being center with the entire ROV, but rather being in the electrical dry box.

In order to prevent *Redemption* from rolling we added two aluminum angle pieces (20 cm in length) to hold two half buoys on either side of the ROV. The Aluminum angles and buoys act as wings to stabilize *Redemption's* buoyancy and keep the ROV balanced.

E. Claw

Our company designed a new revolutionary claw called Dubs, out of respect for the Applied Physics Laboratory at the University of Washington, whom released the RFP. This was our way to pay respect to them for allowing us to be of assistance to them. ***Figure 4***

It is constructed from a vex claw using two 10 mL syringes attached to a 40 ft. tube. One syringes is screwed into the right side of the vex claw, so that it can move when we push or pull the syringe plunger at the other end of the tube. The amount of water going through the syringes and tubing is 140 mL for maximum power.

After testing our original design, we found that our claw was having difficulty gripping objects underwater. So, we decided to fix the issue by adding a gear belt to the tips of the claw to create more grip. This easily solved our problem and allows dubs to get tasks done efficiently.

Figure 4:
Redemption's
Claw "*Dubs*"

F. Electronics Enclosure

The electronics enclosure is a vital component of our ROV systems. We needed to have a central location on our ROV to easily connect to the electronic components such as our camera and thrusters. We decided to house all electronic components in a glass tube. To place the tube in the correct central location, we 3D printed two base mounts that are attached to our frame in which the tube is housed. For grip, we put a layer of hot glue on the mount where the tube rests.

Inside the electronics enclosure there is a pair of power distribution blocks that allows for power to be distributed easily, and to have a quick connect/disconnection point.

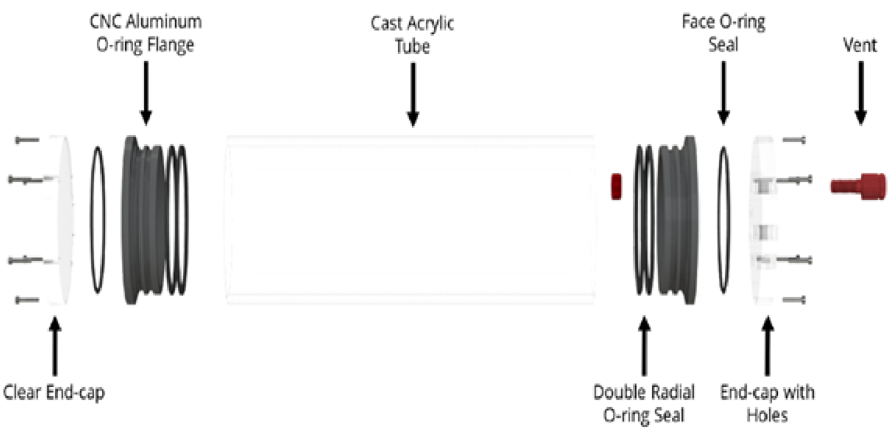


Figure 5: 4" Acrylic Tube with hardware

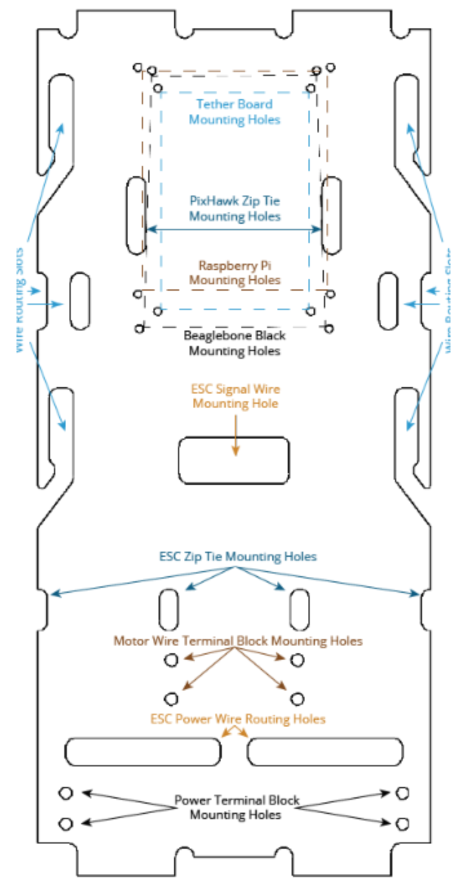


Figure 6: Electronic Tray

G. Control Box

The control box is made from ¾ inch Birch plywood. The ¼" Plexiglas top is fastened with a continuous piano hinge and the bottom is closed off with ¼ inch peg board for ventilation. The box dimensions are 44.45cm x17.78cm x17.61cm. Joysticks are used for control of the thrusters and are placed 7.62cm from the bottom edge and 12.7cm from the side edge. Also located in the control box are the OBS transmitter push button, RCA camera output, and the power kill switch. ***Figure 7***

On each end of the control box exterior there is a tether relief and strain relief for the tether wires and the 12 volt power-in cord. The interior of the control box is where the electronics are housed. A terminal block is used to distribute the 12 volt power supply. The power source terminal block feeds 4 electronic speed controllers (ESCs), which is the power source for the T100 brushless thrusters. Additionally, we feed a DC to DC step down transformer 12 volts to 5 volts to power the Arduino microprocessor. An Arduino shield is used to distribute the power and signal inputs/outputs. Based on Arduino coding, we connected signal wires from ports of the Arduino to Joysticks (one for thrust and one for heave). A Phantom electronic component is used for camera feed via a CAT5e signal wire. The Phantom is connected to the power terminal block that distributes 12 volts for signal for the camera.

Bullet connectors and terminal blocks are used at each end of the ESC's and thrusters for quick release and disconnect in case of thruster frailer. *Redemption* is also equipped with terminal blocks for fast and easy disconnect of all vital electronic components. This added fixture is one of the fundamental standards of our failsafe electronic system should a component require replacement.

Figure 7: Picture of Final Control box

H. Arduino & Joysticks connections explained

Arduino Uno controls the T100 thrusters for heave, thrust and yaw. To do this, it sends coded signals to the Electronics Speed Controller (ESC), in the form of pulse width modulation, or PWM. These are digital signals which can only be sent as 1 or 0. However, by alternating between these so that the signal is sent in pulses of different percentages of "1" or "0", a wide range of options are available to control the thruster motor speed. In order to send these signals, the Arduino needs to read analog input signal from the joysticks and the correlated output of the correct signal from there. The joysticks consist of 2 potentiometers, which have a reading of 0-1023 on each axis as a value that is outputted depending on our joystick's position. The potentiometer on the right controls the thrust of the motors. However, the potentiometer on the bottom (when looking from straight above) influences this, and is the turning potentiometer. The Arduino starts with the center position of the axis, which corresponds to a PWM of 1500, and means no signal. It then adds the turn command's thrust value to the forward command's value to one motor, and subtracts the turn command from the forward command on another. This means that if the joystick is moved left or right, the motors will go in opposite directions, allowing yaw movement.

Figure 8: Arduino Uno

Figure 9: Joystick

I. Electronics Speed Controller (ESC)

30A Electronics Speed Controller (ESC) ***Figure 10***, manufactured by Afro, is the essential part of our ROV. They are needed to run a three-phase brushless motor thruster. Blue Robotics preprogrammed the ESCs with forward/reverse firmware to allow for easy user assembly. The ESCs allow the motor to be controlled by the Arduino Uno in the control box. They connect to a single motor using three wires and are powered using three wires. While normally, more wires would be needed to be used for data, like a ground wire and a data wire, the ESCs already have the data ground with their power source's ground. We discovered this when we were doing testing. We overlooked plugging in the ground wires, and found that the motors were still working fine. We performed additional research to verify that an internal ground was in use.

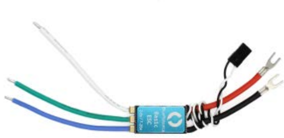


Figure 10: Electronic Speed Controller

J. Thrusters

Redemption consists of three T100 Thrusters from Blue Robotics ***Figure 11***. The T100 thrusters from Blue Robotics are powerful and cost-efficient. We program the motors to run at 85% power, which has an amp draw of under 6 A for each motor. The T100 thrusters have 4 screw holes for mounting the motors. We designed new mounts for the thruster motors that are made specifically for attaching to PVC or Aluminum. This mount is a 90 degree angle piece of one inch aluminum that is strong enough to keep our thrusters mounted to the frame without any unwanted movement.

Figure 11: The Blue Robotics T100 thrusters that are on *Redemption*.

K. Camera

Redemption uses a Low-Light Analog camera purchased from Blue Robotics ***Figure 12***. The camera is ideal for low-light situations, with a sensitivity of 0.0003 lux.; perfect for underwater exploration. The Low-Light Analog Camera has a 2.1mm lens, with a wide-angle field of view. The camera signal is sent via Fathom-S interface ***Figure 13***.

Figure 12: The Blue Robotics Low-Light Analog Camera as seen on *Redemption.*

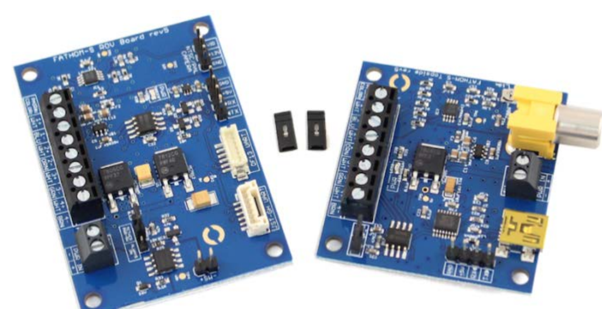


Figure 13: Fathom-S Tether Interface Boards provide a video and communication interface between the ROV and control

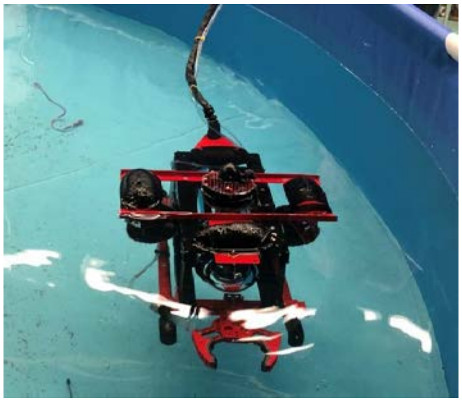


Figure 14: *Redemption* showing perfect neutral buoyancy. Picture by Val Cantu

L. Tether

The tether was designed to allow *Redemption* to maneuver throughout the water with minimal drag. All wires are enclosed in yellow casing in order to protect both the environment and the ROV.

- The tether is 10.67 meters long.
- The tether includes 2 cat5e wires (one solid, the other stranded wire, both include 8 conductors), 1 – 8 conductor 18ga, 1 – 4 conductor 18ga, one pneumatic hose (clear tubing), and 2 hydraulic hoses (clear tubing).
- Tether strain relievers are placed at the ends of the tether and the power supply to ensure that nothing is too stressed during operation.

Figures 15 & 16: tether strain relief (left) and the wires fed into the tether (right).

Finally, for our tether, we took several precautions in order to ensure safety and functionality. Where the tether leaves the control box, we used a strain relief to ensure that the wires inside the control box couldn't be pulled. Before the tether reaches the enclosure, we designed a 3D printed strain relief that prevents the connections from being directly pulled upon and possibly becoming disconnected. On the outside of the electronics enclosure, cable penetrators are attached to an aluminum end cap with 14 holes. The cable penetrators allow the wire to pass through the aluminum end cap without allowing water to enter.

M. Lift Bag

The company, when it came to deciding whether to build a lift bag from scratch or to buy one ready to use, first measured what the benefits and drawbacks of each option would be. If we were to build one from scratch, it would be time consuming but it would ensure that we would know everything about the lift bag. If we were to buy a professional one, it would be guaranteed to work but it would require a copious amount of money. After checking our budget and planning the time necessary for both options, we decided to create our very own lift bag.

Figure 17: Lift bag created out of swimming

The lift bags are made primarily out of the lining of a 10 ft. "Summer Waves" swimming pool ***Figure 17***. Other materials include PVC, the metal hook in plastic coat hangers, hot glue, and a metal clamp. Made to mimic the traditional lift bag, we started by cutting out a circular piece of the pool with a diameter of about 1.2 meters (4 ft.). Then, multiple small semi circles were cut along the edge to almost give it a star-like look. Once that was done, we put the star points onto a 2" PVC pipe and clamped them together with a metal clamp. We then attached hooks that we made using clothing hangers to the PVC pipe using hot glue and zip ties. In order for the lift bag to not be too buoyant, fishing weights were added in the PVC pipe. These materials are all cost efficient and light in weight. We added extra weight below the hooks so the ROV could grasp the bag while still maintaining view of the hook.

N. OBS System

The Ocean Bottom Seismometer (OBS) is a device specially designed to detect earthquakes or seismic activity underwater. When seismic movement is detected by the OBS, a weight at the OBS's core moves in correlation with the detected seismic activity and the movement is recorded via a rotating drum or other similar recording device. One of the tasks in the RFP was that the product must be capable of surfacing an OBS after it has received power, by installing its power cable. In order to make sure our product will be the best, Aquabot Technicians constructed a simulated, non-working, OBS to test.

Figure 18 & 19: OBS Anchor (right) and the OBS (left).

Comprised of PVC, a trailer magnet, a shower-drain, Velcro, floatation, and a common garage door receiver; our company's OBS ***Figure 18*** and its anchor ***Figure 19*** were able to provide our pilot with a realistic work environment. The OBS itself is equip with a shower drain so that it would be connected to the anchor via magnetism and a buoy for floatation. The female adaptor (represented by a PVC T-connector) is lined with Velcro so that when the power cable is inserted, it would not fall out easily.

The anchor is used to keep hold of the OBS while it is underwater. It does so through magnetic connection with an electric magnet being fed a constant 12 volts of power. The OBS is released when the ROV sends a transmitter signal to a receiver located in a dry box on the anchor. The signal, when received, kills the magnet's power and releases the positively buoyant OBS. In the case of signal problem, from either the ROV or the receiver, we can still surface the OBS by pushing it off its anchor.

O. <u>Troubleshooting</u>

At Aquabot Technicians, our mission is to provide our clients with a reliable, high-quality product while remaining as cost efficient as possible. When troubleshooting, Aquabot Technicians used the trial, error and document process. When testing connections and testing waterproofing we would call consultants from our neighboring teams for help, knowledgeable in both underwater and land robotics. We would also have our safety specialist perform a safety inspection of the ROV and all of her components. Overall, this troubleshooting technique has never failed us; solving any problems that arise during our company's projects. Whenever the company needed to troubleshoot any of the electronics, we would use a volt-ohm meter and do the following to diagnose the problem:

- Check the power source.
- Test power across all connections and switches.
- Test the fuse itself.
- Test the conductors at their connection points.

In the case that the problem was not electrical, like with the hydraulic claw, members would:

- Do a thorough visual inspection of the ROV and tubing for cuts, bends, etc.
- Check for any air bubbles (hydraulic)
- Check syringes to see if any are loose (hydraulic)

III.Safety

A. <u>Company Safety Philosophy "Not Safety First, But Safety Always!"</u>

Throughout the process of constructing *Redemption*, Aquabot Technicians encountered no lost time injuries. Aquabot employees work in a safe work environment that is maintained and monitored daily by our safety specialist. Sharp edges are rounded off, thrusters have covers, wires are secure and tucked away, and the acrylic tube is sealed. These are just some examples of the safety precautions that our Safety Specialist has taken to ensure a safe work environment. Additionally, our employees are required to wear the proper safety attire at all times while in the shop. We also make sure we apply as little stress as possible on the tether in order to maintain a dependable, quality product. Our safety motto is "Our ROV is a treasure, but not as valuable as our engineers".

Figure 20: Employee Matthew working with a power tool while wearing proper safety attire. Picture by Val Cantu

B. Shop Protocols

While in the shop all employees are required to wear safety glasses at all times. They are also required to clean up their area at the end of each day, including putting up all tools where they belong. Doing this ensures that all tools are accounted for and the shop is safe and presentable. To ensure all employees are safe while working with power tools we ensure that they have a partner watching them at all times.

Specific shop protocols are implemented while working in our labs. Appropriate safety equipment, such as safety goggles, ear protection, gloves and footwear were used when handling power tools.

Figure 21 & 22: Tools placed on the tool wall at the end of a work day. Picture by Val Cantu

C. Training

Each of our employees on Aquabot Technicians are required to shadow a 2-3 year employee at the beginning of the year for the first 2 months. During this process, they are trained in safety skills, communication skills, organization skills, and work skills. By doing this our newer employees become comfortable with the veterans who already know the ways of the shop. They also start off with circuit boards in order to see how important each detail is when working, even on a small scale. Doing this ensures that at the beginning of each year the returning members are ready to begin and teach the new members to produce quality products.

Figure 23: Aquabot CEO Elijah showing new employees what to do on deck. Picture by Val Cantu

D. Vehicle Safety Features

With soft skids and smooth edges, *Redemption* contains multiple safety features designed to keep her crew and work environment safe during operation. Any and all barbed edges are rounded off by sanding down all protruding corners and miscellaneous burrs. Propellers have shroud covers to ensure that *Redemption* protects all wildlife and habitats during operation. In addition, Aquabot Technicians enclosed all interior and exterior conductors to ensure maximum electrical protection. *Redemption* also has a direct power switch so in the scenario that the ROV experiences a malfunction in any way, shape, or form the pilot will be able to shut off its power and avoid the risk of harming the habitat and endangering the safety of wildlife.

Figure: 24 Thrusters with covers (Left) and ***Figure 25 & 26:*** sharp edges are sealed off with hot glue (Center and Right). Pictures by Val Cantu

E. Operational and Safety Checklists

Occasion	Check ✓	Category	Safety Precaution
Before Working	■	Company	Proper attire must be worn (close toed shoes, safety glasses, no loose clothing, etc.)
	■	Physical	All propellers are shrouded
			Sharp edges on ROV are filed down
			Weight in air is a maximum of 25kg.
			ROV has a diameter of a maximum 85 cm.
			Exposed wires are contained in proper strain relief
			Components are all connected to ROV
			Buoyancy must be secured correctly in ROV
	■	Electrical	Anderson Connectors are the main connection to MATE supply
			Fuse is within 30cm range of the main connection.
			No exposed wires
			Wires are secured by the tether strain relief
While Working	■	Company	When working with machinery, members must wear safety goggles and face masks.
			Adult supervision is needed to be in the shop.
			Every machine has a designated work space.
	■	Physical	Tether is properly secure.
			Watertight housing must withstand 4 meters of pressure.
	■	Electrical	Cameras are secure and the cap is off.
			No exposed wiring.
			Openings are sealed properly.
			Electrical components are at the surface in control box
After Working	■	Company	Clean up work area
			Clean any water on the floor
	■	Physical	ROV is cleaned after testing
			Separate and identify wiring from DC and Control Voltages.
	■	Electrical	Make sure ROV has no leaks
			Make sure the control box is organized and neatly

IV. Logistics

A. Budget and Project Cost

Category	Part Description	Quantity Cost	Quantity	Cost
Frame	10ft P.V.C Rods	$2.25	4	$9
	Watertight Enclosure 4”	$203	1	$203
	6-32 X 3/4 Round Head, Combo Machine Screw	$1.49	2	$2.98
	6-32 X 1/2 Round Head, Combo Machine Screw	$1.49	2	$2.98
	6-32 Hex Nut	$1.49	2	$2.98
	8-32 X 3/4 Round Head, Combo Machine Screw	$1.49	2	$2.98
	8-32 X 1/2 Round Head, Combo Machine Screw	$1.49	2	$2.98
	8-32 Hex Nut	$1.49	2	$2.98
	10ft Flat Aluminum	$8.29	4	$33.16
	90 degree Aluminum Angle	$9.29	4	$37.16
Motors	T100	$119	4	$476
Electronics	Fathom-S Tether Interference Board Set	$85	1	$85
Cameras	Low-Light Analog Camera	$32	2	$64
Tools	Drill bits	$10	10	$100
	Miscellaneous Tools	10	2	$20
Presentation	Polo’s	$6	25	$132
Budget				$1100
Total Cost				$1,171.24
Left Over				$60.76

B. Travel Expenses

Category	Details	Cost
Fuel/Travel		$2,400
Meals	11 people: 3 days with 2 meals per day ($7 each)	$990.00
Rooms	3 Days: 4 rooms at $118 per night	$1416.00
Total		$4,806

V. Conclusion

A. Challenges

The construction of *Redemption* presented our team with complex problems that required creative solutions in order to solve. During buoyancy testing we discovered that tolerances in the frame caused the acrylic tube to protrude, a couple of inches farther than it should have, shifting the center of mass away from where it should be. To solve this problem we turned the frame upside down and reattached the tube on what used to be the top. This allowed the tube to rest in a more stable position.

Testing our ROV proved especially challenging this year, as we did have a pool in our shop, but it was only about 3 feet, we really needed our local natatorium. At this place, the pool goes down to approximately 12 feet in depth, which made it perfect for practicing and simulating the real missions.

B. Future Improvements

Some future improvements that could be made include using our time more efficiently, and ensuring we have our parts to meet our own deadlines. We feel that if we worked a little more diligently our ROV would have been done a lot quicker, thus giving us more time to make the ROV more efficient. A huge improvement our company could make is sticking to our timeline.

Another improvement to keep for the future would be the breakup of the team. This year Aquabot Technicians saw it in our best interest to branch off the team into three separate groups. This division created three other employees to be placed in leadership positions besides the CEO. Having the break up between the writing team, research and development, and the engineers strengthened the business in all aspects. This improvement made everyone’s part that much more vital.

C. Critical Analysis

Testing:

a. Buoyancy (Flotation and Ballast)

i. To test flotation and ballast before regionals, we took our ROV to our local pool and brought along several pieces of flotation and ballast. At the pool, we added a couple lengths of ballast, in the form of rebar, and floats, in the form of buoys (whether it be a quarter, half, or a whole one), until we had a slightly neutral buoyancy on our robot.

b. Motor Power and Camera Feed

i. As we continued to test our ROV at our local pool, we figured out that there was a voltage drop when running our motors. This caused two major problems; our camera feed was jittery and blacking out, and secondly, our motors would glitch and jump around unpredictably. After testing for continuity after every point via voltmeter, we discovered the problem to be our direct feed of 12 volts to our Arduino. As a solution, we fed a DC to DC Transformer 12 volts, that spat out 5 volts for our Arduino, which led to our motors running smoothly. However, our camera feed was still acting up. To compensate for this, we adjusted the code to run our motors at a lower power. End result, our motors ran smoothly and our camera feed was efficient.

D. Senior Reflections

I have been competing in the MATE competition for the past 3 years. I was invited to attend the MATE competition alongside the companies of Aquabot Technicians and Gulf Coast Robotics in 2015. With that experience I came to realize that I wanted to have a job position on either company. The next year I was employed to Aquabot Technicians as the Display Board Specialist. With this experience in underwater robotics I have learned how to manage my time, cooperate with others, and learn some really great presentation skills. Cooperation with others is the most important aspect to having a successful company.

I have been able to overcome many mental blocks and better myself. MATE has helped me decide what type of career field I would like to go into. I plan on going into the field of Architecture or Computer Science. I am extremely proud of my team and I know that they will continue to succeed in the years to come.

-Ariana Benavides

Being a part of this program allowed me to gain leadership traits that made me stronger as a person. I have also made many friends that I will defiantly miss next year but I cannot wait to see what they will create next year. This program also allowed me to make a difference in our community, moving on to internationals, and the outreach we participated in made a difference in my school and in the younger generations' life.

-Madelyn Perez

I’ve learned so much in this program and it has made me a better person in so many aspects. I’ve gained so much knowledge in engineering such as problem solving, wiring electronics, and learning about marine science. I was able to grow as a teammate and now a leader to my peers. This by far has been one of the greatest experiences of my life and I will dearly miss it when this year ends.

-Elijah Euristi

My name is Shelby Rivera. I have been competing in the MATE competition for 3 years now, and ironically my entire time of employment has been with Aquabot Technicians. I have been involved in numerous projects, but my for sure job position was Technical Documentation. Looking back on my journey I am nothing but grateful for the experience. Underwater robotics has taught me how to be flexible in my work, able to quickly manage multiple tasks within a limited timeframe and communicate. Through stressful situations, I have learned how to work efficiently and effectively to provide a quality performance whether it be on deck or behind a computer. My employment has given me in-depth knowledge of electronics and computer programming, and has even taught me to be a leader. Managing a large team full of my peers was definitely a great challenge, and there were times of great stress where I felt I was ineffective, but I was able to overcome those feelings and fill my role, aiding everyone one step closer to achieving a common goal. Being able to take charge while also being the one listening to instruction has affected other areas of my life, including my career plans. I have decided to pursue my interests as either an architect or architectural engineer. I will use my technical knowledge and leadership to fulfill my desire to find success.

-Shelby Rivera

In the beginning of the year I was not in the underwater robotics class due to class scheduling. Once I was able to get my schedule changed around and get back into the class they took me with open arms. It took me awhile to get in a groove and back to work but when I did it just all came back to me. I learned so much from my counterparts like the different electronics that goes into our ROV. We all failed together figured out why it failed and fixed that problem to make everything work. We are not a perfect team but we know what it takes to make it one.

-Anthony Escotiola

Five Senior 3-year employees. Pictures by Val Cantu

E. Acknowledgements

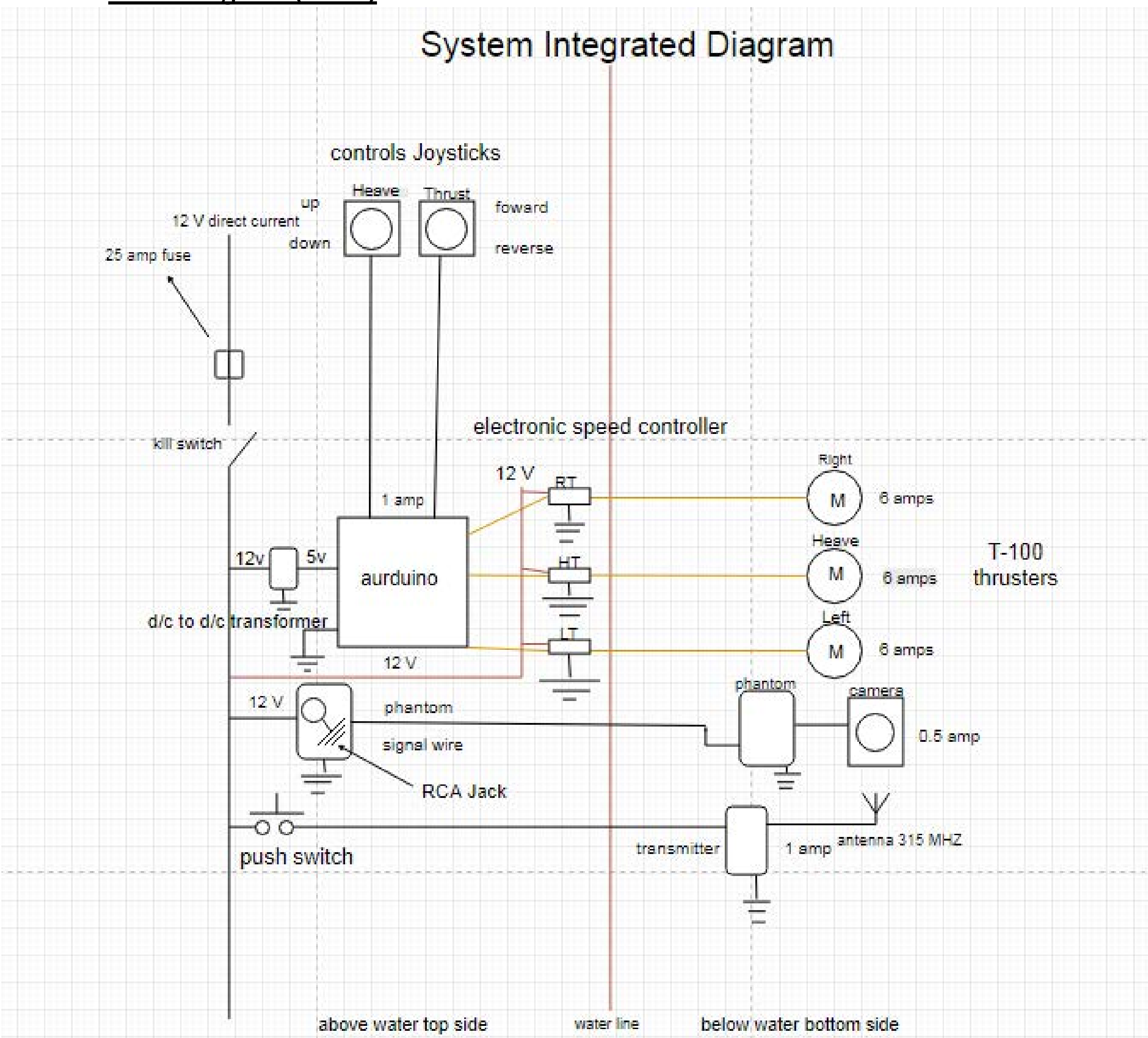
Citgo- For sponsoring our program at Foy H. Moody High School
CCISD- For providing us with our initial budget and transportation to competition
Gulf Coast Robotics- For aiding us during the construction of *Redemption* whenever possible
Corpus Christi Natatorium- For allowing us to test our product under realistic conditions
YMCA of the Coastal Bend- For allowing us to test our product under realistic conditions
Mrs. Charles- For mentoring us and coaching us
Mr. Bayarena- For mentoring us and coaching us
Val Cantu- For his pictures and ideas
Blue Robotics- For providing us with parts necessary for the completion of *Redemption* and aiding us with any difficulties with their products
Amazon- For providing us with parts necessary for the completion of *Redemption*
Home Depot- For providing us with parts for the completion of *Redemption*'s dry box
Sutherlands- For providing us with parts for the completion of *Redemption*'s frame
Mrs. Benavides- For supporting our team by helping us communicate with CCISD
Dr. Benibo- For supporting our team throughout the year in any way
Dr. Clement- For supporting our team throughout the year in any way

E. References

https://www.bluerobotics.com/
https://huston.marinetech2.org/
https://www.homedepot.com/
https://www.sutherlands.com/
https://www.mate.org

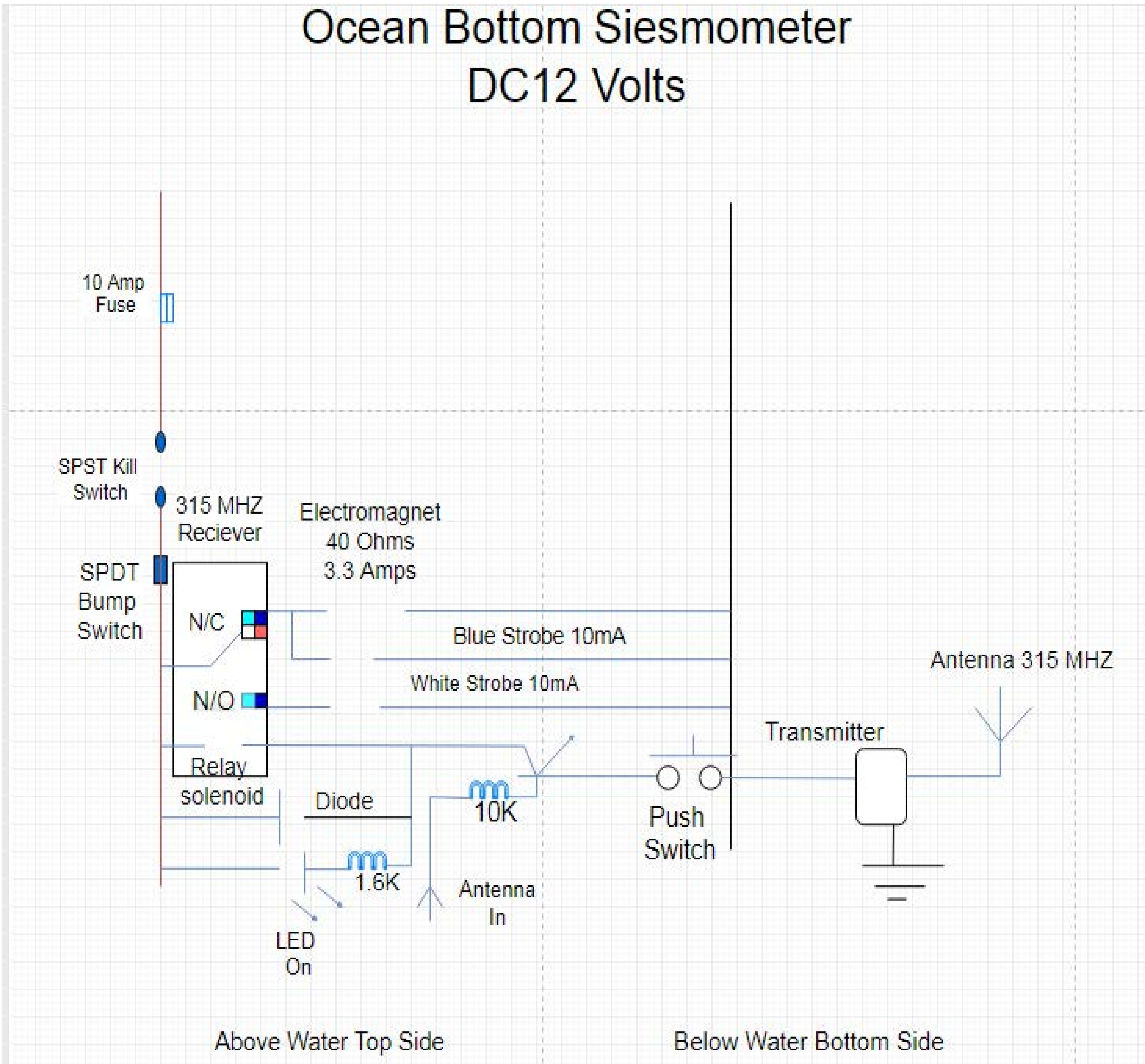
I.Appendices

A. Wire Diagram (ROV)

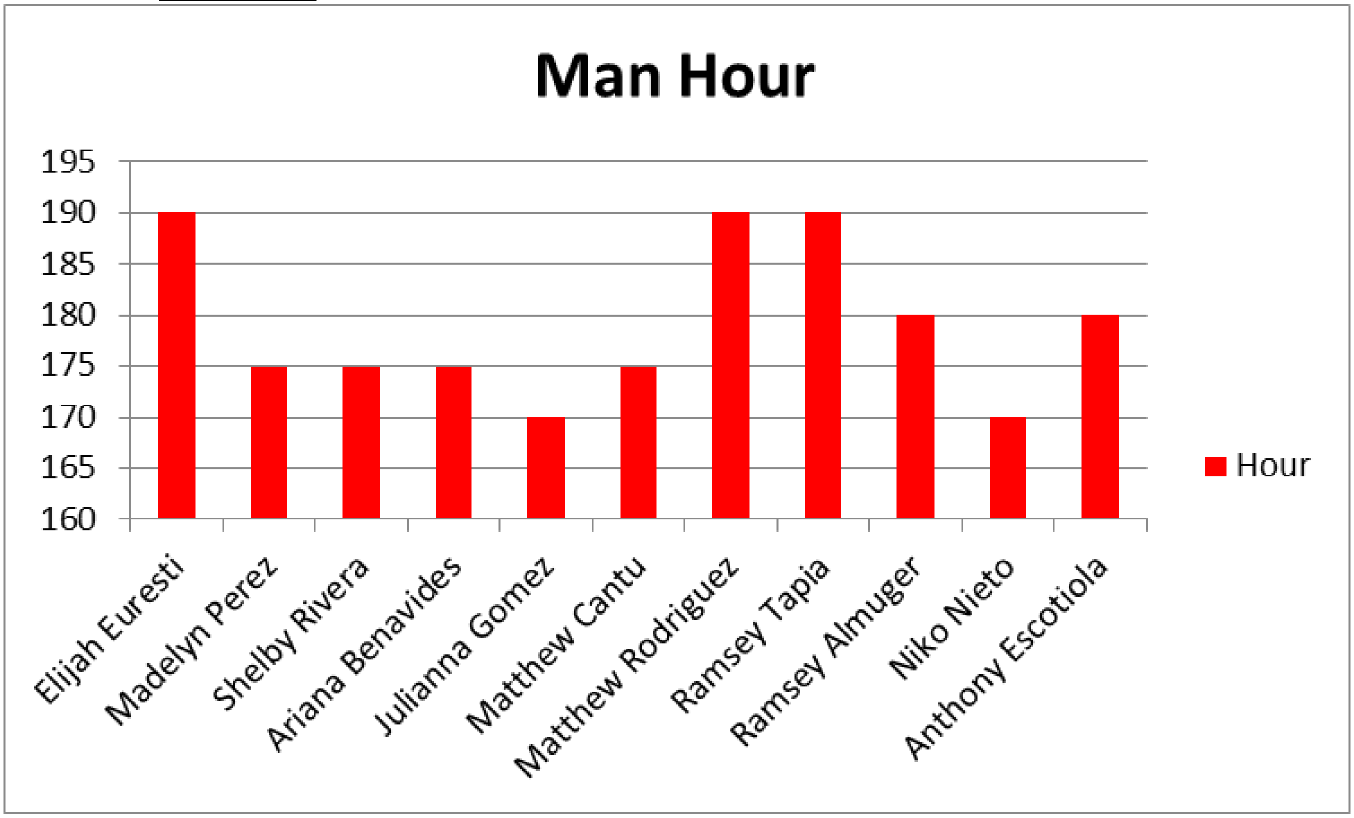


Motor Thruster Right	6 amps
Motore Thruster Heave	6 amps
Motor Thruster Left	6 amps
phanton/camera	0.5 amp
Transmitter ocean bottom siezometer	1 amp
Total	19.5 amps

B. Wire Diagram (OBS)



C. Man Hours



The Aquabot Technicians wanted to create a fully effective ROV and we accomplished this by working on average at least 45 minutes a day Monday through Friday for five months. We all averaged and achieved a maximum of 165 man hours per staff member and conducted a total of 2,812 hours working on completing *Redemption*.

D. Job Safety Analysis

Describe the Job Step	Potential Hazards	Recommended Risk Control Measures	Responsible Person(s)	Initials
Working with Electricity	An employee can be shocked.	● Safety attire is worn. ● No open wires. ● No hazardous materials are placed near wires while in use.	Safety Specialist- Anthony Escatiola	
Using Solder Iron	Employees burning themselves.	● Safety Glasses are worn. ● Gloves are worn. ● Area is cleared.	Safety Specialist- Anthony Escatiola	
Using PVC pipe cutter	Employees cutting themselves.	● Have another employee overseeing the process. ● Wear protective gloves. ● Keep hands away from the blade.	Safety Specialist- Anthony Escatiola	
Using Heat Gun	Employees can be burned by extreme heat.	● Employees should wear gloves. ● Stay clear of the heated end. ● Wear protective gloves.	Safety Specialist- Anthony Escatiola	
Electrical Cords	Employees can trip and fall.	● Can be taped down to minimize tripping. ● Can be hung above to prevent tripping ● Be unplugged after each use.	Safety Specialist- Anthony Escatiola	

Safety Glasses	Not wearing them.	● Wear them. ● Ensure everyone has a pair assigned to them. ● They remain in a special place for easy access.	Safety Specialist- Anthony Escatiola	

E. Timeline