ROVer 2

Immanuel Lutheran School

Alpena, Michigan USA

ROV Team

Grade 6

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Grade 8

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Mentors

Mr. Bryan Dort, Mr. Arthur Hoch, and Mr. Warren Kindt

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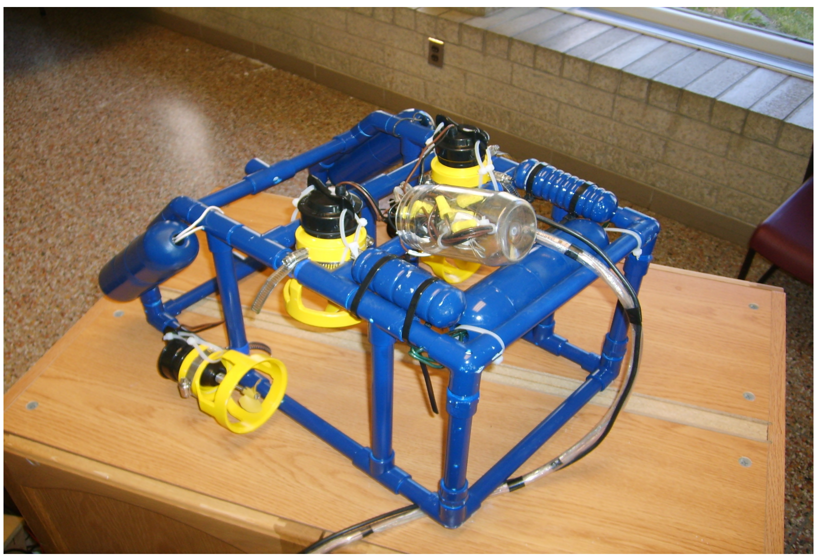
Abstract

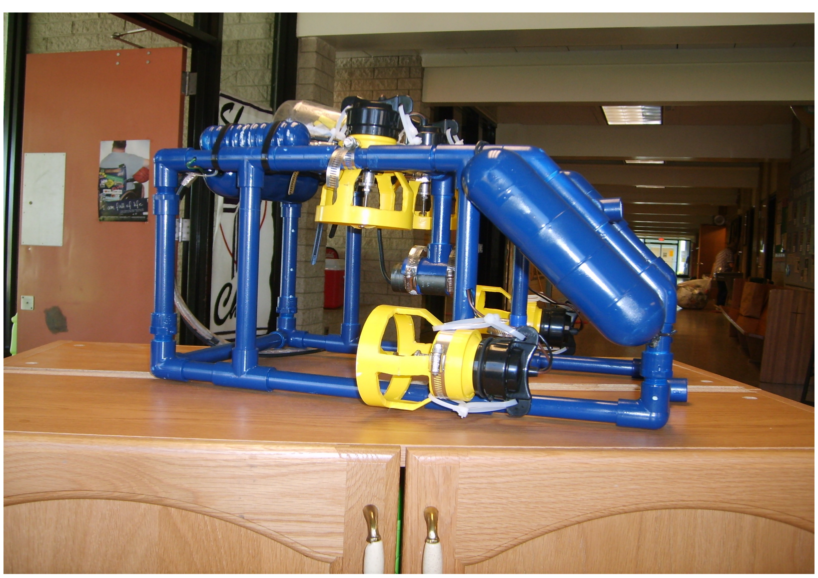
The Immanuel ROV team began meeting weekly in October 2007. We discussed ideas on the frame and construction of an underwater research robot. We began by brainstorming about improvements to make over the ROV we had last year. We decided on a frame design that we all agreed was an improvement over last year. Buoyancy testing provided locations for float placement on the ROV. We drilled holes in the ROV frame to let water quickly fill the PVC pipes. When we finally learned what the mission tasks were, we began thinking about tools that could complete each of the mission tasks. We made three simple tools which connect to the ROV frame. Our ROV, named ROVer 2, was designed to be a cost effective device for carrying out underwater mission tasks.

Completed ROV

Front/side view



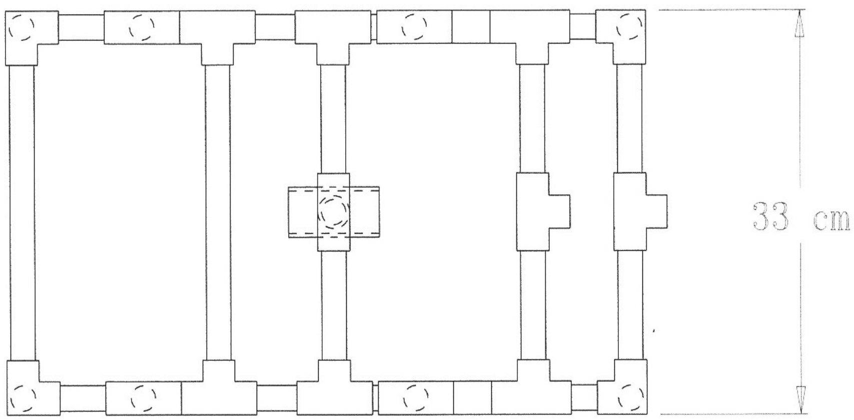
Overhead rear view



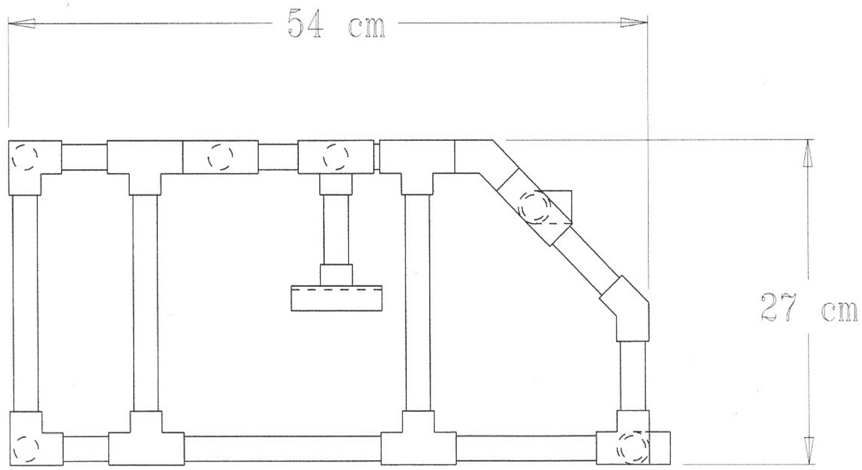
Right side view

ROVer 2
Frame

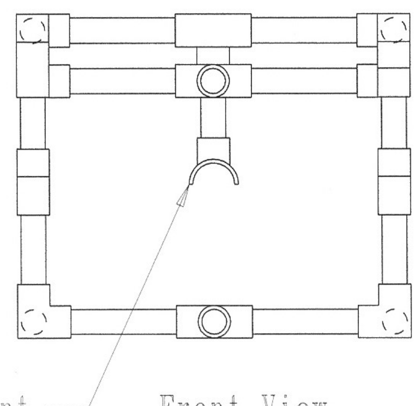
Drawn by: Shawn Kaschner



Top View

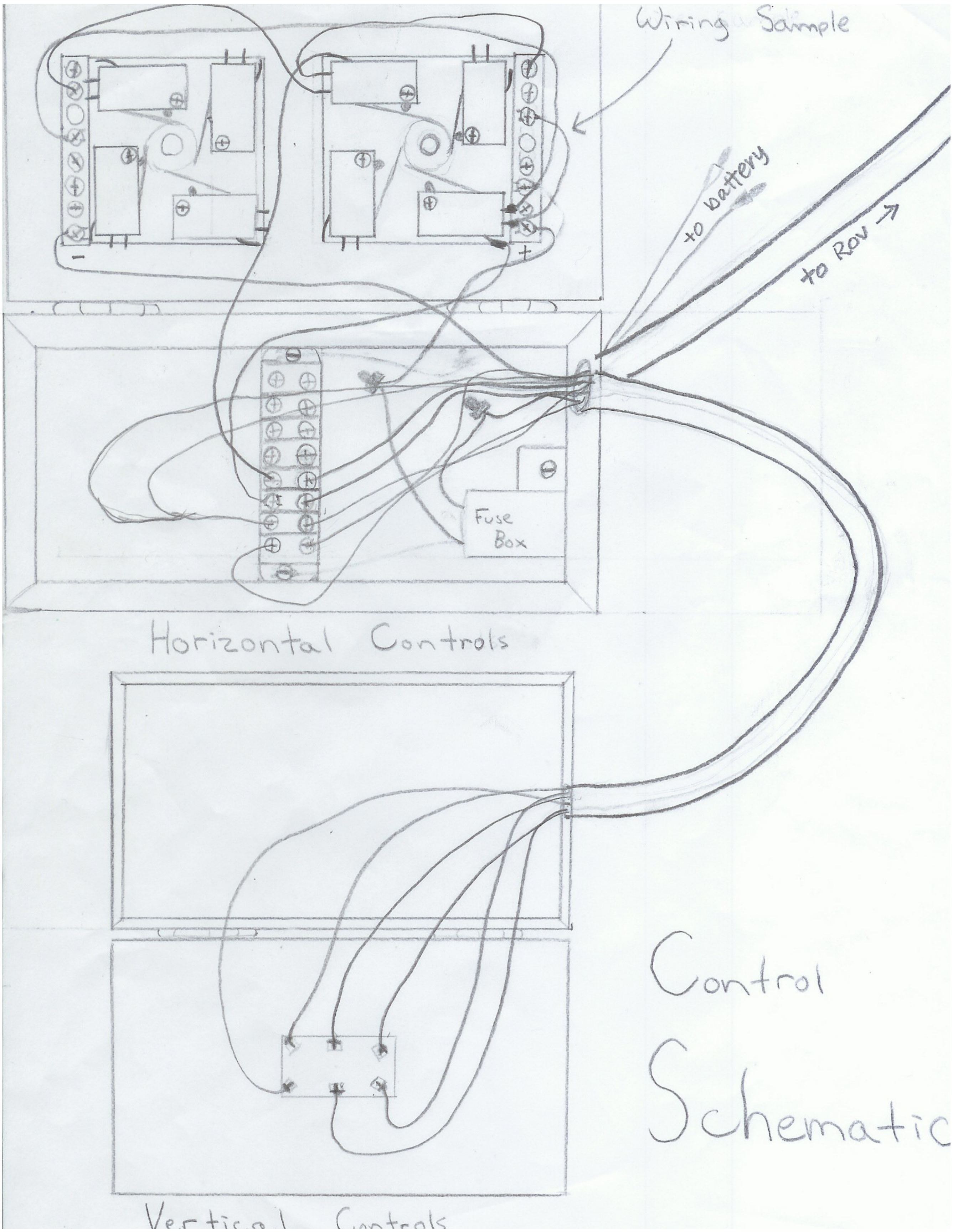


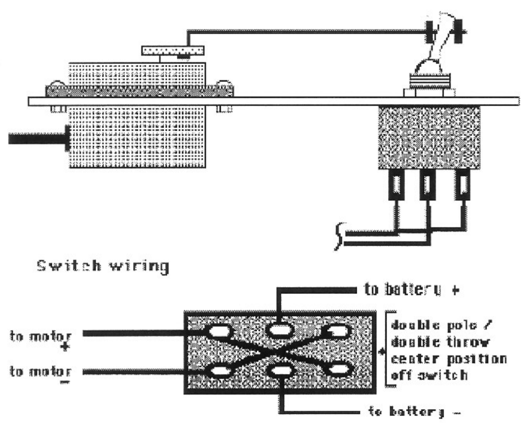
Side View



Front View

Control Schematic





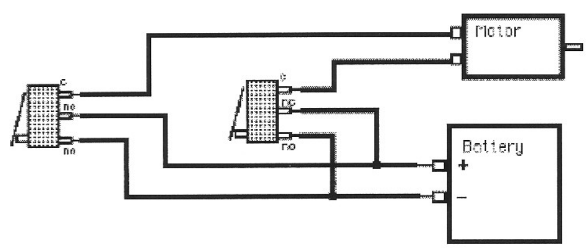


Illustration 1: Wiring helps for joysticks and switch.

2008 ROV Budget/Expense Sheet

Item	Cost	Source
PVC materials	$21.34	Budget and donations
30.48 meters of speaker wire	$21.98	Donations from Mr. Hoch and Mr. Kindt
Wire pulling lubricant	$5.97	Donations from Mr. Kindt
15.24 meters of plastic tubing	$21.50	Budget
Digital thermometers (4)	$67.85	Donations by Mr. Dort and Mr. Kindt
3 cans of spray paint	$15.00	Home Depot gift card - Regional Prize
2 commercial joysticks	$10.00	Team inventory from 2007
4 V625 motors	$50.04	Team inventory from 2007
1 color video camera	$265.00	Team inventory from 2007
4 propellers	$5.96	Team inventory from 2007
4 propeller adapters	$12.00	Team inventory from 2007
10 hose clamps	$28.00	Team inventory from 2007
	$153.64	Total building expenses 2008

Funding Sources	Money Raised
Stock sales	$2535.00
Bottle drive	$357.00
Car wash	$562 with matching grant
Community support	$5025.00
Church Support (not stock)	$1800.00
MATE Travel Assistance	$500.00
Plaza Pool (in-kind pool practice time)	$120.00
Family Enterprise (in-kind set-up & art charge waived)	$250.00
United Way	$250.00
Matching Thrivent Grants	$500.00
Total	$11,899.00
Estimated Base Expenses	$10,000

Design Rationale

The Frame

Our ROV is made of polyvinyl chloride (PVC) pipe that was formed into a pentagonal prism. We chose to use PVC piping because it is lightweight, and easy to work with. It is also inexpensive and readily available. We used plastic and aluminum floats to try to make our ROV as neutrally buoyant as possible. The framework is sort of a van shape. This van shape opened up the overhead view at the front of the ROV. Larger PVC pipes were cut to create propeller guards allowing us to place motors on the outside of the ROV frame. We found that placing the motors farther apart gave a quicker turning response to the controls.

The Electrical System

To power our ROV, we used an electrical system that controlled our four different motors and the camera. We used three joysticks to control the motors: one for vertical motion, and two for horizontal moving. Our ROV can move the basic six directions: up, down, left, right, forward, and reverse. This system is powered by a 12-volt portable, rechargeable battery that is attached to our ROV by an electrical, waterproof tether.

The Tether

The tether was designed by pulling wires through plastic tubing. The plastic tubing was 1.27cm in diameter. Later, we had trouble with water flowing up through the tubing, so, we used caulk to block the ends for buoyancy, and for protection from water coming up the tether. We wanted to avoid using foam floats, because if they get too deep in the water, the pressure can crush them, and they would not be any use.

The Camera

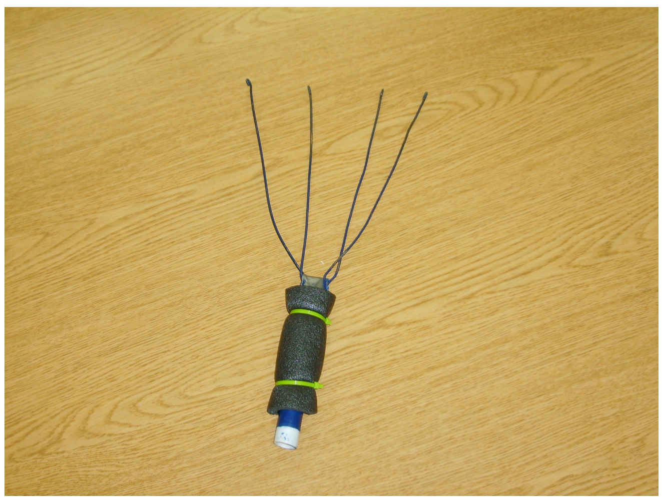
A single underwater camera is used to view the ROV's position and movement, as well as to use the mission tools.

Mission Tools

<u>Vent Crabs</u>

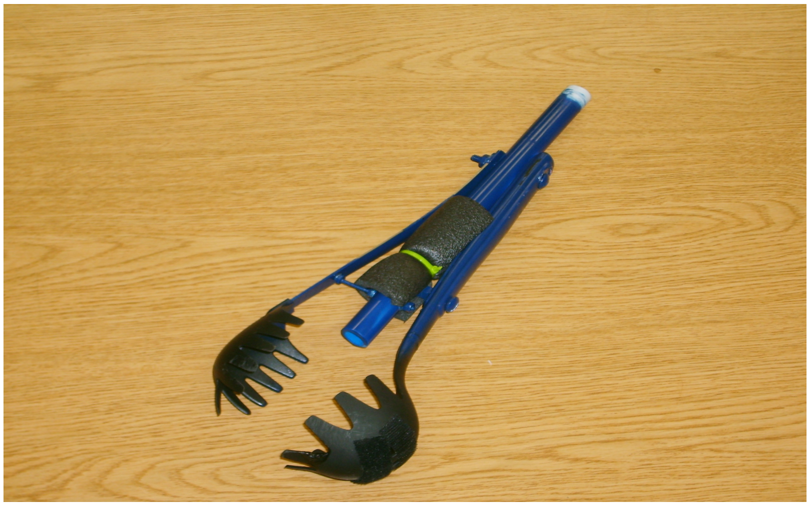
The first mission objective was to immerse our ROV (Remotely Operated Vehicle) and retrieve three vent crabs from the ocean floor and bring them to the surface where our team members could remove them from the water.

The tool we used was made from two pieces of coat hanger wire and a small piece of PVC piping. We made a large fork from a short piece of PVC pipe and two pieces of hanger wire. We attached the wire through a hole which was drilled in the pipe The ends of each wire fork were bent up to secure the crab that is resting on them.



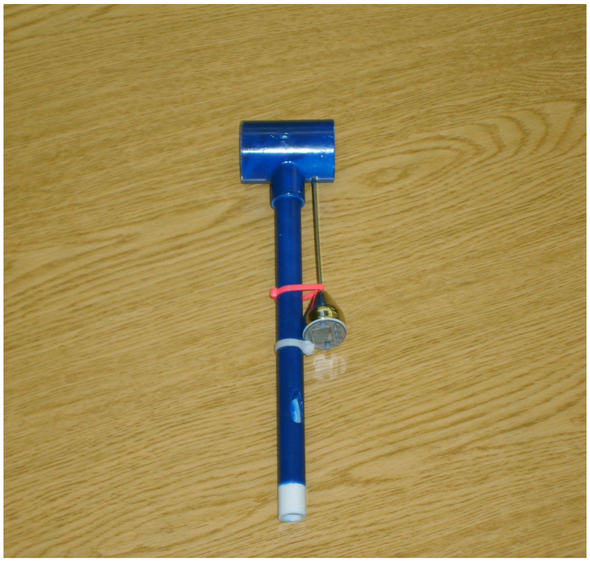
Black Smoker Tool

The second challenge was to collect black smoker samples from a hydro-thermal vent. In this simulation, the black smoker samples are actually rocks, and the hydro-thermal vent is a collection of PVC pipes. We created a tool to collect the samples using two spaghetti scoops mounted to a section of 1.5 cm pipe. Each scoop is bolted in two separate places of the PVC pipe to keep them from pivoting sideways. When we first tested the tool, we were unable to pick the black smoker samples off of the vent, so we heated and bent some of the fingers out so they could fit between samples (rocks) on the vent. After we bent the fingers, we had a lot more success. When the black smoker samples would fall, it seemed as if they always fell Velcro up. After we noticed this, we decided to place Velcro on the bottom of the scoop. We put foam pipe insulation around the pipe to offset the weight of the tool.



Temperature Tool

The third task that we had to complete was taking the temperature of a hydro-thermal vent. The water would be flowing out of the PVC pipe (the hydro-thermal vent) and we would have to take the temperature of it and say it to the judges. For this task, we used a PVC pipe that was attached to our ROV on the front. We would fit this PVC pipe, which was slightly larger than the hydro-thermal vent, over the hydro-thermal vent top and the water would flow over the sensor and the read-out of the thermometer would be placed right in front of the camera, so we could tell what the read-out was, and also see where we were going. Then, after we were sure of the temperature, we would tell the judges at our control shack.



A Difficult Challenge To Overcome

Our tether has been one of the most difficult challenges we have had to overcome. Our tether from last year's ROV was made from a 12.2 meters of braided nylon rope, and was very thick and bulky. The noodles which we added to the tether for buoyancy made it hard to handle and often caused tangles. Also, the tether held a lot of water which caused the ROV to nose upward when moving forward. When the nose started to rise, it would make the tasks harder to accomplish.

During the construction period of ROVer 2, our new ROV, the team was considering how to make a new tether and what material to build it with. We decided to use clear plastic tubing with 18 gauge speaker wire running through the tube.

The first time we tried to push the wire through the tube, but too much friction was caused by the wire isolation rubbing on the plastic from the tube. We were only able to push the wire ½ meter into the tube.

On the second try, we used a vacuum and a piece of string. First we used the hose from the vacuum to bring the string through the plastic tubing. Once the string was fed through the tube, we connected all of our speaker wire to one end of the string. When all was secure, team members pulled on the string, which snapped.

On our third try, we did everything that was done in the second attempt except using a thicker and stronger string. On this attempt the thicker string snapped as well.

On the final attempt, we purchased a silicone wire pulling lubricant. This allowed the wires to slide through the tube with incredible ease.

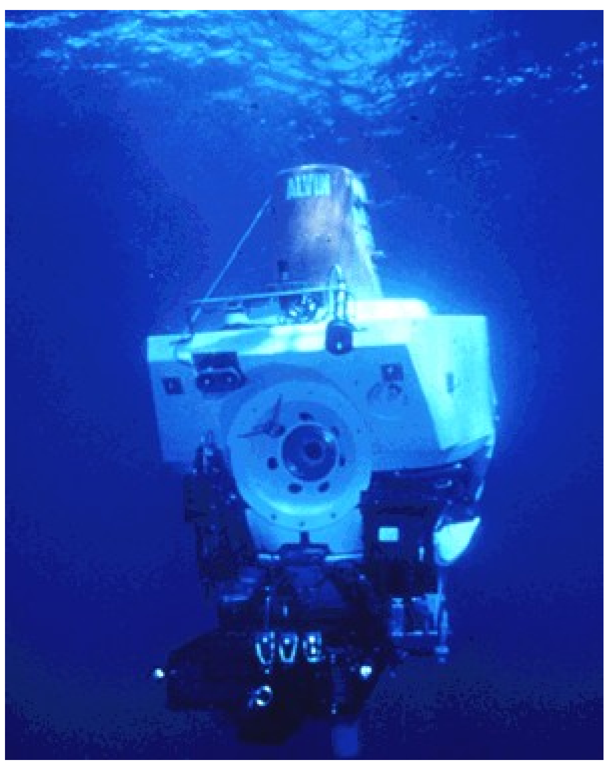
Another tether problem occurred when we were practicing one of our mission tasks. We noticed that water started creeping up the tether and into the main control box. As a temporary repair, air was pumped through the tether to keep water out of our controls. Later, when practice was finished silicon caulk was forced in each end of the tether. In sealing off the tether, air was trapped inside the tether which helped us with our buoyancy issue. As the final touch, we placed a foam noodle 1½ meters down the tether from the ROV to stop the ROV from nosing upward as it had the year before.

Future Improvements

If the Immanuel Lutheran ROV Team could make any improvements on their ROV, they would probably make improvements of the different tools that they had to use to complete the different tasks, and they would also try to make their ROV more balanced. They could make our tools more effective and easier to work with. If they had more time, they could also try to make other tools to complete the tasks operated either by electronics, hydraulics, or motors They saw different techniques at the regional ROV competition and thought that it would be a good way to complete the tasks. The only problem would be that if something happened with the operation that they were using, it would cause many problems. To improve the tools that they already have, they would try to put caulk in the ends of the PVC piping, so that it added buoyancy and so water could not seep inside. The ROV team would also try to work on buoyancy and practice while moving the floats to different locations. They would also work on their poster more, and take more pictures throughout the building process.

Description of a Scientist and/or Research Project that uses ROVs to Study Mid-Ocean Ridges

Alvin, the world's first deep-sea submersible, helped scientists discover the hot-spring's ecosystems. At first, Alvin was used for the U.S. Navy in the 1960s, it is close to eight meters long and is a self-propelling capsule that is able to carry three people. In an attempt to make the first direct observation of sea floor spreading, scientists of project FAMOUS (French-American Mid-Ocean Undersea Study) used Alvin to dive on a segment of the Mid-Atlantic Ridge. On this expedition no hot-springs were observed. In 1977, Alvin went on an expedition to the Galapagos Rift, this is where the hot-springs and strange creatures were found. Other submersibles have been built and have been successful since the making of Alvin. Alvin's maximum depth is about 4,000 meters. The Japanese research submarine, Shinkai 6500 was built in 1989, and it can work at depths of 6,400 meters. Japan and the United States are working together to develop research submersible systems that would be able to reach the deepest spots of the ocean.



Reflections

I knew that teamwork was important before joining the MATE ROV program, but after working with the team, I realized how important it actually was. No one can do one thing, you need someone there to help you. Everybody on the team contributed in someway to create the ROV. Each of us had a special talent, one was good at working with PVC pipe, and another was good at coming up with ideas. Some people I thought that would not contribute with the team, were the people that made a lot of good improvements for us. We probably wouldn't of done so well in the competition, if we didn't have all of the great members on our team.

Brooke Godsey

This year I got to drive the ROV. It was a totally new experience for me since I did not drive last year. I'm pretty good at video games, so I thought I would be a good driver. The controls were a lot different than I expected, but after I practiced, I got better at them. I now do well at the underwater missions.

Justin Metzke

During my brief time on the Immanuel ROV team I have learned a lot. The thing that I learned the most about was the Cad Key 99 designing software. The motivation that I had to start this program was that someone on our team was required to make a scale drawing of our ROV. With the Cad program I drew out a scale drawing of our ROV. Now that I know about Cad Key I am taking a class called Introduction to Drafting and Cad in the high school I will be going to next fall.

Shawn Kaschner

This year is my second year on the Immanuel Lutheran ROV Team, and I have, and still am, learning valuable, life-long lessons. This year I learned a lot about electrical engineering and how to solve electrical problems. I rewired our same control box from last year, and, when we painted our ROV, made sure all the wires were kept safe. I also reconnected them when we were done painting. This year has been an awesome year and I hope that my team and I do our best at the MATE International ROV Competition in San Diego, California, and that we do it to the glory of God. I hope to be on the Immanuel Lutheran ROV Team next year, and to learn and do even more things.

Amanda Dort

I learned a lot about the MATE ROV program, and how to use the tools. One of the tools I used was a Dremel tool. I had to use it to cut propeller guards, and to smooth out the edges that I cut. It was a little hard at first, but once I started to use it and cut more, it was easier. Once I finished cutting the propeller guards, we placed them on the ROV. While I was using the Dremel tool, I learned how important it is to wear safety goggles. Little bits of PVC pipe were flying out in all directions and hitting my eyes and face. They were like little grains of sand, being flown around. I'm really glad that MATE has safety rules about using equipment.

Courtney VanWagoner

References

Underwater Research

“Exploring the deep ocean floor: Hot springs and strange creatures.” <http://pubs.usgs.gov/gip/dynamic/exploring.html> (accessed 23 May 2008).

Construction Help

<http://www.rctankcombat.com/articles/speed-control/Toggle.gif> (accessed 4 June 2008)

<http://technologydude.com/index.html (accessed 3 May 2008).

Bohm, Harry, and Jensen, Vickie. *Build Your Own Underwater Robot and Other Wet Projects.* Vancouver: Westcoast Words, 1997.

Acknowledgments

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