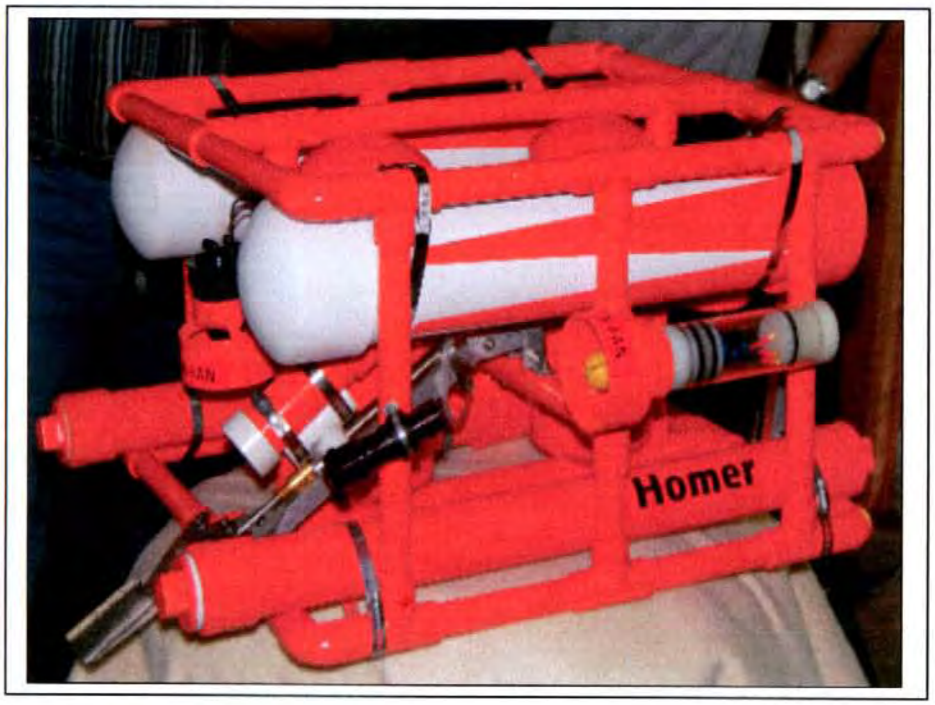
Great Lakes Homeschool Group
Great Lakes ROV Team
Technical Report

2007 International MATE ROV Competition



"Homer"

Team Members:
Benjamin Ford, John Ford, Scott Rhudy,
Hannah Zowada, Nathan Zowada

Mentors:
Cary Ford, Tim Zowada

I. Abstract

This project's goal was to develop and construct an underwater ROV (Remotely Operated Vehicle) to compete in the 2007 MATE (Marine Technology Education) ROV competition. Our vehicle was designed to complete the missions as quickly and efficiently as possible. These missions simulate underwater salvage, collection of research specimens, and maintenance of a wellhead. The missions have to be completed within specified time limits and under adverse conditions. We created our ROV to operate in extreme environments and be able to handle depths in excess of 17 meters. The seals of the thruster motors can tolerate enormous temperature changes and have the thrust necessary to operate in strong currents.

We "over-engineered" our electronic compartment with the use of .625cm steel tubing and acrylic end domes of the same thickness. We designed our ballast system so the operator can adjust the buoyancy to enable the ROV to collect objects weighing 5kg. Throughout this report The Great Lakes ROV Team will explain the design and function of the machine's systems.

Fig. 1-1: Early stages of the ROV's design.

Fig. 1-2: All team members learned new skills.

Fig. 1-3: First test revealed a need to adjust ballast in order to achieve neutral buoyancy.

II. Budget

Period:

School Name: Great Lakes Home School Group

From: 03/01/07

Instructor/Sponsor: Cary Ford

To: 06/01/07

Funds

Date	Deposit or Expense	Description	Expenses	Donations	Balance
03/01/07	Donation	Parent Donation		$ 1,500.00	$ 1,500.00
03/09/07	Expense	Cabela's, Thruster Motors	$ 51.71		$ 1,448.29
03/09/07	Expense	Tower Hobbies, Prop Adapters	$ 20.35		$ 1,427.94
03/21/07	Expense	Seabotix, Thruster Props	$ 33.12		$ 1,394.82
03/21/07	Expense	The Home Depot, Thruster Reducers	$ 9.53		$ 1,385.29
03/21/07	Expense	Super Circuits, Camera	$ 62.56		$ 1,322.73
03/30/07	Expense	Vantec, Attenuator and Resistors	$ 38.00		$ 1,284.73
04/02/07	Expense	HiTec RCD, Radio Controller	$ 119.44		$ 1,165.29
04/02/07	Expense	Horizon Hobby, Electronic Speed Control	$ 167.95		$ 997.34
04/07/07	Donation	The Home Depot		$ 178.34	
04/07/07	Expense	The Home Depot, PVC Pipe	$ 178.34		$ 997.34
04/07/07	Expense	Lowe's, Stainless Hardware	$ 48.35		$ 948.99
04/07/07	Expense	Sunrise, BNC Installation	$ 5.00		$ 943.99
04/09/07	Expense	Buyheatshrink.com, Heat Shrink	$ 53.34		$ 890.65
04/09/07	Expense	Donald Engineering, Pneumatic Line and Fitting	$ 67.38		$ 823.27
04/11/07	Expense	The Home Depot, Stainless Hardware	$ 2.42		$ 820.85
04/11/07	Expense	Lowe's, Air Valves & Pipe	$ 91.48		$ 729.37
04/14/07	Donation	The Home Depot		$ 86.16	
04/14/07	Expense	The Home Depot, PVC Pipe	$ 86.16		$ 729.37
04/16/07	Expense	The Home Depot, Black Pipe	$ 12.42		$ 716.95
04/18/07	Expense	The Home Depot, Pneumatic Line	$ 5.28		$ 711.67
04/19/07	Expense	Lowe's, Stainless Hardware	$ 32.96		$ 678.71
04/22/07	Expense	Advance Auto, Adhesive Tape	$ 13.17		$ 665.54
04/22/07	Expense	Lowe's, Silicone and Rubber Seal	$ 21.93		$ 643.61
04/23/07	Expense	Wal-Mart, Poster Board	$ 9.37		$ 634.24
04/24/07	Expense	Lowe's, PVC Pipe	$ 5.05		$ 629.19
04/24/07	Expense	The Home Depot, Paint & Fittings	$ 37.62		$ 591.57
04/25/07	Expense	Sunrise, Coaxial Quick Connect	$ 9.72		$ 581.85

II. Budget Continued

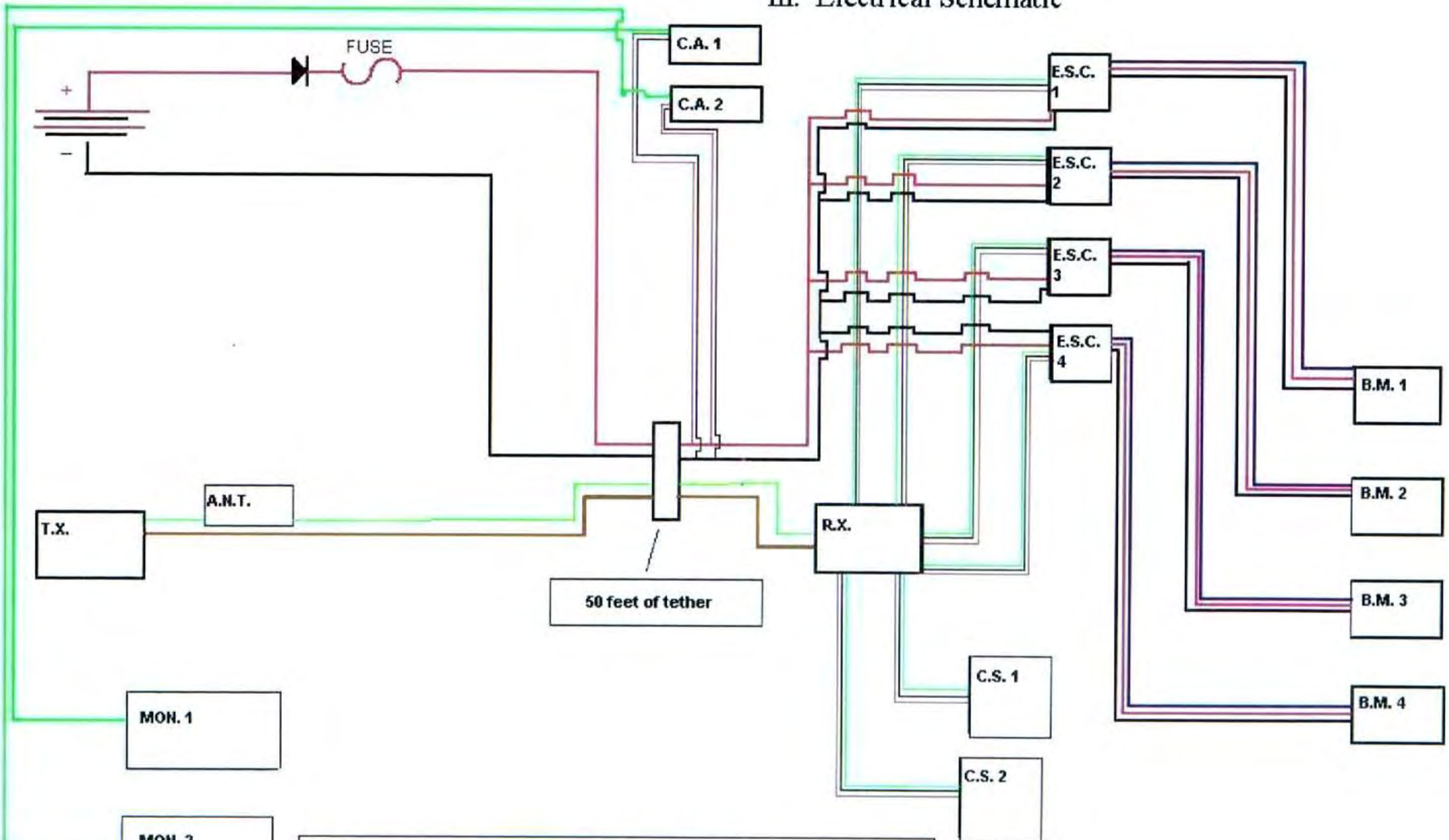
School Name: Great Lakes Home School Group
Instructor/Sponsor: Cary Ford

Period: From: 03/01/07 To: 06/01/07

Funds

Date	Deposit or Expense	Description	Expenses	Donations	Balance
04/26/07	Expense	CarQuest, Fuse and Terminals	$ 4.32		$ 577.53
04/27/07	Expense	Wal-Mart, Foam Insulation	$ 8.38		$ 569.15
04/27/07	Expense	CarQuest, Tether Cover	$ 34.98		$ 534.17
04/27/07	Expense	Radio Shack, Banana Plugs	$ 5.29		$ 528.88
05/07/07	Expense	Global Plastics, Acrylic Domes 50% Discount	$ 42.00		$ 486.88
05/11/07	Expense	MSC, Thruster Housing	$ 108.16		$ 378.72
05/11/07	Expense	Hi-Maxx, Brushless Motors	$ 111.93		$ 266.79
05/14/07	Donation	Applied Industries		$ 65.28	
05/14/07	Expense	Applied Industries, Seals	$ 65.28		$ 266.79
05/23/07	Expense	MSC, Thruster Materials	$ 41.97		$ 224.82
05/27/07	Donation	Pelican Case		$ 200.00	
05/27/07	Expense	Pelican Case, Electronics Case and Flashlights	$ 200.00		$ 224.82
05/28/07	Expense	Wal-Mart, Strainers	$ 4.75		$ 220.07
05/28/07	Donation	Industrial Magnetics		$ 110.93	
05/28/07	Expense	Industrial Magnetics, Brushless Motors	$ 110.93		$ 220.07
05/30/07	Expense	Super Circuits, Camera	$ 78.67		$ 141.40
		Total Construction Costs	**$ 1,999.31**		

III. Electrical Schematic



A.N.T. - Attenuator
B.M. Brushless out-runner electric motor
C.A. - Camera
C.S. - Camera servo
E.S.C. - Electric speed controller
Mon. - Monitor for camera
R.X. - Receiver
T.X. - Transmitter

- Diode

Green – Signal
Red – Positive 12volt
Black – Negative 12volt
Blue – Signal for brushless motor(s)
Brown - Ground for signal

IV. Design Rationale

The Frame Design and Lighting System

Fig. 4-1: Learning the art of PVC construction.

The Great Lakes ROV Team researched previous ROV designs for several weeks and discovered that polyvinyl chloride (PVC) is a durable, cost-effective and easily assembled material for frame construction. The rectangular frame is constructed using 1.9cm tubing with an outside, rectangular dimension of 56cm wide, 59.5cm in length and 37.5cm in height. These dimensions allow for maximum stability while remaining within contest restrictions. The frame is drilled at every joint along the ventral and dorsal surfaces to allow water to enter, making it possible to maintain neutral buoyancy.

Mounting various items to the frame is easily accomplished by drilling, bolting or through the use of stainless steel band clamps. Two waterproof flashlights are positioned for optimum viewing using stainless hardware.

The Buoyancy System

The ROV's design includes two separate ballast systems. First, a static system is used to establish neutral buoyancy, a second adjustable system allows the ROV to ascend rapidly and compensate for variable payload. The static ballast system is comprised of two lO.2cm x 59.5cm watertight PVC tubes. Each tube is mounted horizontally as high dorsally and as far laterally as possible. In addition, there are two 5.lcm x 59.5cm watertight PVC weight tubes. The weight tubes are mounted horizontally as low ventrally and laterally as possible. This maximum distance between the flotation and weight tank, increases stability.

Once we determined the amount of weight required to achieve neutral buoyancy, O.9kg were moved to the opposite side of the mechanical arm in order to compensate for it's weight.

An adjustable ballast system was not required to complete the missions, however the benefits of such a system made the creation of such a system worthwhile. Our system is comprised of two lO.2cm x 31.5cm PVC tubes mounted vertically at the center of gravity and as far forward and aft as possible.

Each tube is sealed at the top and open at the bottom. This forms a type of miniature diving bell. Each bell is drilled in the top to receive a l.2 cm compressed air line from the surface. Use of adjustable valves at the surface permits each bell to be operated independently. The independent manipulation of these bells greatly increases maneuverability and allows the operator to adjust for variation in payload.

Fig. 4-2: Our Bell Tanks in Home Depot orange.

When the ROV is first placed into water, air becomes trapped in the bells. To allow for rapid descent, a hand-operated vacuum at the surface is utilized to remove the trapped air. Rapid ascent is achieved by: filling both bell tanks using compressed air.

The Control System

Fig. 4-3: Our radio control transmitter.

Our control system was designed and constructed to gIve us a completely proportional method of controlling our ROV. We accomplished this by using a FM (Frequency Modulation) 75mz transmitter to send RF (Radio Frequency) signals to our machine. The signal is transmitted through 23m of RG-174 mini coax cable. This transmit signal is received by a 75mz receiver that is housed in the ROV. Since our transmitter was intended to transmit signals through air and not through the more conductive RG-174 coax, we had to modify the transmitter so the receiver wouldn't be overloaded by the increase in RF power. We did this by installing a 10db (decibel), 50 Ohm attenuator in the transmitter. This attenuator lowers the RF power.

Once the receiver obtains the signal from the transmitter, it sends commands to our two Mamba 25 amp electronic brushless motor controllers. These controllers allow us to throttle our four thrusters independently and proportionally in both forward and reverse directions. The controllers also allow us to electronically adjust the starting torque, timing, and the percent of reverse throttle available to our thruster motors. This allows us to adjust the thruster's power to adapt to different conditions. For example, if the ROV is operating in a current, we can increase the motor's timing to gain more thrust. In a situation that doesn't required as much thrust, we can retard the timing to lessen the current draw. We believe this proportional control system gives us a huge advantage over ROVs using non-proportional systems. In addition, this system is much more reliable and less expensive than computer systems \vith the same capabilities.

The Thrusters

Fig. 4-4: Brushless motor housing.

The thrusters we used in the regional competition consisted of (4) 1800 LPH (Liters Per Hour) bilge pump motors. We placed these inside nozzles made from PVC pipe adapters. These nozzles greatly increased the thrust produced and at the same time significantly reduced the current draw of the motors. Please refer to the graph for more thrust information (pg 12). These thrusters produced a fair amount of thrust, but because of our ROV's large size and the water currents at the international competition, we decided to find a way to increase their thrust. We did this by replacing our original motors and housings with those of our own design.

At the heart of the thrusters are the HC2812-0650 brushless outrunner motors. These motors are made by HiMaxx motors, and are rated at 80-85% efficiency as opposed to the 45-55% efficiency brushed motors we used in the regional competition. Because the efficiency is so much higher, the motors will produce more thrust, while using the same amount of power. These motors are outrunners, meaning their exterior rotates. This gives these motors huge amounts of thrust at a low RPM (Revolutions Per Minute). As their name implies, these motors don't use brushes, rather they have an internal stator that is charged by the electronic motors controllers. Doing so causes the stator to develop a magnetic charge. This causes the can to rotate. The motor code tells us many things about these motors. The first is the number 2812 after the HC. This tells us that the motor has a 28mm can diameter and the internal stator is 12mm in diameter.

The 0650 tell us that for every volt given to the motor, it will spin at a rate of 650 RPM, so with no load and 12 volts of power they will spin at 7800 RPM.

The motors are housed in watertight casings that we machined from nylon 6/6. The housing's body is made from 5cm OD (Outside Diameter) extruded acrylic tubing. At the heart of the housing is the prop shaft. We machined these from non-hardened 0.952 OD stainless steel, and then hardened them at 480 degrees Celsius for one hour. By doing so, we hardened them to a Rockwell hardness of 45. We then pressured (2) 0.952 x 1.905cm ball bearings into each of our nylon bearing housings. A SKS CRW5 high pressure lip seal was then installed between the bearings and the exterior of the housing. Each end assembly is sealed to the main body using compressed o-rings. Please refer to the thrust and current usage graph for thruster performance information (Pg 12).

Fig. 4-5 & 4-6: Machining our acrylic brushless motor housings and the finished product. The white portion is machined from nylon for its' lightweight and strength.

The Electronics Housing

All of our ROV's electronics, with the exception of our number one camera, are held in the electronics housing. This housing is constructed from a 23cm long piece of 5cm ID (Inside Diameter) high pressure 0.625cm wall steel tubing. Welded on each end of this tube are steel flanges. These serve as a mounting bracket to attach our 10cm ID acrylic domes. These domes are 0.635cm thick and are attached to the flange using stainless steel bolts. These bolts also seal the domes against their rubber gaskets. Our signal and power wires enter the compartment through a multiple-pin, underwater bulkhead connector. This connector ensures a watertight seal, and allows us to remove the tether from the ROV. The ROV's thruster leads enter the compartment through a gland seal that is compressed around the wires, creating a reliable, watertight seal.

The Tether

The ROV (Homer) receives control commands from the surface via a 21 meter tether The tether is composed of three separate units encased in flexible 2.55cm automotive electrical wire sheathing.

The first unit consists of five 0.64cm air lines. Two for the universal pneumatic appendage, two for the adjustable buoyancy system, and one for the depth gauge. In addition to delivering air to the ROV, the air lines aid in making the tether naturally buoyant. To prevent the ROV from becoming entangled in it's tether, a slight positive buoyancy was needed. We achieved this by adding 15cm pieces of 255cm foam pipe insulation every 2 meters, to within 6m of the surface controls.

Fig. 4-7: Homer's tightly bound tether.

The second unit consists of (2) 10 gauge, a 12 volt power supply cable, and a 4G-174 coax cable. Waterproofing was accomplished by encasing the entire length of the tether in electrical shrink wrap. The 12 volt power supply cable includes a 25 amp in-line fuse.

The final unit consists of (4) waterproof camera wires that carry video signals in real-time to the surface.

The Camera System

Homer is able to be operated through the use of (2) onboard cameras. Both cameras provide black and white images which provide us with greater contrast. The cameras are not waterproof and therefore require that they be mounted in waterproof containers. In order to prevent condensation from forming each camera container is equipped with two small silicon bead packets.

Waterproofing the first camera this was easily achieved by mounting it behind the fore acrylic dome of Homer's electronic compartment. The PC212XS DC camera is 2.55cm square and 1.9cm thick. The resolution is 380 lines with a low light rating of 0.1 lux. The camera is mounted to one vertical and one horizontal servo allowing a camera view of any forward direction necessary.

Fig. 4-8: Camera Case

The second camera is a small PC74WR DC lipstick design with 420 lines of resolution and a low light rating of 0.1 lux. It is enclosed in a custom-made 5.1cm x 7.6cm PVC case with a clear lexan lense. This case is mounted just behind the claw of the universal appendage allowing a clear view of the claw's function. Mounting the camera in this manner allows the operators to view from above and below the ROV and anywhere in-between simply by raising and lowering the arm of the universal appendage. As an additional safeguard against condensation this case has been filled with helium gas.

The Appendage Design

Our team determined that a universal appendage and two mission specific appendages were necessary to complete all three competition missions.

The universal appendage is comprised of an elevating arm with an opposable, grasping claw, similar to a human arm and hand. This universal appendage (which will be referred to as arm and claw) is pneumatically operated and is comprised of two 1.9cm x 23.7cm stainless pneumatic cylinders.

Each cylinder receives 40 psi compressed air through 1.28cm air lines from the surface. The surface air lines are attached to both pressure and bleeder valves. Air pressure is used to extend the cylinder, thus opening the claw and/or raising the arm. Spring tension is used to contract the cylinder, thus closing the claw and/or lowering the arm.

Fig.4-9: Homer's stainless steel universal appendage and attached lipstick camera.

As air is released through a pressure valve, attached cylinders can be fully extended against spring tension. When closing a pressure valve and opening a bleeder valve, the opposing spring tension compresses the cylinder. The first cylinder is used to raise and lower the arm. The arm can be raised 10.2cm above and lowered 7.6cm below the ROV. A needle valve permits the arm to stop at any degree of elevation or descent. This is very important as a camera is mounted on the arm just behind the claw. The claw can be opened to a maximum width of 19.0cm.

The universal appendage is modified with the addition of two removable, screened baskets at the claw to collect algae in mission 2, while the narrow design of the closed claw permits precise threading of a string through the U bolt in mission 1.

To assist in removal of the well head cap in mission 3, a simple stainless steel rod with a hook is mounted at the bottom front of the ROV.

A "T" appendage is used to control the hot stab in mission 3. This "T" shaped appendage is mounted at a 45 degree angle. It is equipped with a spring-loaded finger to hold the hot stab. Once the hot stab is inserted into the well head, the ROV easily overcomes the spring-loaded finger tension by descending, thus releasing the hot stab.

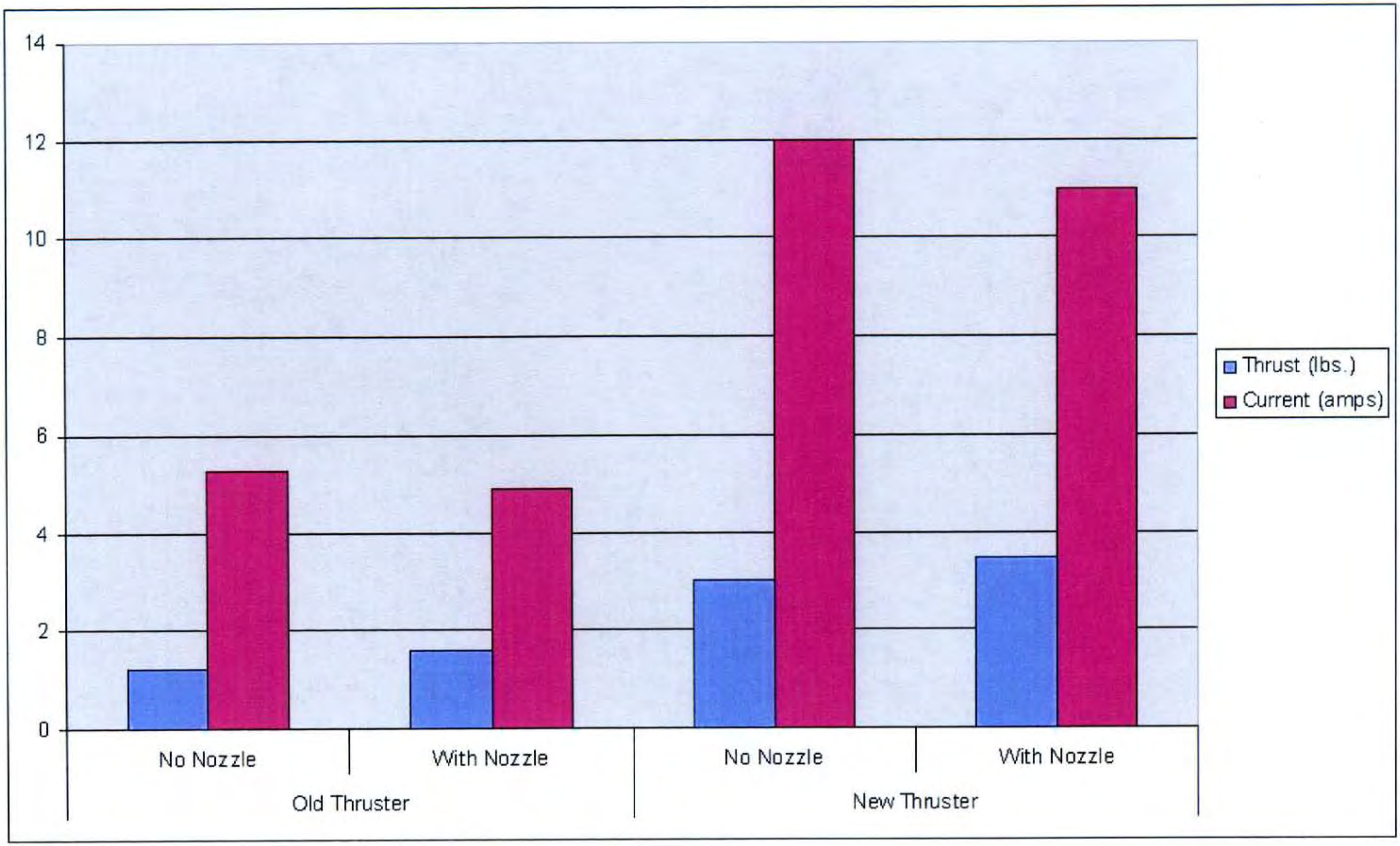
Sensor Monitors

Fig 4-10: Depth Gauge

Homer's power monitoring is completed with the use of an ammeter and volt meter at the surface. These ensure that Homer will not exceed the competition restriction of 25 amps.

A diver's depth gauge receives pressure at the surface through an air line. The end of this line is attached to a home made air bladder constructed out of a PVC tube open at one end, encasing a balloon. The depth gauge has been custom labeled at one meter intervals. A compass is visible via one of Homer's onboard cameras. These monitors allow the operators to efficiently orient the ROV underwater.

Compressed air pressure is monitored at the surface using an inline air pressure gauge. In addition an inline air dryer is used to prevent condensation from freezing within the air lines.


14
12
10
8
6
4
2
0
No Nozzle
With Nozzle
No Nozzle
With Nozzle
Old Thruster
New Thruster
Thrust (lbs.)
Current (amps)

V. Challenges

This project presented our team with many challenges, but the greatest of all was sealing the electronics and thrusters from moisture. Originally, our electronics were sealed in a 5cm ID PVC tube with screw-on caps. This compartment leaked in several places, mainly where the signal wires entered. This leakage led to the destruction of a receiver. To prevent future leakage, we designed and constructed the compartment described in The Electronics Housing section of this report.

Another challenge was sealing our thrusters. Our original thrusters were water sealed, but for our brushless thrusters, we had to devise a fail-proof seal. This presented a huge challenge, because of the water pressure, vibrations, and the friction caused by a shaft rotating at 7800 RPM. To overcome these hurdles, we used a SKS CRW5 high pressure lip seal. This seal features a Viton lip, capable of ensuring a watertight seal at pressure up to 3.5kg per square centimeter (50 psi). This far exceeds the water pressure exerted on the ROV during the competition.

Fig. 5-1: Checking for leaks.

VI. Troubleshooting Techniques

Our initial design goals stated that we wanted to build a ROV that used proven techniques, of durable construction, and was versatile in operation. Having satisfied the first two goals, we then concentrated on versatility in operation. We did not want to build a ROV that could only complete the task in each mission. We wanted to build a ROV that could do more. Homer's pneumatic appendage and the increased power of the brushless thruster motors are evidence of this. Our desire to make our ROV as functional and versatile as possible is probably most evident in the adjustable buoyancy system.

Reviewing the MATE mission parameters, the team realized that it was not mandatory for the ROV to have an adjustable buoyancy system. The team reviewed the benefits such a system would provide and designed a system to fulfill our needs. Using the equation V = Phi x radius squared x height, we were able to determine that we would need two independent 15 .3cm x 31. 5cm PVC bells for a maximum combined buoyancy of 11.3kg. This design allowed for a lot of adjustability but we found that the large size of the tanks left little room inside the ROV frame for anything else. In addition, the bell tanks had to be mounted adjacent to each other reducing the effectiveness of the ability to raise and lower the front of the ROV.

Fig. 6-1: Determining size of buoyancy tanks.

Our next design utilized two independent 10. 2cm x 31. 5 cm bell tanks. Although not as buoyant as our first attempt, we discovered that by reducing the diameter of the bells they could be mounted with 22.8cm of space between them. The separation of the bells made it possible not only to adjust for increased payload, but also made the ROV more maneuverable.

Our team soon realized that additional problems would occur when the ROV is moved from 22 degrees Celsius to one near freezing. Condensation formed on the camera lens. The problem was approached systematically by first ensuring that the camera compartments had not leaked. The next step was to make the air within the camera cases as dry as possible. Budget restrictions dictated that our solution would have to be inexpensive. Our solution was to place two silicon bead packets (found in new shoe boxes) be placed inside the camera cases. We placed the packets in front of a fireplace to dry the beads as much as possible before placing them inside the cases. As an additional fail-safe we drilled and tapped the camera case mounted on the universal appendage. We then flooded the case with helium and plugged the holes.

Our experience with condensation made us determined to avoid similar problems with Homer's other systems, so we looked for potential problems and determined that condensation could also freeze inside the air lines if they were exposed to temperatures below freezing. An in-line compressed air drier was installed just in case.

VII. Skills Gained

- **Awareness of Engineering Profession:** In the beginning of our project, our understanding of engineering as a profession was limited in it's scope. We didn't know what designing a ROV entailed. We had never designed a vehicle, created a CAD (computerized assisted design) ofa vehicle or worked from a budget.
- **Analytical Thinking:** Our team learned effective methods of thinking and problem solving our difficulties. Every aspect of the ROV competition brought new challenges which required creative problem solving and an observation and analysis of the problem. From the inception of our team, assignment of duties, the way we chose to work for weeks on the design rather than beginning right away with construction; all played a part in the problem solving of the ROV challenge. We discussed every aspect of the design for weeks before coming up with what we felt was the best solution to the various mission challenges.
- **Communication:** Our common thread was being homeschooled. We had many different personality types and at first, many different ways of trying to get our points across. What we discovered in the end was that the easiest way to communicate with team members, mentors, donors and the public at large during our many fundraisers was to listen, then talk. We tried to be specific to avoid miscommunication. We tried to stick to the point without becoming side-tracked. We also tried to make sure that all team members knew what was happening and when to avoid lost time, expensive errors and hurt feelings.
- **Physics:** The experience of actually using an equation to determine buoyancy was fun! To actually use math to determine the size of our ballast bells was amazing. We calculated, tested, then recalculated and retested. It saved us lots of time, materials and frustration by getting it right the first time rather through numerous trial and error procedures.
- **Exposure to Professionals:** We called, emailed and spoke to various professionals about our project. From NOAA personnel, electricians, underwater ecology biologists, Marine Sanctuary staff and university professors, we became more aware of the multitude of career opportunities associated with use or development of underwater ROVs. We learned to be succinct to avoid taking too much time from busy professionals who were willing to talk to us. We also learned to organize our thoughts and questions before talking to each professional so that our time was optimized.

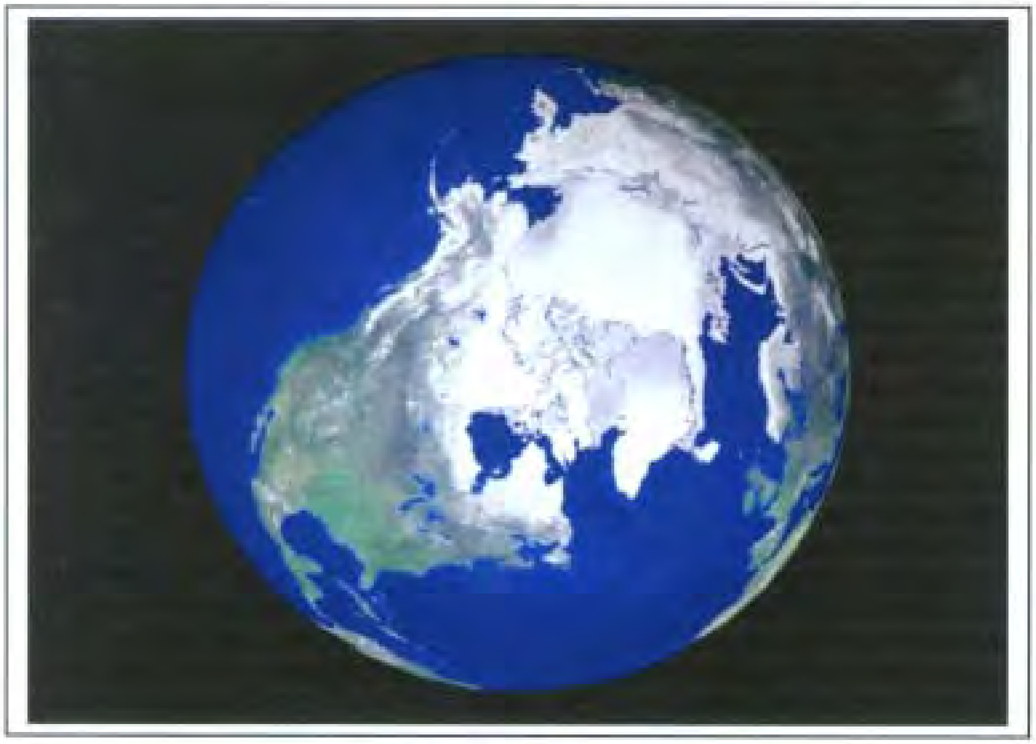
VIII. Future Improvement

- **Frame:** The contest parameters this year made it very advantageous and cost effective to use PVC for our frame construction. In the future the Great Lakes ROV Team may choose to use a metal frame which would allow us to have a more compact design and more durable construction .

- **Electronic Valve Controls:** Although very effective, this year's air control manifold consisted of (8) ball valves connected using black pipe. This proved to be heavy, bulky and difficult to transport. Using electric valves, we could reduce the size and weight of our valve controls and improve portability and ship-ability.

- **Time and Money Constraints:** Our team first became aware of the MATE competition just 6 weeks prior to the regional competition. During that time, we had to form a team, the members had to find out exactly what ROV s are, research ROV construction and explore various methods of operation currently being utilized. Our ROV was constructed in the 5th week followed by testing during the 6th week. Fortunately our team has an excellent working relationship and everyone completed their portion of the ROV design and construction on time. Had more time been available, the team could have spent more time being creative and less time concerned with fundraising to cover costs of the entire project. Since time was short, fundraising efforts were limited and therefore the team used less expensive alternatives to our original preferences and design.

IX. Arctic Culture and History



The *Umialik*

The Inuit people are a proud people. They are proud of their beautiful language and their customs. They accept pizzas and the Mexican food and the videos, but they fight to keep their world the way it has been (Jenkins, 330). The Inuit know that in this extreme environment, their survival depends upon the collective knowledge of past generations.

This is especially evident during the May whaling season. Perhaps the most prestigious position in Inuit culture is that of the whaling captain known as *umialik.* This position cannot be obtained with a degree or by winning an election. The position of *umialik* can only be obtained through extensive experience and respect of the Inuit people. The lives of the whaling party and the entire village depend upon the *umialik* He must have an extensive knowledge of ice, it's properties and movement patterns. The Inuit people have over 300 different words for ice (MacLean). Some of the words that the Inuit use for ice include:

- *aisitaq* - cracked ice made by force of moving ice
- *anaglu* - black ice
- *augafaruaq* - ice thrust up at an angle
- *ataigvik* - shore ice patch on coastline
- *atigniq* - new ice forming a smooth apron around pre-existing ice
- *aayugaq* - ice ridging, or crack across a shallow lagoon or bay
- *aluksraq* - young ice punched by seals forming a seal blowhole

The story is told in Peter Jenkin's book Looking For Alaska of an *umialik* hunting on the land-fast ice with his crew. They sit quietly waiting for the migrating whales to pass when suddenly the silence is broken by the *umialik* shouting for everyone to hurry and pack everything. Without anyone else being aware, he has noticed the moving slab ice and icebergs. He had been silently calculating the current and ice movement and he determined that the icebergs and pack ice had changed direction and was now moving straight at them. The *umialik* knew that when land-fast ice is hit by moving ice, the force causes the ice to shatter and go up into the air in ridges that can be higher than a two story house. Some of his ancestors had been killed in this way. Others suffered a slow death by being trapped on an ice flow moving out to open sea.

As the Inuit of Alaska are exposed to modern influences of the world, it is encouraging that they have realized the value of preserving their culture. To lose their history and culture would result in the lose of knowledge that has taken centuries to obtain.

Bibliography:

Jenkins, Peter. Looking For Alaska.
New York: St. Martin's Press, 2001.

MacLean, Edna A. "Culture and Change for Ieupiat and Yupiks of Alaska." 2004. <http://www.alakool.orginative_ed/articles/EMaclean-CC.htm>(accessed 9 May 2007).

X. Reflections On The Experience

The Great Lakes Homeschool ROV Team came together for the first time in February 2007. We were acquaintances but barely knew more than each other's names. We quickly learned that each member brought a special talent or area of interest to our team and decided to capitalize on that when we researched, designed and constructed Horner our ROV. Scott Rhudy's love of all things electronic, and hobby of flying radio control airplanes made him a shoe-in to design the electronics and control the ROV at competition. Benjamin and John Ford have been taking apart and reassembling snowmobiles, tractors and cars for years. They were immediately interested in putting together a ballast system and appendage and set to work creating, discarding and cutting out 3D patterns for the ROV. Nathan and Hannah Zowada went to work constructing the framework and poster. They were unparalleled in their technical drawings and camera expertise, as both enjoy computers and photography.

To begin such a extensive and technical project with only 6 weeks to achieve our goal of competing in the regional competition made many wonder if we could possibly meet our deadline. The team quickly became a cohesive group who recognized each other's talents, learned to respect each other's opinions and helped each other along the way when troubleshooting problems. We worked closely with adults who taught us life skills of using mechanical equipment, welding, physics, communication, teamwork, analytical thinking and budgeting.

This experience has provided us with a sense of accomplishment and pride in knowing that we set a goal and despite numerous problems including lack of funding and lack of knowledge, we overcame each problem one at a time. We learned to prioritize and trust each other. It has been an experience we will always remember, with lessons that cannot be learned in school.

XI. Acknowledgements

Cary Ford Team Mentor

Tim Zowada Mentor

Otsego County Sportsplex

The Home Depot

Kiwanas Club of Petoskey

Midstate Bolt and Screw

Bernie Hellstrom

Industrial Magnetics

Steve Ruberg, NOAA

Patrick McMullen

Thunder Bay Marine Sanctuary

Steven Hanson, MD

Applied Industries

Hytec RCD USA Inc.

Gaylord Ace Hardware