Doombot 2.6

Thomas Jefferson High School for Science and Technology

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Lab Directors: Ms. Lisa Wu and Mr. Jeffrey Leaf

Mentor: Mr. Justin Manley, Mitretek Systems

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Abstract

This project is the result of a collaborative effort to design and build a remotely operated vehicle (ROV) for entry into the MATE and MTS ROV Competition. The ROV is engineered to complete the following seven tasks: recover a towfish; read an inscription on a bell; patch a leaking barrel; identify and collect a certain species of fish; tag a tubeworm and mussel bed; and collect carbonate samples. These tasks are accomplished by using a manipulator and a standard aquarium net. PVC is used for a framework to easily attach systems. Ballasting is accomplished by connecting inner tubes to the ROV and supplying air to them through an air tether and a bicycle pump. Electrical components are powered and controlled by a handyboard that allows greater ease and maneuverability. The ROV is propelled by three thrusters, which are separately controlled for maneuverability. Rewards of this product are twofold. Concepts of engineering were learned, including CAD design, as well as academic concepts of electronics, physics, and prototyping. Exploring an environment similar to those of marine sanctuaries and working side by side with a mentor provided a window into the technical field of marine research. Learning teamwork, time management, and the value of testing were further benefits to the project.

Photographs

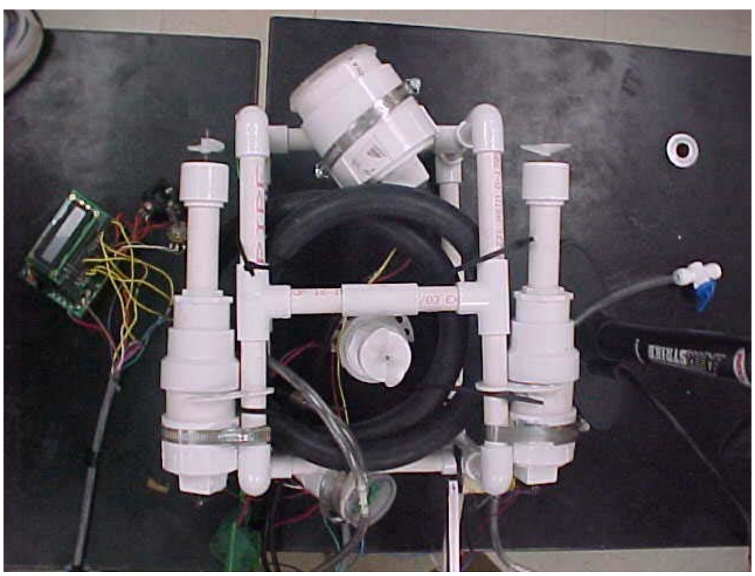


Fig 1 – Top View of ROV

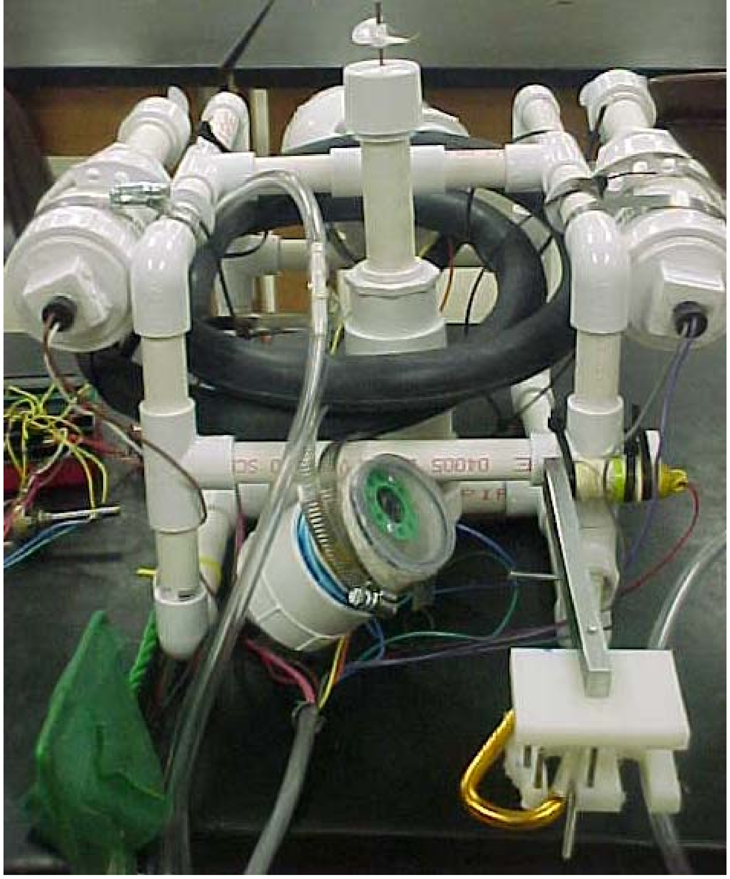


Fig 2 – Front view of ROV

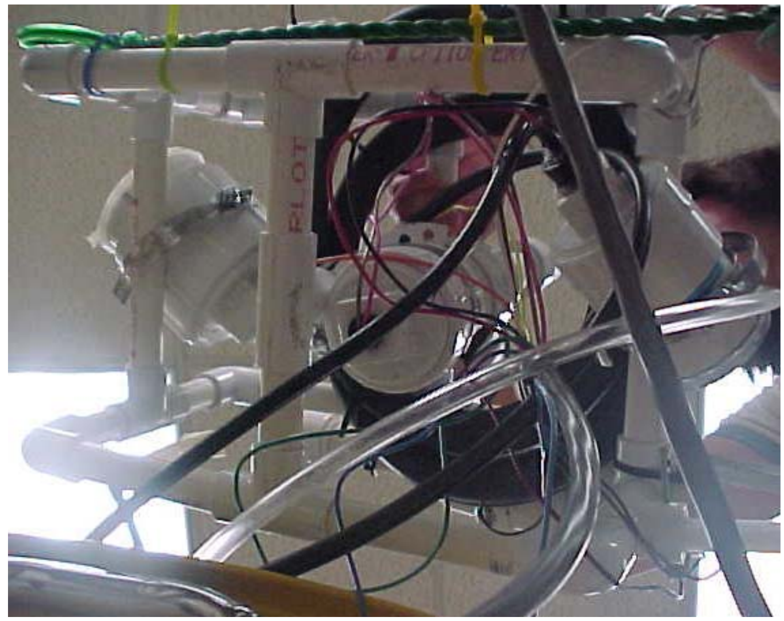


Fig 3- Bottom view of ROV

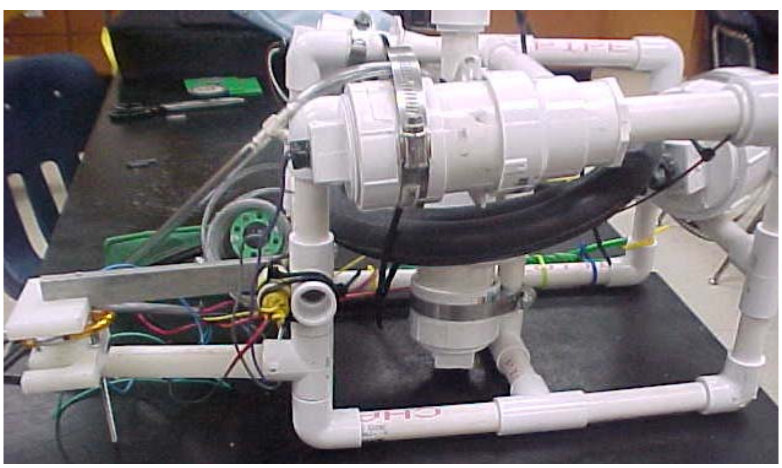


Fig 4 – Side view of ROV

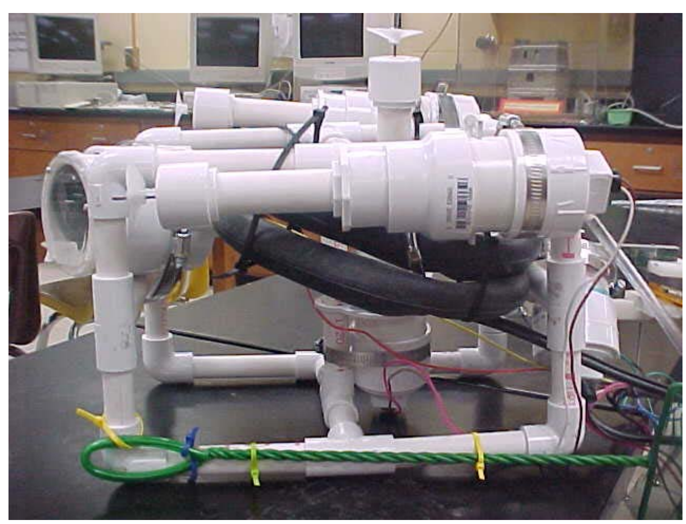


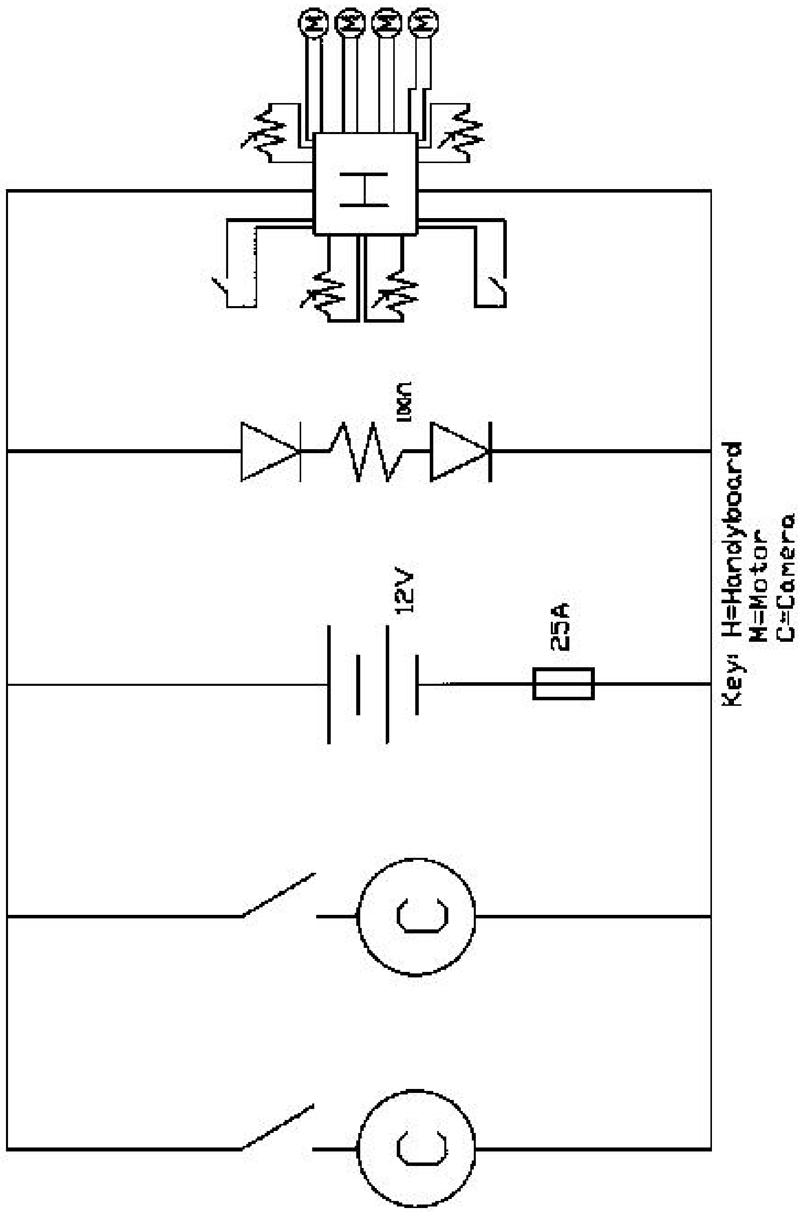
Fig 5 – Side view of ROV

Table 1 - Budget/Expense Sheet

PVC for Structure	Purchased by TJHSST Science Dept.	$5.00
Ballasting Tubes	Purchased by TJHSST Science Dept.	$10.00
Bike Pump	Purchased by TJHSST Science Dept.	$12.00
Handyboard	Lent by Electronics Tech Lab	$200.00
2 variable resistors	Purchased by the Energy Systems Tech Lab	$2.40
2 switches	Purchased by the Energy Systems Tech Lab	$0.50
One dual-variable resistor joystick	Purchased by the Energy Systems Tech Lab	$3.60
Thruster housing: PVC, Epoxy, Screws, Plastics, O-Rings, Aluminum	Purchased by TJHSST Science Dept.	$14.00 each, $84.00 total, with extras
Thruster motors	Purchased by TJHSST Science Dept.	$4.00 each, $24.00 total, with extras
Forward-facing camera	Lent by Oceanography Tech Lab	$30.00
Rear-facing camera	Lent by Robotics Tech Lab	$20.00
Assorted wires, resistors, and LEDs	Donated by the Electronics Tech Lab	$3.00
Assorted screws and silicon rubber adhesive sealant	Donated by the Prototyping Tech Lab	$2.00
High-insulation A/B switch	Purchased by the Energy Systems Tech Lab	$10.00
PVC plastic tubing	Donated by the Prototyping Tech Lab	$2.00
Assorted coax/RCA male/female connectors:	Purchased by the Energy Systems Tech Lab	$10.00
Coaxial cable (2 100’ lengths)	Purchased by the Energy Systems Tech Lab	$80.00
¼” polycarbonate plastic	Purchased by Grace Chung	$4.00
O-rings	Purchased by Grace Chung	$5.00
Acrylic plastic	Donated by the Prototyping Tech Lab	$3.00
½” polycarbonate plastic	Donated by the Prototyping Tech Lab	$20.00
Air Tube	Purchased by TJHSST Science Dept.	$25.00
Wire Spool (100’, 12 semiconductors)	Purchased by TJHSST Science Dept.	$113.00
Heat Shrink	Donated by the Energy Systems Tech Lab	$10.00
Low speed manipulation motor	Lent by Robotics Tech Lab,	$50.00
Nylon material and Aluminum	Donated by the Prototyping Tech Lab	$13.00
Valves and Switches for Air Tube	Purchased by TJHSST Science Dept.	$12.00
Balloons for waterproofing manipulation	Donated by Catherine Gray	$0.10
Twist Ties	Donated by Catherine Gray	$3.00
Hose Clamps	Purchased by TJHSST Science Dept.	$7.00
Shroud for Propellers	Donated by Catherine Gray	$4.00

Estimated Total Cost: $764.60

- **Figure 6 - Electrical Schematic**



- **Design Rationale**

Stucture

Our prototype was built from a kit that we ordered online. We used the Seafox ROV design from the book *How to Build an Underwater Robot* by Harry Bohm and Vickie Jensen. After building our prototype, we looked at our resources (finances and tools) and decided to build a PVC frame, because it is inexpensive, simple to cut and assemble, and easy to modify. For our competition ROV, we enlarged the design slightly to accommodate our large thrusters and two cameras. We also added an extra support for the vertical thruster.

Figure 7 - Prototype

We selected 1.27 centimeters PVC for many reasons. It was inexpensive at just over a dollar for ten feet. We could cut it easily with available tools. There were also numerous ways to attach our cameras, thrusters, and manipulation devices to the PVC (screws, hose clamps, epoxy). We noticed, however, that the PVC bends slightly under pressure, but since our ROV was not designed to dive very deep, this was not a problem.

Manipulation/Payload Tools

When we examined manipulation devices for collecting items during missions, we found many different options. These included the use of vacuum devices for suction, robotic arms, hooks, nets, and electromagnets. To save time, energy, and funds, we sought a universal design that could be applied in the greatest number of missions. Further assessment of each mission and the tasks to be completed dictated which of these would be the most successful.

Many tasks involved picking up items that have loops. Retrieving the towfish necessitated a device which could be hooked onto the eyesplice and then detached from the ROV and brought to the surface separately by rope. Repairing the leaky barrel required moving the patch (held by either a rod or loop) with precise movements. Tagging both the methane source and the mussel bed involved holding and then placing the tag, a large ball with an open structure, on the identified area. This led us in the direction of a design that could open and close securely over an object of relatively small width. The only missions that deviated from this design need were the collection of the fish and lava rock, which required other, more open, devices.

Our first concept involved the use of a spring-loaded carabineer using a default position of open. When electricity was applied to an electromagnet located at the base of the arm of the carabineer, it was designed to close over whatever object was currently being lifted. The advantages of this model were that it required only a simple flip of the switch to control, and once closed, it had very little chance of reopening and accidentally dropping an item. It could be used for any item with a loop of large enough radius, although it would not be as helpful for cumbersome items or those that needed to be manipulated very specifically. Also, the electromagnet (which we made by wrapping 22 gauge wire around a 15 cm iron nail) was cumbersome, and the large amount of power needed to run this otherwise simple item eventually ruled it out.

Figure 8 - Electromagnet

Our next concept was a rotating clamp, which could open and close when needed. Although we originally looked into a more complicated version, we decided that one with a single locus of rotation would serve our purposes and limit the amount of wiring needed. The clamp consisted of two arms, each with a rectangular Velcro pad located at the extended end. The bottom of the two arms was attached directly to the ROV frame and remained stationary at all times. The top arm was attached to a low speed motor, which could move the arm up or down. This design allowed the clamp to open and close, thus grasping objects which had been hooked on the pad's finger-like protrusions. We found this original design ineffective because it placed too much pressure on the bottom pad, causing the pad to buckle, and also did not allow for the removable feature needed for the towfish. Our solution was to shorten each arm and add metal rods extending from the upper pad. We also removed the Velcro pads to reduce the difficulty we found in opening the arms to grasp objects. This design change allowed us to hold open a carabineer if items had to be hooked and then pulled up separately from the ROV due to weight or efficiency. Although we tested different materials for the arms, we eventually decided on nylon and aluminum, because they were sturdy and available.

A standard aquarium net was attached to the base of the ROV for securing items which could not be hooked. The net was mounted with its mouth facing sideways so that, once an object was caught, it would not float out of the net during vertical motion. There would be no independent movement of the net, which would be manipulated by vertical or horizontal movement of the ROV itself. We felt confident that, with enough practice, this stationary net would be sufficient to secure the remaining items.

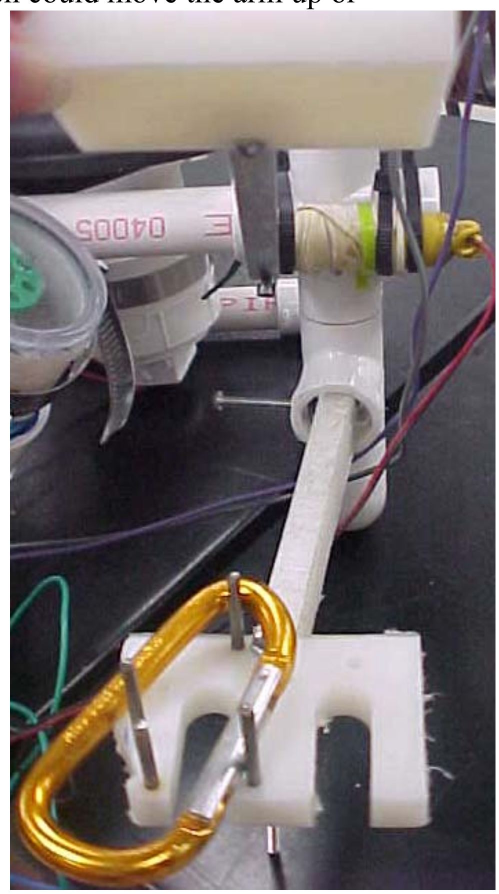


Figure 9 - Manipulator

Imaging

Our imaging system consists of two separately powered on-board cameras, one forward-facing and one rear-facing. Two switches allow us to alternate between cameras. Originally, we had only a single forward-facing camera, but we later decided two cameras was a much more efficient design for maneuvering our ROV. Instead of turning the entire robot around every time it needed to back out of a corner, we could simply use the rear-facing camera as the forward-facing one. With two cameras, the problem of camera switching arose. We considered a splitscreen solution, but realized that the technology involved would be beyond our time constraints. Instead, we implemented a manual switch. The standard television monitor dictated the wiring system for the two cameras, so both cameras use coaxial cables.

In addition to the basic imaging design that consists of the cameras and cables themselves, we also had to design waterproof casings for the cameras. Both casings consist of a cylindrical PVC pipe base, either 6.35 cm or 7.62 cm diameter (depending on the camera). Objects are viewed through polycarbonate and acrylic end caps. These end caps look like a "T" in cross section and fit tightly into the PVC; they are additionally waterproofed and sealed with silicon rubber adhesive sealant. The other end of the casings have threaded end caps. One threaded cap is cemented onto the PVC base with PVC cement, and the other has a rubber stopper that the coaxial cable passes through. This design would prove to be the most waterproof, especially with the PVC cement, silicone rubber adhesive sealant, and rubber stoppers. The threaded end cap design allowed access in case of wiring emergencies. Finally, our designs were based on financial constraints (for example, the polycarbonate was so expensive that we could use it for only one of the camera-side end caps, whereas the acrylic and PVC were very inexpensive) and on availability of materials in our technology laboratories.

Figure 10 - Camera Housing

Propulsion

The propulsion system consists of three thrusters, two horizontal and one vertical. Each thruster includes a 12 VDC high speed motor with an extended shaft. The motor and shaft are inside PVC casing and are held in place with a plastic motor mount epoxied to the inside of the PVC. A small propeller was mounted at the end of each shaft. In order to waterproof the thrusters, the wires were attached to each motor and were routed through a rubber stopper and tapered hole in the end of the thruster. At the other end, the extended shaft was fed through holes drilled in two different sizes of PVC caps. A rubber o-ring was placed around the shaft and compressed between the two caps to create a waterproof opening for the shaft. This will create heat and friction, but we will not need to run the motor for an extended period of time, and we also have replacements if the original thrusters wear out. The water should also cool the shaft significantly to prevent overheating. Goop™ was used for additional waterproofing around the stopper and the motor mount.

The design of the thrusters is a modified version of a design by Steve Thone for his ROV "Stinger" (http://www.homebuiltrovs.com). We chose Thone's design because it has enough power to propel our ROV while being relatively small, inexpensive, and simple. We modified his design to address flaws which we detected and to use the resources available to us. Some of the modifications we made include the waterproofing mechanisms including the rubber stoppers and o-rings used with PVC caps. The short motor shaft was connected to a steel extension shaft using a hollow aluminum rod. We acknowledge that in general, using different kinds of metal together is not wise because of corrosion of parts. However, the aluminum and steel were the available metals for the needed sizes of rods, and corrosion should not cause a problem for the few months that we will be using the ROV.

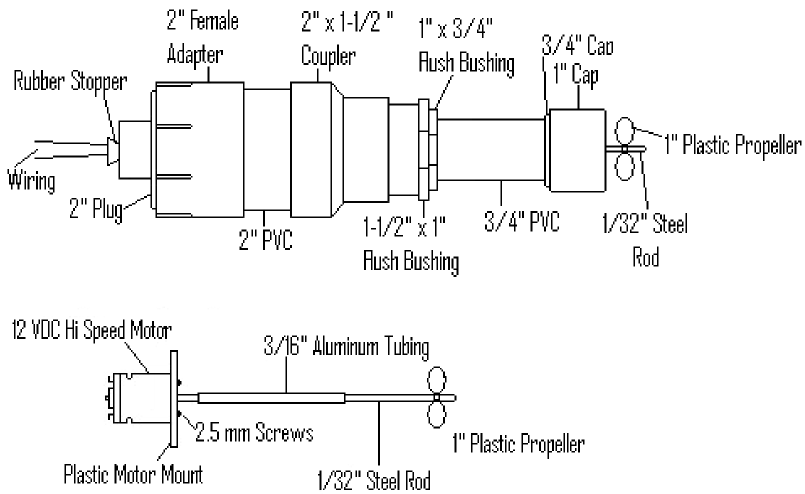


Figure 11 - Thruster Designs, Modifications of Steve Thone's

Ballasting

Before beginning work on the ballasting system, we researched various ways to control buoyancy and vertical motion. We studied dive planes, swim bladders, air chambers, bilge pumps, and diving weights. We chose to work with air bladders, since they are relatively simple and easy to work with.

Our system consists of two bicycle inner tubes which we attached to the top of the ROV with plastic ties. Two inner tubes were used for more buoyancy. The tether fits the outside of the tube valves. The tether is soft, yet tight enough that, when screwed on, the threads of the valve hold the vinyl of the tether tightly and form a watertight seal. The two inner tubes are each attached to a short length of tether, and those two pieces connect to the primary air tether with a three-way connector piece. The primary tether runs up to another three-way connector. One of the remaining two sides is attached to a bicycle pump, and the other is linked to a thumb valve. This will allow us to pump air into the tubes, and then release air from the surface quite easily. Also, having round tubes mounted on the ROV's top means that no matter how much air is pumped into the tubes, it will be equally distributed around the circles. We ran into a few minor problems while working on the ballasting system. We had trouble finding inner tubes small enough for the ROV, and then when we did find them, we had to figure out how to remove the air release mechanism from inside the nozzle. We also had to find the right size vinyl tubing and a matching air release valve. This took several tries and various prototypes involving aquarium tubing and equipment before we settled on our current system.

Control

Our first prototype ROV was controlled through a simple switching system. If one of the switches was turned in one direction, the motor that corresponded to it would go “full blast” in that direction. We quickly realized that a system in which the speed of the motors could be controlled would be much more effective than a “bang-bang” switch system for two main reasons. First, a system that can control speed would be easier to use. Remembering which switches to use and when to switch them was not intuitive or easy to do at all. None of our teammates was able to effectively adapt and control even a very simple ROV using only a switch system. We realized that if our ROV was to become any more complicated, a switch system simply wouldn't do for our purposes. Second, maneuverability would be improved with a different system. Being able to vary the speed of the thrusters on the ROV would make it much easier to maneuver within the confines of the mystery reef. We knew it would be advantageous to be able to slow down and view the surroundings, or maneuver around a bend in the reef. Moving at maximum speed for every situation would only lead to overshooting and mishaps that would cost more time then they would save.

It was obvious to us that certain motors and functions of the control system would be better left to switches. For instance, the manipulator arm should either be opened or closed, never somewhere in the middle. In addition, the speed of the manipulator didn't need to be varied over the course of the competition.

We chose to design and implement our ROV control around a joystick and dial-based system. A joystick is the main component of our control system, and manages the directions and speeds that each motor turns. A joystick was chosen because it provides and intuitive way to control our ROV: push left on the joystick and the ROV turns to its left. Because the user will be looking at a screen, it will be easier for him/her to associate the movement of the ROV on screen with the movement of the joystick. The operation of the motors also required several different speeds, but rather than associating these into the joystick (which would have required a degree of refined detection unavailable to us), we chose to have one variable resistor control the speed of the left and right thrusters, and another variable resistor to control the speed of the up/down thruster.

A final addition made to our control system was a switch, which inverts the control system. This was added in order to make steering backward out of tight situations easier. Because we have two cameras (one on the front and one on the back), inverting the controls allows a user to steer using the rear-facing camera the same way one would steer using the forward-facing camera.

Our entire system is integrated through the use of a handyboard, a microcontroller that was chosen for its ability to receive a large number of analog and digital inputs, translate them into code, and output power to up to four motors. It can also (via H-bridge circuitry) reverse the polarity of the motors, so was an ideal choice for this project. Because it could be programmed, it was easy to change how fast and strong the motors turned at any point in the process. The resulting control consists of two dials, two switches, and a joystick, which, when labeled, make maneuvering our craft through the water a simple task. Fuses are a safety measure designed to protect the wiring in our circuits. If too much current is drawn, a fuse breaks, thus preventing the other wires in the circuit from overheating and ruining the circuit since a fuse is much easier to replaces and fix than a ruined circuit. Our circuit makes use of a 25 A fuse immediately after the power supply which prevents this overdrawing of current.

- **Challenges**

Technical challenges we encountered were in making the ROV do what it needed to do. These challenges have been discussed previously in this paper.

Meeting times and funding were our two greatest challenges. As a group of high school seniors, we found it difficult to find meeting times during which we were all available. We have all been very busy throughout the school year with college applications and visits, sports, jobs, music, and other extracurricular activities. An added inconvenience was that our members were divided between two class periods, so organization between these two subsets of our group was difficult. Not only were we in two different class periods, but also because of block scheduling, our classes rarely met on the same day.

Although our school was more than willing to help in the costs of the project, we also sought outside help and sponsors. We were often met with false promises and impenetrable red tape at companies. Many stores committed funds to us over the phone, but when we showed up to the store, the manager who agreed to meet us would be unavailable. We would then have to go through the paperwork and waiting periods again. A specialized PVC company even sent us the wrong materials, and then after we returned the PVC, would not reimburse us until two months later, despite numerous phone calls.

- **Troubleshooting Techniques**

To keep everyone apprised of all aspects of project development, we began a 'Yahoo! Group' which conveniently sends e-mails to the whole group, and automatically sends replies to everyone as well. We also received help in creating a website with seven 'web logs,' so each group member and advisor could sign into the website and post responses or updates into any of these 'blogs' (some blog content is shown in the Appendix). This facilitated communication with our mentor. Weekly lunch meetings helped us to remain structured as a whole group.

For funding, the school purchased, lent, or donated most of the materials and equipment for the ROV. In retrospect, we spent too much time soliciting help and donations from hardware and electronics supply stores. This delayed our construction and added unnecessary stress.

- **Lessons Learned and Skills Gained**

This project helped us learn how to delegate tasks yet remain cohesive as a group. We developed communication strategies using technology available to us from Yahoo and our school service provider. With assistance from a classmate, we acquired basic knowledge of website building.

We learned to use machine tools, such as the milling machine, lathe, and drill press. We learned to use hand tools, such as a soldering iron, power drill, and jig saw. We developed knowledge of engineering systems, the engineering process, teamwork and communication, process and time planning, and presentation, adhesives and glues, materials processing, electronic circuit design and Computer Aided Design. When we enrolled in the competition, we were effectively without any knowledge of what to do or how to begin. Through research, practice, and continuous re-evaluation, we have developed an ROV that meets the requirements, can accomplish the tasks, and can be controlled. We are proud of the perseverance, brainstorming, and creativity that led to our final designs and systems.

- **Future Improvements**

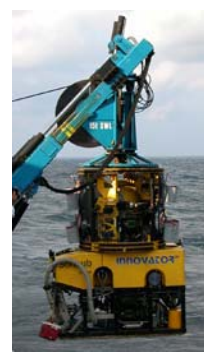
A simple but more expensive improvement could be made by replacing some of the metals within the thrusters to prevent rust caused by the dissimilar metals. More effective wiring and connections could be made. These wires and cables should all be securely collected in a large tether. The expense of flexible tether material with a large enough diameter to house our individual cables and wires deterred us from reaching this goal.

With more time and more resources, a few design features could be changed to improve imaging. The lighting design could be moved outside the camera housing. Also, a breadboard of LEDs could be mounted on the front of the ROV. The resulting feature would provide more light and wouldn't risk the reflection of the LEDs off of the plastic end cap into the camera lens. In addition, it would be nice (albeit much more complicated) to streamline the imaging system so that the video plays on a laptop, which would eliminate the need for extraneous connectors and the expense of moving a large TV monitor cross-country. Finally, if there were some way to lighten the coaxial cables, that would also be a welcome improvement to the imaging system.

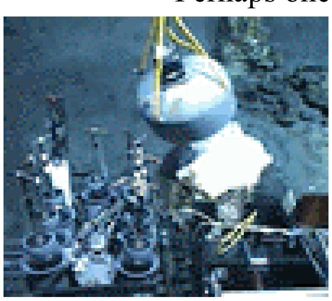
- **How ROVs Are Currently Being Used to Explore and Understand Our National Marine Sanctuaries**

In recent years, remotely operated vehicles have become a very important tool for many involved in underwater exploration, from those who maintain deep-water installations to scientists on the cutting edge of marine research. ROVs are able to perform tasks which could not be accomplished by any human or other vehicle, and are often used in potentially dangerous situations or in places where the environment needs to be left as unaffected as possible. Our National Marine Sanctuaries have found diverse ways to use ROV technology to further their goal of preserving and protecting our waters.

An important use of ROVs is their assistance in scientific research, collecting samples both conveniently and relatively inexpensively. They are also essential in collecting lost equipment and dropped tools that might otherwise be lost forever at the expense of the researchers. In 2003 a vehicle known as the *Sheerwater* was designed as the first research vessel built solely for sanctuary use. It began its service in the Channel Islands Sanctuary located off the coast of Santa Barbara. Although this is a manned vehicle, it carries additional ROVs, each specialized for its own research purpose. These ROVs study such variables as conductivity and temperature or collect samples of sediment. The *Innovator 12,* shown on the right being lowered into the water, has also been used for research in Flower Gardens National Marine Sanctuary in a program aimed at discovering more about the regional coral systems. The more information these ROVs return to scientists, the more scientists can learn about what makes this habitat last and apply the information in the future.



Perhaps one of the most famous ROVs is *Jason* [Fig. x], the vehicle that helped discover the Titanic. Its mission highlighted another important use ROVs; the ability to infiltrate tight spaces such as sunken ships and discover information about them. The *U.S.S. Monitor* sank off the coast of Cape Hatteras during the Civil War, and now has found a new function as a National Marine Sanctuary, dedicated to recovering historical artifacts and protecting other wrecks from future damage. ROVs have been used to discover what biological processes have occurred within the ship and to facilitate in the recovery of historical relics. To the right is a photograph taken by an ROV of the hull of the *U.S.S. Monitor.* One dilemma of the research of sunken ships is that each time the wreck is entered there is a risk of destroying the fragile remains, compromising any further knowledge that can be gleaned from the site. Small ROVs, when operated with precision, allow scientists and historians to overcome this problem and still learn as much as possible from these unique sites.



ROVs have so many useful applications in marine sanctuaries, such as topographic mapping and assessing commercial damage, that they have become an integral part of the undersea research process. As marine technology advances, the opportunities for exploring our last frontier seem endless.

Resources:

NOAA Ocean Explorer Technology: Remotely Operated Vehicles. http://oceanexplorer.noaa.gov/technology/subs/rov/rov.html

Remotely Operated Vehicles at Work in Marine Sanctuaries. www.**marine**tech.org/**rov**_competition/ ROVs_in_Sanctuaries_Rev.pdf

National Marine Sanctuary Program Home. http://www.sanctuaries.noaa.gov/

National Marine Sanctuaries Press Release. May 12, 2003. "Channel Islands National Marine Sanctuary Christens New Research Vessel" http://www.sanctuaries.nos.noaa.gov/news/pressreleases/pressrelease05_12_03.html

Channel Islands Marine Sanctuary. About the Sanctuary. http://www.cinms.nos.noaa.gov/focus/about.html

Sound Waves Monthly Newsletter. Nov. 2003. Life in the Deep Gulf of Mexico – Exploring Deep Water Coral Habitats. http://soundwaves.usgs.gov/2003/11/fieldwork.html

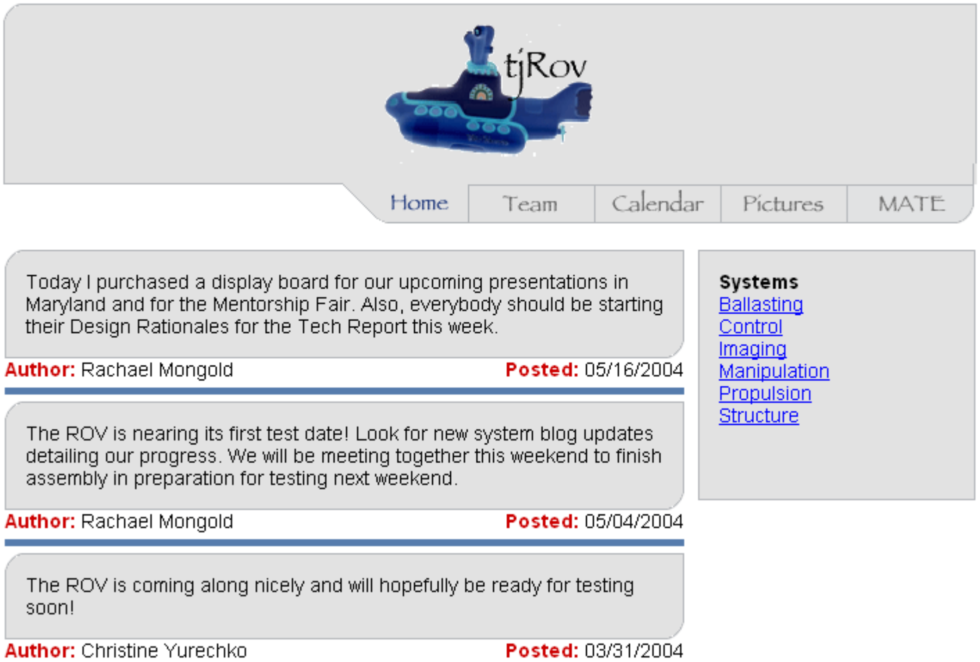
Deep Sea Robots. Uses for an ROV . www.physical.com/deep6/**rov**use.htm

- **Acknowledgements**

Without our mentor, Mr. Manley, we would not have been able to complete or even begin such a task. We would like to thank Mitretek, his company, for lending him to us for meetings. His questions helped inspire our own creativity. Our school has been a big help in acquiring the funds and resources that we needed. Our teachers, Ms. Wu and Mr. Leaf have been supportive and helpful throughout this year. Mr. Anderson and Mr. Buxton have been extraordinarily helpful by letting us use their prototyping laboratories and inspiring us to be resourceful. Ms. Phillips and Ms. Curtis of the Science Department at our school have been particularly valuable to this project, by working with us on the school's funding. Ms. Clement, also of the Science Department, opened her pool to us for ROV testing, and we greatly appreciate her contribution. Mr. Washer, Dan Kuebrich, and Ryan Mongold were integral to the functioning of our website. Steve Thone's thruster design and *How To Build and Underwater Robot* by Harry Bohm and Vickie Jensen helped us begin the design process of our own ROV.

Appendix A

Website Homepage: http://www.tjhsst.edu/~rmongold/tjrov/index.php



Here, you can see that the home page allowed us to easily navigate our pages. The tabs on the top bar switched between the home page, the team and calendar pages (shown below), and the pictures and MATE page. The Systems Toolbar on the right allowed us to travel directly to system blogs. We signed into the site to be able to post using IDs and passwords.

Website Team Segment: http://www.tjhsst.edu/~rmongold/tjrov/team.php

Catherine Gray cgray@lan.tjhsst.edu	Public Relations/Vertical Motion A senior in the Oceanography Tech Lab, is working on vertical movement, ballasting, and public relations. She has taken courses in Marine Biology and Robotics at Jefferson.
Christine Yurechko cyurechk@lan.tjhsst.edu	Structural Design/Computer Graphics A senior in the Oceanography Techlab, Christine is in charge of the general structure and the CAD modelling of the ROV. She has taken classes in CAD and AP Biology at Jefferson.
Grace Chung gchung@lan.tjhsst.edu	Electronics/Control System Grace is a senior in the Energy Systems Technology Laboratory. She is working on the video imaging and central control systems for the ROV, and has taken classes in analog and digital electronics and prototyping.

Team

- Catherine Gray
- Christine Yurechko
- Grace Chung
- Kim MacDonald
- Matt Faria
- Rachael Mongold
- Veronika Bath
- Mr. Leaf
- Mr. Manley
- Ms. Wu

Kim MacDonald pegasus04@cox.net	Thrust/Horizontal Mobility A senior in the Oceanography Tech Lab, is working on propulsion.
Matt Faria olentzaro1@yahoo.com	Electronics/Control System Senior in Energy Systems. He is working on the control systems for the ROV. He has taken courses in Robotics and Electronics.
Rachael Mongold rmongold@lan.tjhsst.edu	Ballasting/Vertical Motion Studying in the Oceanography Senior Tech Lab, she is working on vertical movement, ballasting, and prototyping. She has taken courses in Marine Biology and Prototyping, and was a member of the National Ocean Science Bowl team, which placed 5th in the country last year.
Veronika Bath ronikaerin42@yahoo.com	Manipulation/Robotics A senior in the Oceanography Tech Lab, she is working on manipulation units. She has taken courses in Marine Biology and AP Biology at Jefferson

Website Calendar: http://www.tjhsst.edu/~rmongold/tjrov/calendar.php

Calendar

February
- Send and deliver fundraising letters
- Continue finalizing the design of systems
- Finish website and begin to utilize effectively
- Order and purchase necessary parts

March
- Build systems
- Alter design as we build and discover more effective alternatives

April
- Finish building the ROV

May
- Testing and adjusting, especially ballasting

June
- Complete testing
- Prepare for competition in terms of displays
- 25-27 MATE Competition

Example of A Website Systems Blog (Ballasting shown):
http://www.tjhsst.edu/~rmongold/tjrov/viewblog.php?blogid=4

We showed our working ballasting system to Mr. Manley on friday. It worked quite nicely. He suggested that we purchase some spare parts to have, just in case anything happens to the ones we have now. Today I got 3 more inner tubes, and this week I'll try and get some more plastic tether splitter valve things.

Author: Rachael Mongold **Posted:** 05/16/2004

BALLASTING IS FINISHED!

We finally got everything worked out! The entire ballasting system is complete and in working order now.

We encountered a few problems along the way - but thanks to some very nice people at Fischer's Hardware, and some great advice from our Prototyping lab director, Mr. Buxton, everything turned out wonderfully.

We have two bike inner tubes plastic - tied onto the top of the ROV. I haddn't realized that releasing the air from the tires would be difficult underwater, since a small pin has to be pushed within the valve on the tube. I was quite concerned that we would have to either: cut the valve off of the tire and find some way to connect the tether to the inner tube - or create some sort of small mechanism that would be able to push the pin inside the valve. Fortunately, Mr. Buxton was able to remove the air release pin from both of the tubes.

The tether, luckily, fits the outside of the tube valves perfectly. It is soft, yet tight enough that when screwed on, the threads of the valve hold the vinyl of the tether tightly - and it forms a watertight seal.

The two inner tubes are each attached to a short length of tether, and those two pieces then connect to the main air tether with a three - way connector piece. The main tether runs up to another three - way connector. One of the remaining two sides is attached to a bike pump, and the other is hooked up to a thumb valve. This way, we can pump air into the tubes, and then control its release from the surface quite easily. Also, having round tubes mounted on the ROV's top means that no matter how much air is pumped into the tubes, it will be equally distributed around the circles.

Author: Rachael Mongold **Posted:** 05/11/2004

Tonight I picked up another 12 inch bike inner tube. I inflated it with the pump, and attached it to the other inner tube. Hopefully these will be enough to balance the weight of the ROV - now my problem is trying to figure out how to connect the two to one tether. I may need another valve.

Author: Rachael Mongold **Posted:** 05/05/2004

A lot going on with ballasting lately -

Went to Wally's Aquarium Shop and got some aquarium tubing and a simple valve setup so that we can put air release valves in-line with the tether. After I realized how difficult that would be, I made a trip to Home Depot and got a simple 3/8 inch in-line switch valve. This should be much easier to install and control.

After a long and frustrating debate with the online inner tube people, I cancelled the order for the inner tubes due to time constraints. (it was going to take 6 weeks for them to arrive!) Tonight I purchased a different inner tube, a 12 inch bike inner tube, and a cheap bike pump. After getting it home and inflating it, I think I might need to buy a second one. We'll have to see about that.

This week I will be able to hook these up together at school. I will need to use hose clamps to connect the valves, and I still have to figure out how to connect the tether to the bike pump fixture. After that, I also need to figure out how to mount the tubes onto the ROV itself. For testing purposes though, I will probably just use plastic ties.

Thats all for now -

Author: Rachael Mongold **Posted:** 05/04/2004

The inner tubes have been purchased and should be on their way from the warehouse now. Now I will be able to start looking for valves that can work with the inner tubes and the tether.

Author: Rachael Mongold **Posted:** 04/07/2004

Hurrah! I just found an 8 inch inner tube that looks just perfect for what we need! Tonight I will order a few of them so we can test them with doombot. The site is here: http://ww2.harborfreight.com/cpi/ctaf/Displayitem.taf?itemnumber=47880

Author: Rachael Mongold **Posted:** 03/31/2004

While discussing buoyancy issues, we also decided that it would work nicely if the ROV could somehow be plugged (the pvc) halfway up the vertical tubes so that the top half of the structure could be kept full of air, while the bottom half could have holes drilled in it so it could fill with water and therefore be more stable. We will look for pvc pieces that we could use as plugs inside the tubes. I have also continued to search for inner tubes for the air bladder - I have realized that the ROV will be fairly small and that a small inner tube will be needed - our visit to Home Depot demonstrated that wheel barrows have nice small tires, so I will check those out soon as well.

Author: Rachael Mongold **Posted:** 03/30/2004

We will have one tether leading down into our ROV, with all the wires and the air. We found large spools of possible tether materials at Fischers Hardware. The sizes/prices are in my labbook which Ms. Wu is grading, but I will get that information and update this.

Author: Catherine Gray **Posted:** 03/29/2004

Here are some website where we can buy Air Rings of different sizes. http://www.surgicalshop.com/rubbergoods.html. Scroll down to the bottom, and I guess we could get the 12" one for about $14. http://www.westburypharmacy.com/Merchant2/merchant.mvc?store_code=WP&screen=PROD&product_code=039172. 13.75" for $7. I called my brother, who used to be an avid biker and worked at Performance, and he suggests that I research bike inner tubes. I'll work on that this week.

Author: Catherine Gray **Posted:** 03/29/2004