Underwater Rescue Research Company

Rescue Robot Team:

Elizabeth Thomson:

- CEO and Engineer

Morgan Woloszyk:

- Co-CEO and Data Collections

Breanna Domrase

- Tether Engineer

Sam Beatty

- Pilot

Nathan Cosbitt

- Pilot

Katie Thomson

- Mentor

Dave Beatty

- Mentor

Technical Report

Marine Advance Technology Education

May 24, 2012

Mission

OUR COMPANY IS DEDICATED TO FINDING, PROTECTING, AND PRESERVING THE ENVIRON-MENT FROM POTENTIAL AQUADIC HAZARDS

Thunder Bay Junior High
Alpena, Michigan 49707
1-800- ship-wreck
www.rescuerobot.com

Underwater Rescue Robot

Abstract

We are a group of sixth grade students who are focused on protecting our environment. Our team designed a specially adapted remotely operated vehicle (ROV) for the purpose of investigating the environmental threats that old shipwrecks like the MS Gardner (an oil tanker that sank during WW II) have on the surrounding ecology. We designed our ROV with specific payload tools to assess the MS Gardner's environmental threat level. We built it small (35cmx20cmx22cm) to have a quick response in the water to make sure our tools could be quickly delivered and used on the hull of the MS Gardner. We have four thrusters each capable of 5 Newton's of thrust at full power. In addition to the main four thrusters, we added a fifth horizontal thruster to give our pilots better handling in the wreck. This horizontal thruster allows our ROV to move left or right quickly. We have engineered multiple tools and sensors and tested them to ensure that our ROV is effective and capable of carrying out this mission successfully. Our overall design was to keep it simple in order to increase the ROVs dependability. Complicated ROVs have complicated breaks down, and to make our lives easier, we designed our ROV to be reliable. The less parts to break, the less you have to fix.

Underwater Rescue Robot

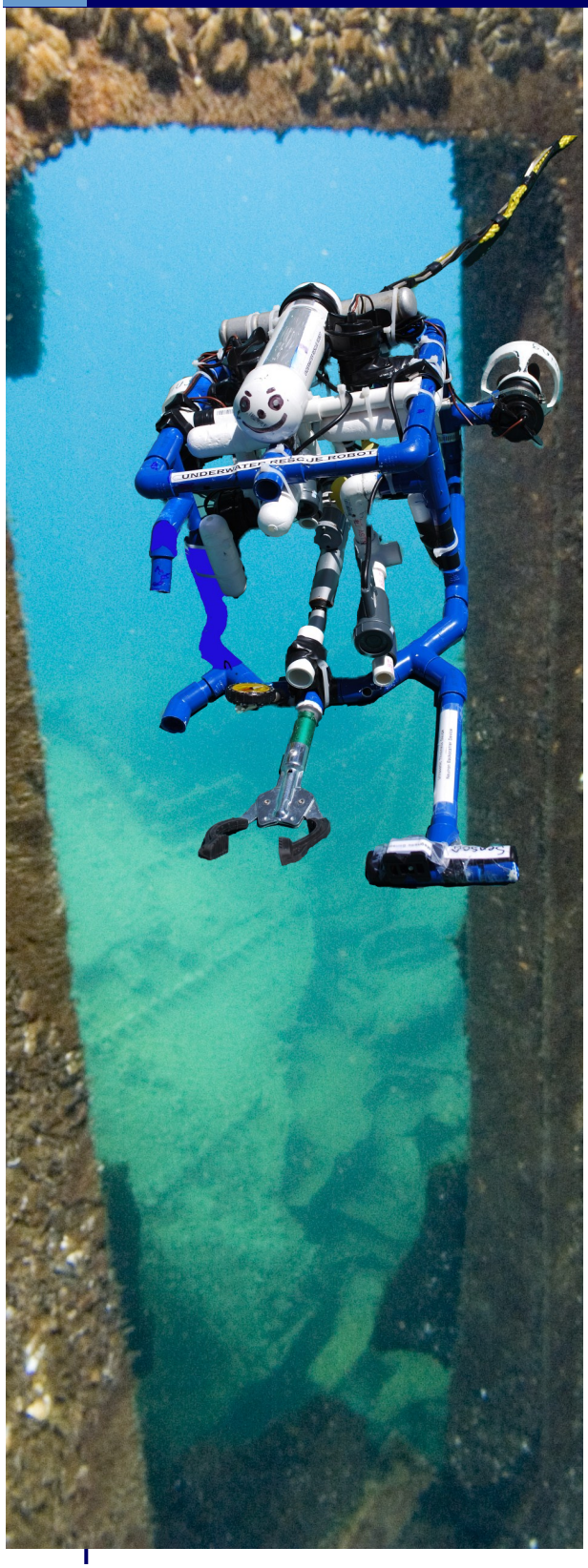


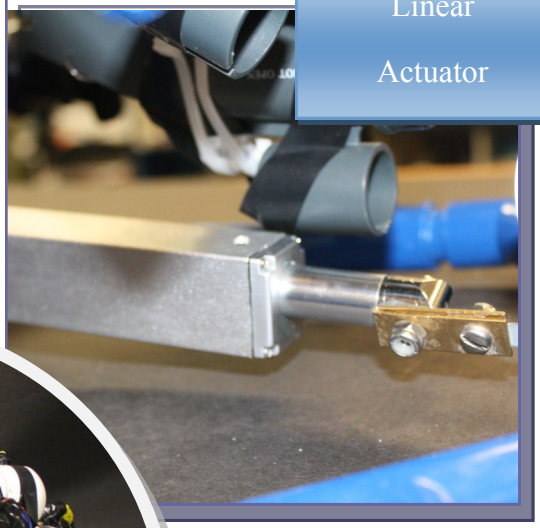
Table of Contents

Underwater Rescue Research Company

ROV Photo Profile

Dual Camera System

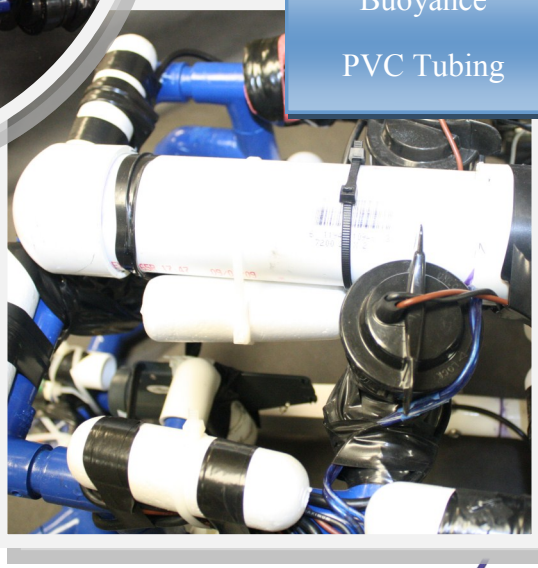
Linear Actuator



Main ROV Frame

Magnetic Sensor Backscatter Device

Buoyance PVC Tubing



Underwater Rescue Research Company

Protecting
Preventing
Preserving

Underwater Rescue Research Company

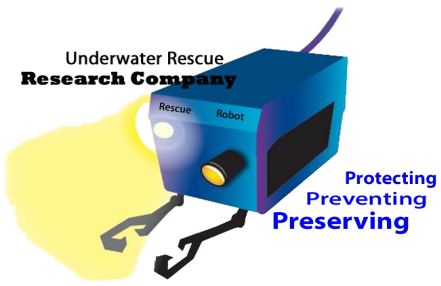
Expense Sheet

ROV Expenses

Item	Cost	Source
Scheduled 40 PVC Pipe	$45.00	Donated
Tether and Control Panels	$75.00	Donated
Thrusters		Reused from last year.
1 Camera & Monitor	$110.00	Donated
1 Camera & Monitor		Reused from last year.
Stanley nail finder	$2.50	Purchased by team
Compass	$6.00	Old Birthday Gift
Mechanical Grabber	$18.00	Purchased by Team
Linear Actuator	$120.00	Donated
Electrical tape/wire ties	$17.50	Purchased by team
Small trim floats	$8.00	Donated
Pool Time	$300.00	Donated
Total Team Cost for ROV	$30.00	Donated = $664.00

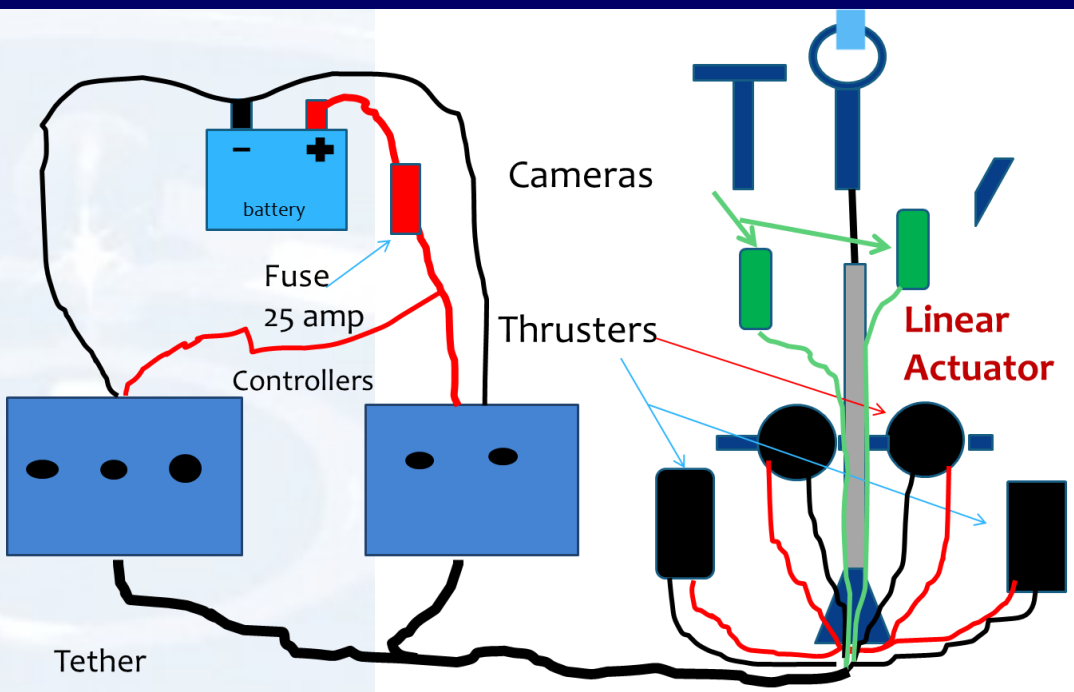
Funding Source	Money Raised
Thunder Bay National Marine Sanctuary Fund Raiser	$340.00
Private Donations	$1,000.00
Spaghetti Dinner Fund Raiser	$600.00
Lost Lake Woods Club Fund Raiser	$300.00
Alpena Mall ROV Showcase Event	$250.00
Optimist Group of Alpena	$500.00
Ossineke Chamber of Commerce	$100.00
Alpena Booster Club	$100.00
Total	$3,190.00

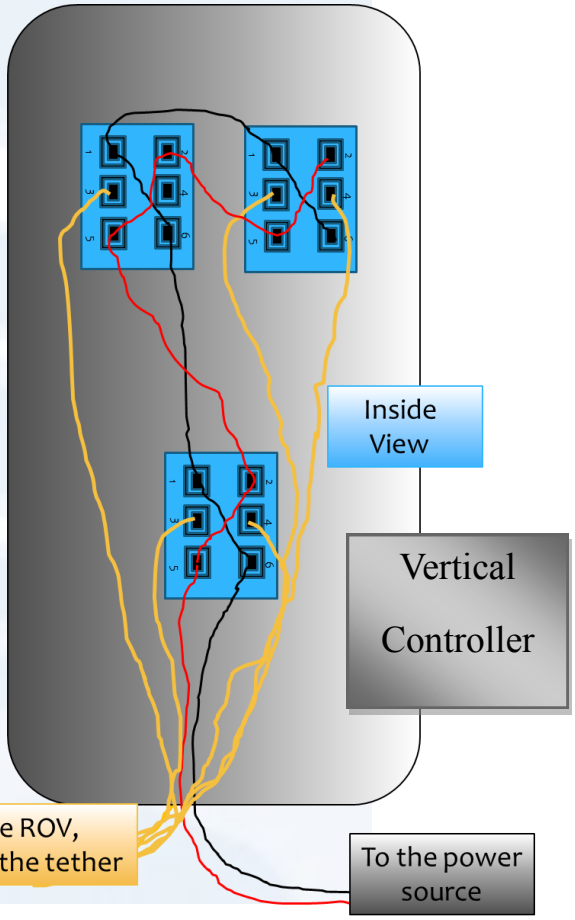
Travel Expenses for International Competition Total $5,000

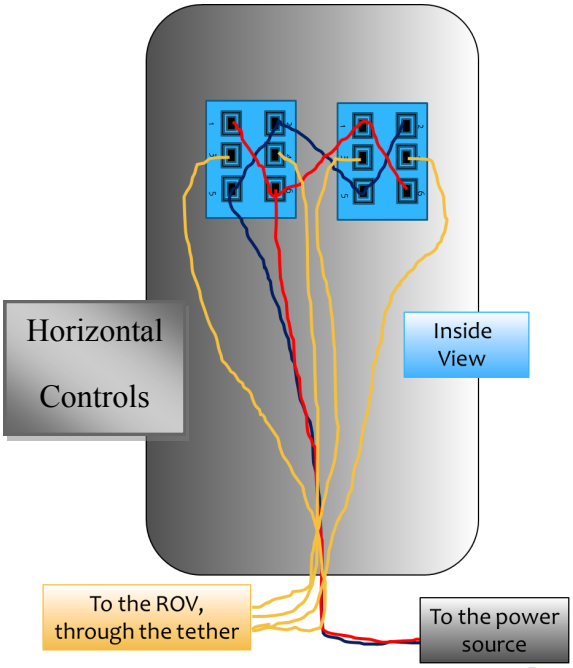


Underwater Rescue Research Company

Electrical Schematic







Underwater Rescue Research Company

Design Rational

Structure

We used a combination of 5mm plastic fitting to give our frame it's small unique shape.

Our team of tether engineers developed our tether and frame structure to reach the depth of 15 meters. We constructed the frame out of half-inch schedule 40 PVC pipe. We chose these materials to construct the frame because of its strength versus its cost and how easy it is to use, cut, and build. The structure is strong enough to effectively complete low depth research on shipwrecks. This allows us to offer low cost research to non-profit organizations that don't have large university dollars or government funding. Low budget research for economically challenged non-profit organizations.

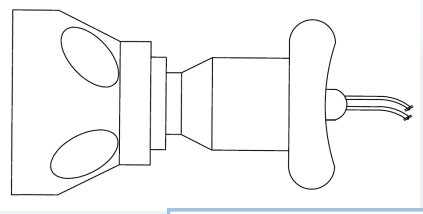
Control

The control system is not that high tech, but it gets our ROV where it needs to go. The ROV is controlled by individual toggle switches. We have two control panels and our ROV needs two pilots to control them. One pilot controls forward and back and the other pilot controls up and down along with the mechanical grabber. The controls are linked to the ROV by the tether. We have eight conductors total on our ROV's tether.

We decided to design our controls for two pilots because in the other competitions it was too hard for one pilot to do it all.

Propulsion

Horizontal Thruster with large propeller



CAD image of one of the horizontal thrusters

Vertical Thruster

We have five thrusters. Both forward and reverse thrusters are matched to have equal amount of thrust. We tested each thruster to match them. Each thruster has 5 Newton's of thrust. Each thruster, at full power, pulls 3 amps. We placed the up/down thrusters in the center of the ROV to increase our lift speed to get to the top of the water. Our forward/back thrusters are located on the outside of the ROV to give us better turning ability. When we first designed the ROV, we placed the vertical thruster on the inside of the frame, but when we tested in the water it turned really slow. This is why we moved them to the inside.

To increase our ROV speed we used a larger propeller on the horizontal thrusters. We found a propeller that was just a little smaller than the propeller guard. This change gave us an additional two newtons of thrust on the thrusters.

After the regional competition, we added a fifth thruster. We had trouble getting the ROV in position on the debris piles, so we added another horizontal thruster. This thruster lets us move the ROV left and right with just one thruster. This gives us an advantage in not having to back the ROV up to adjust our position.

Ballast

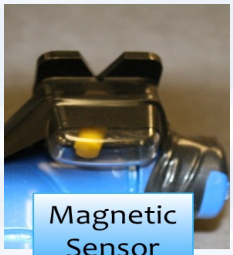
Main Ballast Tube

Trim Ballast Float

Our ROV was designed to be neutrally buoyant. We designed it this way in order to hold position to complete the sonar scans. The buoyancy is made up of PVC pipe and plastic floats to trim it. The buoyancy of our ROV makes it stable. The ROV remains on the same plane as we utilize the driving tools of our ROV, so we are able to complete the tasks we need to, just like in real life. Stability is important because if the ROV isn't stable, it won't go in a straight line and it will be going wild. When working with old shipwrecks, it is important to be in control or we will damage the wreck and cause more problems than we are trying to solve. Stability is key in ROV research.

Sensors

Ultra Thickness Gauge



Magnetic Sensor

All Sensors On Frame.

We have multiple sensors on our ROV. We have a compass, neutron back scatter device, and an ultra thickness gauge with the purpose of preventing a possible environmental threat. These sensors are unique to the design of our ROV because we built them into the frame of our ROV. Metal Detection Device is installed on our ROV so that we can test encrusted debris piles to see if they contain metal and might be part of the shipwreck.

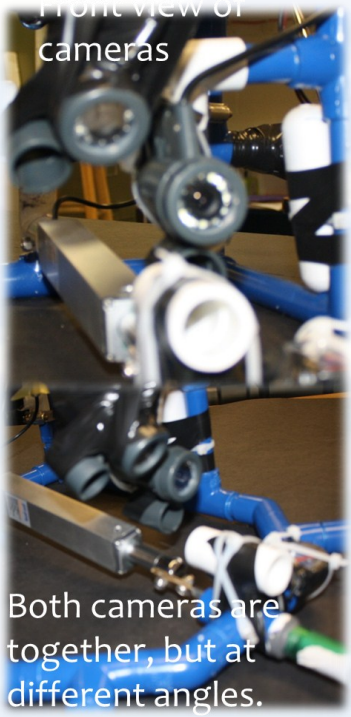
Payload Tools

Mechanical Grabber

Linear Actuator

We took a grabber stick and cut the pole off which left just the jaws. We took the linear actuator that we used last year and designed the frame around it so that it was in the center and balanced. The actuator opens and closes the jaws of the gripper. The actuator only moves about six centimeter. This is just a little more than what we need to open and close the grabber. The pilot has to make sure he doesn't over drive the actuator because the actuator is strong enough to break the ROV frame. We know because it has happened twice, but I think we got it redesigned so it doesn't happen again. We positioned the actuator to be open all the way and than attached the arm. This way it won't separate the ROV frame.

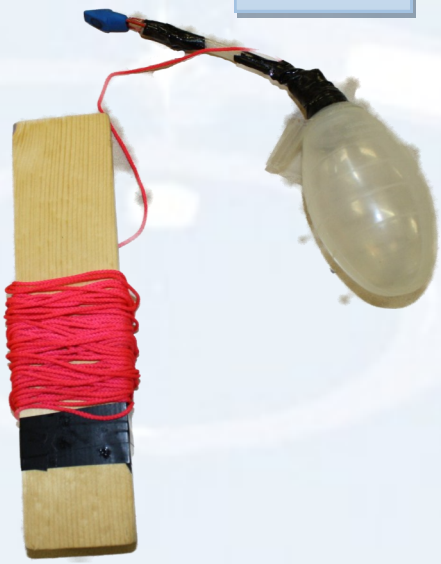
Cameras



We designed our ROV to support two cameras. Both cameras have a depth rating of 20 meters. We placed one camera in order to operate the mechanical grabber. The second camera is placed so we can use it to scan the shipwreck and have a clear view of the forward motion of the ROV. The cameras are black and white, but they work great when there is not a lot of light.

The Big Challenge

Sample Extractor



Close-up of Extractor Plow Tip

A challenge our team, The Underwater Rescue Robots, faced was when we worked to find a way to penetrate the MS Gardner's hull to take a sample of one of the fuel tanks. This took us a long time to do and many different things that we built to get the sample. The first thing we tried was a turkey baster, but it didn't go in far enough and it let in outside water. We tried two different basters, but nothing. One of our pilot's, Nathan, mother works as a nurse and we borrowed a large suction bulb with a longer tube on it. It didn't work because it was too weak to hold up under the pressure. So, we took a tube that was just a little bigger than the other tube and slid it over the existing tube to make it stronger. This worked and we got it to penetrate, but it got filled with the petroleum jelly that covers the hole on the ship. We had to have a way to push the jelly out of the way without plugging the suction tube. Elizabeth, CEO, came up the idea to put a plow type device in front of the tube to push the jelly out of the way. This let the end of the suction tube to stay unplugged. It worked in practice, but we did not get the chance to use it in the competition.

Troubleshooting (A team effort)

Last year we worked a lot on trouble shooting and it helped us a lot. Mr. Thomson would break our ROV and have us find what happened. This helped us this year because we didn't have Mr. Thomson around much because he was working with younger teams and would only come around when we were really stumped. The best way to troubleshoot is to start at the source. So, lets say the actuator is not working, this happens every so often, you start with the power. Does anything else work? If nothing else is working like a thrusters than it has to be a main power problem. Maybe the plugs are not in all the way or the fuse is blown.

This year we have a power jumper that plugs into the battery and it has a switch and a fuse (see picture to the left). Each camera and control box has its own power cord that plugs into the jumper, this lets us hook-up quickly and the plugs can only go one-way, so no one can plug something in wrong. This has saved a lot of fuses this year because last year it seemed like we needed a fuse every time we powered up.

Once you know you have good power, than it is either a loose wire (this is usually what happens to us) or the part is broken. We took care of the loose wires by soldering them together and sealing them. So, I hope we spend less time troubleshooting and more time getting the mission completed.

Morgan and Nathan soldering wire connections together.

Underwater Rescue Research Company

Lesson Learned

Our team learned lots of things, but one thing is that no matter what we all did, if everybody didn't agree on something, it wouldn't work. Like when we built the design, it was originally a rectangle/square. But now it's a hexagon, well the bottom is and the top is a square. This was something we compromised on, so that each member of the team felt they had something in the design of the frame. Last year it took us forever to get the frame done, everyone was bickering over the dumbest things. This year we understood that we had to pull it together and work as a team. Also, when we wanted jobs nobody could agree on, so eventually, we stopped, and politely figured out the jobs so everyone was happy about it. We made pretty good choices, I guess because we just got 2nd place against high school kids. I mean, we did pretty well for people who have had these problems and more, but we got through them, anyone could have, but we did it the right way. Now look at us, we just got second place with all these problems, we got through them and we still won. As a team we have learned that it takes giving up and compromising on your ideas, so that everyone feels good about the solution. This is so hard, but I think this is one thing that has made us better.

Underwater Rescue Research Company

Future Improvements

Old Actuator

New Actuator

It leaks here, so we added the O-rings and coated the whole actuator in plastic sealant.

One of the hardest challenges our company has faced is the liner actuator, (aka "the arm"). We were having problems on the pool side at our practices. It kept on getting disconnected, so it would not move at all. The first time it broke it took us about 45 minutes to fix. Then the next week we had the same problem, it got disconnected. But that only took about 10 minutes to fix. Then the very next week the same thing, it got disconnected. But, this time we caught on to it and we did it really quick. So, we put electrical tape on it so it wouldn't do that again. Then on the competition day, we tested the arm and it did not work, but we knew what was wrong . We made the wires extra tight with the tape so the wires would not move. Then we got it in the water and did our thing.

We didn't want to have wiring problems again, so we soldered and sealed all the wires. Then we worked to waterproof the actuator. Our actuator has worked well, but we need to take it apart and clean out the corrosion every once in awhile. After the regional competition, we were making the actuator safe of the international competition and the gears in the liner acuter completely broke. Now, we had to get a new arm. We are waterproofing this one with plastic seal spray and O-rings. We are hoping this arm does not have any problems, especially in Florida. This arm is our present and future improvements and the hardest problem of the bunch.

Underwater Rescue Research Company

Reflection

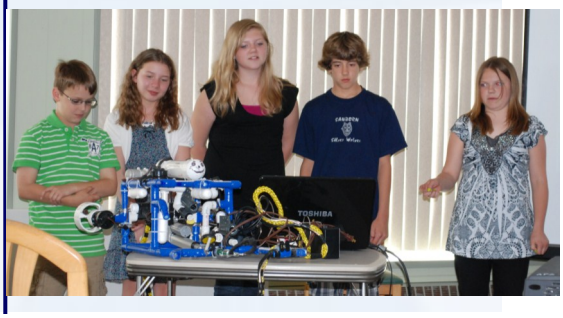
Team Work!

As a whole, our team has matured and grown together. We have made a lot of improvements since last year. This is proven due to our 6th place finish last year versus our 2nd place finish this year. We have gained experience, improved ours skills, knowledge, confidence & team work. Critical thinking is another asset gained. And that reflected on our placing this year.

Our team has improved at presenting our ROV missions to the public. We have gained confidence presenting to small and large groups of people. When we do a presentation, we are very confident with our words and answering questions. All members are ready to answer questions as needed. The team has had an excellent experience with our ROV from interviews at schools to interviews around the state. We have also done many presentations. We have been interviewed on our local television news station. In addition to being interviewed on the local news, we were interviewed on two different radio stations.

We have been a dedicated team while meeting, working on & practicing missions. Our team works well together and encourages one another. Each member is of equal value. Our team recognizes that we need each other to be the best that we can be.

Due to several design changes and adjustments, our ROV is a lot better. It is more aerodynamic so we don't waste time in the water getting down to the mission. Last year's ROV required two of us to carry it and we still had a hard time carrying it. Because of the small more compact design of our current ROV, it is easier for us to handle it. This year our linear actuator is almost three times as fast! Together, we designed and tested our own grabber to make it more useable during the mission.



Acknowledgements

Thank you very much to:

On the Radio

General Manager, Darrel Kelly,

Of Great North Radio Network

Steve Wright's Morning Show on 99.3 Today's Country

Sam Beatty (Pilot)

Appearing on WBKB Alpena Channel 11.1

*The Marine Advanced Technology Education (MATE)

*Thunder Bay National Marine Sanctuary

*Dr. David Beatty, DDS

*Our Team Mentors:

*Dave Beatty

*Katie Thomson

*All that helped us get to Florida and our local media for helping us get the word out about our team.

Underwater Rescue Research Company

Rescue Robot

Protecting
Preventing
Preserving