By Madison Dressler
and Michael Miller

MATE ROV Competition 2019

Aquatic Robotics

Technical Report

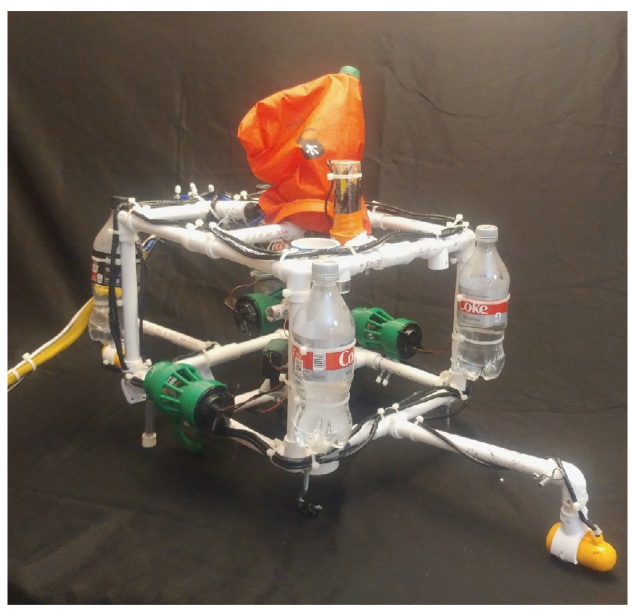
Company Information:
Name: Aquatic Robotics
School: David Thibodaux STEM Magnet Academy
Home: Lafayette, Louisiana, United States

Company Employees:

Ethan Leblanc CEO, Design Lead	Year 1
Dylan Dressler Build Lead	Year 1
Madison Dressler CFO, Marketing Lead	Year 1
Andrew Falcon Electrical Lead	Year 1
Michael Miller Strategy Lead, Design	Year 1
Chai Sutton Electrical/Design	Year 1
Nolan Marone Electrical	Year 1

Company Mentors:
Chris Leblanc
Nicolette Darjean

designvision
illustration & animation



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Abstract

Aquatic Robotics is a first-year company made up of seven high school students who have used their varied knowledge and capabilities to build a remotely operated vehicle (ROV). The ROV, Betty, performs a multitude of functions: to ensure public safety through the inspection and reparation of underwater machines and structures, to monitor and maintain clean waterways, and to preserve historical items for years to come.

To perform these functions, Betty has been fitted with an assortment of attachments, some of which have been designed via Inventor and made via 3D printer while others have been manually constructed and altered to serve their purposes: two cameras at various angles in order to best maneuver Betty into position and to measure the radii of the cannon, two actuated hooks that are used to carry the trash rack (both the damaged one and the repaired version) the water sample, the cannon markers, and the reef-fish ball, one non-actuated hook to pick up and carry the cannon, a magnet to sense whether the cannon shells are magnetic or not, and one lift bag to help carry the cannon to the surface by adding additional lift power to Betty

These simple tasks given to Betty closely mirror real-world problems that are solved through the use of ROVs, such as removing a tire from the floor of the pool would amount to clearing litter and polluted items from the Mississippi River that damage its ecosystem.

Mission Theme

Eastern Tennessee is a picturesque landscape, containing the Smoky Mountains and Kingsport, a town with long winding hiking trails, Boone Lake (and its dam that bears the same name) and the South Fork Holston River. Boone Dam is hydroelectric and is mainly purposed for the control of flooding in the Tennessee River area.

However, the appearance of a sinkhole in recent years has called attention to the dam. Repairs are made on a constant basis. Problems like these are best dealt with through operation of a remotely operated vehicle (ROV) as they do not require the risk of huma lives if a danger like a sinkhole or perhaps if dangerous creatures are present. In the past decade, ROVs have quickly become relevant, and every year they become more so; they surpass the efficiency of humans for certain jobs. For example, an ROV equipped with just a camera and underwater capabilities could monitor water flow and inspect for cracks that damage the structural integrity of the dam.

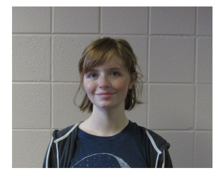
This is just an example of what ROVs can be made capable to do. Equipped with hooks, fish carriers, claws, and image recognition software, the ROV could use these to complete a variety of tasks. With the hook, one could attach a carrier for water, when could then be brought back to a laboratory for testing its quality after it is retrieved from a specific area, or carry a container of grout in order to fix cracks that habitually appear. Fish carriers could be used to transport fish into habitats for which there is an imbalance that must be restored. A claw could be used to grab polluted items, such as tires and cans, and remove them from the area, healing the ecosystem of the river piece by piece. The image recognition software could identify species of fish and determine whether some needed to be removed or added from that particular ecosystem.

Teamwork

Team Roles

Dylan Dressler Build Lead

Dylan designed the props used on the robot and constructed them. He built and designed the Mini ROV using his engineering skills.



Madison Dressler C.F.O. and Marketing Lead

Madison was in charge of all the documents, pictures, scheduling, and most note taking. She did the marketing poster, the technical documentation, company spec sheet, and compiled the scheduling. She was also the company's photographer.

Andrew Falcon Electrical Lead

He did all of the Electrical aspects of the ROV. He did all wiring, the switches, and the tether.

Ethan LeBlanc C.E.O. and Design Lead

He did the main parts of the design and parts of the build. He 3-D printed all of the custom modules on the robot and designed the prints. He helped out in every aspect of the robot.

Michael Miller Designer and Strategy Lead

Michael helped design many of the ROV's elements. He was also a big help dealing with the marketing work. Michael was the strategy lead and knew most of the competition and the tasks at hand.

Nolan Marone Electrical

Nolan created and designed the control box for the ROV

Chai Sutton Electrical

Control box alongside Nolan

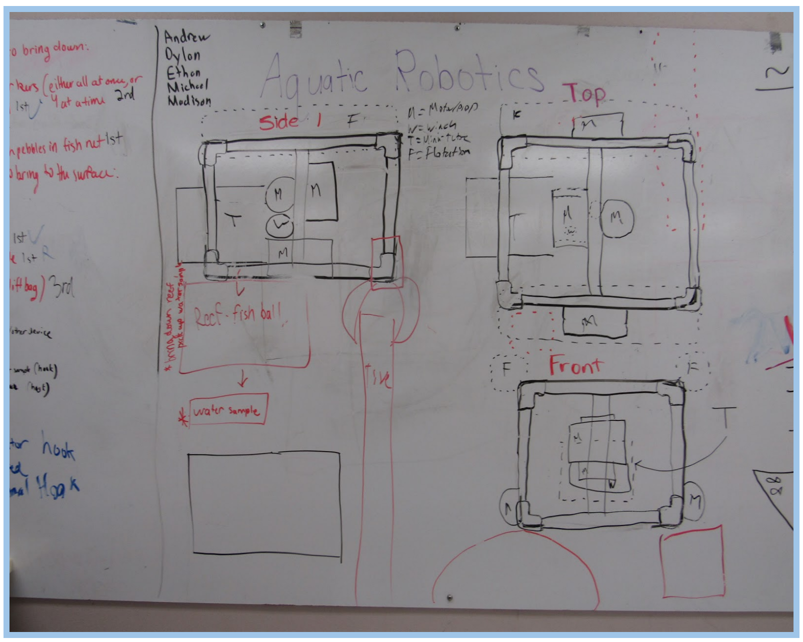
Brainstorming Process

Aquatic Robotics met every Monday, Thursday, and Saturday starting in January, and began meeting every Monday, Wednesday, Thursday, and Saturday in the last week of February. During the January meetings, we had brainstorming sessions and discussions about every aspect of the robot.

Ethan, as the team leader, led the discussions. Michael would bring up parts of the robot that we needed to discuss, and all members of the team discussed it together.

Mr. Chris came to some of the sessions and used his expertise to give ideas to the team on the design and build of the robot.

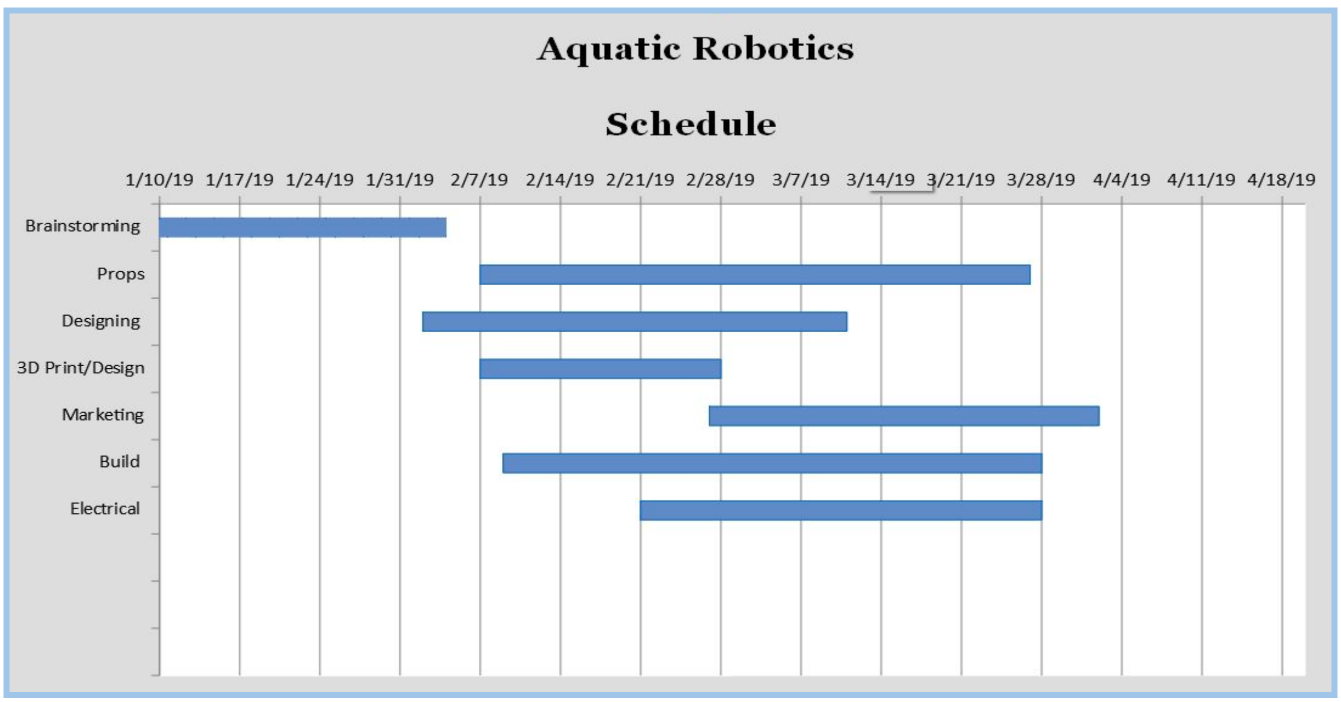
This is an example of one of our brainstorming sessions. We speculated possible placements for certain attachments.



Pictures by Madison Dressler

Project Management

Aquatic Robotics first met every Thursday to gain knowledge of the competition and go over the manual for the competition. The company held brainstorming sessions every Monday in January with our mentors. In February, the company started designing the props after the main frame was built, and Ethan started designing parts for the 3D printer. The marketing and strategy leads, Michael and Madison, started compiling the necessary information to complete the technical documentation and all other needed documents for competition. In March, the company was putting together the ROV and the Electrical lead, Andrew, started his part in the ROV. Michael and Madison continued finishing the marketing requirements and the documents. Madison managed the schedule and kept track of the tasks that the company was completing during each meeting day.



Design Rationale

Process

Our position on design was that of least complexity. As we were in new waters, it was important to design systems that relied on as few moving parts/electronics as possible. We also looked at using systems in multiple ways to complete separate tasks.

When designing a system, we first look at what it needs to accomplish, and if it can be done by something that may be purchased instead of designed and built ourselves. While seemingly the easier route, anything bought will have to be modified to suit our specific needs, and may be more trouble than producing something ourselves.

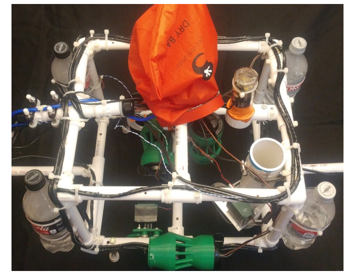
Next, we looked at a variety of barebones concepts to accomplish a task. These concepts were compared against one another, taking into account variable such as electronic use, complexity, materials needed, time to construct, and ease of construction. Electronic usage and materials are most important as in this competition, electronics are much more limited than in FRC. On the other hand, materials are important as the process of buying materials verses using something on hand is a time delay worth considering.

Once a concept is decided upon, we looked at the best way to go about the finer details of said design. Many times there are flaws in a design only exposed once a prototype is produced and tested, which is why many concepts are drawn up re-evaluated as we discover new information.

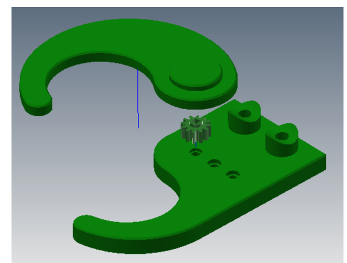
After a final product is produced, it is included in the main ROV design, and taken into account for further designs, with how it may constrain or help accomplish other tasks.

Systems

- **Buoyancy**
  - For our buoyancy, we decided to use water bottles instead of the foam many teams employ. This is because we found pool noodles would slowly take on water, and lack the ability to be fine-tuned to the specific weight of our ROV. The bottles allow us to variably dial up and down the amount of lift provided from each corner of out frame, letting us deal with uncentered weight.



- **Claws**
  - Aquatic Robotics designed two actuated hooks through a design program called Inventor and created them via a 3D printer. They are designed to be easily used and activate at the flick of switch, as well as allowing the pilot to drop props like the trash rack more accurately than a non-actuated hook.



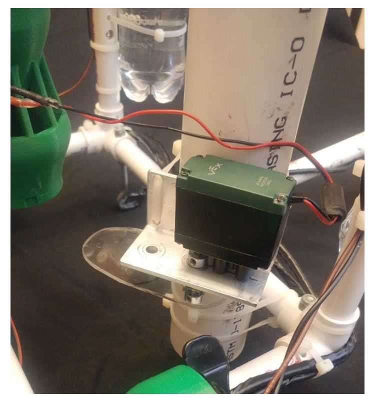
- **Lift Bag**
  - Betty is equipped with a lift bag that can hold four to six liters of air or water; it functions as a way to lift Betty to the surface as well as add additional thrust power when going to the surface or lifting heavier objects such as the cannon or the tire. The lift bag uses a variable system of releasing/ adding air from the bag; there is a bottle/bottle cap pait attached to the top of the bag, with variable sized holes drilled in, allowing the bag to bleed air at a selected rate.
    - A tube is inserted into the lift bag; a bike pump is used to manually pump air from the surface down and filter it into the lift bag

- **Magnet**

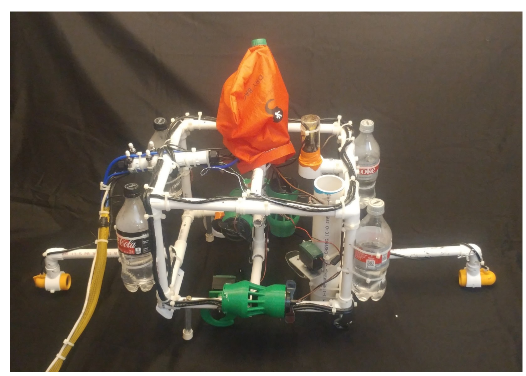
A strong magnet has been attached to the PVC frame of Betty; it is used to detect whether the cannon shells are magnetic or nonmagnetic.

- Aluminum Hook
  - Along with the actuated claws, Betty has been fitted with a large hook along the bottom of the frame. The hook was constructed out of metal and was tapered down to a point and the end of the hook for safety and efficiency reasons. The hook can be used to pick up props like the water sample or the trash rack, but is is used mainly to pick up the cannon and the tire. It's mounted in the center of the frame to provide the greatest lift and to stop the ROV from being unbalanced when lifting heavy loads.

- Grout & Trout
  - Placed on a corer of the frame is a dual-purpose dropper system. Basicaly, it's a tube we load with whatever cargo needs carrying(Grout bettles and trout fry). The cargo is held in by a rotating door, which is retracted to drop the cargo down the chute into whatever receptical it needs to be delivered into.



- Cameras
  - Betty is equipped with three cameras, which are placed at various positions to provide different vantage angles to maneuver Betty. One is at the top of the frame pointing downwards, one is placed at the back facing towards the front and can be repositioned as it is attached to an arm that can move about 90 degrees up and down , and one is at the front and has a repositable arm attached to it



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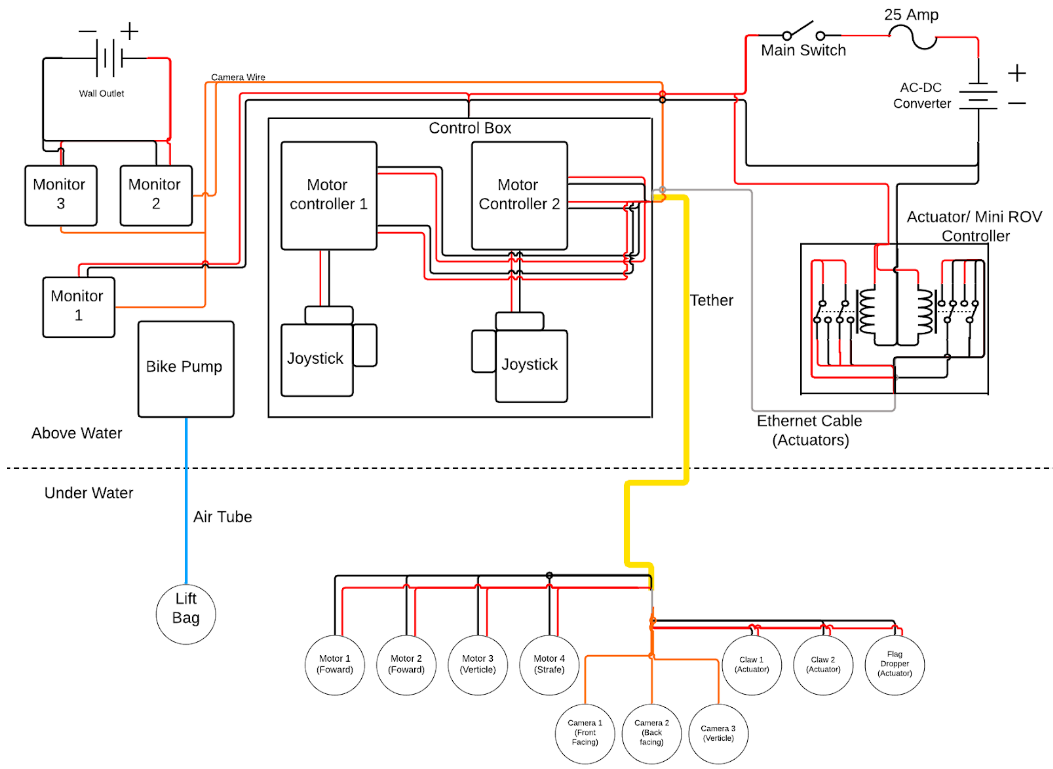
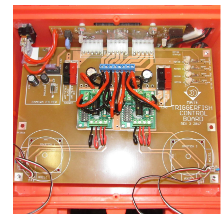




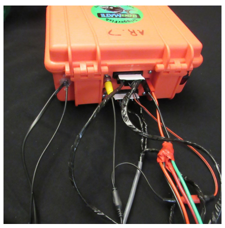
❖ Fuse Calculations:

Item	Quantity	Amps (Each)	Total Amps
Camera (Main)	2	0.3	0.6
Camera/Monitor (Yellow)	1	1.2	0.5
Thrusters	4	2.5	10
Actuators (VEX)	4	2.8	14
		Max Use	25.1
		Overcurrent(x1.5)	37.65

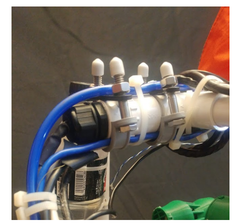
Safety

Safety Features

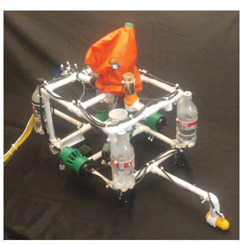
Our control box was purchased as a kit from the seamate site and constructed as the instructions said. The kit's PCB has all wires and sections labeled. The control box makes use of DC current exclusively, with AC power being used for the monitor.



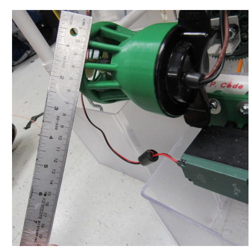
The tether has proper strain relief leading away from the control box as well as from the ROV, both employ temporary restraints such as zip ties, reinforced by permanent attachments such as hot glue and EPoxy.



Aquatic Robotics has passed the Fluid Power Quiz, and will employ a manual bike pump leading to an open-ended hose. No pressurized containers or compressors are used.

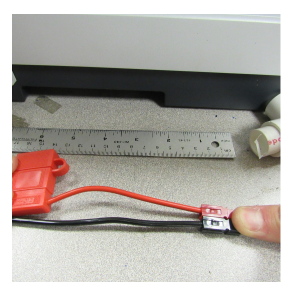


All main propellers have been shrouded with a 3D printed design, with credit to Steve Thone for the creating the design.
https://www.myminifactory.com/users/sthone



All sharp edges on the ROV have been filed down, with all wires being secured to the frame.

Anderson Powerpole connectors were used in conjunction with a 25 Amp fuse located within 30cm of the main connection point.



Safety Procedures

When performing any dangerous activities, every member took certain precautions to make sure no injury took place, ans are shown in this checklist here

- General Shop
  - Safety Glasses worn while using power tools
  - Gloves worn while cutting materials
  - Hair tied back
  - Proper footwear that cover toes
  - Pants worn in the shop at all times
- When Soldering
  - Fume hood
  - Safety glasses
  - Hair tied up
  - No loose clothing
- Drilling PVC
  - Safety glasses
  - No loose clothing
  - Hair tied up
  - Clear work area
- 3D Printing
  - Close hood before starting the print
  - Clear area for printing

Critical Analysis

Testing and Troubleshooting

Aquatic Robotics met every Monday, Thursday, and Saturday starting in January, and began meeting every Monday, Wednesday, Thursday, and Saturday in the last week of February. During the January meetings, we had brainstorming sessions and discussions about every aspect of the robot. Ethan, as the team leader, led the discussions. Michael would bring up parts of the robot that we needed to discuss, and all members of the team discussed it together. Mr. Chris came to some of the sessions and used his expertise to give ideas to the team on the design and build of the robot.

Different parts of the ROV were tested individually as well as all together, to insure their validity and usefulness. Each proposed design was tested by attempting to perform the task in water, as well as in the shop.

Challenges and Lessons Learned

Our main challenge was that this is our first year doing MATE ROV. In the 2017-2018 year, we did the FRC Competition. The new competition greatly differed from FRC, as it often focused on cooperation with other teams at competition, whereas MATE ROV focused more on the cooperation within the team. It also gave us a completely different type of robot to build, as our members had never constructed any type of underwater ROV, much less on this grand scale. It was very difficult for us as a unit to transition from an FRC mindset to a MATE mindset in how we approached tasks and our time management. FRC gave us a much shorter time-span to complete out robot, so it was difficult to not waste time. However, we eventually developed a schedule for time and made sure to complete at least one thing every practice. Eventually this bloomed into a complete unit that worked together in sync and got work done extremely efficiently.

Accounting

Cost

Bill of Materials							
Item	**Description**	**Material**	**Source**	**Quantity**	**Measurement**	**Unit Price**	**Total Price**
Major System Names Here	*Describe the Part (Axle, Bearing, Lifter, Solenoid)*	*What is it made from*	*Where did you buy it (Home Depot, AndyMark, Supply House, Etc.)*	*How Many*	*Piece, Inch, Etc.*	*Cost Per Unit ($) New*	
Frame:							
1/2 in PVC	Frame Material	PVC	Home Depot/Lowes	4	10 ft	$3.97	$15.88
PVC Joints	Frame Material	PVC	Home Depot/Lowes	30		$1.00	$30.00
Shrouds	3D Printed Motor Shrouds	PLA	3D Printed	4		$20.00	$80.00
Bottles	Coke Bottles for Buoyancy	Plastic	Donated	4		$0.00	$0.00
Vex Motor	Repurposed Vex Motor		Broken/From Shop	4		$12.99	$51.96
Steel Graph	1/4 in Steel Chicken Fence	Steel	Home Depot/Lowes	1		$9.98	$9.98
Plastic Sheet	Coregated Plastic Sheeting	Plastic	Home Depot/Lowes	1		$19.98	$19.98
Ruler	Aluminium Yardstick	AL	Shop	1		$23.97	$23.97
Vex Gear	Vex Gear Kit	Plastic	Shop	1		$12.99	$12.99
L-Bar	1.5in L-bar	AL	Shop	1		$6.64	$6.64
Churros	Aluminium Churro	AL	Shop	2		$2.00	$4.00
						Subtotals:	**$255.40**
Station:							
Fish Monitor	Fish Monitor/Camera Kit		Donated	1		$150.00	$150.00
Battery	Car Restarter		Home Depot/Lowes	1		$39.88	$39.88
Wire	Eithernet 8-Wire Cable	Copper	Shop	1		$10.84	$10.84
Tubing	Blue Turbing	Plastic	Shop	1	50 ft	$15.90	$15.90
Bike Pump						$12.50	$0.00
Controller	Part of Seapaech Motor Kit			1			$0.00
Monitor			Donated	1		$100.00	$100.00
						Subtotals:	**$316.62**
Mini-ROV:							
Fish Camera	See Fish Monitor for Price		Donated	1		$0.00	$0.00
SP Motor	SeaPearch 1 of 15 in kit		Seaperch Store/From Shop	1		$130.00	$130.00
Wire	16 Gage Steel Wire			1	25 ft	$1.96	$1.96
						Subtotals:	**$131.96**
Misc:							
Kit	SeaMate Triggerfish Rov Kit	N/A	Semate Store	1	N/A	$700.00	$700.00
Zip Ties	Misc Zip Ties Used		Lowes/Home Depot	1		$25.92	$25.92
Elec Tape				3		$1.97	$5.91
Duct Tape				2		$8.47	$16.94
E-Poxy	2 Part E-poxy			2	8 oz	$17.42	$34.84
Vasaline				1		$6.15	$6.15
PVC Glue				1		$9.98	$9.98
Tape Meas	Loose Tape Measure			1		$5.71	$5.71
Misc	Cost For Misc nuts/bolts/mats			1		$20.00	$20.00
						Subtotals:	**$825.45**
						Totals:	**$1,529.43**

Acknowledgements

Chris LeBlanc
Owner, Design Vision- 3D Visualization & Reconstruction

He was there to help us through a lot of the engineering aspects and the brainstorming sessions. Mr. Chris strung along a lot of ideas, and talked us through the problems we had. He also donated various materials to the team, as well as the team shirts.