Carrollton Junior High School

ROV: EWOK

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Location: Carrollton Junior High School, 510 Ben Scott Blvd., Carrollton, GA 30117

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Top row: Lucy, Abbey, Mallory, Ethan, Elizabeth C
Bottom row: Amy, Katy, William, Elizabeth G., Shiv

Abstract

As we, the Carrollton Junior High School ROV team, prepared for the Marine Advanced Technology Education (MATE) Remote Operated Vehicle (ROV) competition, we arrived ready for the hard work we knew we would face. Our goal was to build an ROV that could complete all mission tasks and qualify for the international competition. The 2010 competition focuses on the Loihi seamount, and tasks revolve around undersea volcanoes including: taking various readings, acquiring sea life, moving and depositing sensors, and plotting data. Many different components were needed to accomplish the various tasks and we drew inspiration from our successes and failures from the previous two years of competition.

A vacuum system was constructed to collect crustaceans and agar; which was inspired by a similar vacuum we used two years prior. We constructed a pneumatic claw to perform the majority of the remaining tasks. Our team faced many struggles during construction, but learned and improved from each challenge.

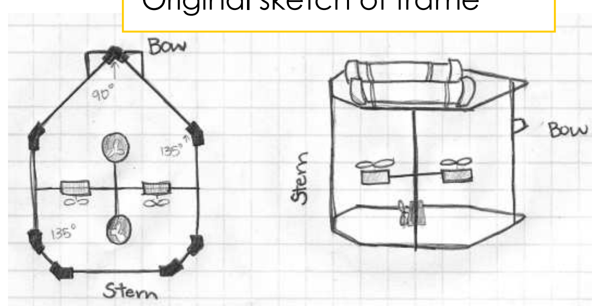
Our technical report outlines the progression of construction of EWOK, detailed explanation and pictures of design components, electrical schematics, problems and solutions, lessons learned, a detail budget, and our reflections.

Design Rationale: Body

Frame:

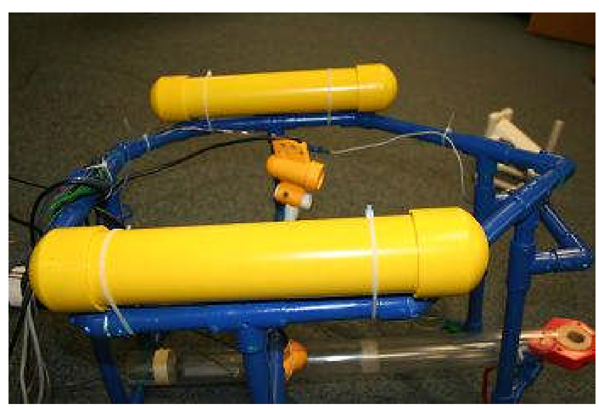
For the frame of EWOK, we initially decided to use the same frame as last year because of the success we experienced with it. However, once we started looking at the specific tasks we had to perform, we decided to reduce the size of the frame almost in half. This would allow us to maneuver around the cave more easily. The frame of EWOK is constructed of ½ inch PVC pipe and held together by non-corrosive screws. We created a 90 degree angle at the front in order to make EWOK more hydrodynamic.

Original sketch of frame



Ballast System:

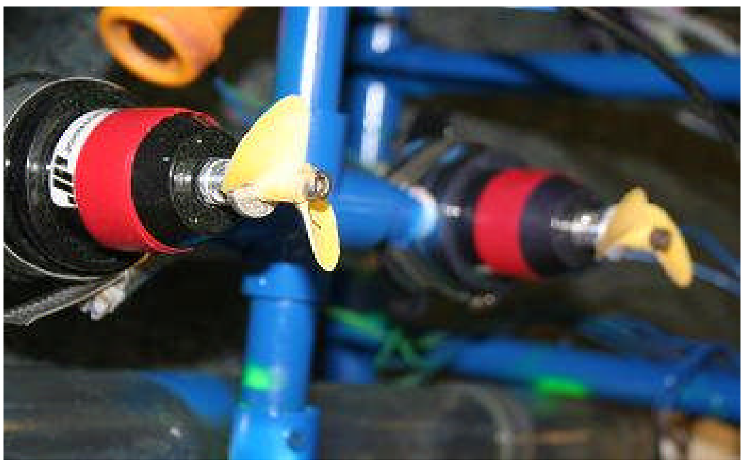
On top of EWOK is a passive ballast system constructed of 2" PVC pipe with caps on both ends. The end caps are glued onto the pipes to keep the pipes airtight. The ballast system allows us to rise to the surface quickly when we need to return materials. This system works extremely well to obtain neutral buoyancy.



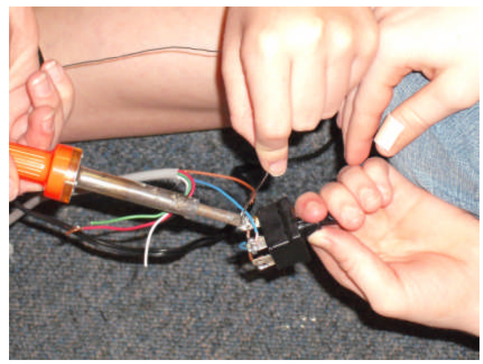
Yellow ballast tanks on top of EWOK

Propulsion:

EWOK has four 500 GPH (gallons per hour) bilge pumps that we use for propulsion. Two bilge pumps are used for upward and downward movement and the other two are used for forward and backward movement. We utilized these pumps because they were a readily available waterproof propulsion system.

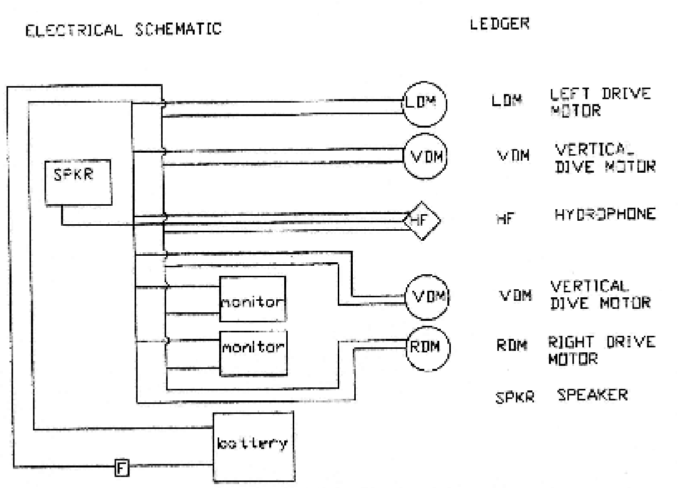


Motors with propellers for forward and backward movement



Abbey and Ethan soldering the switch for the motor

Electrical schematic



Design Rationale: Components

Vacuum:

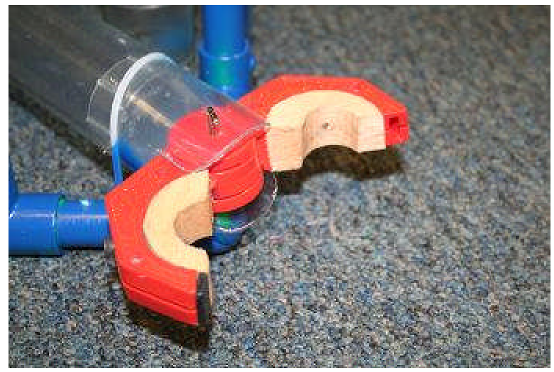
In order to collect the crustacean samples and agar, we constructed a vacuum from 2" plastic tubing with two Y-joints. Balsa wood caps were used on two ends because they are lightweight and would not interfere with the balance of the ROV. A bilge pump was used to create the suction, and a mesh net was installed to keep the crustaceans and agar from entering the bilge pump. A removable container was installed at the rear Y-joint to catch the crustaceans and agar and enable us to easily access them.

Front of vacuum where crustaceans and agar are suctioned up

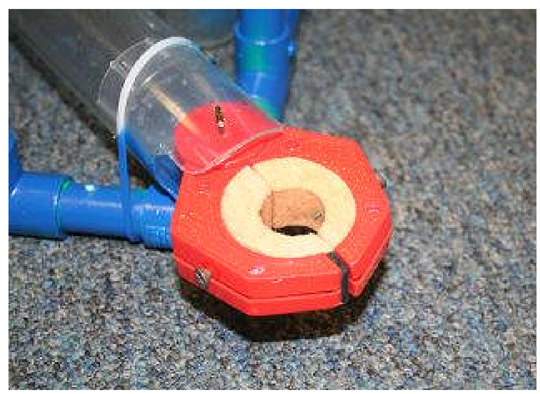
Back of the vacuum where crustaceans and agar are collected in a removable canister.

Claw:

The claw was adapted using a toy "grabber". We disassembled the grabber and retained the pinchers. We inserted the pinchers into the end of clear 2" plastic tubing. We inserted a study metal down the length of the tubing to help open and close the pinchers. The rod is attached to a pin in the pinchers and the other end of the rod is attached into a syringe that functions as a pneumatic system to move the claw. We debated using an electronic claw, but decided to keep it simple and use a low tech pneumatic system constructed out of two syringes, plastic tubing and filled with water. We figured that we would be less likely to have a major malfunction and could quickly make any repairs to the syringe system if needed. The syringe system also allows us to drain the water for easier transport.



Claw in the open position



Claw in the closed position

Thermometer:

We adapted a digital meat/cooking thermometer with a metal probe to take the temperature of the venting fluid at three different heights on the chimney. The thermometer is attached to the frame using a piece of PVC with balsa wood inside of it to keep it fitted in place. We used balsa wood so that the thermometer would not attempt to pick up the temperature of what was holding it. The PVC is attached so that it will allow the probe to rotate from a 45 degree angle, needed to take the temperature of the 40 cm and 80 cm vent sites, to a 90 degree angle, which is needed to take the temperature of the 100 cm vent height. The thermometer ranges from 0 to 200 degrees Celsius. The temperatures will be displayed on a handheld unit in degrees Celsius at the control shack. The co-pilot will take the temperature readings and graph the data.

Metal probe that rotates from 45 to 90 degrees

Digital display in degrees Celsius

Hydrophone:

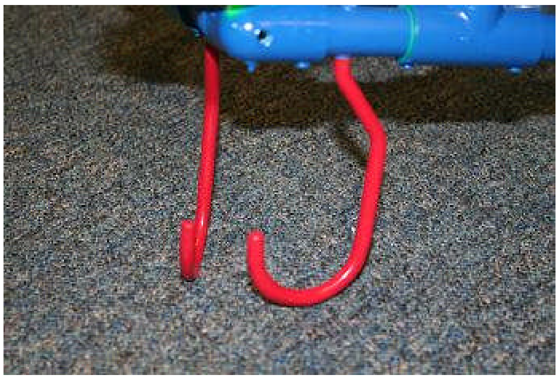
Our hydrophone is a piezoelectric hydrophone, which we use to identify the correct "rumbling" site. We wired our hydrophone with insulated wires that are attached to a small amplifier located at the control shack. The frequency range of our hydrophone is approximately 80-20,000 Hz. The operating temperature is anywhere from -20 to 30 degrees Celsius.

Hydrophone

small amp that boosts the hydrophone signal

Hooks:

Attached to the front underside of EWOK are two J-hooks coated in red plastic that we added to move the HRH to the correct "rumbling site". The hooks are spaced just far enough apart to allow us to easily pick up the HRH deposit it into the correct resting place.



Hooks for moving HRH

Design Rationale: Controls

Cameras:

Attached to EWOK are two LED cameras that allow us to pilot remotely from the control shack. The cameras are positioned to give us a clear view of all our components as well as the props so that we may complete the mission tasks.

LED Camera

Tether:

Our tether is approximately 75 feet in length, which allows us ample length to complete all mission tasks. We bundled all cables and wires together and zipped tied them together. We placed small strips of pool noodles along the tether to make it buoyant and keep it out of the way of EWOK while in the water.

Tether

Control Box:

Our control box is a small black box with five toggle switches. Two switches control forward/backward movement, two switches control upward/downward movement, and one switch controls the vacuum.

Control box with toggle switches

Challenges and Troubleshooting

Frame: Initially we wanted to use the same PVC frame from last year's ROV and change the components to complete the new tasks. However, the cave mission required us to reduce our frame almost in half.

Claw: We added the pneumatic claw after regional competition because the hooks we used initially did not allow us to secure the communications connecter in order to insert it in HUGO. Also the "sling" we used to grab a spire was ineffective, and the claw now enables us to secure a spire and return it to the surface.

Hydrophone: Our first hydrophone was constructed using a Piezo buzzer inserted into a film canister filled with mineral oil and connected to an amp poolside. We were never able to achieve the desired volume with our constructed hydrophone so we purchased a piezoelectric hydrophone that we were able to lengthen the cable and insert into our amp.

Ballast tanks: To begin with our ballast system was comprised of 3 inch PVC pipes. The 3 inch pipes caused EWOK to have positive buoyancy. We changed the ballast tanks to 2 inch PVC pipes and shortened them to 35 centimeters each. This allowed EWOK to obtain neutral buoyancy and give us better diving and surfacing control.

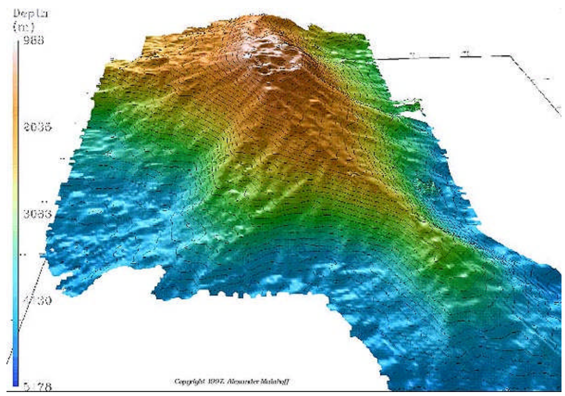
Future Improvements

Throughout the duration of this project, we came across many difficulties and challenges, ranging from engineering problems to unexpected scheduling and organizational challenges. Although the journey has been a long and arduous one, the team, on the whole, has executed the job with exceptional determination in the midst of demanding tasks.

Completing the ROV took time and persistence. We met twice a week sometimes until six o'clock in the evening and sometimes on Saturdays. The task of building the ROV took a very devoted group of middle school students along with a helping hand from our mentor, William Hicks. Based on the challenges we faced, future improvements need to be made for next year.

Changes in communication need to be made to have increased productivity during the building process. Each member of the ROV team needs to be more alert and aware of the task at hand, instead of drifting off topic and focusing on other things. The team should be separated into a construction team and an essay team. The teams need to meet in different spaces on meeting days; therefore decreasing the numbers of students present, minimizing the lack of unnecessary discussion, and improving productivity.

Loihi Seamount



Loihi Seamount

The Loihi seamount is considered the youngest volcano in the Hawaiian chain. Rising more than 3,000 meters above the Pacific Ocean floor, Loihi is located on the flank of Mauna Loa volcano, a bigger, older and still active volcano on the Big Island of Hawaii. Although submerged in the Pacific Ocean, Loihi is still taller than Mt. St. Helens was before its devastating volcanism in 1980. Prior to the 1970's, Loihi was not thought to be an active volcano. Instead, it was believed to be a quite common seamount volcano of the kind that surrounds the Hawaiian Islands.

In 1970, people's ideas about the seamount changed radically after an expedition that went to Loihi to study an earthquake swarm (intense, repeated, seismic activity) that had just happened there. It was discovered that instead of being an ancient seamount, Loihi was actually an active volcano. The volcano is mantled with old and new lava flows. Also, it is actively venting hydrothermal fluid at its south rift zone and summit. Explorations continued at a steady pace until a startling event in 1996.

The 1996 Eruption

Beginning on July 17, 1996, Loihi came to life with a vengeance. Creating the largest swarm of earth quakes ever recorded on any Hawaiian volcano, Loihi sustained this activity for two months. By the end of August, more than 4,000 earthquakes had been recorded by the Hawaii Volcano Observatory (HVO) network, and over 40 earthquakes with a magnitude between 4 and 5 were documented by the World Wide seismic network.

Explorations

Following the 1996 eruption, exploration of the Loihi seamount increased rapidly. In August of 1996, a National Science Foundation-funded expedition to the Loihi seamount by University of Hawaii scientists began to investigate the unique 1996 eruption and discover its cause. Additionally, there was an expedition in August of 1996 called the Rapid Response Cruise led by Fred Duennebier. Later that same year, there were many more expeditions, usually in manned-submersibles. Furthermore, in October of 1997, Fred Duennebier along with a team of scientists deployed the Hawaii Undersea Geo-Observatory. This became one of the leading technologies used to learn about Loihi.

<u>HUGO</u>

In 1997 during the month of October, new technology was brought to Loihi by Fred Duennebier and his team of expert scientists. The Hawaii Undersea Geo-Observatory’s (HUGO) main purpose was to make it easier to learn about the Loihi seamount. In the second week of October, a hydrophone was deployed at the newly-installed HUGO. Unfortunately, the system stopped communicating a few days afterward.

On January 19, 1998, HUGO was visited by the Pisces V submersible for the first time since its deployment. A new hydrophone (underwater microphone) was installed, but no sounds from Loihi were heard. In February, however, the scientists monitoring Loihi found that it appeared to be erupting again. This was based on signals sent from the hydrophone.

In November of 2002, the Hawaii Undersea Geo-Observatory (HUGO) was removed from the Loihi summit after being there for 5 years. The scientist who developed HUGO, Fred Duennebier, wishes to put it back on Loihi in a few years with improved technology. Also, the power/communications cable would be protected with steel armor.

Today

Today the Loihi seamount still attracts many curious scientists. Additionally, Loihi is still a very active volcano. The Loihi seamount is undeniably one of Hawaii's most interesting features and will continue to arouse curiosity for years to come.

Works Cited

Rubin, Ken. "Loihi Volcano." *Hawaii Center for Volcanology*. Hawaii Center for Volcanology, 19 Jan 2006. Web. 29 Mar 2010. <http://www.soest.hawaii.edu/GG/HCV/loihi.html>.

"Loihi Seamount." *Hawaii Volcano Observatory*. Hawaii Volcano Observatory, 26 Mar 2000. Web. 29 Mar 2010. <http://hvo.wr.usgs.gov/volcanoes/loihi/>.

Budget

Expenditures

Item	Price Per Item	Quantity	Total	Balance
Pack of 1/2" PVC T's	$2.20	3	$6.60	$6.60
PVC Pipe	$2.20	10	$22.20	$28.80
Pack of Elbows	$2.20	3	$6.60	$35.40
PVC Cross	$1.07	1	$1.07	$36.47
3 Inch PVC Caps	$3.77	2	$7.54	$44.01
Bilge Pumps (500 Gallons/Hour)	$18.99	5	$94.95	$138.96
Battery	$80.00	1	$80.00	$218.96
Cameras	$115.00	2	$230.00	$448.96
Wires	$179.00	1	$179.00	$627.96
Propellers	$3.50	4	$14.00	$641.96
Soldering Iron	$21.00	1	$21.00	$662.96
Hydrophone supplies	$45.00	1	$45.00	$707.96
Piezo hydrophone	$57.00	1	$57.00	$764.96
Hotel rooms-regional	$100.00	4	$400.00	$1164.96
Travel to regional/gas	$50.00	1	$50.00	$1214.96
Travel to Hawaii-air	$1150.00	6	$6,900.00	$8,114.96
Lodging-Hilo dorms	$285.00	5 nights	$1425.00	$9,539.96
Food-Hawaii	$88.00	6	$528.00	$10,067.96
Transportation to and from airport	$200.00	1	$200.00	$10,267.96
Baggage	$100.00	6	$600.00	$10,867.96
Shipping EWOK	$400.00	1	$400.00	$11,267.96
Poster supplies	$75.00	1	$75.00	$11,337.96
Airport car storage	$20	6 nights	$120.00	**$11,457.96**

Income

Donation/Contribution	Amount	Total
Club dues ($35/ 10 members)	$350.00	$350.00
Phyllis and Mack Skinner	$250.00	$600.00
SLM recycling	$200.00	$800.00
Carole and Doug Mabry	$50.00	$850.00
United Community Bank	$100.00	$950.00
Rotary Club	$100.00	$1050.00
Howard and Jana Seeman	$50.00	$1100.00
Carrollton Evening Sertoma	$100.00	**$1200.00**

Totals:

Expenditure	-$11,457.96
Income	$1200.00
Grand Total	-$10,257.96

Reflections

As we reminisce on all of the experiences gained and friendships strengthened throughout the extent of this project, we have come to realize all of the growth we achieved. We grew not only as individuals but as a team as well. Our knowledge of ROV uses was broadened by learning about ROV applications at the Loihi seamount.

Because the team as a whole rose to the challenge of constructing EWOK, each individual member of the team had the opportunity to gain knowledge and to learn about many different engineering skills such as wiring, sound amplification, hydraulics, and architectural design using computer aided drafting.

Obviously, the engineering part of the experience was only a fraction of what we personally took away from the project. When we first started the project we had difficulties working together and communicating effectively, but we eventually were able to pull it together, and we became a more united and ambitious team. We learned how to function as a team, and depend on one another.

Acknowledgements

We would sincerely like to thank the following parties:

- Mr. William Hicks
- Our families
- Phyllis and Mack Skinner
- United Community Bank
- Rotary Club of Carrollton
- SLM recycling
- Carol and Doug Mabry
- Howard and Jana Seeman
- Carrollton Evening Sertoma Club
- MATE
- Grey's Reef's