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I. AquaBot Technicians Employee Introduction 2019

CEO

Ramsey Tapia – Senior
Rank: 2 GPA: 4.5
College: University of Texas at Austin Engineering
Leadership Highlights: President of National Honor Society
President of Future Business Leaders of America
Vice President of National Technical Honor Society

CTO

Chris Torres – Senior
Rank: 36 GPA: 3.9
College: Texas A&M University Kingsville, TX
Leadership Highlights: Academic Decathlon,
Science Club, Youth and Government

Control Specialist / Electrical Engineer

Matthew Rodriguez - Junior
Rank: 56 GPA: 3.6
College: University of Texas at Austin Engineering
Leadership Highlights: SkillsUSA, Mu Alpha Theta, Secretary of Society of Hispanic Professional Engineers

Technical Documenter

Lidzy Jimenez - Junior
Rank: 6 GPA 4.2
College: University of Texas at Austin Engineering
Leadership Highlights: National Technical Honor Society
National Hispanic Honor Society, Vice President of Society of Hispanic Professional Engineers

Accountant

Noah Chavez – Junior
Rank:148 GPA:3.6
College: College Station
Leadership Highlights: Key Club, Guitar Club, Junior Council

Safety Officer

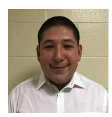
Eric Vela - Senior
Rank:9 GPA:4.1
College:Texas A&M University - Kingsville
*Leadership Highlights:*Co-Captain of Baseball, Chairmen for Men 4 STEM, Men 4 STEM board member 9,10,11th grade,

COO

Katarina Ramos - Senior
Rank: 3 GPA: 4.4
College: University of Texas at Austin Communications
Leadership Highlights: President of National Technical Honor Society, Vice President of Future Business Leaders of America
Vice President of Senior Council

Safety

Gabriel Armenta - Junior
Rank: 141 GPA: 3.1
College: Texas A&M University Kingsville, Texas
Leadership Highlights: SkillsUSA
Destination Imagination, Junior Council

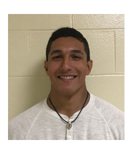


Mechanical Engineer

Francisco Serna - Junior
Rank: 10 GPA: 4.1
College: University of Texas San Antonio
Leadership Highlights: President of Junior Council, National Honor Society, Spanish Honor Society

CFO / Electrical Specialist

Amaya Nunez - Sophomore
Rank: 69 GPA:3.5
College: Trinity University
Leadership Highlights: Sophomore Council President, Treasurer of Future Business Leaders of America, Junior Varsity Track and Field



Prop Specialist

Matthew Cantu - Junior
Rank: 24 GPA: 3.9
College: St. Edward's University
Leadership highlights: National Honor Society
Golf Captain, Junior Council

II. Vision and Mission

A. Abstract

As technology advances, infrastructures and erstwhile constructions that were engineered before the technological revolution of the new millennium are not as reliable and constantly need to be repaired with contemporary engineering processes. Much like with the Boone Dam, the wearing down of the wavering framework is of potential danger to the people in the community as well as the ecosystems in the area. This is where our Remotely Operated Vehicle (ROV), *Legacy*, comes into play; it is designed around the premise of the Request For Proposal (RFP) by Eastman and MATE Center to inspect areas of potential damage, data collection, and to replace material items in disrepair. Aquabot Technician's *Legacy* is built with an adaptable setup to ensure the completion of each desired task. Our team's main objective is to facilitate mobility and conserve space for our micro-ROV ***Figure 1*** within the main frame while meeting the size and weight constraints. Selecting aluminum and polyvinyl chloride (PVC), we constructed our primary ROV to be spacious enough to hold a fail proof electronic on-board dry box, brushless motor thrusters, and a self launching micro-ROV. The materials chosen for our design were selected to create a safe mounting frame, and platform for a runway to launch and dock our micro ROV with precision. The design is a product of combining modern coding, an electric claw, two (2) cameras, and countless hours of collaborative teamwork culminating in our final product *Legacy*.

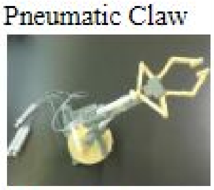
Figure 1: Micro ROV

III. Design Rationale

A. Design Process

When Aquabots received a debriefing of the mission, the first step in our design process was analyzing the different tasks we had to complete. After meticulously reviewing the competition manual, we brainstormed ideas that conformed to the constraints while taking into account the key components needed for certain tasks. Since our company is a group of people with unique ideas, it was sometimes difficult to come to a consensus when it came to the overarching design. So, the pros and cons of each design were evaluated and the best overall was chosen.

Once an agreement was reached, it became time to build a prototype to start testing. After the design was now physical, we noticed some aspects weren't going to pan out as planned. For example, the original frame for the main ROV was too bulky and could potentially hinder its general movement. Some testing was required where the team would partake in test runs and place the prototype ROV into the water so as to inspect its functionality.

	Price	Efficiency	Strength	Ease of Operation	Total
Subsea Gripper  (Photo by Blue Robotics)	4	10	10	9	33
Hydraulic Claw  (Photo by VEX Robotics)	10	3	3	7	23
Pneumatic Claw  (Photo by thingiverse)	6	4	5	7	22
Custom Electronic Claw  (Photo by Best Buy)	7	5	7	8	27

The claw was a vital part of our strategy and would be the component we relied on the most. This meant that the type of claw was an important choice to make and would need to be thoroughly thought out, considering both the pros and cons. The most promising types of claws were the Subsea Gripper and the Custom Electronic Claw. The difference in the totals was too much to ignore and we decided not to risk having a claw that was disadvantageous.

a. Build vs. Buy/ New vs. Used

The decision whether to build or buy materials for our robot was a very important decision for us, not just to lower the cost of our robot, but also to increase the sustainability of our company. Many of the main components of our robot were built rather than bought, which stemmed from us wanting to accommodate to our specific needs to ensure we could deliver the best product. For example, the entire main control system of our ROV was built. The same applies to the Micro ROV and the ROV frame. Building these integral components of our ROV increased the sustainability of our company as we are able to make changes and adjust the system without outside assistance and it allows us to cut down costs dramatically. The main thing that was bought for our ROV was the Newton Subsea Gripper, purchased from Blue Robotics. The reason we made the decision to purchase the claw was because we wanted to devote our time towards things that needed more prioritization.

Another main decision was choosing to utilize new or previously used materials. We decided to use some things from previous years, but mostly kept the items we reused to a minimum since we had the funds to do so and we wanted to purchase most of the parts to ensure the highest quality. We decided to reuse the Arduino, Raspberry Pi, and terminal blocks that went through a rigorous round of testing to ensure they were up to our ideal conditions. Many of the new items were from Blue Robotics, including the Dry Box enclosure, penetrating screws, ESC's, and the T100 thrusters.

B. **Mechanical**

The main frame as mentioned, was built using a combination of aluminum and polyvinyl chloride (PVC) in order to create a firm structure that was capable of sustaining parts that would be mounted onto it. The main rectangular frame was made from the aluminum strips, connected at the junctions with screws in order to ensure a sturdy base to mount other components. The shape of the frame was created by utilizing its simple shape with the task that need to be done in a time efficient manner ***Figure 2***. For additional structures within the main frame,

Figure 2: Main frame in the process of being built

unused aluminum and PVC pipes were utilized to decrease the spending costs. The PVC is also a strong material that served as reliable support when fastening parts while allowing us to easily replace pieces.

Our choice for thrust were the Blue Robotics' T100 Thrusters. With 22.1 newtons of thrust, our ROV should maneuver smoothly and with precision in order to avoid losing time. Two heave thrusters allow for a faster, more efficient ascension and descension, which, as mentioned, could work to save time we could use in doing the tasks. The placement of said thrusters was also a key component in the ROV's maneuverability. By positioning them on either side of the frame and having them in different orientations, it facilitates the movement and positioning of the ROV.

Figure 3: Arduino Uno used

C. **Control System**

The Aquabot Technicians assembled the control box in a way that would allow the ROV, *Legacy*, to maneuver a desired route with precise controls for the pilot. The control box was constructed out of wood to create a 6 in. cube, a considerable reduction from preceding years where the dimensions were larger. The size was reduced so as to avoid wasting space, which in turn reduced material costs. The previous year, Aquabots encountered complications with the control system's imprecise movement and inability to add modes. The main design objective on this year's control box was efficiency and accuracy in the completion of each task. The box's main feature is a USB host shield, located on an Arduino Uno ***Figure 3***. This shield attaches directly to the header pins of our Arduino Uno and adds an expansion USB port. This port with a Bluetooth USB dongle connected to it is what allows a PS4 controller ***Figure 4*** to connect and be used for controls instead of a standard joystick. This shield is a sort of plug and play as we do not need to do any extra setup except for pushing it into the Arduino header ports ***Figure 6***. The dongle itself needs at least 8V to operate at a stable rate which ensures that we will not drop in

Figure 4: Model of controller used

Figure 5: Analog Joystick

Figure 6: Arduino Shield

connection while operating our ROV. Since the shield gets its power from the Arduino Uno directly, we have to power our Arduino Uno with 8V with the use of DC to DC Converter. In order to provide enough power for the hardware inside, the control box requires 12 Volts of power to be fully functional, along with an on and off single throw double pole switch in case water were to enter the box. In the event that the Bluetooth Signaling does not work, Legacy has a backup Control system which uses a series of C and C++ plus Arduino functions to control 5 thrusters via analog joysticks. These 5 joysticks are positioned on the control box in an x like shape to reduce the area being used ***Figure 5***.The way we accomplished this was by getting a Arduino expansion shield. This shield has all of the joysticks power and signal wires connected to it while being out of the way of the digital system in the dry box. If we need to fall back on this system, all we would need to do it switch shields and re-flash the joystick code into our arduino. Switching systems can be done within 1 minute and it ensures that we will always have a functional robot to perform with. Because the main and backup control systems are arduino based, switching control systems is as easy as switching shields ***Figure*** *7*.

Figure 7: Innards of the control box

Figure 8: Blue Robotics' Newton Subsea Gripper

D. **Dry Box**

The container used to hold the electronic components is Blue Robotics' Watertight Subsea Enclosure. Using terminal blocks we connected the 12 Volt power supply (ground 12 Volt) to the Newton Subsea Gripper ***Figure 8***. We also fed it a 5V ground and a 5V signal wire from the Arduino. Next, there are five electronic speed controllers (ESC) that are given a 12V power and ground as well as a 5V signal from the main arduino in the control box while a separate arduino in the dry box gives them a 5V ground. From there, those ESCs connect to the thrusters and out of the dry box. Additionally, using a DC to DC transformer, we convert 12V to 5V to supply a Raspberry Pi with power for our camera. Finally, we added a power indication light that requires 12 volts to

Figure 9: Dry box enclosure

operate that can show us if we are experiencing a loss in power to our dry box. This is very important as we need to know if the power draw from our thrusters is exceeding 12V and can ensure we have good power distribution into our dry box while underwater ***Figure 9***. When it comes to troubleshooting, this light is a handy feature to visually see when a voltage drop occurs; therefore, letting electrical engineers understand a(n) electrical component(s) is pulling too much power from the circuit ***Figure 10***.

Figure 10: Low-light camera

E. 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 plexiglass tube ***Figure 12***. 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 ***Figure 11***. 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. This allows us to easily change and test connections in the event we need to open up the dry box.

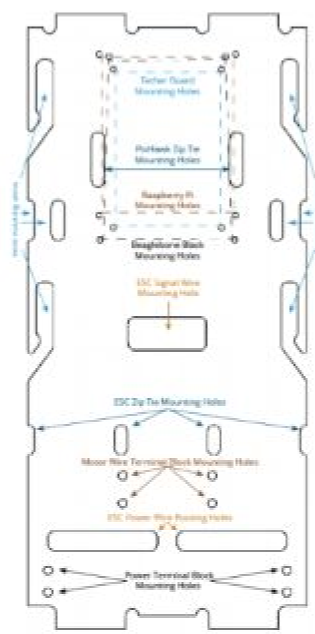


Figure 11: Dry box electronic tray

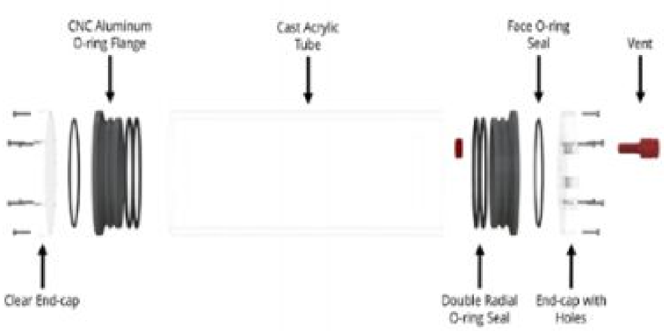


Figure 12: Dry box components

F. **Newton Subsea Gripper**

The newton subsea gripper, a single function manipulator, is a fully equipped electrical gripper that allows Legacy to grab items underwater quickly and reliably. The gripper has jaws that open to grab objects up to 2.75″ or 7cm in diameter. The plastic jaws are mounted with custom aluminum screws to create a corrosion resistant mechanism that does not need any lubrication. The jaws are driven by a linear actuator that uses a geared brushed motor and lead screw. The claw is able to be connected as a ESC which enabled to mount and code it faster. The claw features has a safety measure to detect when the claw is gripping an object and prevents the claw from crushing the object. ***Figure 13***. This is very important because if any ocean life is caught onto the gripper they will not be in danger. In the picture, below there is a full scale 2D drawing of the gripper itself. The overall aspect of the subsea gripper made it easier and faster for Legacy to complete its tasks.

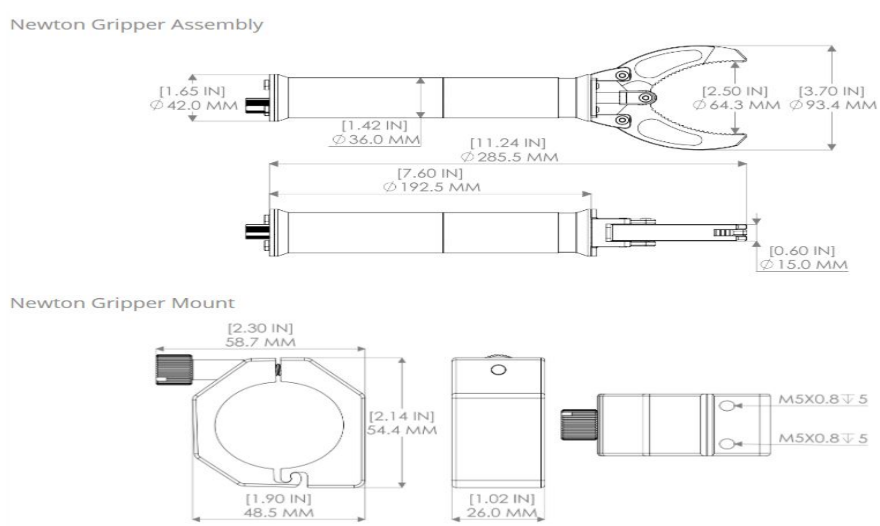


Figure 13: Newton Subsea Gripper Technical Details

G. **Electronic Speed Controllers (ESCs)**

25A Electronics Speed Controller (ESC) , 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

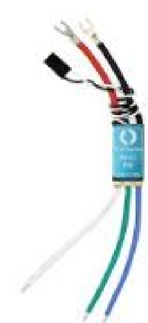


Figure 14: Electronic Speed Controllers

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 colored wires and are powered using three wires. Through testing, we discovered that additional signal and ground wires were not necessary because it was pre-built into the esc's ***Figure 14***. We performed additional research to verify that an internal ground was in use.

H. **Software**

The overall software system runs off of 2 separate types of softwares. The first one is an arduino responsible for running the controls for the entire system. The arduino coding software is a mixture of C and C++ functions integrated within at least 200 lines of coding, which implement libraries to interface with the bluetooth dongle that connects to the controller ***Figure 15***. The second software is a Raspberry Pi that uses two different types of codes. While the first one allows a camera to turn on and show its feed on a screen, the second code uses openCV and is a manually trained machine learning program that distinguishes between the different shapes and colors while submerged underwater. This allows it to automatically categorize between the different shapes and color and determine the quantity of each category. The Raspberry Pi utilizes Python 3, which is an excellent programming language for machine learning and helps us maximize the capabilities of our visual system. To allow us to access and modify the raspberry pi while in the sealed dry box, we installed a wireless keyboard and mouse dongle that connects to a keyboard and mouse we have on deck and gives us the ability to edit the raspberry pi without needed to unseal the dry box. As for our main control system, the main backbone of the coding elements that we needed to access our Bluetooth dongle was from a library that we installed into the Arduino coding software ***Figure 16***. This

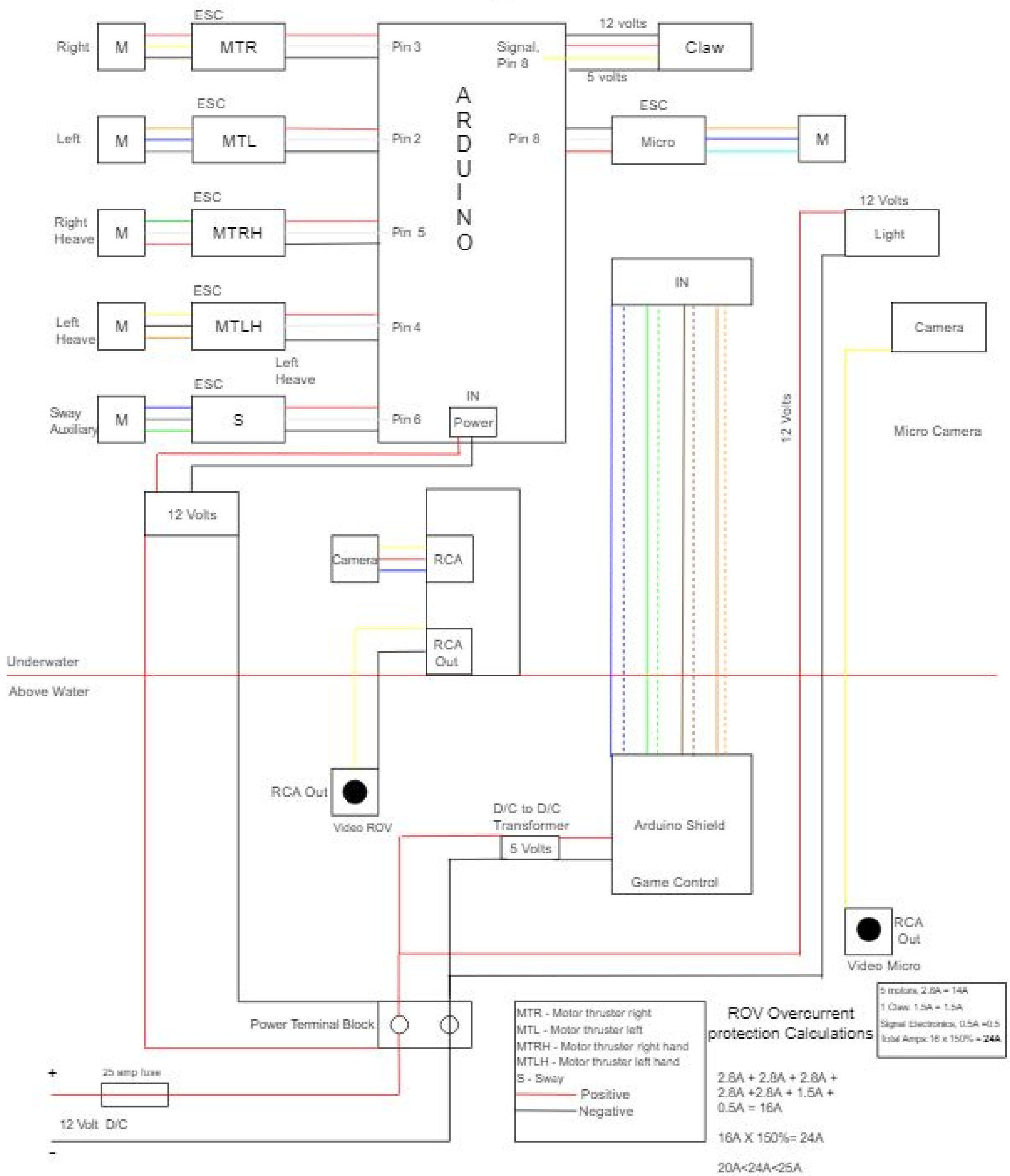
Figure 15: Snapshot of Python 3 coding

Figure 16: Bluetooth Dongle

implements the coding blocks and adds more actions into the software that allows us to code in the connection and controls for our Bluetooth controller. The Bluetooth PS4 library also includes the ability to connect to the PS4 controller via a wired connection and has a wide range of other controllers that we can code and adjust into our code and control system. This library, however requires a USB port to operate and that is the reason we have the USB shield on top of our Arduino, which, when paired with the Bluetooth dongle, is what makes our entire system run.

I. **System Diagram SID**

SID Diagram



Every electronic circuit created by Aquabot Technicians must be thoroughly documented. Therefore, a SID diagram is created. By drawing our electronic circuits, wire by wire, when an error arises, we know where to start and go, in terms of troubleshooting.

J. Camera System

The ROV's camera connects to the Raspberry Pi and runs through a program with Python. ***Figure 18***. The Raspberry Pi Camera v2 is a high quality 8 megapixel Sony image sensor. ***Figure 17***. The system's code is programmed to run only 15 minutes unless turned off since letting it run would be inefficient. In my order to do so, a library that allowed us to code a specific key to shut down the camera had to be installed. In being able to code the camera we used python to enable a machine learning program that reads shapes underwater and makes the robot that much more efficient. In having this new library that allowed us to increase the amount of time we could see underwater for a longer period of time which will enable us to get more tasks done.

Figure 17: ROV's Camera

Figure 18: Raspberry Pi

K. Buoyancy

Buoyancy was easy to gauge because the ROV was negatively buoyant due to the weight of all of its components. This meant that all that was needed was to add buoys little by little until Legacy 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 Legacy from rolling we added two aluminum angle pieces (20 cm in length) to hold two half buoys on either side of the ROV ***Figure 19***. The aluminum angles and buoys act as wings to stabilize Legacy's buoyancy and keep the ROV balanced. This whole process was to minimize the amount of setbacks we had.

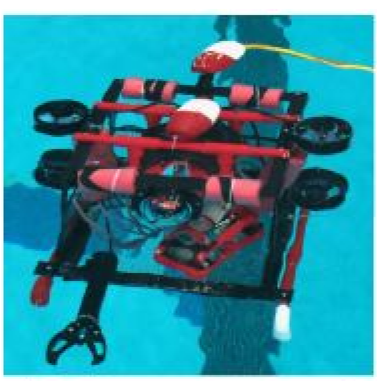
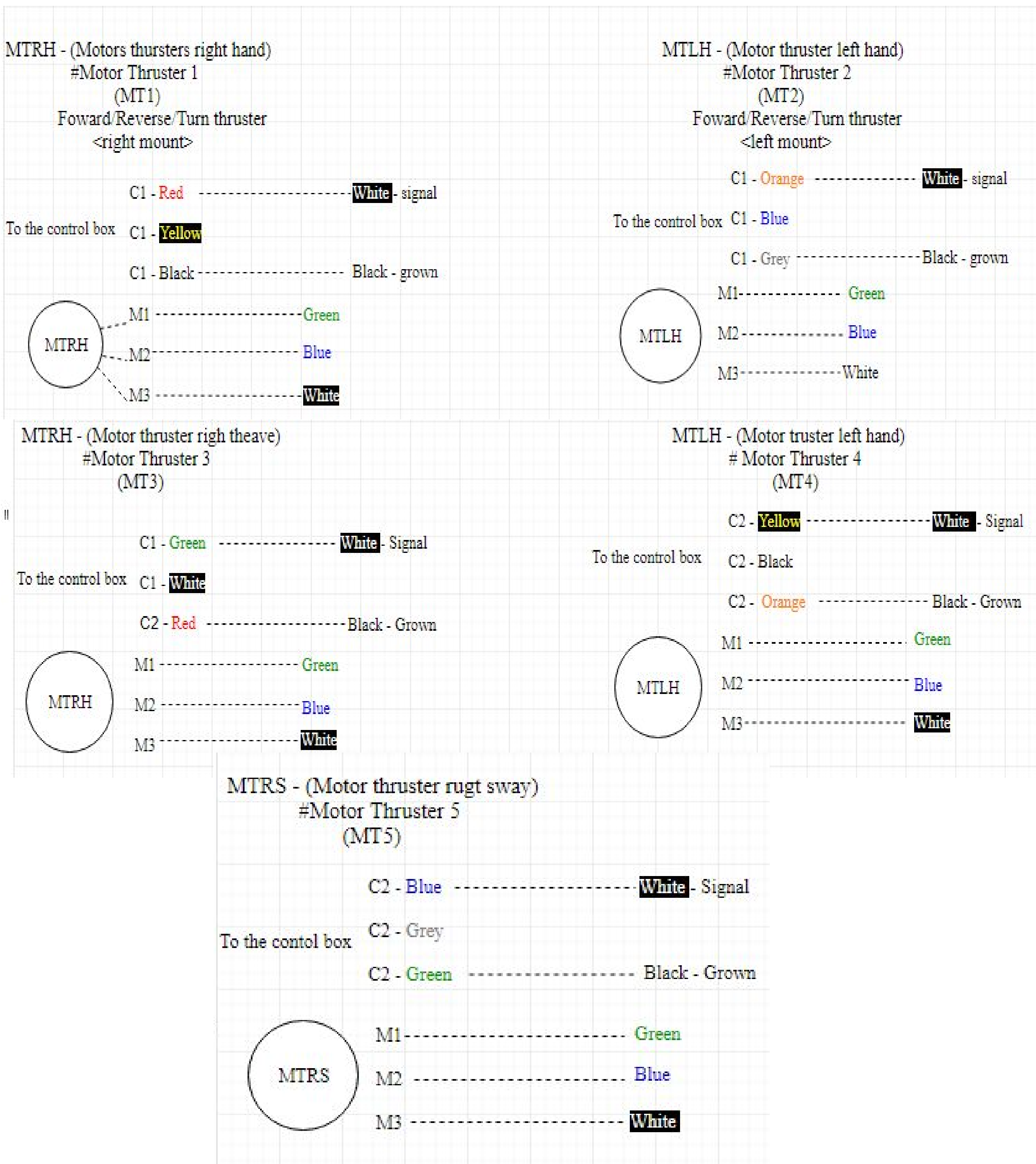


Figure 19: Testing the buoyancy of our ROV

L. Thrust

Our choice for thrust were the Blue Robotics' T100 Thrusters ***Figure 20***. With 22.1 newtons of thrust, our ROV should maneuver smoothly and with precision in order to avoid losing time. Two heave thrusters allow for a faster, more efficient ascension and descension, which, as mentioned, could work to save time we could use in doing the tasks.

a. Motor Thruster Diagram



M. Tether

The tether was designed to allow Legacy to maneuver throughout the water with minimal drag. The difference from previous designs is that now, the only thing running down the tether is 8 signal wires for ESCs, claw, and the tether control motor. This means that Legacy's tether is considerably smaller than previous designs. Despite its size being decreased, there would still be some tension at the end of the tether where it enters and connects to the primary ROV frame, so tether relief was added ***Figure 21 and 22***.

We are running 12.19 meters of each of the following wires within our tether:

- 1 x 18 Gauge, 8 conductor (stranded).
- 2 x Cat5e, 8 conductor (stranded).
- 1 x 18 Gauge, 4 conductor (stranded).
- 2 x 14 Gauge, Single conductor (stranded).

The smaller tether allows us to move more efficiently underwater as it doesn't provide as much drag as other thicker designs. The small tether also allows us to easily pack up the ROV and transport it with easy and compact cable management.

- The tether is 12.19 meters long

Figure 21: Tether relief (left)

Figure 22: wires feeding into tether (right)

N. Troubleshooting

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)

O. Mission Specifics

a. Micro-ROV

Figure 23: Failed 3D printing

The original idea was to include a 3D-printed frame for the micro-ROV, however, due to complications with the printing and sizing, the plan was scrapped. Despite its large amount of advantages, 3D printing wasn't feasible enough to continuously print parts that weren't effective and an improvisation was needed. ***Figure 23.*** Attached to the micro-ROV, a tether control system was also a implemented into the design. The 15.24 cm restriction made it very difficult to create a frame with 2 motors, a light, and a camera.

Eventually, we realized that 2 thrusters would provide an overload of thrust for the Micro-ROV. As our final design, we created our current Micro-ROV ***Figure 24 and 25***. Using an 8 conductor 18-gauge 3 meter wire, we were able to successfully inspect a dam foundation via our Micro-ROV. In the grand scheme, we went with a PVC frame for the Micro-ROV because it allowed for a flexible and adjustable layout for the electronics.

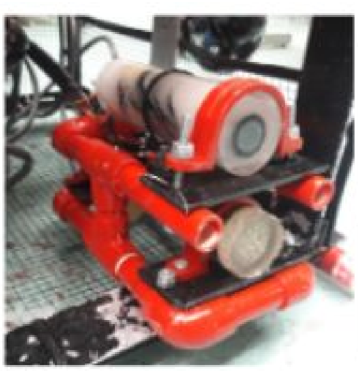


Figure 24: Top-Left view of micro-ROV (left)

Figure 25: Side view of micro-ROV (right)

b. Tether Control for Micro-ROV

Initially, the idea of retracting a 3 meter tether was quite daunting to the mechanical engineers of Aquabot Technicians. However, after a vast amount of brainstorming, we decided to go with the design seen in ***Figure 26***. Using a 12V brushed motor, retracting the tether of the Micro-ROV was possible. Because the brushed motor worked via 12V power and ground, we could easily activate tether control whenever it was necessary with the flip of a switch on our control box.

Figure 26: Micro-ROV tether control

IV. Accounting

ASSETS			***TEAM EXPENDITURES***			
Team Member Dues	Sept. 15,2019		Travel Tee Shirts	Presentation Polo	Kehma Wrist Band	Meals
Ramsey Tapia		$100	$7	$15	$18	$20
Chris Torres		$100	$7	$15	$18	$20
Katarina Ramos		$100	$7	$15	$18	$20
Frank Serna		$100	$7	$15	$18	$20
Matthew Rodriguez		$100	$7	$15	$18	$20
Matthew Cantu		$100	$7	$15	$18	$20
Lidzy Jimenez		$100	$7	$15	$18	$20
Amaya Nunez		$100	$7	$15	$18	$20
Gabriel Armenta		$100	$7	$15	$18	$20
Noah Chavez		$100	$7	$15	$18	$20
		$100	$7	$15	$18	$20
Fundraiser / Chesse Cake	Oct. 15,2019					
Team Profit		$225				
Fundraiser / BBQue Plates	Nov. 15,2019					
Team Profit		$320.00				
Total Team Cash Flow		$985				

PARTS EXPENDITURES	Description	Quantity	Cost	Total
Main ROV / Micro ROV	Thrusters	5	$119.00	$595.00
	ESC's	7	$43.00	$301.00
	Raspberry Pi	1	$57.00	$57.00
	Arduino	2	$22.00	$44.00
	Arduino/Shields	2	$10.00	$20.00
	USB remote	1	$10.00	$10.00
	Game Controller	1	$20.00	$20.00
	Key Board/Mouse	1	$36.00	$36.00
	Monitor	1	$79.99	$79.99
	4"cylinder w/caps	1	$305.00	$305.00
	Cameras	2	varies	$64.00
	Tether wire / shething	1	$93.00	$93.00
	Aluminum flat bar	1	$8.84	$8.84
	Spray Paint	2	$6.00	$12.00
	Wire Mesh	18	$9.37	$168.66
	Misc. bolts/nuts	varies	varies	$10.53
SCHOOL DISTRICT INKIND				$840.02

OFFICE EXPENDIITURES			Total
Technical Documentation	1	$25.00	$25.00
Display Board	1	$120.00	$120.00
Spec Sheet	1	$1.50	$1.50
SID	1	$1.50	$1.50
SCHOOL DISTRICT INKIND			$211.98

TRAVEL EXPENDITURES	
Transportation	$2,000.00
Lodging	$1,100.00
Meals	$847.00
SCHOOL DISTRICT INKIND	$1,977.00
CITGO INKIND	$1,970.00

TOTALS	
Team Cash Flow	$985.00
INKIND	$5,147.00
EXPENDITURES	$6,120.02
Balance	**$11.98**

V. Job Safety Analysis

Describe Job Step	Potential Hazards	Recommended Control Measures	Responsible Person(s)	Initials
Brainstorming Session	Miscommunication	• Make every employee write down ideas and read one at a time aloud. • Never discourage an idea/person. • Take a vote to ensure fairness.	CEO- Ramsey Tapia Safety Specialist - Gabriel Armenta, Eric Vela	

Safety Glasses	Not wearing them.	• Wear them. • Ensure everyone has a pair assigned to them. • They remain in a special place for easy access.	CEO- Ramsey Tapia Safety Specialist - Gabriel Armenta, Eric Vela	
Meeting Deadlines	Not being met.	• Have calendar posted where all employees are able to view when necessary. • Have incentives. (ex. Picking bus seats) • Grades based upon meeting cutoff date.	CEO - Ramsey Tapia Safety Specialist - Gabriel Armenta, Eric Vela	
Employees Contributing	Work not being evenly distributed.	• Assign specific task along with a deadline for a grade. • Do daily checkups. • Discuss why work is not being done.	CEO- Ramsey Tapia Safety Specialist - Gabriel Armenta, Eric Vela	
Employees Working Together	Employees have a conflict with one another.	• Separate them and find the problem. • Sit them down to discuss how to fix it. • Fix it with necessary steps found while discussing problem.	CEO- Ramsey Tapia Safety Specialist - Gabriel Armenta, Eric Vela	
Control Box	Electrical Surging	• Make the control box Waterproof.	Programmer-Christopher Torres Electrician- Matthew Rodriguez	
Pool	The pool will leak out water, which could leak water onto exposed wires	• Have mopping shifts, use flex tape to seal the hole in the pool.	CEO - Ramsey Tapia Safety Specialist- Gabriel Armenta, Eric Vela	

a. Shop Protocols

When entering 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.***Figure 27 and 28.*** 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. We also have a safety inspector insuring that all employees follow protocol at all times to insure the most safest environment for all who enter the shop.

Figure 27: Crimpers in their designated spot (left)

Figure 28: Drill Gun in its designated spot (right)

b. Company Safety Philosophy "Not Safety First, But Safety Always!"

Throughout the process of constructing Legacy, 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"

c. 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

VI. Teamwork

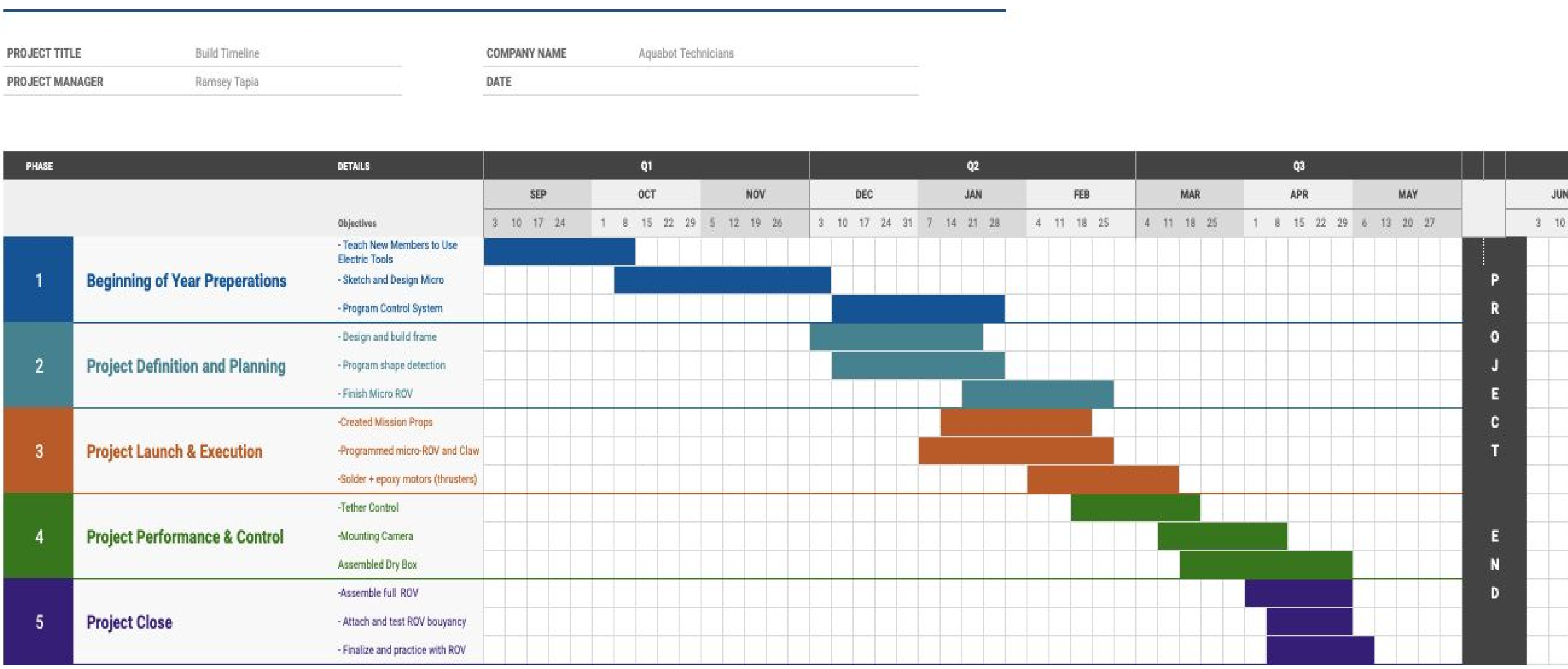
Even if a team is successful, the most important part is their cooperativeness. Without a solid communication within a group, it is almost guaranteed the team will fail if they are not willing to work together. The point of working as a collaborative group is to build on each other's ideas and create a sense of unity within the company in order to facilitate movement towards set goals.

Our approach towards improving our efficiency was to create an overarching plan that we used to organize more concise goals. This would help break down our tasks and let us prioritize assignments. To further improve the team's overall productivity, it was split into two task forces to divide the workload: the building and writing team.

Each subdivision specialized in different areas revolving the completion of the ROV. The writing team was in charge of any form of documentation, ranging from brainstorming, to finances and to planning a schedule for the builders. This, of course, entailed a great amount of communication within the writing team and with the building team. The building team was provided with the aforementioned schedule and had to meet deadlines in order to avoid throwing the team off its path to success. They were also responsible for abiding to the writing team's strategy when building the ROV and its additional components.

In the beginning, the writing team focused on developing a strategy that focused on creating a efficient ROV that was able to maneuver in water. From there, the writing team planned on tackling the most major tasks and working our way down to the tertiary tasks.

VII. Project Build Timeline



a. Timeline Explanation

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. The detailed spreadsheet listing above are the details of the tasks that needed to be completed. They were given firm deadline that had to be done with proper documentation to insure the best outcome. An accumulation of the ROV construction along with the mission accessories were prioritized on a calendar for employees to strive and accomplish the goal of the week. 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 and document to insure the overall monthly and yearly timelines were met. The goal/s was to be completed and documented at the end of the week in our engineering notebooks so we could meet as a team and present further tasks for next week. To evaluate progress, daily entries were documented and if needed were continued the following week. This detailed timeline allowed us to get our work done and innovate an ROV that met all requirements.

VIII. Future Improvements/ Lessons Learned

Aquabot Technicians is a team returning from competing at Internationals, implicitly proving that the ROV's design may have had some advantages that worked in our favor. Because of that, our team decided to keep some of the primary features of previous designs so as to implement them into the new build and maximize its efficiency. The main aspects that were kept were the control system, more specifically only the controls. Some modifications had to be made to improve the system. The previous year's control system wasn't precise in movement and was hard to maneuver. Modes, such as the hover and dead mode, which allowed the ROV to remain suspended in one spot and stay at the bottom of the pool respectively, also couldn't be added and the wiring would eventually wear down and not work as effectively. The frame's general shape was also kept. The three dimensional rectangular shape would ensure that there was the utmost room available to accommodate whatever would be in the interior of the frame. However, this year, more depth and height was added to the previous year's design to ensure enough space for the micro-ROV and tether control. The tether's functionality was also a problem. Its thickness created a lot of dragging force and prevented the ROV from getting its full heave ability. This was because it contained 3 clear tubes: two for a hydraulic claw and one for a lift bag system. In addition to those, the tether included an 8 conductor and a 4-conductor thruster wires, along with an 8 conductor CAT-5 solid wire and a another 8-conductor CAT-5 stranded wire. With so much inside, the tether became an additional issue that affected the ROV's potential efficiency and had to ultimately be rearranged so as to prevent the same error from occurring again.

IX. Senior Reflections

Ramsey Tapia

My role in underwater robotics is the foundation to outstanding achievements. Due to perseverance and kind heartedness, I was given a full ride to pursue a career in Computational Engineering at the University of Texas at Austin. In conclusion, I would like to thank my mother, Crystal, my counselor, Roxanne Deleon, my dedicated teachers, and my amazing friends.

Joining underwater robotics has been the best decision I have ever made in my life. It has given me firsthand experience of becoming an engineer. Most of the skills I possess today are because of Underwater Robotics at Foy H. Moody High School. Thank you, Moody and to all the wonderful staff.

Katarina Ramos

Following my brother's lead, I came into the CITGO Innovation Academy at Foy H. Moody High School my Freshman year. I immediately threw myself into a whole new world of engineering and leadership opportunity. Throughout my three years, I have been able to experience so many competitions and presentation opportunities. From compete at internationals with my team in Seattle, Washington to the numerous professional presentations I've had the honor of being the leader for, I was able to practice professional leadership and still enjoy high school.

From the events and organizations I have participated in, I have been award many academic and outstanding awards. But more importantly, participating in underwater robotics has guided me to find my passion and potential career choice. Because of my experience and enjoyment of speech, I have decided to study at the Moody College of Communications at the University of Texas at Austin.

In conclusion, without my mentor finding me among many other freshman, I would have never found my future. I want to take the time to thank and appreciate my mentor, teachers and staff, my parents, and my wonderful teams throughout the years. You all helped to mold me into the young adult I am today.

Christopher Torres

Pursuing Underwater Robotics has been one of the best decisions I have ever made. It has really helped me solidify my degree plan of pursuing a computer science degree at Texas A&M Kingsville. And it really gave me a good view of how being a computer scientist would be as I have spent countless hours coding and developing software and hardware for our Remotely Operated Vehicle.

Being a part of Underwater Robotics has helped me gain many fantastic recognitions like the STEM Student of the month for August 2019 and going to New Orleans to present for our very own Underwater Robotics.

It has really been an eye opening experience being CTO which allowed me to lead our technical team and make the tough decisions that paid off in the end with our completed ROV

In conclusion, I wouldn't be who I am today without this class and amazing opportunity and I would like to thank everyone that helped me get here and who has helped me along the way.

Eric Vela

Joining Underwater Robotics my sophomore year was the best decision I have ever made. Being part of this team the past 3 years has molded me to being the person I am today. While being in Underwater Robotics i have learned and developed life skills I am going to need and use for the rest of my life. Now I know what I want pursue as a career, I want to pursue a career in Mechanical Engineering and also in Business at Texas A&M Kingsville. If it wouldn't have been for the help from being a member of the CITGO Innovation Academy and Underwater Robotics I would never have had the opportunities I have had these past four years.

In conclusion, if it wasn't for my mentor choosing me among many other freshman to join the underwater robotics teams at the regional competition in 2015, I would have never found my future. I want to take the time to thank and appreciate my mentor, teachers and staff, my parents, and my wonderful teams throughout the years. You all helped to mold me into the young adult I am today.

X. Acknowledgements

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CITGO - For sponsoring our pro at Foy H. Moody High School
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Corpus Christi Natatorium - For allowing us to test our product under realistic conditions
Blue Robotics - For providing us with parts necessary for the completion of Legacy and aiding us with any difficulties with their products
Home Depot - For providing us with parts for the completion of Legacy
Sutherlands - For providing us with parts for the completion of Legacy
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Mrs. Charles - For mentoring us and coaching us
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Dr. Benibo - For supporting our team throughout the year in any way
Dr. Clement - For supporting our team throughout the year in any way

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