2009

Carrollton High School

ROV Team

Trojan 1

Team Members: Class of ’10: Bennett Stedwell (Marine Technology) Class of ‘11: Matthew Cline (Civil Engineering), Caroline Cooper (Environmental Science), Patrick Dost (Marine Biology), Kaj Hansen (Astrophysics), Rebecca Hutcheson (Medicine), Russ Ives (Medicine), Bo Lovvorn (Engineering), Jayanta Ray (Computer Programming/ Engineering), Karl Sanchez (Astrophysics), Laren Smith (Engineering), Justin Whitaker (Aerospace Engineering), Katherine Wilson (Medicine)

Coach: Mr. Huff

Mentors: Dr. Cooper, Dr. and Mrs. Stedwell, Mr. Daniel,
Mr. and Mrs. Dost, and Dr. Ray.

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Figure 1:

Team Members work on toggle switches.

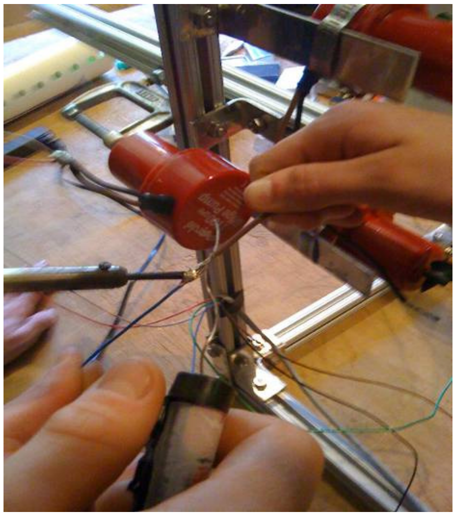


Figure 2:

Team Members work on soldering a motor.

Abstract

The 2009 mission goal is to construct a remotely operated vehicle (ROV) that performs submarine rescue. Remotely operated vehicles are the eyes and arms of marine rescue; they are economical, efficient, and safe. This year's mission simulates (1) inspecting a submarine for damage, (2) opening a submarine escape tower hatch, (3) placing pods inside the escape tower, (4) inserting an air hose into the ventilation system, (5) turning the air flow valve, and (6) docking with the mating site. Our main objective is to construct a reliable, maneuverable, and versatile platform from which tasks can be completed. After salvaging as many parts as possible from the previous year's ROV, the team has worked to incorporate better design features to improve its functional and safety.

The ROV frame is constructed from lengths of aluminum extrusion in the shape of a rectangular prism; with mounting rails which allows easy placement of the thrusters, cameras, and interface devices. The Carrollton High School ROV, *Trojan 1* (Figure 3), features a multi-purpose manipulating hook for recovering the pods, a mating skirt, and a claw to carry, deliver, and retrieve the air hose. The ROV is maneuvered using toggle switches in a control box and has a passive ballast system to maintain neutral buoyancy. Our team has had the opportunity to collaborate with local electricians and engineers for technical help. By making many improvements in our ROV design and functionality, we have enriched our knowledge not only in building ROVs, but also in leadership, organization, and teamwork.

Figure 3: *Trojan 1* ROV

Mechanical Drawing

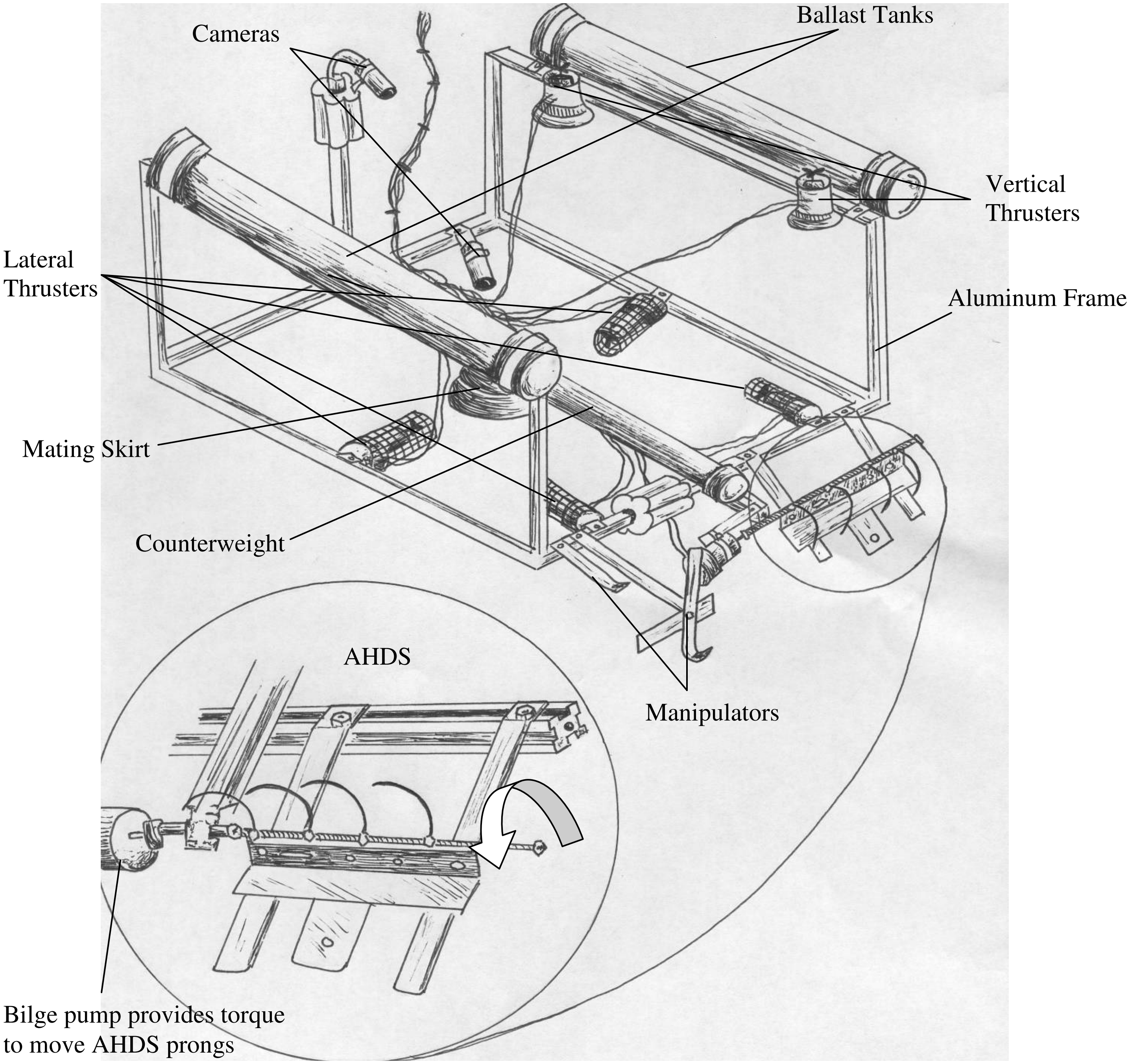


Figure 4:
Mechanical Drawing of *Trojan 1* ROV
Drawn by Rebecca Hutcheson

CHS Trojan 1 ROV 2009 Budget

Item	Uses	Qty	Cost/unit	Total Direct Cost	Total Value	Source
.5 0z rosin	Solder	1	$3.07	$3.07	$3.07	Purchased
Spade 12-10	Misc for Building	2	$2.12	$4.24	$4.24	Purchased
60' trtnveltp	Misc for Building	5	$0.74	$3.70	$3.70	Purchased
1/4-20x1/2s/s hcs	Bolts	100	$0.18	$18.00	$18.00	Purchased
1/4"-20 s/s fhn	Nuts	100	$0.12	$12.00	$12.00	Purchased
12 oz. silver sdr015	Solder	2	$5.87	$11.74	$11.74	Purchased
4 oz. nsf primer purple	ABS Primer	1	$2.70	$2.70	$2.70	Purchased
Cement pvc 4 oz.	ABS Cement	1	$2.40	$2.40	$2.40	Purchased
Heat shrink tubing 1/4"	Shrinking Wire Insulation	2	$2.12	$4.24	$4.24	Purchased
Heat shrink tubing 3/8"	Shrinking Wire Insulation	4	$2.12	$8.48	$8.48	Purchased
#12 stranded green	Terminal Wire	1	$18.60	$18.60	$18.60	Purchased
3"x5' abs dwv pipe	ABS Pipe	1	$9.27	$9.27	$9.27	Purchased
Abs cap 5817	ABS Caps	6	$4.95	$29.70	$29.70	Purchased
Tubing <A>	Shrinking Wire Insulation	1	$2.09	$2.09	$2.09	Purchased
Tubing <A>	Shrinking Wire Insulation	1	$1.92	$1.92	$1.92	Purchased
.25oz ldfree .032	Solder	1	$4.16	$4.16	$4.16	Purchased
.50oz 6040 sdr032	Solder	1	$2.34	$2.34	$2.34	Purchased
.25oz ldfree .032	Solder	2	$4.16	$8.32	$8.32	Purchased
Bilge pumps	Thrusters	2	$37.40	$74.80	$74.80	Purchased
Bilge pumps	Thrusters	7	$37.40	$ -	$261.80	Re-Used
Foam Pipe Insulation	Tether Flotation	6	$2.41	$ -	$14.46	Re-used
Cameras	Visual Sensor	2	$530.67	$ -	$1,061.34	Re-Used
Stretch Netting	Safety Partitions	1	$5.30	$ -	$5.30	Re-Used
Banana Clips	Connectors	2	$5.34	$ -	$10.68	Re-Used
Toggle Switchs	Control Switches	9	$20.30	$ -	$182.70	Donated (3) Re-used (6)
Revere medium tape 1	Elect.Waterproofing Tape	2	$2.00	$ -	$4.00	Donated
Rubber Electrical Tape	Elect.Waterproofing Tape	1	$5.21	$ -	$5.21	Donated
Project box	Terminal/Control Box	1	$6.41	$ -	$6.41	Donated
Fuse holder itc inline	Fuse Holder	2	$2.13	$ -	$4.26	Donated
Fuse itc inline	Fuses	1	$3.41	$ -	$3.41	Donated
19" Tool Box	Storage	1	$10.66	$ -	$10.66	Donated
1/2" ABS Cap 5817	ABS Caps	2	$2.00	$ -	$4.00	Donated
Rubber Electrical Tape	Elect.Waterproofing Tape	1	$5.21	$ -	$5.21	Donated
1/2" ABS 90 Elbow 5807	ABS Elbow	2	$1.04	$ -	$2.08	Donated
1/2" X5 ABS DWV Pipe	ABS Pipe	1	$3.57	$ -	$3.57	Donated
3 X 25 mm Al. Brackets	Joints/ Brackets	50	$1.06	$ -	$52.97	Donated
Main Wire (Gray)	Tether	1'	$347.75	$ -	$347.75	Donated
Plunger	Mating Site	1	$8.56	$ -	$8.56	Donated
Metal Bracket	AHDS	1	$8.53	$ -	$8.53	Donated
Poplar Wood	Carrying Frame	1'	$14.70	$ -	$14.70	Donated
Zip Ties	Connectors		$21.40	$ -	$21.40	Donated
Hose Clamps	Clamping	7	$1.64	$ -	$11.48	Donated
Propellers	Props	8	$1.25	$ -	$10.00	Donated
Alum Extrusion 3x2.4m	Frame	3	$34.00	$ -	$102.00	Donated
Prop, right / 4.0mm gs (se)	Props	5	$4.50	$ -	$22.50	Donated
Prop, left / 4.0mm gs (se)	Props	5	$4.50	$ -	$22.50	Donated
Wooden Wire Spool	Tether Transportation	1	$5.35	$ -	$5.35	Donated
Total				**$ 221.77**	**$ 2,434.60**	

Notes: Donations include purchases made by parents and gifts in kind and support from local businesses.
Re-used means salvaged from last year's ROV.

Donated or Re-used Parts Value $2,212.83

Electrical Schematic

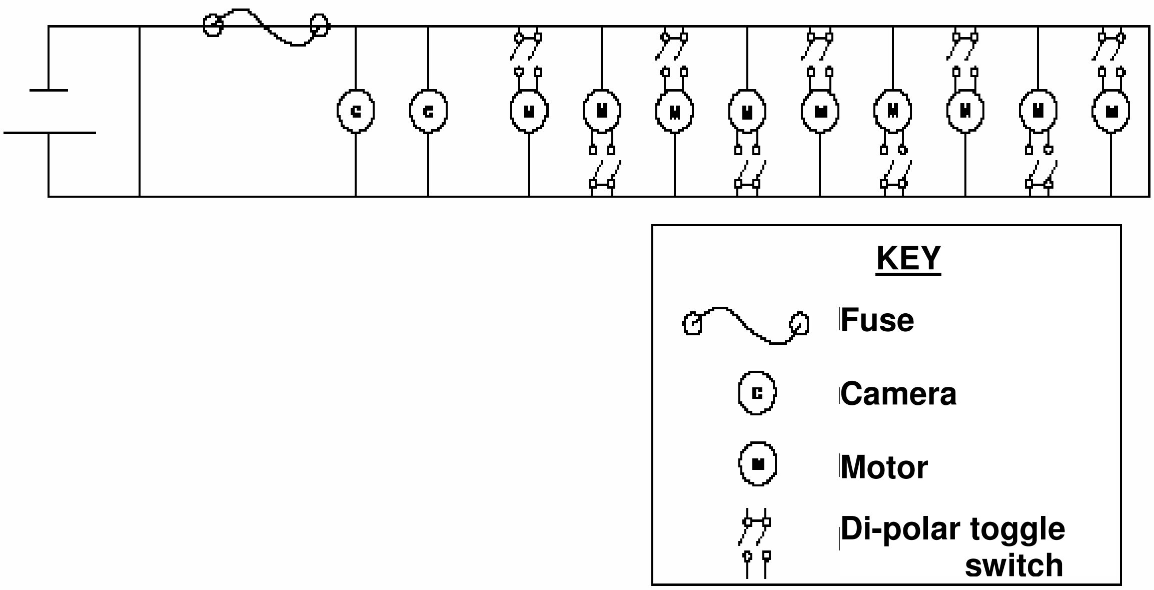


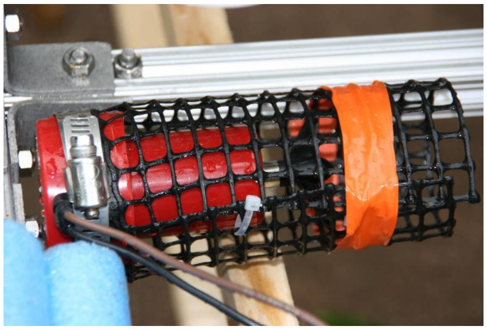
Figure 5: Electrical Schematic of *Trojan 1* ROV

Design Rationale

Frame – *Trojan 1*'s frame consists of railed aluminum extrusion connected together to create a rectangular prism. The dimensions are 66 cm x 61 cm x 20 cm. We chose railed aluminum extrusion because it is easier to attach, detach and move items mounted on our ROV using the rails. The decision to use aluminum over poly vinyl chloride (PVC) was made because aluminum has more structural integrity than PVC. In layman's terms, we wanted something that would be able to take a beating and keep on rolling. In addition, aluminum is easier to recycle for future competitions.

Thrusters (Figure 6) - There are a total of eight thrusters on *Trojan1*. Four are positioned near the bottom of the frame which steer the ROV in the four cardinal directions; two for moving forward and backward, and two for lateral motion. The lateral thrusters give us the ability to reposition our ROV on the same y-z (vertical and front-back) axis plane but change our x-axis position. The lateral thrusters are all 4,200 liters per hour (LPH) bilge pumps.

Figure 6: Bilge Pump with Propeller and Safety Partition



There are four 4,500 LPH bilge pumps that act as vertical thrusters. They move the ROV up and down and are located in the four upper corners of the frame. On all movement orientated thrusters, propellers have been attached, converting ordinary bilge pumps into fully functional thrusters. The team has also included a ninth bilge pump on the Air Hose Delivery System (AHDS) which is used to transport an air hose into the hatch.

Control System – The ROV control scheme consists of two black boxes. One box houses the toggle switches for nine motors. We decided to go with toggle switches to control our ROV because it was the simplest and most cost efficient means of creating our control system. Also, if anything breaks inside the control box, toggle switches are easily removed and replaced. The second box in our control system is our terminal box, which protects the circuit series. Inside this box there are two terminals to simplify the wiring from twelve leads down to only two leads which go directly to the battery. Terminals are plastic devices with leads for power coming out. Those leads are all connected through the toggle switches to their respective motors. Essentially, electricity from the battery goes into one end and is then transferred down to all the other leads. This helps in organizing the wires and helps with troubleshooting an electrical problem. The final part of our control system is a 25 amp in-line fuse to protect the system from shorting out and to protect our team from injuries due to electrical discharge. The electrical schematic is shown in Figure 5.

Based on the criteria below and the lack of software expertise in our team, we decided to go with the more simple hardware-only method of operating our ROV using a control box and toggle switches.

Comparison of Software vs.	**Hardware**
Benefits 1) Cable for completing very complex tasks 2) Very versatile	**Benefits** 1) Can easily replace parts 2) Lower cost than software 3) Easy to use 4) Small learning curve 5) Allows the entire team to participate
Downfalls 1) Costly 2) Very complex 3) Difficult to troubleshoot 4) Restriction on possible pilots	**Downfalls** 1) Not capable of performing as complex tasks

Cameras (Figure 7) - There are two cameras on *Trojan 1*. The first camera is located in the upper rear center of the ROV and is dedicated to viewing and maneuvering of the ROV, in addition to identifying the damage points on the submarine. The second camera is located on the underside of the ROV and is multifunctional. This camera views the mating skirt, the end of the air hose, and the delivery system for the Emergency Life Support System (ELSS) Pods. We chose to use two cameras this year because of the range of tasks that we have to complete; not only do we have to drive the ROV, but we also have to work with tools located under the belly of *Trojan 1*. We could not position a single camera to effectively view all required angles.

Figure 7: Upper and Lower Cameras

Ballast (Figure 8) – *Trojan 1* has two ballast tanks which are constructed of 7.62 cm acrylonitrile butadiene styrene (ABS). Each ballast tank has two end-caps which have been sealed off to prevent leakage. Our system is a passive ballast system which means that there is a fixed amount of air in the tanks. After weighing the ROV, a buoyancy equation was used to calculate the necessary ballast size. A passive ballast system is ideal, as a scuba tank does not need to be used. Also, our pilot already has nine switches to manipulate; by having a passive ballast system, we eliminate the need for one more switch. The ballast tanks are mounted using four aluminum rods, two for each tank, that have been bent around the ends of the tanks. The ballast tanks are located on the upper outside port and starboard sides of *Trojan 1*'s frame. The ballast placement allows for optimal balance.

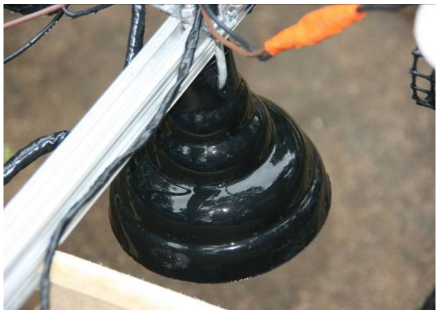
Figure 8: Ballast Tanks

Air Hose Delivery System (AHDS) (Figure 9) – The AHDS was designed based on the idea of a hand clamping down on the air hose in order to secure it for delivery and retrieval from the stranded submarine. We used two lengths of 29 centimeter aluminum plates bent at a 45 degree angle to mount the AHDS to the ROV. The next part of the AHDS is the upper frame and hooks; we used a section of a file cabinet frame and a small length of aluminum rod to create the upper portion of the AHDS. To this upper frame, we brazed four nuts onto a metal bracket to act as hinges for the hooks. Our hooks consist of brass rods crimped onto the threaded aluminum rod which has a joint constructed to connect the bilge pump and hooks. The ninth bilge pump controls the claw of our AHDS, closing the claw around the air hose on the journey down to the stranded submarine and opening it to deliver vital air to the submarine; then it closes around the air hose before returning it to the surface.

Figure 9: Air Hose Delivery System

Mating Skirt (Figure 10) – One of the tasks that our ROV has to complete is mating with the stranded submarine for twenty seconds to simulate an actual transfer time for sailors from the sub to the ROV. To complete this task, we settled on adhering to our mantra to keep it simple. Our team chose to use a rubber plunger attached to the ROV with the same type of U-bolt used for the ELSS Pods. The chosen method of mating gives the pilot slight articulation of the mating skirt, giving us the ability to ensure a proper and secure connection with the submarine.

Figure 10: Mating Skirt under ROV



Multi-Tool (Figure 11) – Mission Objective Hooks – In order to complete the rest of the mission tasks, two hooks consisting of aluminum plates were designed with specific tasks for each one. The first hook, designated the Pod Hook, is dedicated to picking up the ELSS Pods; it is constructed of a single aluminum plate with a 45° bend at the tip to stop the pods from slipping off the hook. We designed this system to be efficient at picking up multiple pods at one time. This allows us to not only deliver more pods to the downed submarine, but also to decrease the amount of time necessary to deliver the five ELSS Pods, since time is of the essence in a rescue mission. The second hook, the Manipulating Hook, consists of an arm connecting it to the ROV and two aluminum plates in the shape of a cross. One is positioned horizontally and is used to open the conning tower hatch and manipulate the air valve. The other plate is positioned vertically and has a hook at the bottom. This hook is used to rotate and open the submarine escape hatch.

Figure 11: Pod Hook (left) and Manipulating Hook (right)

Challenges

During the team's first timed trial at the regional competition, the female connectors to both of our cameras lost electrical connection. As a result, we spent the duration of the first run troubleshooting the problem and attempting various methods to resolve the issue. The first attempts at dealing with the problem involved simply wiggling the various connections, such as the video jacks into the TV. When this failed to produce an image, we checked the fuse to make sure that power was getting to the cameras. When this yielded unsuccessful results, we used our multi-meter to isolate where the break in the connection was, which we determined to be between the battery and the cameras. Using this method, we discovered that the female connectors were where the problem originated. At this point, we realized we would have to resort to more drastic methods to solve the electrical failure. We unplugged *Trojan 1* from the battery so that we would not risk electrical shock or cause our fuse to blow. Then we used wire cutters to remove the male and female wire connectors, giving us access to the exposed wires which we then stripped. By exposing the wires, we were able to connect the two wires directly, twist the ends of the exposed wires together, positive to positive and negative to negative, and plug in the battery to test whether the connections worked. After we had ensured that the cameras worked, we soldered the wires together. Then, we wrapped the connections in black electrical tape thus protecting the connections, and we plugged the banana clips back into the battery. Thankfully, the cameras functioned normally during our second competition run.

Troubleshooting Techniques

Last year, as first time participants in the ROV competition, the members of the Carrollton High School ROV Team were not yet familiar or comfortable with the processes involved in designing a ROV. Because of this, the members did not efficiently go about designing and gathering resources for the construction and testing of various components. For example, last year we often came up with multiple ideas that went untested, and we often would abandon those ideas without suitably investigating their feasibility. In contrast to the methods that were applied last year, the team members now build a prototypical component to perform adequate testing of the concept, discarding those prototypes that do not work as planned. By using valuable experience and knowledge that was gained from the ROV competition last year, the CHS Team is now better able to problem solve when designing parts for the ROV. More importantly, the prototypes go through an extended testing phase to ensure achievability.

Everything on the ROV has gone through many adjustments and alterations. A prime example of this process would be the development of the ballast system. The team has redesigned the ballast system several times in order to allow the ROV to achieve neutral buoyancy. We have reduced the size of the tanks, repositioned them, and even added weight to the center of the apparatus to achieve the appropriate balance. We have decided to stay with a two-tank ballast system on either side of our ROV for optimal stability. Another instance of prototype testing would be the AHDS that is used to manipulate and handle the air hose. The team originally planned to use a large piece of ABS pipe cut and formed to grasp the air hose, but we have decided to use the AHDS mechanism that our design expert, Laren Smith, envisioned. This design now adequately holds the air hose when moving through the water. Also, it allows us to insert the air hose into the submarine with much more ease than our original idea.

Payload Description

Descriptions of the Air Hose Delivery System (AHDS) and Multi-Tool (Pod Hook and Manipulating Hook) are given in the Design Rationale section and shown in Figures 9 and 11, respectively.

Alternatively, the team could have selected a powered “grabbing device” which would have combined the various tools into one. It was decided that the additional weight, tether, and controls were too great of a risk for malfunction.

Future Improvements

If there had been more time, the team would have tried to develop a program to control the ROV through a computer. Software control would make it easier to perform complex tasks such as turning and opening the escape hatch on the submarine. Although developing a program and connecting it to the ROV thrusters would involve also added cost, it would require a lot more time to make it work properly. Once the software program is written and tested, software could be easily adapted to incorporate new tasks in future years.

In the 2009 competition, the Carrollton High School ROV Team has encountered many obstacles throughout the construction and research processes. While our entire team met challenges to the best of our abilities, we realize that there is still room for improving and streamlining our efforts. One major improvement our team needs to focus on next year is organization and efficiency. During the construction and research processes, the team encountered numerous minor setbacks. While the individual setbacks appeared minor at the time, the total impact on the project was unacceptable. Many of these setbacks could have been prevented had our team been more organized. We often found ourselves scrambling to find the necessary parts to fix a component or sifting through pages of paper to find the proper document that needed to be edited. For example, dividing the technical paper into sections that individual team members were responsible for led to fragmentation of the paper. This made it difficult to maintain control over the editing process, which was completed as a group effort soon after. We recognized the need to deliver a cohesive message in the paper but initially lacked the organizational skills to execute it.

The regional competition has made the shortcomings of our team's structure readily apparent. We have since made changes that have created a more unified team. Now, all parts, tools, and components are kept in their proper places to ensure that no essential items are misplaced. The paper in its entirety is now kept on all flash drives and computers with which the team works. When one section is changed, the paper on every drive and PC is also changed to ensure unity throughout. By performing these two simple tasks, our team has found that we work much more productively. The CHS ROV Team will continue to use such methods in subsequent competitions to build better ROVs and to write better technical reports.

Lessons Learned

At the regional competition, our team learned the importance of proper measurement of *all* components. While practicing, we had been using ELSS (Emergency Life Support System) Pods that were below the required one Newton weight. In our test pool, *Trojan 1* had no difficulty in lifting the pods. Upon reaching the regional competition, we realized that our ROV did not have enough thrust to lift the ELSS Pods. Had we properly measured the weight of our pods, we could have prevented such a huge setback. The team has learned from this technical mistake and has since made sure that every component of our mock-up submarine has been properly measured and weighed to match the exact specifications.

In addition to researching the history of submarine rescue, the team was keen to learn how the U.S. Navy currently performs submarine recue. Through a personal contact, the team was able to set up a conference call on May 19, 2009 with U.S. Naval officers. Chief Brua and Lieutenant Commander Kennedy, executive officer of the Deep Submergence Unit (DSU), were interviewed by eight members of the ROV team. This call took place after the regional ROV competition.

During development, we encountered several interpersonal conflicts between team members. Toward the end of construction and research, team members had grown weary and were not at their best level of cooperation with each other. This led to disputes that further delayed completion. Despite these difficulties, our team was able to rally together and persevere to the end. However, we now have a better understanding of the need to set expectations, communicate ideas, listen, recognize strengths in each other, and respect our teammates.

Description of Submarine Rescue Systems

Since their inception, submarines have constantly been in demanding situations which often jeopardize the lives of all those on board. Though sinking is very rare for these complex systems, when this does occur, the results are often disastrous, usually resulting in the deaths of many crewmen. In order to remedy problems confronted while rescuing stranded sailors, several different systems have been developed over time. The earliest attempt at a submarine rescue system came in the form of the McCann Rescue Chamber (Figure 12)(“Modern”). This system utilizes a chamber attached to the rescue vessel via a tether and requires a diver to attach a down cable to the submarine escape hatch. The McCann rescue chamber is then lowered from the ship to the submarine and mates with the escape hatch. This system was used to rescue 33 submariners from the USS Squalus in 1939 (“Diving”). However, one of the major flaws of this system was the degree of inflexibility in the process of rescuing. For example, the vessel attached to the diving bell had to be moored from four sides directly over the submarine as the bell descended. This is due to the fact that the chamber is unable to propel itself.

The next step in the evolution of the submarine rescue systems utilized an independent underwater vehicle known as Deep Submergence Rescue Vehicle (DSRV)(“Deep”). The vessel was internally piloted to the submarine, where it could mate with the hatch and carry as many as 24 people to the surface. Though this system is more maneuverable than the McCann Rescue Bell, the lack of a tether causes run times for the DSRVs to be limited to roughly ten to twelve hours, for this is the length of the battery charge.

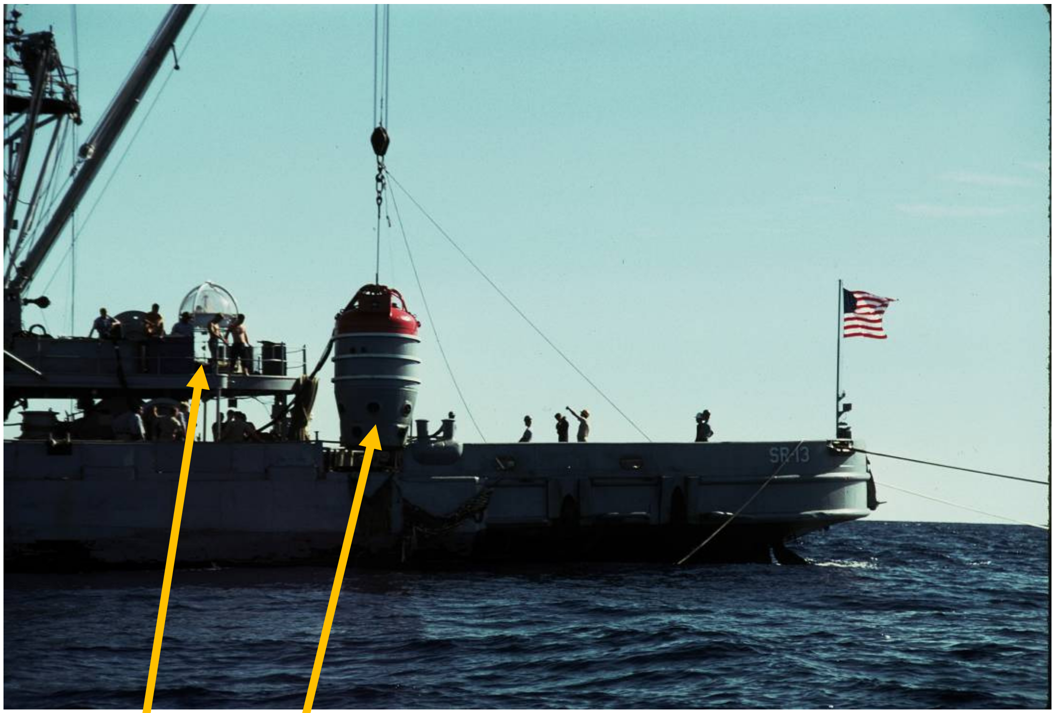


Figure 12:
U.S.S. Kittiwake
Courtesy of Dr. Ray Stedwell
Photo from: Feb. 10, 1989

The most recent iteration following the DSRV system utilizes a combination of features from both the McCann diving bell and the DSRVs. Known as Pressurized Rescue Modules (PRMs), these vehicles are comprised of a tethered chamber equipped with thrusters and cameras to maneuver to the mating site of the damaged submarine. The PRMs can hold a maximum of 16 people and can be pressurized to different atmospheres of pressure (Deep).

One of the most significant complications associated with deep-sea submersible rescue is decompression sickness, more commonly known as the bends. Any certified diver or sailor who performs deep-sea operations is constantly aware of the possibility of severe injury due to the bends. Essentially, when a diver enters deep-sea situations where the pressure is much higher than one atmosphere, nitrogen is absorbed into his or her bloodstream by breathing compressed air. The nitrogen is then circulated throughout the body along with oxygen saturating all the body tissues with nitrogen. Standard operating procedure is for divers to slowly ascend, giving the dissolved nitrogen time to be released through expiration. However, divers will occasionally have to make emergency ascents that do not allow the dissolved nitrogen enough time to slowly dissipate. Instead, nitrogen bubbles within the body rapidly expand causing massive internal damage. It is like shaking up a soda bottle and then opening the top. If it is opened slowly enough, it does not bubble over. If it is opened too fast, it bubbles everywhere.

The results of decompression sickness are internal pain throughout the body, though most commonly in the joints. Sensations ranging from mild tingling to excruciating pain have been documented. Passive or active movement often magnifies pain in the joints. More seriously, the dissolved nitrogen can rapidly form bubbles within the bloodstream. These bubbles can be carried through the blood to vital organs such as the heart and the brain. If they enter a small enough blood vessel, they can cause total blockage and ultimately cause hemorrhaging due to rupture of the blood vessel. If he/she is forced to make an emergency ascent, they must be rushed to the nearest hyperbaric chamber. Once inside, atmospheric pressure is increased to simulate the high pressures experienced during a deep-sea dive. This causes the nitrogen to re-dissolve into the bloodstream, thus stopping further damage. The pressure in the hyperbaric chamber is then slowly returned to normal atmospheric pressure. By doing this, emergency care providers prevent the bubbles from forming again. Unlike the McCann Rescue Chambers which stays at a constant pressure of one atmosphere, the PRMs can adjust to the pressure at which the trapped submariners are held. This, however, creates the potential problem of decompression sickness once they reach the surface. The rescued sailors can then be transferred to a hyperbaric chamber for recompression treatment (Chief Brua, personal communication, May 19, 2009). For every 11m traveled down a water column the pressure increases by one atmosphere. For example, at 110m of water, there is 10 times as much nitrogen being absorbed into the blood compared to at sea level.

Figure 13:
Pressurized Rescue Module *Falcon*
Courtesy of U.S. Navy Deep Submergence Unit
Photo from Oct. 8, 2007

The *Falcon* (Figure 13) is the PRM currently used by the U.S. Navy, and was built by Phoenix International through a public/private partnership (Chief Brua, personal communication, May 19, 2009). Previously, submarine rescue mother ships had to sail to the site of the downed submarine, which could take several days. Now the *Falcon* can be airlifted to any location in twenty four hours or less. It can be deployed from any ship with a very large deck and a winch. The *Falcon* is controlled and powered through a tether from a van located on the mother ship's deck. The mating skirt on the *Falcon* is universal so that it can dock with any international submarine.

The *Falcon* shares many similarities with the CHS ROV *Trojan 1* we have built. Aside from the fact that *Trojan 1* cannot carry people, it has a similar control system, tether and basic design. Specifically, both systems are semi-independent remotely operated vehicles designed to operate in submarine rescue situations. Chief Brua of the U.S. Navy's Deep Submergence Unit (DSU) said, "…At the forefront of this field, the CHS ROV Team is the next generation for what is to come in submarine rescue…" (Chief Brua, personal communication, May 19, 2009). In this modern age of technological advancements, the CHS ROV Team in conjunction with the MATE organization is poised to forge the future of submarine rescue systems.

Reflections

Our team is made up of almost all new members. The knowledge we have gained through work in construction of the ROV is very valuable for this year's competition and our lives. We have learned many skills at our meetings, such as how to solder, how to make a proper ballast system, and how to wire an ROV. Yet, there are many more things we have learned that cannot be mounted on an ROV. In brainstorming ideas for our frame, we have learned specific things like the traits of an aluminum rectangular prism. Perhaps more importantly, we have also learned how to discuss ideas and make decisions. When our ROV kept listing n the water, we learned proper problem solving techniques to work it out. Throughout the process, we have grown in knowledge and our team-building skills; both our ROV and the ROV team are working more efficiently. We now know that cooperation has to come first since our ROV is a team effort. Finally, we have realized that we must always keep learning, which is half the fun.

Acknowledgements

Our ROV team has gone through a lot of ups and downs. We all know that we will go nowhere without the people that have helped us along the way. George Herbert once said that, “One good mother is worth a hundred schoolmasters.” This could not be truer for our team. Our moms bring reason, organization, transportation, and food. Mrs. Dost graciously lends us her house for working on the ROV and ideas that make the ROV work. Mrs. Ives brings ideas, support, and food for the team. Dr. Ray guides us with her expertise in writing technical reports. Mrs. Stedwell watches over our meetings, lending support and solving problems. Our dads also contribute to the ROV. Mr. Dost formulates ideas in regards to the structure of our ROV, and Dr. Stedwell gives us suggestions for the paper. We would like to thank all of our parents for all the help they have given us and will give us, since the ROV team is a huge commitment for both members and their families.

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