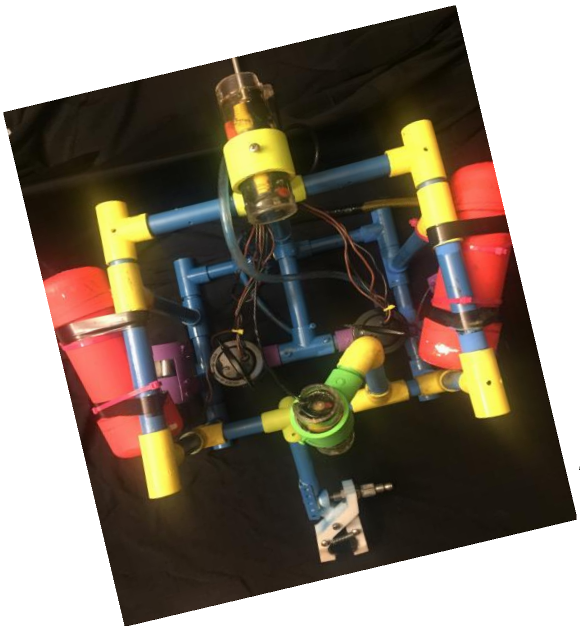
ASAES Underwater Robotics

Sabana Grande, Puerto Rico



Abstract

Construction of ROV L-Marrgafar began in 2015. This is our first year in a worldwide competition as MATE. We have created a prototype with the necessary measures and comfortable to maneuver in the water. Mounting two chambers both forward. One of them helps us address the robot and the other is directed to watch the clip. We have designed our our floats in PVC cover caps with epoxy for durability.

It is built in PVC removable to allow adjustment of freshwater and saltwater. They are made to our propellants covered in PVC. Two L.E.D.s was installed lights for illumination.

Overcoming various challenges through hours of hard work, we have gained valuable knowledge and skills. We have learned to use CAD software to generate wiring diagrams, persevere through teamwork, communicate effectively, maintain documentation, and manufacturing through various techniques. We also learned about the real environmental problems involved in the Gulf of Mexico. We also learned about the moon of Jupiter, Europe and natural conditions, ice. In the future, we will manage our project, so there is more time for practice before the competition.

Table of Contents

1. The Saints Underwater Robotics team. 5

2. Executive Summary 6

3. Design Rationale 6

4. Frame of L-Marrgafar 8

5. Special Features 10

   * Motor Housing 10

   * Pneumatic Arm 11

   * Cameras 11

   * Tether 12

   * Depth finder 12

6. Control Board 13

7. Propulsion 14

7. SID Diagram and Fuse calculation.. 15

8. Pneumatic Arm Diagram 16

9. Buoyancy Calculations 16

10. Financial Report 17

11. Safety.. 19

12. Safety Summary 19

13. Things we can do 20

14. Things we cannot do 21

15. Challenges we overcame 21

16. Future Improvements 21

17. Reflections on the experiences... 22

18. References 23

18. Sponsors/ Acknowledgements 24

The Saints Underwater Robotic Team

Photo 1: Photo taken by Lernisse Collazo teacher of the Saints Underwater Robotic Team (From left to right)

Fabián Martínez .... Presentation & Design Engineer

Michael Orengo .... Presentation Designer & Mechanical Team

Ronald Riopedre ....Tether man & Mechanical Team

Randall Torres ....Tether man & Mechanical Team

Gabriel Cruz .... Presentation Designer, Co- CEO & Co- CFO

Ramón Pérez .... Co-Pilot & Safety Specialist

Alex Cabello .... Pilot & Electric Team

Alondra Cartagena ....Chief Financial Officer & Co- CEO

Andrea González .... CEO

Lernisse V. Collazo (not in the picture) .... Mentor

Executive Summary

Here at Saints Robotics Team, robotics is considered an intriguing and exciting new experience for all of us. Some of the things we sought in the construction of our robot were quality, style and efficiency. We strive to find solutions to problems that come our way and tend to solve them with easy and lasting solutions which also allow us to gain experience for further troubles. This also helps us learn the problems that may arise in the competition since this is our first time competing in a MATE ranger class competition. We wanted to work our best for our first year competing so we decided to give our all.

The construction of our robot began using the original vector design found at the MATE Center and since then we have made our own changes and modifications to allow us maneuver the robot easily and perform each task as best as we can for this competition. Our design represents that the original designs MATE provides combined with current technology can perform as many tasks and missions as any other robot designs.

We choose the name L-MARRGAFAR because we wanted to select a name that is different and special to us. Each letter represents the unique first letter of each and every team member here at Saints and it represents all the effort we put as a team and our hard work to enter this competition with our robot. Our teamwork is strong and all of us combined could make things function as best as possible thanks to all our dedication and determination. The name also represents the combination of all different abilities and skills that we posses. We continue to advance as a team with every challenge we have faced and our robot reminds us to keep moving forward as a team because together we have managed to combine all our strengths into one.

Design Rationale

Since this is our first year we searched for a design that could be efficient and easy to control for us. Eventually we discovered the Triggerfish Vector design at the MATE website and began designing our own. We gathered every possible tools and materials that we needed to begin building. We decided to use the PVC and gathered as much as we needed to create L-MARRGAFAR. It was a long and difficult process since our resources were limited but we managed to finish our design exactly as we wanted it to be.

We all concluded that we needed to make board meetings every Thursday to observe our progress and discuss all the tasks that had to be completed. We also read chapters related to all the fundamental aspects we needed to include in our robot (frame, power, propulsion, etc.) and began gathering ideas for our robot. Every team member brought forth their own idea. Most ideas seemed to make the tasks easy to accomplish in a short amount of time. Then we modified the robot to meet our own needs so we could navigate it easier and perform the tasks. The most noticeable modifications were a two camera system, our own robotic arm using a pneumatic system, and a fish finder for measuring the depth and temperature.

We assembled each part we needed and made our modifications. The best asset we had on designing was the help of some members who previously participated in Sea-Perch and had experience with robotics so they identified future troubleshooting. Their knowledge and advice served us well.

As our robot progresses we continue to learn more as we tested our robot in a real world pool and we have concluded that we have provided an efficient design that will serve well for this competition and we will continue learning and adapting to any challenge that might come ahead.

L - MARRGAFAR Frame

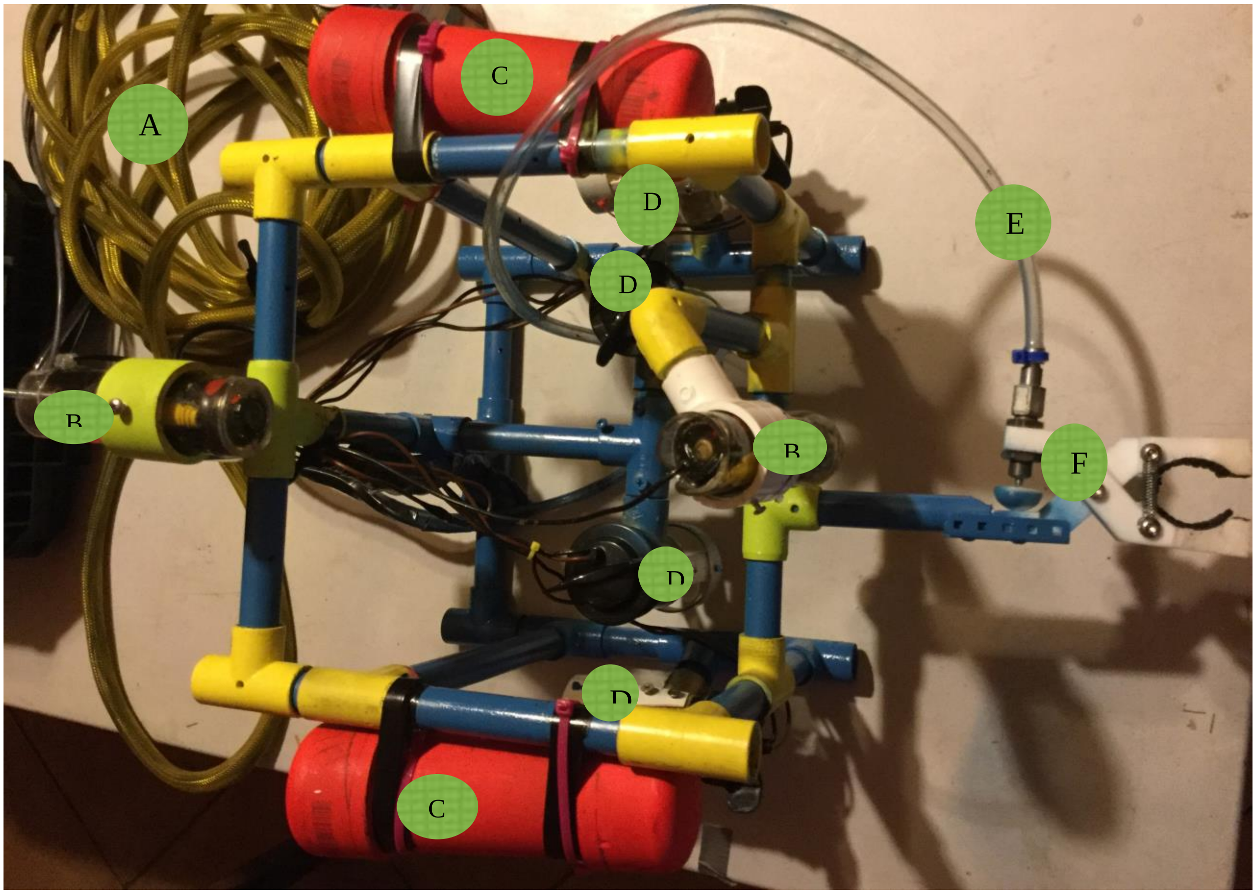


Photo 2: Photo of L-MARRGAFAR – ROV. Photo by Lernisse Collazo

Key

- A- Tether
- B- Camera
- C- Buoyancy
- D- Motor
- E- Windsock
- F- Robotic arm – Pneumatic arm

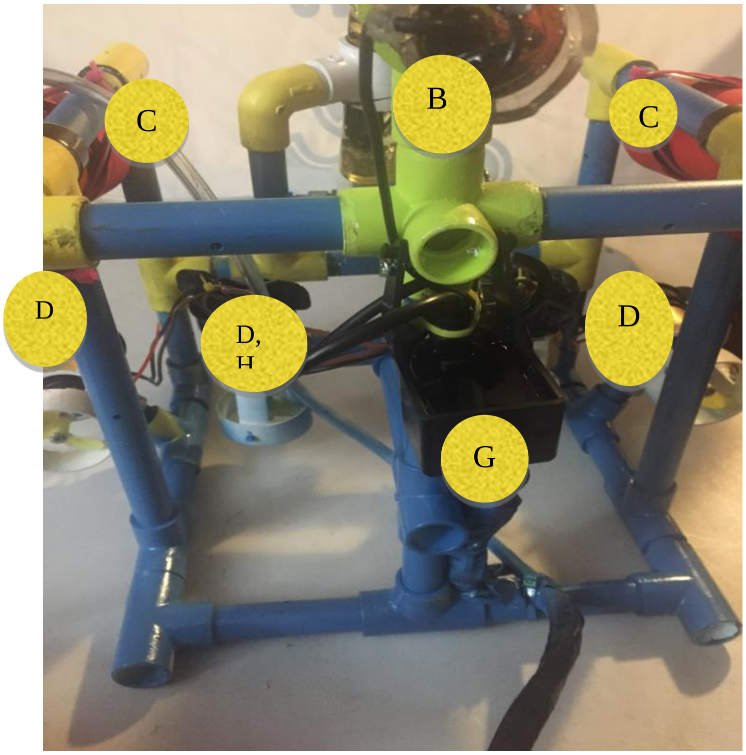


Photo 3: L- MARRGAFAR Frame back. Photo by Lernisse Collazo

Key

A- Tether

B- Camera

C- Buoyancy

D- Motor

E- Windsock

F- Robotic arm – Pneumatic arm

G- Sensor of Depth finder

H- Motor Housing

Special Features

Motor Housing

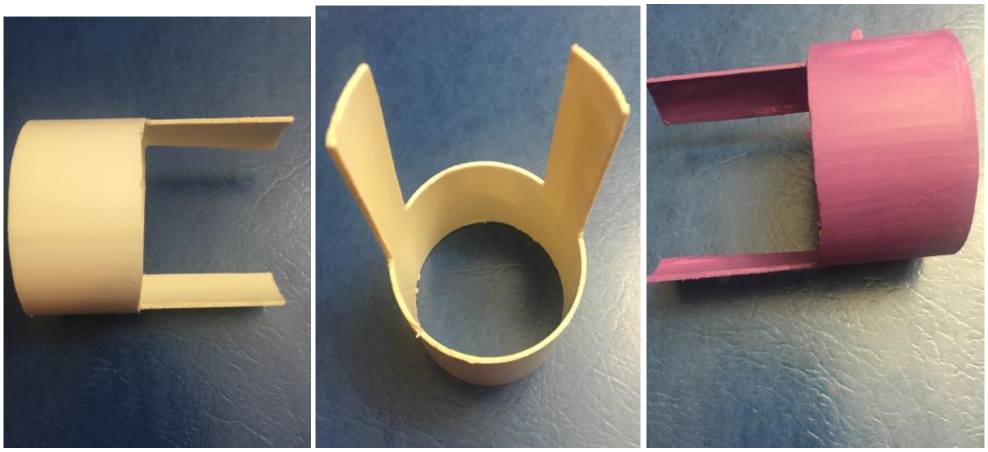


Photo 3: PVC Motor Housing. Photo by Lernisse Collazo

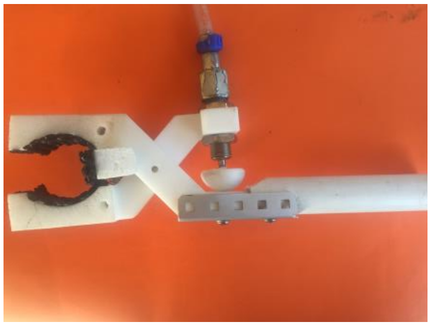
To aid our propulsion system we have added PVC motor housing to streamline the thrust from our motor. We cut the PVC to protect the propellers. The specific advantages to using this design are as follows.

- Safe encapsulation of propellers
- Cheap
- Enhanced thrust capability

It's was made motor housing for each propulsion motor of ROV.

Pneumatic Arm

Photo 4: Photo of robotic arm, this pneumatic arm. Photo by Lernisse Collazo



The robotic arm is the pneumatic arm. The arm is CAD design in 3D printed. Had a windsock and this is connect to a compressor system of 40 PSI for open and close the arm. This compressor use battery of 12 V.

Camera

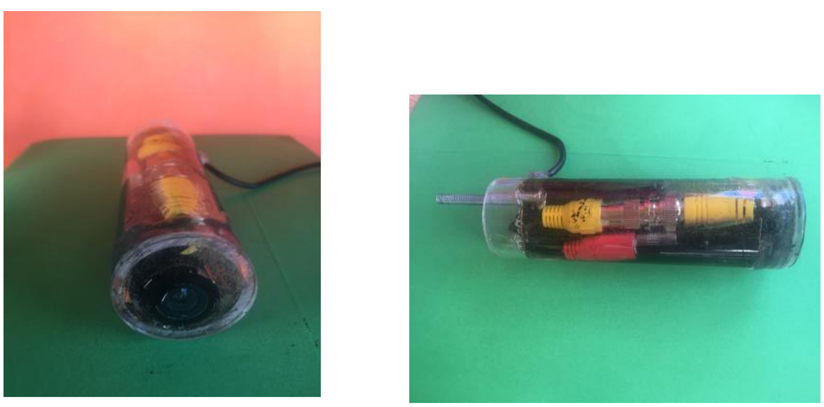


Photo 5: Photo of Camera and Monitor system. Photo by Lernisse Collazo

Our team has two waterproof cameras. All cameras operate on 12V. They all have two wires coming from them. We have two monitors in the black dry box.

Tether

Photo 6: Picture of floating tether. Photo by Lernisse Collazo

The tether connects the ROV to the electrical distribution control box. It consists of two 10 AWG power cable, two cables for cameras, one fish find cable and one windsock S for pneumatic arm and abrasion resistant tether wrap and strain relief to protect connector. It controls power and signals operations of the ROV system. The tether had 40 foot, 18 gauge, 8 strands tether wire.

Depth Finder

Photo 9: Digital Depth Finder. Photo by Lernisse Collazo

The our depth finder of the ROV, the team opted to use HawkEye Digital Depth Finder. This reads temperature of water and water depth. Has DepthTrax intelligent sonar delivers precise depth reading up to 200 feet at speeds up to 60 mph. It is easy to use and reasonable cost.

Control Board

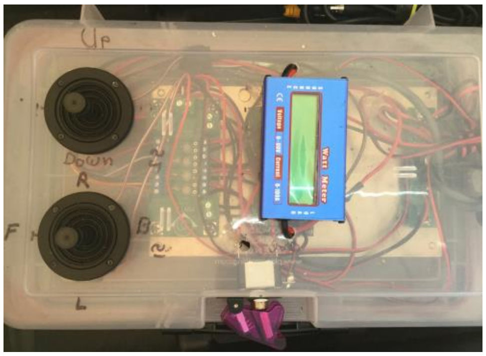


Photo 7: Photo of Control Board. Photo by Lernisse Collazo

The Control board is composed of:

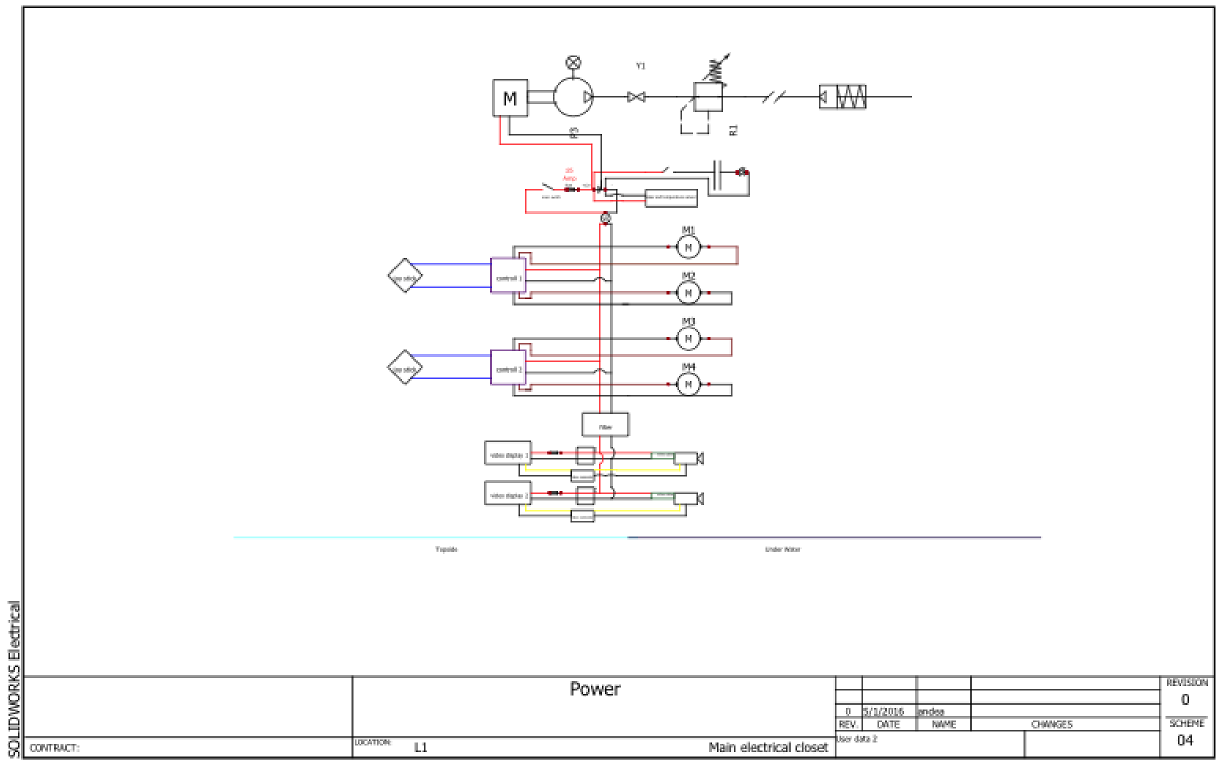
- Tether cable
- Two joystick
- One fuse
- One watts and voltage gauge
- Two output – monitors
- Two output – cameras
- Four output- motors
- One output-water temperature and depth finder
- Main kill switch

Propulsion

Photo 8: Photo of propulsion of the ROV. Photo by Lernisse Collazo

For propulsion of the ROV, the team opted to use Johnson pump cartridge 1250 GPH with propellers. While a custom motor and housing setup might have yielded more power and efficiency.

SID Diagram



Fuse Calculation

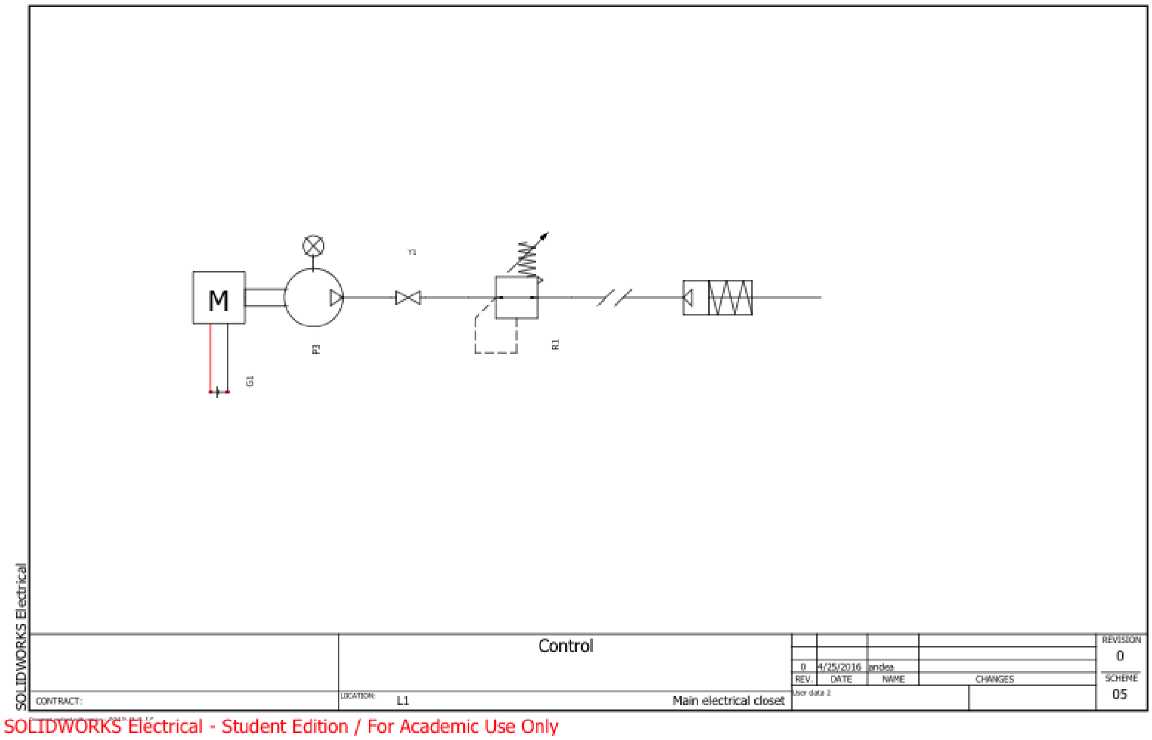
Fuse = (current)(1.5)

(watts) = 84w = (7A)(1.5) = 10.5 ≈ 15A

(voltage) 12V

84 watts = 12 V X 7 amp (Battery)

Pneumatic Arm Diagram



Buoyancy

Photo 10: Photo of the Buoyancy system. Photo by. Lernisse Collazo

The buoyancy is made tube and cap of PVC. Closing by Epoxy glue.

Buoyancy Calculations

In order to make Alpha neutrally buoyant, we needed the buoyant force to equal the force of gravity $F_b = F_g$. This is logically equivalent to (Pf)(V)(g) = (m)(g) where Pf is the density of water, V is the volume of our robot, g is the acceleration due to gravity, and m is the mass of the robot. After a few calculations...

Component	Number (dim)	Mass (g)	Volume (cm^3)	Density (g/cm^3)
Frame		1435.00	28316.85	0.05067
Motors		245.00	2726.40	0.08986
Arm assembly		185.00	14049.86	0.01316
Air tank		225.00	8390.18	0.02681
		2090.00	53483.29	0.1805

Thus we have...

$F_b = (999.97\ kg/m^3)(53483.29 \times 10^{-6}\ m^3)(9.8 m/s^2) =.\ 5.24 \times 10^{-4}$ N

$F_b = (2090.00 \times 10^{-3}\ kg)(9.8 m/s^2) = 20.5 N$

Financial Report

Item	Source	Cost	Number	Extended Cost
Johnson Pumps 1250 GPH Motor	Johnson Pumps	$37.00	4	$148.00
MATE Triggerfish Kit	MATE	$675.00	1	$675.00
1"x2" PVC pipe	The Home Depot	$2.24	1	$2.24
1/2 x20 Black electrical tape	The Home Depot	$5.24	5	$26.20

2" PVC	The Home Depot	$3.24	1	$3.24
Cap of PVC of 2"	The Home Depot	$1.98	4	$7.92
Camera	Amazon	$10.97	2	$21.94
LCD TV 7"	Amazon	$30.00	2	$60.00
Depth Finder	West Marine	$167.00	1	$167.00
Black Dry box	The Home Depot	$35.00	1	$35.00
Air Compressor	Don Benja hardware	$29.00	1	$29.00
Windsock 40 foot	Sabanera Hardware	$15.00	1	$15.00
Box screws	The Home Depot	$9.95	1	$9.95
Spray paint	The Home Depot	$5.50	2	$11.00
Acrylic tube	San Germán glass	$6.00	2	$12.00
Epoxy glue	The Home Depot	$5.98	1	$5.98
Valve of compressor	The Home Depot	$3.98	3	$11.94
LED light set	Amazon	$15.00	1	$15.00
Special glue	Amazon	$15.00	1	$15.00
Cable ties	The Home Depot	$6.95	4	$27.80
Butt Connectors heat Shrink	Amazon	$30.58	1	$30.58
Anderson power pole connectors	Amazon	$14.39	1	$14.39
Robotic Arm	CAD Design	$125.00	1	$125.00
Tools set	The Home Depot	$220.82	1	$220.82
Robot Box transportation	Sabanera hardware	$100.00	1	$100.00
			Total	$1,800.00

Safety

Safety is a primary concern for L-Marrgafar. L-Marrgafar is designed to be safe at all times. We followed all safety protocols and wore proper eye protection at all times in the worksite. Precautions were taken when cutting and sanding, working with electric circuits and soldering. We were able to finish the building of our ROV without many mayor incidents. Some being scrapes and burns. All work involving machinery was done by us members having the proper skill set to use the tools.

The L-Marrgafar frame is made completely out of PVC pipe. It is designed to fit in the regulation space provided. Wires in our ROV are well organized to ensure no possibility of entanglements. All wires were waterproofed in the process. Special safety protocols were taken into concern to ensure safe functioning of our ROV underwater.

Safety Summary

Company

- Eye protection worn at all times
- Job-specific protection accounted for (gloves, facemask, fans - depends on the job)
- Licensed driver/mentor present at all times
- Power tool training required prior to operating the tools
- Complicated power tools used the supervision of an outside mentor, in the workshop setting

Physical

- No sharp edges exposed on the ROV
- All connections are secured with PVC casing
- PVC Motor Housing protecting the engine propellers

- The transportation of the ROV must be carried out by 3 people: one carrying the ROV, one carrying the tether wire, and one carrying the black box dry with the control box

Electrical

- All naked wires and non-waterproofed connections are located on the control board.
- All underwater wire connections sealed with butt connectors heat shrink and epoxy
- Abrasion resistant tether wrap and strain relief to protect connector
- Main power on/off switch
- The control board are securely with Velcro in black dry box

Things we can do

This robot is equipped with two cameras which allow the pilot a closer look to any object or area also has a pneumatic mechanical arm that can pick up most of the objects.

This robot is able to measure water temperature and depth. It is programmed with joystick command which control the 4 motors and allow the pilot to control the speed and movement to complete each missions.

The ROV is designed to meet the following missions competition MATE: measure the water temperature, the thickness of the ice, the depth of the ocean, connecting the ESP, find the serial numbers, collect the oils samples, collect the coral reef to samples and rigs to reef.

Things we can't do

Currently this ROV cannot move the pneumatic mechanical arm vertically or horizontally; only can open and close the claw. Its claw cannot pick up items that measure more than 1 inch. We cannot just move the camera to take 360 degrees visibility; we have to move the entire ROV to have a wide view of the pool. We cannot measure a depth more than 40 feet.

Challenge We Overcame

Our first challenge was to design the frame of the ROV. We had to analyze it size and achieve a design that was easy to handle. We design a motor protectors which blocked the water flow to the propellers and this affected the movement and speed of the ROV. We had to redesign them so that the water flow reached the propellers. We faced with the problem of floats which were filled with water after throw the ROV on the pool several times. We overcame this problem by opening the floats, emptying them and re sealed the lid with other type of glue.

When we used the claw for the first time we realized that the claw couldn't pick up the object because it tips were wide and slippery. We resolved this situation by reducing the tips and sticking a piece of foam for better grip.

Future improvements

This is our first experience as participants of MATE competition. It will serve as a motivation to continue growing and improving our ROV. In the future we wish to make some improvements to our ROV. We would like to put a mechanical arm that can be controlled by a servomotor. Have a camera that can rotate without the need to move the ROV. Also we wish to make the ROV frame with LEXAN because it is a lighter material. We hope have a wireless control and use sensor to measure water temperature and depth.

Reflections on the experience

Belonging to ASAES underwater robotic, has failed to mature and grow as an individual. When we chose to be part of the delegation of Puerto Rico in an underwater robotics competition it was much excitement and satisfaction for our dedication had paid off. Being chosen to participate in a robotics competition globally been very exciting.

It is the first time our company ASAES Underwater robotic participates outside of Puerto Rico and a world - class categories. Our team we call Saints. We advantage that we have brought to our company? Easy we learned to work together, to respect the opinions of each member, and fight to achieve our goals. We learned a lot of underwater robotics, engineering, electricity, safety, among others.

MATE competition has changed our lives for good. We have matured, we have learned to be responsible, orderly, careful and confident self. He has been a tremendous experience. We have cravings that day comes to start and go through the experience of MATE competition. We know it will be unforgettable for our lives. We hope it is the beginning of many competitions MATE.

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15. Lcdo. González – main sponsor of student Andrea González

16. Héctor Vargas MD - official sponsor of mentor Lernisse Collazo
17. SolidWorks – sponsor of CAD license Solidworks for Students 2016 Edition