

Technical Report

Ranger Class

Submitted by:
Eric G. Lambert Robotics Team
Eric G. Lambert School
Churchill Falls, Newfoundland and Labrador

Mina ROV

(Mina Hubbard the woman who mapped Labrador)

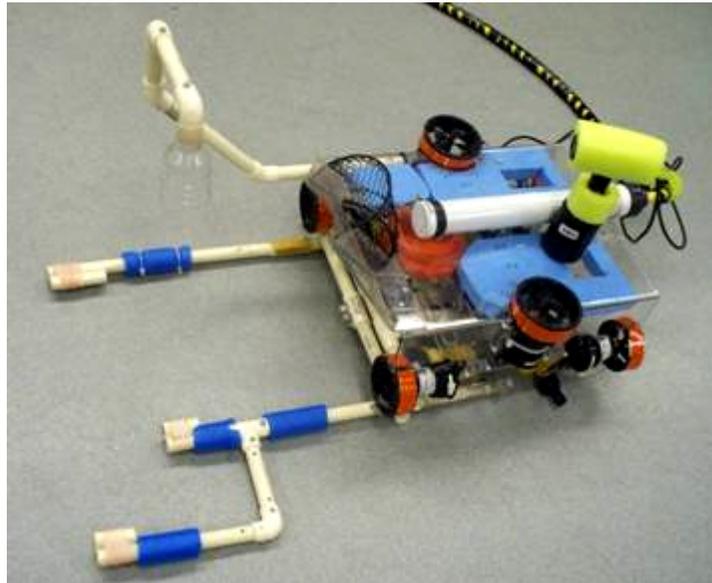


Figure 1: Completed *Mina ROV*

Mentors:

Barry Noble	Instructor
Leonia Card	Instructor
Samantha Kent	University Student
Scott Shears	University Student
Spencer Collins	Electrical Engineer

Team Members:

NAME	YEAR
Danielle Martin	Grade 12
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Krista Collins	Grade 11
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I. Abstract

This being our second year competing at the MATE competition, the Eric G. Lambert Robotics Team began this year by deconstructing the previous year's ROV, in hopes of reusing some of the materials. Our goal was to construct a functioning ROV to compete in the Ranger class at the 2008 MATE International ROV Competition. Having researched various designs and discussing possible models, we decided to construct the main frame of our robot, a rectangular prism, using Lexan. The rectangular prism provides us with the balance and space needed to mount our arms, pumps, motors, and other necessary equipment. It will also be easier in determining the buoyancy of the robot and ensuring that it is neutrally buoyant. We wanted our robot, *Mina*, to glide through the water as much as possible, therefore we chose to reduce surface area and minimize resistance by not having a front, back, or bottom of Lexan. Also the water may flow through the ROV allowing it to move quicker. Through the use of various components, such as magnets, PVC pipe, compressed air, and a solenoid, we have assembled *Mina* to successfully complete the necessary tasks. Our team has benefited from the assistance of some of last year's members, as well as a local electrical engineer, and our coaches. The following technical report includes a description and photos of the ROV, challenges we encountered and overcame, lessons we learned, possible future improvements, an expedition researching hydrothermal vents, our budget, and reflections on our experience this year.

II. Design Rationale

a) Frame

The frame of *Mina* was constructed from Lexan. It was chosen because Lexan is durable, lightweight, and sturdy. In order to ensure that we did not waste the Lexan and because it's difficult to cut after it's been bent into a rectangle, we first constructed a mock up of our ROV out of cardboard (Figure 2). The motors were to be mounted into the sides of the frame; therefore accurate outlines of the motor were made and cut into the cardboard frame. Once Eric G. Lambert Robotics team had completed the mock up, we unfolded the cardboard and used it as a design template for the actual ROV, by tracing the outlines onto the Lexan sheet (Figure 3). To construct the arms and attachments we used PVC 3/4" pipe. We also mounted a small Lexan base on the inside of the ROV such that we could attach one of our cameras and a can of compressed air. Holes were drilled in the base to minimize mass. Beneath this base there is a series of PVC piping that is connected to the pumps.



Figure 2: Mock up of ROV



Figure 3: Tracing outline on Lexan

b) Control System

We modified a tool box to accommodate our controls. Initially we placed holes in the sides, one for the tether to enter and connect to all of our switches, a second to connect with the power supply, and another to mount the main switch. Another piece of Lexan was cut to fit inside the toolbox, so that the switches could be mounted on top of it with the wires running underneath. The



Figure 4: Control box

control box contains four variable resistors that control the speed of the ROV and four double pole single throw (DPST) switches for forward, reverse, up, down, left, and right motion of the thrusters. There are other switches to control the release of the compressed air and a mount for the temperature probe receiver.

c) Cameras

The ROV uses two underwater digital cameras to provide the ROV operator with a clear colored image. One camera is in place, inside the frame of the ROV, to view the arms used to pick up the crabs and a second is mounted on top of the ROV and is used to see the temperature probe mechanism and scoop for the black smoker samples. Both cameras provide a clear view of the surrounding area, allowing the operator to see where she is headed.



Figure 5: Upper Camera

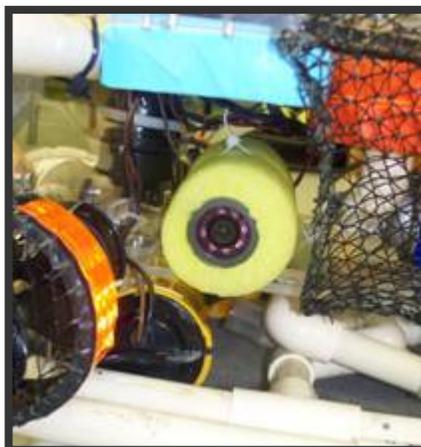


Figure 6: Inner Camera

d) Thrusters

Six 1000 GPH motors are used so that *Mina* may efficiently glide through the water. Four motors are used for both forward and reverse movement and two are mounted on either side of the robot. Due to the fact that, when in reverse, the motors are not as efficient, we decided to mount them backwards to one another. They are wired accordingly, so that when one motor is in forward it is complemented by the one opposite of it, which is in reverse. This ensures that when the robot is moving forward, it produces the same amount of push as when it is in reverse motion. The other two motors are mounted one on each side near the top of the robot, and are both used for up and down movement. Each motor has a four blade plastic propeller, which were selected because during our Bollard test the brass props gave a thrust of 1-1 ½ N while the plastic props produced thrust of about 8N. There are four 500 GPH pumps that, through PVC piping, push and pull giving the ROV lateral motion (Figure 9). Two pumps function at

once, both pulling in one direction while pushing in the other. For safety reasons, each motor is housed inside an ABS shroud with wire mesh stitched and epoxyed to the outside. There is also highly reflective tape and danger signs on the shrouds (Figure 8).

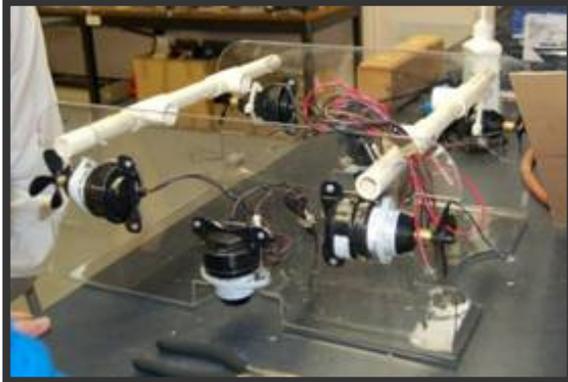


Figure 7: 1000 GPH motors mounted on frame



Figure 8: Finished motor



Figure 9: 500 GPH pumps that provide lateral movement

e) Tether

The tether used for our ROV is being reused from last year. It is 14m long and originally contained ten 18-gauge wires. In order to accommodate for our cameras, there are two cables attached to the outside of the tether with electrical tape. We added 2.5 meters of extra wire to the tether on the end that will not enter the water in order to be sure that it would be long enough. The tether now meets all of our electrical requirements and is flexible enough so that it does not interfere with the motion of the ROV. The wires of the ROV are housed inside a piece of 2" PVC pipe and the tether is connected to the end of this pipe using a compression fitting that is water tight and will allow us to disconnect the tether from the ROV. This will be very beneficial as last year we experienced many problems with the size of our ROV. Because we couldn't disconnect its parts, it was damaged en route. Many other teams also had this problem last year. We have a much longer travel route this year, with stopovers, making it even more essential to have everything separate.

A second function of the PVC pipe is buoyancy. It is placed in the center on the top because, according to Rule 5. from: "What works what won't" in *Build Your Own Underwater Robot*, the weight always ends up below the floats. Since the majority of the weight of our ROV is near the bottom, we had to make sure this pipe connected to the tether was centrally located above everything else.



Figure 10: Components of compression fitting.



Figure 11: 2" PVC pipe where wires meet tether and exit the robot.

f) Mission Oriented Devices

Task 1: Collect up to three vent crabs.

Our team decided that because of the metal eyes that the crabs have, it would be easy to pick them up with strong magnets. Initially we deconstructed several very strong pick-up magnets to find two smaller magnets inside. By placing the smaller magnets side by side they are the same width apart as the eyes. Each pair of magnets is housed, one each, inside two pieces of 3/4" PVC pipe that have been joined with epoxy and cloth. One pair of magnets is mounted on a pipe that runs across the front of the base of the ROV. Three more pairs are attached to long pieces of PVC pipe that extend off the front of the ROV. Both the arms are the same length, however the arm that is on the left has two extensions, one longer than the other, giving us an extra opportunity to catch a crab as well as added convenience. Each arm has a piece of wire going through it that is bent forwards towards the magnets, to help guide the crab to the magnets and to further support the crabs once we have captured them. It will decrease the chances of picking up a crab and losing it again.

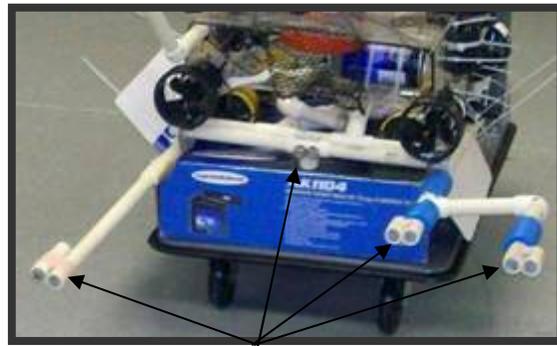


Figure 12: Magnetic arms

Task 2: Collect up to three samples of a black smoker.

On the front of our ROV is a Lexan scoop that is cut so that it may perfectly fit around the black smoker. By simply moving it upwards we collect the samples of the black smoker. We tried various materials for our scoop, such as a dustpan and a mesh wire scoop, however it was decided that constructing our own Lexan scoop cut in a semicircle worked best. Just behind the scoop there is a wire mesh basket, that we fabricated to slant downward, ensures that the samples fall directly into the basket and cannot fall out because of the depth and angle of this basket.



Figure 13: Lexan scoop with mesh basket

Task 3: Measure the temperature of hydrothermal vent fluid.

Extending from the upper right corner of the ROV is another arm built from 3/4" PVC pipe, two 45-elbows, and two 90-elbows. Inside this pipe is the temperature probe. By attaching the top portion of a water bottle to the end of this pipe, using epoxy and cloth, we direct the flow of the hydrothermal vent fluid towards the temperature probe which is located just above the bottle. In order for this water to escape and to be sure that it flows over the temperature probe, we have drilled large holes in the elbow. The probe then takes a few seconds to transmit an accurate temperature reading to the handheld receiver located in the control box.



Figure 14: Arm that contains temperature probe

Once these three tasks are completed the robot is much heavier than when we first descended towards the hydrothermal vent. Since our motors may not be strong enough on their own to bring the very negatively buoyant ROV back to the surface, we designed a mechanism to provide us with extra buoyancy.

By dismantling a trunk release system, we obtained a solenoid. We cut off the top of a marine safety kit, drilled a hole in it, and attached it to the underside of the top of the ROV. A piece of straw attached to heat shrink leads from a can of

compressed air, through the hole, and into the newly formed container. When placed in the water the container fills with water. After the tasks are finished and we are ready to return to the surface, a momentary button is pushed activating the solenoid, whose wire cord is wrapped around the trigger on the can of air. The air goes into the container and displaces the water, giving the ROV more buoyancy.

To determine the size and volume of the container we first conducted an experiment to determine the volume of air needed to float about four average size rocks. This was done by using a dismantled bottle, placing the rocks in the bottom, and allowing it to fill with water. Next, by blowing air into a straw until the rocks came just to the surface and by measuring the amount of water that had been displaced, we knew the volume of air needed. This container serves much the same purpose as a fish air bladder, in that by adding air it will allow us to become less dense and float upwards.



Figure 15: Orange container or "fish bladder"



Figure 16: Solenoid and can of compressed air to fill container

III. Overcoming Challenges

Whenever you have a group of people working together, no matter what the task at hand, there are many challenges to face and overcome. In building *Mina* the biggest challenge faced by Eric G. Lambert Robotics Team was getting materials. Living in an isolated community everything needed to be well thought out. We had to ensure that when our coach was out of town and picking up materials he got everything we needed in the right amounts. When something broke or if we needed more, it could be days or weeks before they were received and sometimes this meant stopping the construction of the ROV while we waited for these parts. The main components that we knew would be needed were ordered well in advance to ensure they would arrive with lots of time to test them and decide whether or not they were the correct part for our task. These materials included new motors, props, and Lexan.

One of our biggest technical problems was connecting the tether to the ROV in such a way that it could be disconnected and still completely sealed and water-proof. We attached connectors to the wires coming out of the ROV and at the end of the tether. This allows it to be easily disconnected and hooked back

together properly. To ensure that wires were not mixed up, we labeled every wire, so that connecting and disconnecting the ROV from the tether will be a task that can be accomplished quickly and accurately. Once we figured out how to connect everything together, we needed to find and decide upon the best method to use to water-proof this connection. Finally we chose a compression fitting that contains an O-ring which water proofs the seal when the parts are put together properly and screwed tightly together.

Another technical problem was that our buoyancy mechanism wasn't working properly because the air was escaping instead of displacing the water. Initially there was only a small section of red straw attached to the nozzle of the compressed air can. This meant that only a small amount of air would go into the orange container and it wasn't enough to give us the amount of buoyancy we were looking for. We quickly discovered that by extending the straw so that it went all the way into the orange container then we could minimize our air loss. Heat shrink was used because of its flexibility and it was attached to the end of the straw by shrinking it. Doing so allowed it to run all the way into the container.

A final challenge faced was working together as a team and coordinating the schedules of the members as well as coaches and mentors. Having had a problem with this in the past, we started everything much earlier this year and tried to move at a faster pace. Often times there were only three or four members of the team present, however through delegation of tasks, everyone knew what had to be done and by whom. It was up to each individual to familiarize themselves with the missions, the environment we would be dealing with, various design ideas, and to keep up to speed with what was being done by keeping in contact with other team members.

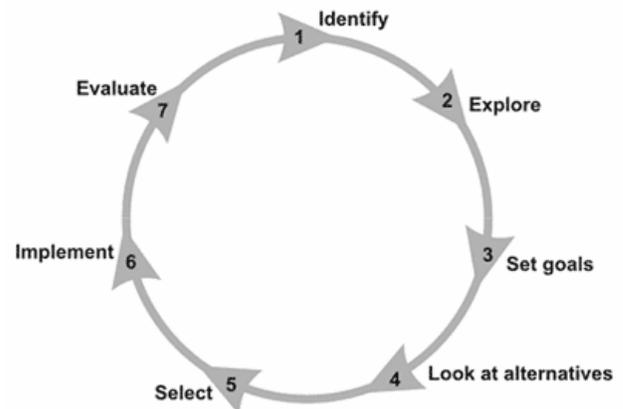
Throughout the course of building the ROV, we greatly increased our problem solving skills as well as becoming more patient with one another. When time was limited it was essential for everyone to stay level headed and listen to our coach. As time progressed we became more efficient and the challenges were easier to overcome.

IV. Troubleshooting Techniques

In constructing *Mina*, our team took all the necessary precautions to ensure that things would run smoothly. For example, we tested all the motors to see which ones worked best with which props and to ensure that output was the same for ones that had to work together. Also, by installing a fuse panel with four fuses and four switches into our control box, we have made it very easy to detect which set of motors has failed in the event of an individual control system failure, such as forward/reverse movement, up/down movement, or left/right movement. This saves us much needed time otherwise spent searching for the cause of the problem. To avoid problems upon arrival at the competition, we chose to construct our ROV in such a way that it can be condensed for travel and quickly reassembled once we've reached our destination. To reduce size and for convenience we modified the tether, such that it may be disconnected from both

the ROV and the control box. As well, with our arms being relatively long, we had to ensure that they could be unscrewed and removed for travel.

By thoroughly discussing and testing various methods that could be used to accomplish each mission, we significantly narrowed down the different possibilities. We used a mock-up in the early stage of production and the purpose of it was to provide insight into reasons why things wouldn't work or what problems might arise. Basically it is the road map you follow to solve problems. Essentially we used a step-by-step procedure in accomplishing this large task. The first step was to identify the problems as outlined by MATE for the 2008 competition. Then we had to explore them and figure out how we could best complete these both quickly and efficiently. Next we set goals, deadlines, and formulated possible solutions to the problems and selected one possibility for each. We did this based on all our knowledge and through discussion of the options. This is when we built a mock-up of our ROV, to help us identify any obvious problems. We then implemented our selections by building the ROV. Following the construction of our ROV, we tested it and evaluated the methods we used. At this point the cycle would begin again as new problems were identified, however it was more efficient because we had already used it for the main construction of *Mina*.



V. Lessons Learned

We the Eric G. Lambert Robotics Team have learned many lessons over the course of this year as we worked on our ROV, *Mina*. First of all, we educated ourselves on the missions, hydrothermal vents, and ROV's by conducting a large amount of research. Through the internet we looked at different designs to get an idea of which ones are more common, seem to work best, or tend not to work well. Also we learned about Archimedes' principle and buoyancy in fluids to help us understand how we could make the robot neutrally buoyant without adding too many weights or too many floats.

We also learned that it's very important not to act on impulse. Important decisions need to be discussed by the whole team to ensure the materials needed weren't wasted and most importantly that time was not wasted. We learned to discuss things through and thoroughly and allowed everyone to have a say instead of wasting precious time arguing.

With regards to the actual building of the ROV we gained much experience with various tools used for cutting and assembling, electrical set-ups, soldering, and how to make sure the materials were neutrally buoyant. Since the beginning

of the year we have all become skilled at drilling holes, stitching, using epoxy, and how to solder wires together and seal them with heat shrink.

VI. Future Improvements

Mina, may be able to complete all the necessary tasks, however that does not mean that it is perfect. One improvement that could be made to our ROV in the future is to have a more flexible tether that would allow for easier motion of the ROV. This would mean a tether that is smaller in diameter and made of a more flexible material. A lighter tether would also be beneficial as we would not have to use as much flotation in making sure that it did not drag down our ROV.

More cameras would not go to waste as they would assist the operators with depth perception. We currently have two cameras angled so that we may have two different views, allowing us to see what we are doing during the missions. Since these cameras do not provide different angles of the same piece of equipment, the operators must deal with looking at things in 2-D and through trial and error complete the tasks. At least one more camera would be beneficial and two more would be ideal. With three-four cameras in total a splitter would be used to ensure that the images from all the cameras could be seen on one screen, allowing the operator to navigate more efficiently.

A final improvement would be to make the overall ROV smaller. The length and width could both be made shorter by about 5cm or more. This would allow us to maneuver much easier through the lava trough and around the hydrothermal vent. As well we could have cut some cost on materials. If the main body of the ROV was shorter, it could also allow our arms to be a bit longer or have more of them, which would make it easier to catch the crabs. Another benefit to having a smaller body to our ROV would be the ease with which it could be transported from the science lab to the pool, as well as around various international airports. Finally it would fit better into our test tank, which could mean fewer trips to the pool.

Our ultimate goal for next year is to be able to work with software, such as Visual Basics and Gadget Master, instead of constructing homemade control box. By using these technologies we would be able to operate our ROV using a computer, which would be much easier than our current layout of a variety of switches. We would be able to use a joystick to control the movement of the ROV and our temperature probe and cameras could easily be worked into the Gadget Master. In speaking with our coordinator, he advised us that it was too late to use software for this year, however next year he will teach us how to use the software. This means that we will also be starting earlier, allowing us adequate amounts of time to get used to the software, and to practice the missions with the ROV. we will also be inquiring about having a our own separate room at the school to be designated the Robotics Fabrication room
Extra time is always be looked for and rarely found, however by starting off right at the beginning of the year and setting goals and deadlines for ourselves, we will have extra time to perfect the robot.

VII. Reflections from the Team

Danielle Martin: Through my experiences of building this ROV I have gained stronger teamwork skills and stronger confidence within myself when it comes to trying new things. At the beginning of this I knew very little on this topic, so I have broadened my horizons and gained much knowledge in a new subject area.

Laura Bonnell: Throughout this year as our team worked to design and build this robot I learned how important it is to design an organized plan and how to wire a robot. I discovered that I enjoy the electrical part of constructing a robot, which may be a career option in the future.

Krista Collins: Through participation in such a large project, I have learned the importance of time management, planning, and working together as a team. It was exciting to try something new, that is outside of my element, and it was wonderful to learn something new every day. In writing the technical report I have gained a much greater knowledge of the basics of ROVs.

Heidi Kent: Throughout the production of this year's ROV I learned, above all, the importance of teamwork. This huge project requires the team to be organized and develop good time management. Also, in addition to this, I learned how to use power tools that I had never used before.

Alyssa Lake: In participating in such a time consuming project, I've learned the importance of time management and working as a team. Since robotics is a new activity for many of us, we needed to put more time into our research so that we could expand our knowledge before we started, which also improved our research skills. A lot of time and effort was put into the construction of our ROV and had we not been able to work as a team or juggle our schedules around, nothing would have been accomplished.

Janine Noble: Working as a team developed helpful leadership and teamwork skills. I learned that hard work, patience, and perseverance pay off.

VIII. Expedition to a Mid-Oceanic Ridge

In August of 2005, David Clague conducted an expedition to research mid-oceanic ridges in the Pacific Ocean off the coast of northern California to southern British Columbia. The *ROV Tiburon* was used in the expedition along with the ship *R/V Western Flyer*.(Figure 18) The Juan de Fuca leg was one leg of this expedition, which explored the Juan de Fuca Ridge, and it contained four components. First they were to survey, map, and sample many of the historic lava flows on the ridge. During the second component of this leg their goal was to

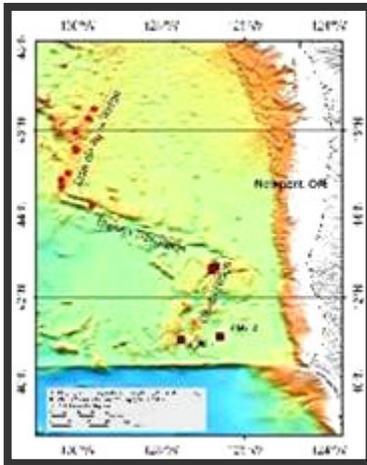


Figure 17: Juan de Fuca Ridge

explore, map, and sample a large and deep lava pond. The purpose of the third leg was to recover and maintenance sensors that were deployed near the ridge. A fourth single dive was in search of active hydrothermal vents and to collect vent biota. This leg would have the most in common with the missions we must complete as part of the MATE International Competition.

The *ROV Tiburon* was the crew's most essential piece of equipment and it contains a special attachment called the Benthic toolsled. It is attached when the ROV is doing geology dives, such as this one. This ROV contains a temperature probe, which serves the same purpose as ours, to measure the temperature of fluid emitted from a hydrothermal vent. They also have sediment scoops that are canvas bags on T-handles that are used to collect gravel. This would be similar to our Lexan scoop, except we are not able to collect samples from the ocean floor, as it was designed to collect black smoker samples. Another similarity between *Mina* and *ROV Tiburon* is that they have both vertical and horizontal thrusters, along with cameras to guide their way.

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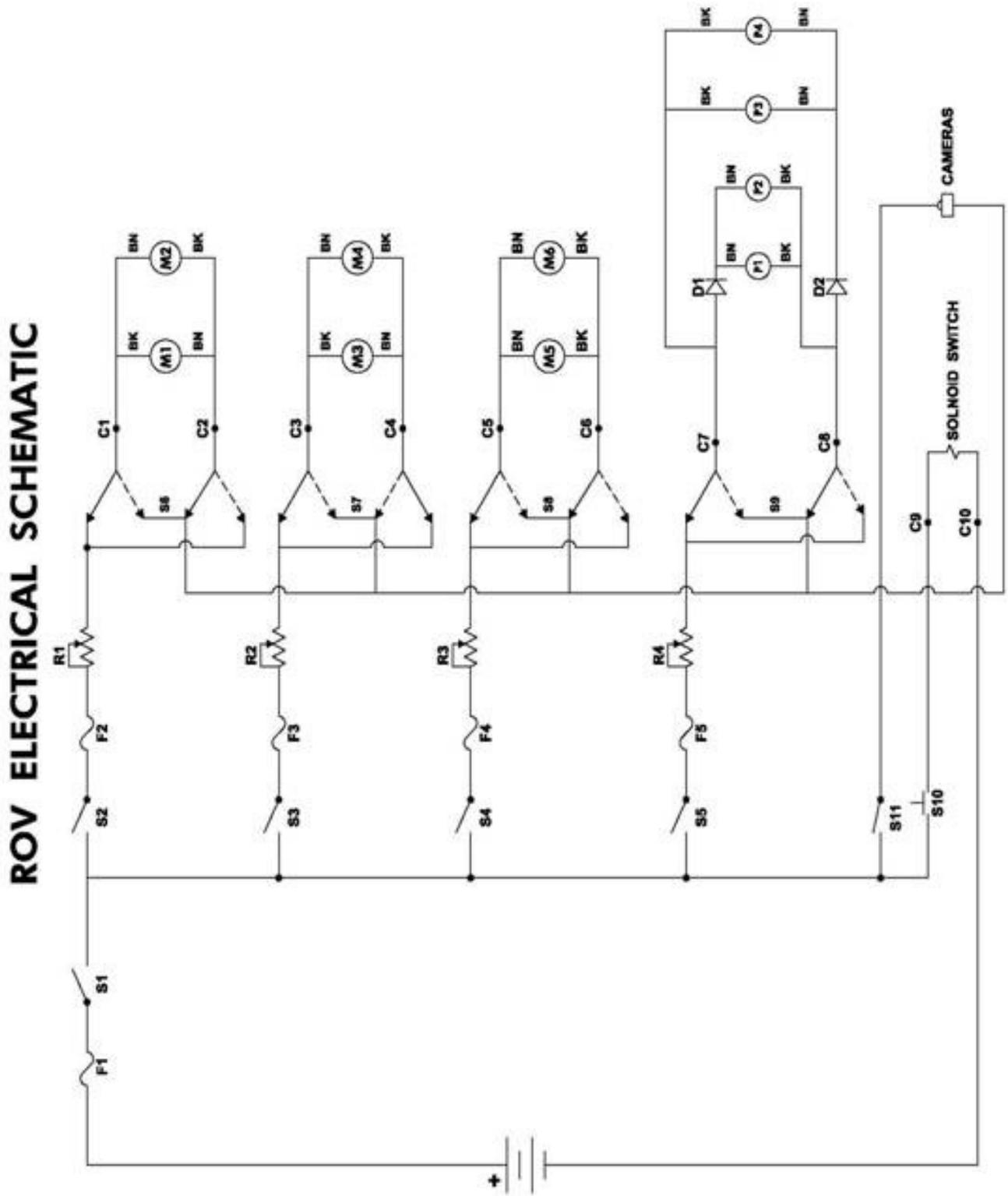
Figure 18: *ROV Tiburon* on board the *R/V Western Flyer*

Sources:

<http://www.mbari.org/expeditions/ridges2005/index.htm>

<http://www.mbari.org/expeditions/ridges2005/gear.htm>

IX. Electrical Schematic



Legend for Electrical Schematic

LEGEND

M1, M2 - LEFT SIDE MOTORS
M3, M4 - RIGHT SIDE MOTORS
M5, M6 - UP / DOWN MOTORS
S1 - MAIN SWITCH
S2, S3, S4, S5 - SPST SWITCH WITH LIGHT
S6, S7, S8, S9 - DPST SWITCH
R1, R2, R3, R4 - VARIABLE RESISTORS
F1 - FUSE, 25 AMP
F2, F3, F4, F5 - FUSE, 15 AMP
P1, P2 - RIGHT PUSHING PUMPS
P3, P4 - LEFT PUSHING PUMPS
D1, D2 - DIODE, 6 AMP
S10 - PUSH BUTTON SWITCH
S11 - SPST SWITCH



**RIGHT SIDE
TERMINAL BLOCK**



**LEFT SIDE
TERMINAL BLOCK**

C9 - LIGHT YELLOW
C10 - YELLOW

X. Budget

Item Description	Quantity	Unit	Cost/Unit	Total Cost (tax incl 13%)	Reused	Given
3/4" T-joint	6	EA	\$0.87	\$5.22		
3/4" 45-joint	7	EA	\$0.74	\$5.18		
3/4" 90-joint	8	EA	\$0.60	\$4.80		
50lb pick-up magnet	4	EA	\$11.30	\$45.20		
Baskets	2	EA	\$1.13	\$2.26		
Marine Safety Kit	1	EA	\$22.58	\$22.58		
Large woggle	1	EA	\$5.00	\$5.00		
Small woggle	2	EA	\$1.13	\$2.26		
Lexan 3/16" clear	1	EA	\$56.00	\$56.00		
CRC-Duster	2	EA	\$3.94	\$7.88		√
Wiring 25'	1	EA	\$7.90	\$7.90		
Heat shrink (pkg)	1	EA	\$6.77	\$6.77		
Flotation foam	1	EA	\$1.13	\$1.13		
1000 GPH motor	6	EA	\$25.98	\$155.88		
500 GPH pumps	4	EA	\$22.59	\$90.36		
Ty wraps (pkg)	1	EA	\$10.00	\$10.00		√
Epoxy 37mL	6	EA	\$6.19	\$37.14		
Fishing line	1	EA	\$10.00	\$10.00		
Trunk release	1	EA	\$28.24	\$28.24		
Camera	2	EA	\$259.00	\$518.00	√	
Tool box	1	EA	\$14.68	\$14.68		
One way switch	1	EA	\$5.07	\$5.07		√
Variable potentiometer	4	EA	\$5.59	\$22.36		
DPST switch	4	EA	\$5.59	\$22.36		√
Green Switch	1	EA	\$5.59	\$5.59	√	
4 Fuse Panel	1	EA	\$45.19	\$45.19		
Plastic prop	6	EA	\$14.00	\$84.00	√	
5lb flex magnet	1	EA	\$7.90	\$7.90		
Silicone	2	EA	\$7.85	\$15.70		
Monitor	2	EA	\$170.00	\$340.00		
Temperature probe	1	EA	\$28.24	\$28.24		
Fitting Compression	1	EA	\$1.62	\$1.62		
Coax power jack	1	EA	\$4.51	\$4.51		
PVC 3/4" joiner	3	EA	\$4.44	\$13.32		
Connector (male)	1pkg	EA	\$10.16	\$10.16		
Connector (female)	4pkgs	EA	\$2.81	\$11.24		
Sealant tape	1pkg	EA	\$6.20	\$6.20		
Tether 45'	1	EA	\$450	\$450	√	
RCA fitting	2	EA	\$6.77	\$13.54		
1/2" coupling	2	EA	\$0.43	\$0.86		
2" central vacuum PVC	1	EA	\$5.64	\$5.64		

2" end cap	2	EA	\$1.80	\$3.60		
Bait well plug	1	EA	\$5.64	\$5.64		√
3/4" PVC pipe	N/A	EA	\$20.00	\$20.00	√	
2" ABS piping 22cm	N/A	EA	\$3.00	\$3.00	√	
Screws	35	EA	\$0.17	\$6.00		√
Cloth	N/A	EA	N/A	N/A		√
Poster board	1	EA	\$11.30	\$11.30		√
Camera mount	1	EA	\$45.14	\$45.14		
TOTALS:				\$2230.64	\$1080.59	\$68.25
TOTAL expense for materials:				\$1081.80		

Trip:

	Travel	Accommodations	Food	Other
Churchill Falls to Wabush	\$250			
Wabush to Montreal	\$1198 * 7 = \$8386			
Montreal to San Diego	\$700 * 7 = \$4900			
Hotel Montreal (3 for 2 nights)		\$840		
San Diego UCSD		\$1275		
San Diego Hotel (3 for 2 nights)		\$840		
Van Rental San Diego	\$400			
7 Days of Meals			\$420 * 7 = \$2940	
Total:				\$19831

Revenue:

Marine Institute: \$4500
 CFL(co):Hydro Company \$3500
 School: \$8000
 Parents & Students: \$4000

Total \$20 000

XI. References

“Build Your Own Underwater Robot and Other Wet Projects” by Harry Bohm and Vickie Jensen

XII. Acknowledgements

Eric G. Lambert Robotics Team would like to thank CFL(co) and members of their staff for providing us with some of the materials needed to build our ROV, including a floatation test tank, as well as helping to pay for our travel to San Diego, California. Other sponsors included Marine Institute, Eric G. Lambert School, and of course our parents. CFL(co) also allowed us access to the pool for trial runs, final buoyancy test, and many practices and we would like to thank the pool staff. We also extend thanks to Eric G. Lambert School for allowing us to practically take over the science lab during the construction of the robot and giving our coach time away from work, so that he may travel with us. Acknowledgement also goes to the University of California, San Diego, for hosting the 2008 MATE International ROV Competition and for the committee’s support throughout the year. Many thanks is also given to our mentors and coaches, who donated their time. We were very fortunate to have them work with us on this project. Their continual support and guidance was crucial in the construction of *Mina* and we greatly appreciate their assistance.