PT Crews H.E.R. ROV

(Port **T**ownsend **Crews "H**and-me-downs **E**xtras and **R**ecyclables**")**

Technical Report

Presented by

Thinkers-N-Tinkers
Mechanical Science Club

Teachers/Mentors**:**
Mr. Mike Kunz

Team Captain:
Emily Kunz

Students:
Emily Kunz
Erik Kunz
David Kunz
Stephanie Jones

TABLE OF CONTENTS

Page

FIGURES

ACRONYMS AND ABBREVIATIONS

H.E.R.	Hand-me-downs Extras and Recyclables
LPH	Liters per hour
MATE	Marine Advanced Technology Education
MTS	Marine Technology Society
PVC	Polyvinyl Chloride
ROV	Remotely Operated Vehicle
UPS	United Parcel Service

ABSTRACT

The Port Townsend Crews H.E.R. (Hand-me-downs Extras and Recyclables) was constructed for use in the Marine Advanced Technology Education (MATE) competition 2007. This year's competition consisted of writing a Technical report (Figure 1), putting together a poster, giving a presentation, and performing three independent tasks, each with a different environmental scenario. The first task was to transport a messenger line (provided by each team) to a buoy anchor at the bottom of the pool, thread it through a U-bolt, and return it to the surface. This was accomplished with a current of 0.1meter per minute. The second task was to deploy a buoy to the designated area at the bottom of the pool, retrieve a "jelly fish," and collect a sample of "algae" from under the ice. Our third and final task was to take a gasket and a hot-stab down to a wellhead, remove the wellhead lid, place the gasket inside the wellhead, and put the well head lid back on. Afterwards, we had to insert and remove the hot-stab.

Our ROV was built with two main goals in mind. The first goal was to try and keep expenses at a minimum. This involved talking with business owners and store managers about our project to obtain sponsorship or a reduction in price for some items. Many businesses were very supportive. MOBILISA, our main sponsor, was a significant contributor to our ROV project, providing us with a large monetary donation. Our second main goal was to successfully accomplish the assigned tasks. We initially had difficulty with our design functionality, but we later were able to conceive ideas to perform the tasks.

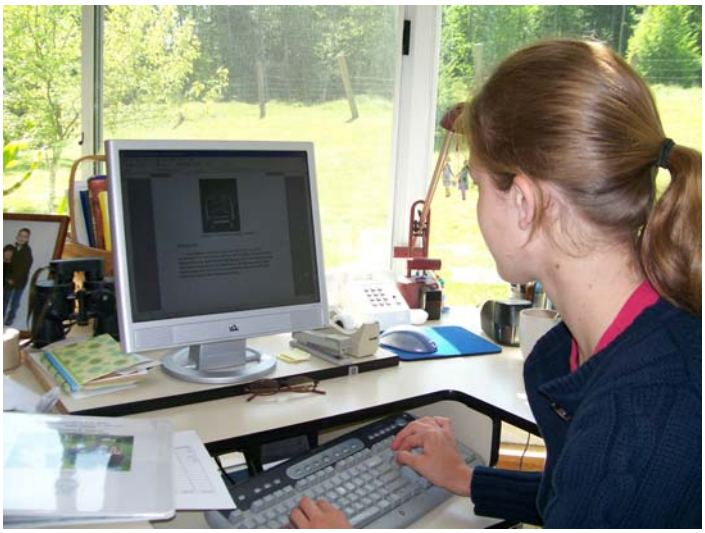


Figure 1. Working on Technical Report

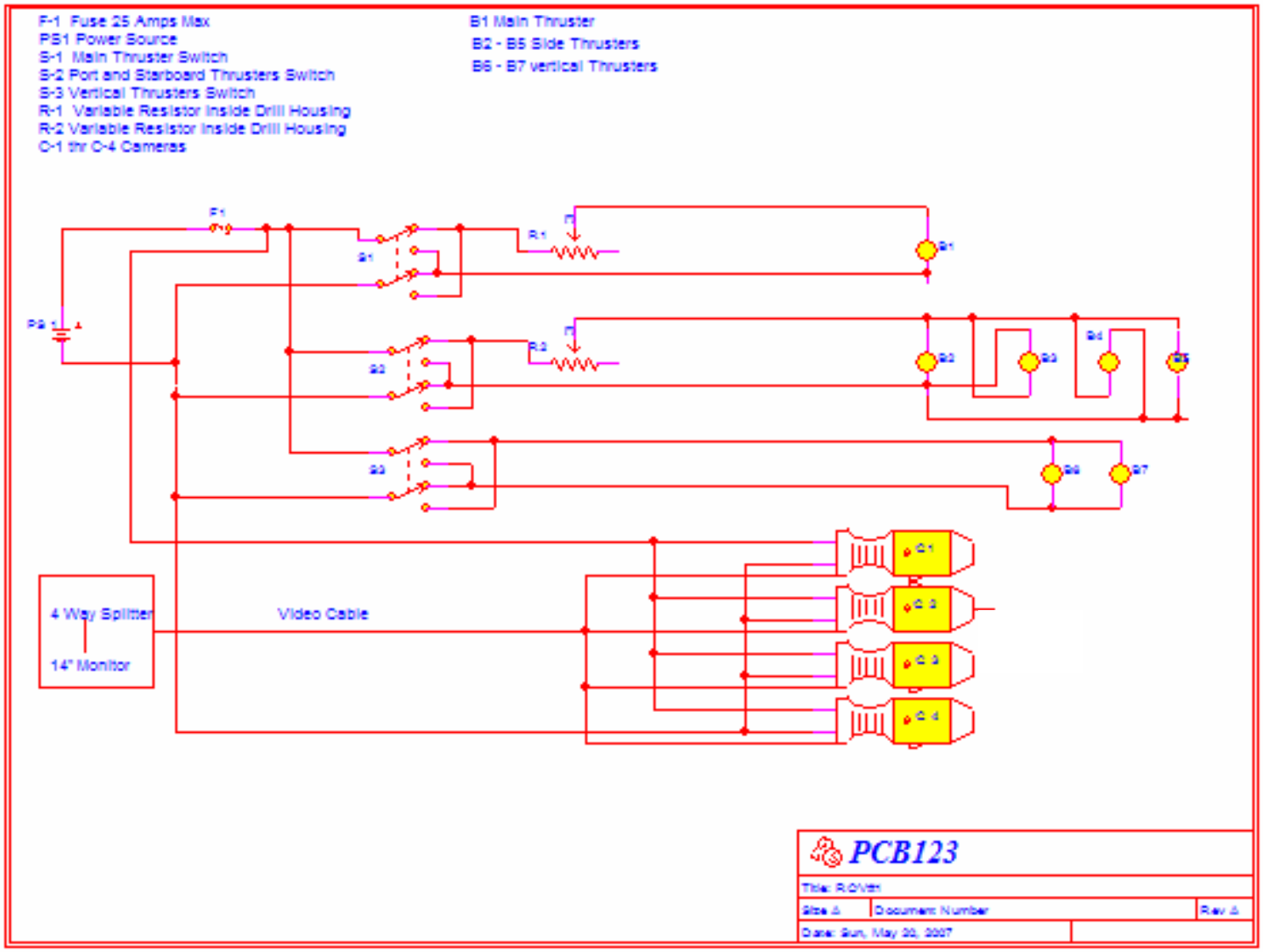
EXPENSE SHEET

Name: **H**and-me-downs **E**xtras **R**ecyclables

Date	Description	Deposit	Expense	Balance	Donated
12/20/06	Glenn Lopeman- Electric outboard				70.00
1/29/07	Naval Undersea Museum - 6 cameras B&W				150.00
2/7/07	Home Depot -RCA Connectors		-6.98		
2/7/07	Henery Hardware - PVC Tubing – donated				62.53
2/14/07	Robert Marett - Electric Outboard				90.00
2/20/07	Academy Northwest School - Robin Summerfelt (fee Waiver)*	150.00			150.00
3/1/07	Home Depot - Tubing, fittings and glue		-34.65		
3/8/07	Chimacum Valley Veterinary Hospital syringes		-4.23		
3/8/07	MOBILISA - sponsor	650.00			
3/29/07	Henery Hardware - 1/4 inch tubing		-20.00		
4/4/07	Double D Electrical - Monitor, 4 way splitter & adapters		-305.00		
4/23/07	Townsend Dive Shop - Aquaseal		-15.20		
4/25/07	Office Depot		-17.32		
5/12/07	MTS - Travel Expense Award	4000.00			
5/17/07	Air Canada - Plane Tickets		-3308.86		
5/17/07	Home Depot - paint, tape, and splices		-16.32		
6/12/07	UPS shipping and packaging (estimate).		-350.00		
6/19/07	Hotel in Vancouver with parking (estimate)		-210.00		
6/21 - 6/25	Rooms at Hatcher House		-208.00		
6/22/07	MATE - Stipends	1000.00			
6/21 - 6/25	Meals (estimate)		-200.00		
	TOTAL	5800.00	-4696.56	1103.44	522.53

*Normal school fee waived. This was not a cash donation, but there was no out of pocket expense for our parents.

SCHEMATIC


F-1 Fuse 25 Amps Max
PS1 Power Source
S-1 Main Thruster Switch
S-2 Port and Starboard Thrusters Switch
S-3 Vertical Thrusters Switch
R-1 Variable Resistor Inside Drill Housing
R-2 Variable Resistor Inside Drill Housing
C-1 thr C-4 Cameras
B1 Main Thruster
B2 - B5 Side Thrusters
B6 - B7 vertical Thrusters
F1
S1
R1
B1
PS 1
S2
R2
B2
B3
B4
B5
S3
B6
B7
4 Way Splitter
14" Monitor
Video Cable
C 1
C 2
C 3
C 4
PCB123
Title: ROV
Size: A
Document Number
Rev: A
Date: Sun, May 20, 2007

ROV DESIGN RATIONALE

Frame

Originally, our design concept was to make the ROV look like some type of marine crustacean, such as a crab, because of the type of task we needed to accomplish. We later decided that in order to easily attach the motors, gripper arms, and cameras, our ROV would need to be boxier. At our second construction meeting, we began piecing PVC sections together until we came up with a design that we thought would allow us to achieve our goals (Figure 2). We later added an inner tube as a buoyancy compensator. We were able to inflate and deflate the tube when we wanted to adjust the depth of the ROV.

To ensure the stability of our ROV, we mounted thrusters as low as possible due to their weight. With the buoyancy compensator mounted high on the frame, the ROV has a boat-like function and can easily maintain stability.

Figure 2. The frame of the ROV

Control System

Figure 3. Controllers

For our control system we used the shell of an electric drill in order to control the motor speed. It was not necessary to have the camera and gripper arm controls on our control system, as they are stand-alone systems (Figure 3). We also have momentary double pole, double throw switches for vertical movement. Additionally, we would not have to be concerned about leaving a switch on and overshooting the target. This method allowed for better control of the vehicle.

Cameras

Our four security cameras were donated to us by the Naval Undersea Museum at Keyport. We waterproofed the cameras by placing them within flashlight cases and sealing them with Aquaseal®. They were easy to attach to the ROV (Figure 4) and they are easy to operate. The images from the cameras go directly to the monitor instead of through the control box. We have a monitor with a four-way splitter so we can see all four cameras simultaneously.

Figure 4. A camera

Tether

Figure 5. Tether

Our tether consists of 8 wires for our controls. Additionally, it contains an air tube for our ballast system, one tube for the gripper arm hydraulics, and the camera cable (Figure 5). These were all connected with electrical tape, pipe insulation, and zip ties every two meters in order to prevent the tether from sinking. The tether length is 18 meters. We used heat shrink and Aquaseal® on all wiring connections to eliminate the possibility of bare wires touching, causing short circuits and possible safety hazards. We also have a 25amp fuse that is easily accessible.

Thrusters

We have four horizontal thrusters (Figure 6) for sideways movement and two thrusters for vertical movement. We used 1923-LPH bilge pump motors with propellers attached. Each thruster draws approximately 1.5 amps. If all of the thrusters were operating simultaneously, we would draw approximately 9 amps, which is two-fifths the power limitation allowed for this competition. For forward movement we are using a trolling motor. This motor draws approximately 5amps when operating at full speed.

Figure 6. Thrusters added to frame

Gripper Arm

Figure 7. Gripper arm

Our gripper arm is constructed from a partially dismantled toy robot claw, tubing, and syringes (Figure 7). We used hydraulics to control the arm. We attached the syringes to the claw, and the claw to the tubing on both ends so when we pulled on the syringes at the surface, the gripper arm would close.

Ballast System

The inner tube on top is used to control the ROV depth (Figure 8). It can easily be inflated with an electric air compressor and is deflated by opening the valve at the surface to let the air out of the tube. We chose the inner tube due to its versatility at the depth requirements. Additionally, inner tubes are inexpensive, easily mounted, and replaceable.

Figure 8. Ballast system

Overall Design

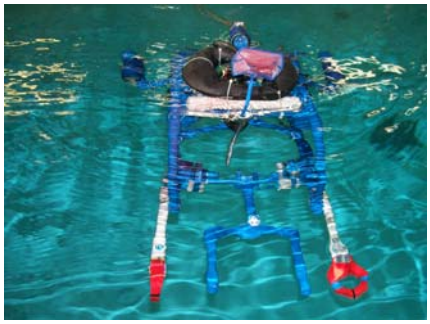


Figure 9. Completed ROV

Once the ROV parts were constructed and assembled, we painted the ROV blue (Figure 9). This made the ROV more visible on the surface, and camouflaged while under water. We left the gripper arms red and made the fish net white so that they can be easily seen under water. This makes the tasks easier to accomplish because these components are more visible through the camera. Our gripper arm will be used for maneuvering the gasket and wellhead. Our hot stab manipulator is made for just the hot stab. The fish net on top of the ROV will be used to retrieve the "algae" from the surface. Our fork will be used for retrieving and deploying the other items.

CHALLENGES

One of the challenges we had during the ROV construction was coordinating our team-mates schedules. We have team members in track and field, soccer, dance, working part-time jobs, volunteering, and attending college. Our teammate in college helped during Christmas break, spring break, and by phone consultation. We also had one team member drop out of our team before the Regional Competition due to a sports competition conflict, so we operated our ROV on a skeleton crew. However, we redistributed our individual jobs, worked together to put together our Engineering Evaluation presentation, and everything worked out well.

Our second problem was trying to waterproof our cameras. After our first pool testing we saw condensation on the lens. At first we thought it was just because of the temperature changes from the pool water, but at our next pool testing the camera case filled half way up with water. During the practice rounds at the competition one of our cameras filled up with water and shorted out. So we then used an extra camera that we had brought as a spare.

We also had problems with our first main thruster. At our first testing there were bubbles coming out of our main thruster. When we came back home we unsealed the thruster and there was a lot of water inside. The motor was also not working properly so we used our spare motor and resealed it with Aquaseal® and Hardman® Urethane.

TROUBLESHOOTING TECHNIQUES

Troubleshooting is a process by which we isolate a problem so that repairs, or in some cases, corrections can be made (Figure 10). This is a logical approach, in which we think about what is wrong and what is working properly to determine where the problem is occurring.

Figure 10. Checking all of our connections

Thruster problems

We had one problem that was easy to correct. Two of our sideways thrusters were working opposite of how we wanted them to function. They would turn left instead of right when we turned the switch to the left. We knew the following: 1) The switches were good; and 2) The power was reaching the thrusters. Our options for corrections included: 1) Rewire the switches; 2) Change position of the wires going to the motors; 3) Switch position of the motors. We chose to change position of the wires going to the motors because they had not yet been soldered and this was the least complicated choice.

Camera malfunctions

The lens on the camera case had condensation on it after our first testing. When we had the ROV out of the water and on the side of the pool we could not see any water in the case, but after the second testing it started filling up with water. After we opened up the case we could see that there was about 12ml of water inside. After we removed the camera from the case we let the camera dry out. The next day we tried the camera and is was working fine. We then resealed the camera and made sure that there were no leaks in the case.

Buoyancy problems

We have not had any problems with the buoyancy except for the fact that it is a very sensitive system. When the ROV first gets in the water it usually sinks to the bottom. When we start filling the inner tube with air it will immediately start going up. We have had problems being able to accomplish our tasks because some of them take place while we are neither on the bottom of the pool nor on the surface and it's hard to get the ROV at an exact depth. To change this we placed two thrusters on the front of the ROV so that we can move the ROV up and down very smoothly with small amounts of movement.

LESSONS LEARNED AND SKILLS OBTAINED

One of the most important skills we obtained was learning to solder more effectively. This enabled us to make better and more permanent connections for the electrical portion of our ROV. We learned how to be safe and use the proper techniques when soldering.

We learned how a wiring diagram works. The wiring schematic makes it easier to troubleshoot problems. The wiring diagram helps in locating the correct wire by the labeling.

We used the program PCB123 for making our drawings of the electrical schematics on the computer. The only problem was trying to make all the wires as straight as possible and finding the correct symbols that would correspond to our components of the vehicle.

Figure 11. Placing the camera inside its case

We also improved our troubleshooting techniques (Figure 11). We learned how to solve problems more quickly and efficiently. Solving problems quickly is very important when under time constraints because we do not want to have delays during the competition.

We kept a schedule of when we had meetings and what we accomplished (Appendix A).

POSSIBLE FUTURE IMPROVEMENTS

If we were to do this project again we would make the following improvements:

- Have a larger team so if anybody drops out then we still have enough team members
- Make a more effective ballast system
- Start earlier to allow more testing time
- Keep a more consistent meeting/working schedule

HUMAN LIFE AT THE POLES

Inupiaq Culture

The Inupiaq, also known as Inupiq, people live in the tundra regions of Alaska north of the Alaska Sound near the Bering Sea (Figure 12). Of all the aboriginal people, they live the farthest north. They are very closely related to the Inuit people of Canada and Greenland, however, their language is closer to that of the Yup'ik people. The Inupiaq people have an intimate knowledge of their land and its wildlife.

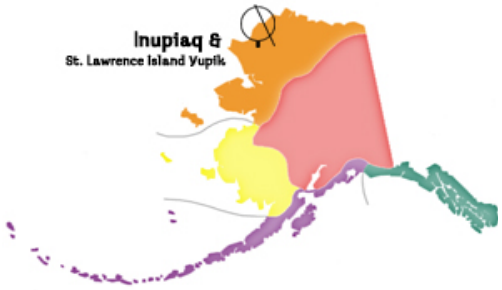


Figure 12. A map of where the Inupiaq people live

Figure 13. Inupiaq people dancing

The Inupiaq people traditionally hunt polar bear, caribou, walrus, seal, musk ox, and whales. They also fish salmon, cod, and arctic char. During the summer months they gather berries and other vegetation. They are one of the few indigenous people continuing to hunt whales today. Although their supply of wood is limited to driftwood, they are still able to build boats, which they use to hunt whales.

The homes of the Inupiaq people were traditionally semi-subterranean, which helped keep their homes insulated. They had tunnel entrances underground to prevent cold air from getting into their living areas. Their homes were almost always made out of sod blocks laid over frames of driftwood of whalebone frames; which were usually dome shaped.

Throughout their lives they have had to adapt to changes in their surrounding culture and climate. Now they have more contemporary homes to help with their adjustment to today's world. They still perform their many traditions and customs (Figure 13), even though they have cars and education similar to that of other Americans.

References

- http://www.alaskanative.net/36.asp
- http://www.allthingsarctic.com/people/inupiaq.aspx
- http://www.uaf.edu/journal/portfolios/

ACKNOWLEDGEMENTS

Our team would like to thank Mr. Mike Kunz for leading us in this project. He scheduled the meetings and kept us on schedule in building the ROV so that we would have it completed in time. We would like to give a special thanks to MOBILISA for providing a very generous monetary donation. With this donation we were able to purchase many of the more expensive, but necessary, parts for our ROV. We are very thankful to the Keyport Naval Undersea Museum for the donated security cameras used on our ROV. Academy Northwest and Robin Summerfelt donated money to our project to help cover expenses. Thanks to Glenn Lopeman and Robert Marett we have two very nice motors for our ROV. We would also like to thank Henery Hardware for donating the supplies we needed to build our ROV's frame. The City of Port Townsend Municipal Pool allowed us to use the pool to practice maneuvering the ROV. Without this practice time we could not have been as prepared for this competition. Our biggest thanks go to the MATE center for giving us this opportunity and for a really rewarding experience. We appreciate and thank each of these organizations and individuals for their support in so many ways.

Sources of Supplies

Chimacum Valley Veterinary Hospital - Syringes
Staples – Poster Board
Home Depot – RCA Connectors, PVC tubing, fittings, and glue
Keyport Naval Undersea Museum – Security cameras
Townsend Bay Dive Shop – Aqua Sealant
Double D Electrical – Monitor, four-way splitter, and adapters
Office Depot – Display Board

APPENDIX A

Project Journal

ROV Meeting Schedule 2007

Date	What we accomplished or learned (as of 05/26/07)	Time Spent
01/20/07	Discussed the ROV mission tasks	1 hr.
01/27/07	Discussed what the ROV will need in order to accomplish these tasks	1.5 hrs.
02/03/07	Drew designs for our ROV	1 hr.
02/17/07	Port Townsend High School science teacher sat in on meeting	2 hrs.
02/24/07	Started making a frame out of PVC	1 hr.
03/04/07	After discussing our original design, we decided to rebuild the frame	1.5 hrs.
03/10/07	We glued the frame and started water proofing the cameras	1.5 hrs.
03/17/07	Attached the thrusters and finished water proofing cameras	2 hrs.
03/29/07	Attached gripper arm and sealed the hydraulics system	1 hr.
04/07/07	Attached the cameras and filled the tubes for the hydraulics with water	1.5 hrs.
04/14/07	Started wiring the control system and attached our ballast system	2 hrs.
04/17/07	Finished the wiring and water proofed the connections.	2.5 hrs.
04/18/07	Attached the inner tube for a dynamic ballast and had first pool testing	1 hr.
04/24/07	Second pool testing	0.5 hr.
04/27/07	Sealed and attached a new thruster	1 hr.
04/28/07	Third pool testing	0.5 hr.
05/01/07	Attached larger ballast inner tube	0.5 hr
05/02/07	Spray painted our ROV and glued cameras in place	1.5 hrs.
05/08/07	Added a fork and a net and started on display board	3.5 hrs.
05/09/07	Drained the water out of a camera and resealed it	1.5 hrs.
05/10/07	Put together poster display and worked on presentation	3.5 hrs.
05/11/07	Finished presentation and organized everything for the competition	3 hrs.
05/12/07	ROV regional competition at Evergreen State College	7 hrs.
05/14/07	Discussed modifications that will need to made to the ROV	2 hrs.
05/15/07	Went to pool for interview by local newspaper	0.5 hrs.
05/16/07	Attached two vertical thrusters and started adding modifications	1.5 hrs.
05/17/07	Worked on Technical Report and updated budget sheet	2.5 hrs.
05/20/07	Worked on Technical Report and updated budget sheet	2 hrs.
05/21/07	Worked on Technical Report	3 hrs.
05/22/07	Worked on resealing cameras	2 hrs.
05/23/07	Took apart tether for wire adjustments	1 hr.
05/25/07	Added wires to tether	1 hr.
05/26/07	Worked on Technical Report	1.5 hrs.
	TOTAL HOURS	**64 hrs**