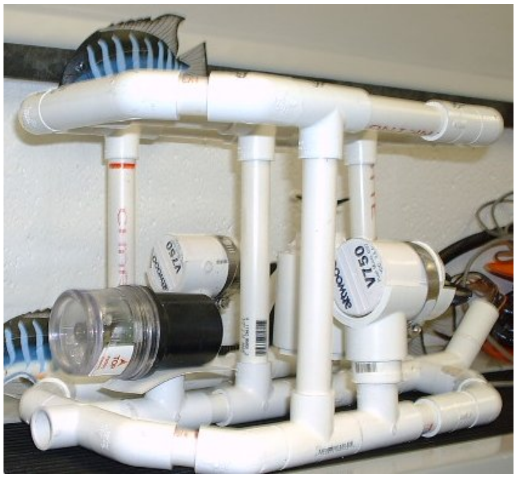
R.O.V Technical Report

For the ROV named "Stolen"

Submitted by the:
Brownsville Area High School Robotics Team
The Serpents

Submitted To:
Mate
(Marine Advanced Technology Center)
For the 2005 National ROV Competition



(ROV Stolen)

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Mentor:
Mr. Kenneth Harasty

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Abstract:

Students at Brownsville Area High School designed and constructed a working Remotely Operated Vehicle (ROV) that we named “Stolen”. It was designed and built to use in the 2005 MATE/MTS National ROV Competition.

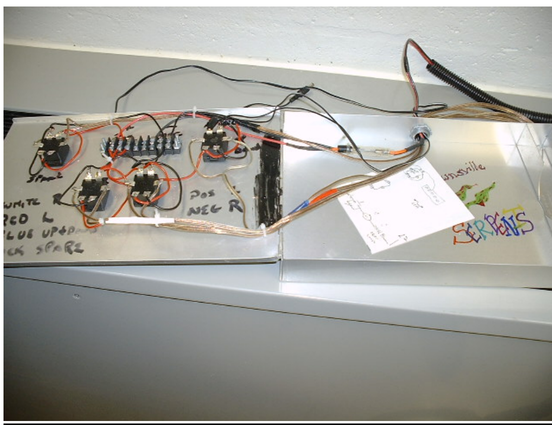
This report will include information on the:

1. Financial requirements for a project of this type
2. Development of the design, such as the choice of the type of compacted frame
3. The selection of materials and parts, including the piping, motors, propellers, camera, wiring, paint, and pipe joint compound.
4. Construction techniques involved in the assembly of the ROV
5. Problems that we encountered in all aspects of this projects
6. Troubleshooting to learn to overcome unanticipated problems
7. Benefits derived from participation in this project, including skill development, increased knowledge and, mostly, working together to build something as a team.
8. Possible future improvements to any future ROV construction projects.

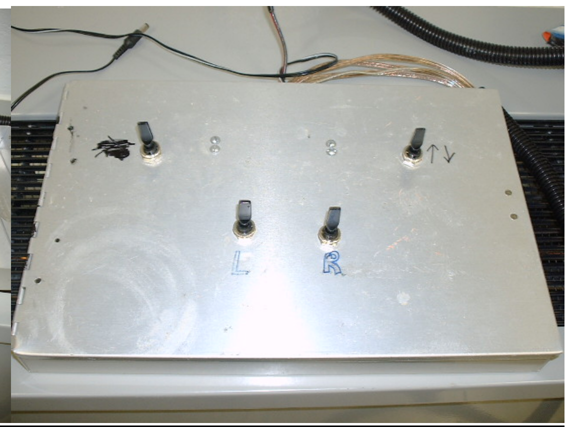
This report also contains photographs of the major components of our ROV, “Stolen”.

Acknowledgements are included at the end of the report

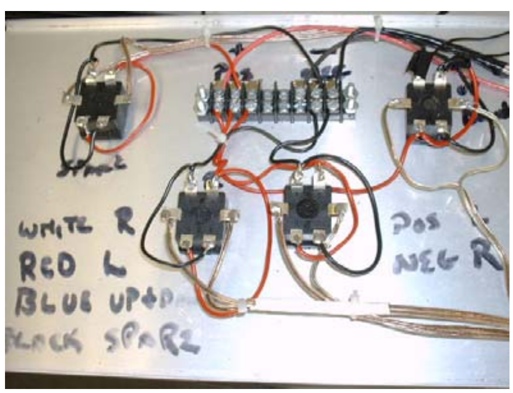
Photographs of "Stolen"



Overview of the Control Box

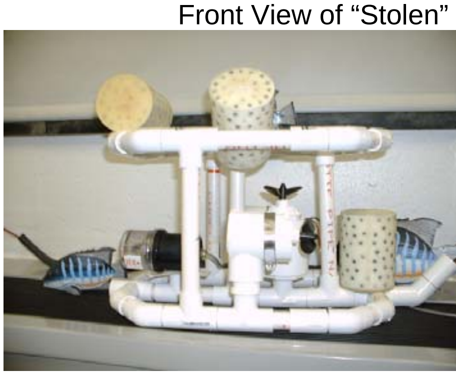


Throwback Toggle Switches to control the motors



The inside of the Control Box

Front View of “Stolen”   Back View of “Stolen”

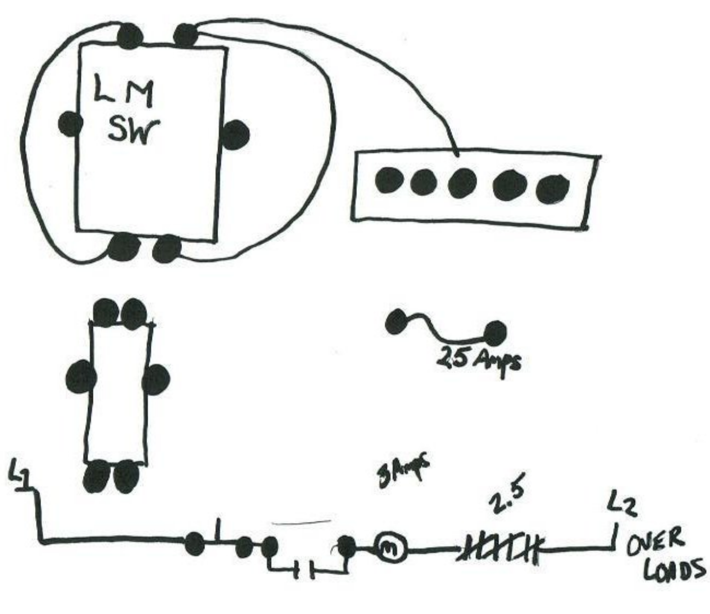


Two Side Views of “Stolen”

Budget Expense Sheet

Date	Deposits or Expense	Description	Amount	Balance
11-2-04	Deposit	Carried Over Funds	$522.24	$522.24
1-14-05	Expense	Camera	$165.95	$356.29
1-15-05	Expense	PVC Pipe	$12.69	$343.60
1-16-05	Expense	PVC Glue	$6.34	$337.26
1-16-05	Expense	PVC Fittings	$42.93	$294.33
2-4-05	Deposit	Lollipop Fundraising	$135.15	$429.48
2-18-05	Expense	Motors	$95.30	$334.18
3-7-05	Expense	Propellers	$20.90	$313.28
3-21-05	Expense	OSHA Safety Decals	$33.97	$279.31
3-21-05	Deposit	MATE Building Funds	$100.00	$379.31
3-22-05	Expense	PVC Pipe Cutters	$31.99	$347.32
4-26-05	Expense	Various Tools	$49.67	$297.65

Electrical Schematic:



Design Rationale:

Structure:

The Brownsville ROV team believes in the philosophy of KISS. We wanted to keep it simple and easy to understand the functional components of the ROV. We used 12.7 mm id PVC tubing. We also used fittings to join the tubing sections together. These included:
• 90 degree angles
• 45 degree angles
• Straight couplers
• End caps
• Tees
• Four-way crosses
• 25.4mm X 19.049mm reduces
• 38.1mm X 25.4mm tees (motor mount)
• 76.2mm X 38.1mm tee (camera mount)
All PVC tubing and fittings were joined by PVC cement. We also have approximately 15.3 meters of tether.

Control System:

Our control system is an electrical control box that was built in a previous year by former ROV team members. The electrical control box consists of throwback toggle systems. Three out of the four toggle switches controls the motors. One switch is to control the ROV when it needs to go right; the other is to make it go to the left. The third switch controls the up and down movements. The fourth switch is left unused so we have the option of another motor, a possible switch to control the manipulator, or another avenue to pursue.

Propulsion:

For the propulsion, we used Bilge Pump Motors. The Bilge Pumps are 750 V. We cut them down to their inner shell. After the were cut down to the inner shell and filed and sanded down, we attached them to the ROV using metal gripping clamps to secure them. We secured the left motor and the right motor on the designated sides and then we secured the up and down motor in the back of the ROV. After placing the motors in their specific area, we attached the propellers. The left and right motors both have propellers that were purchased from the Graupner Company. These propellers are high powered and it has two blades. The rotation is clockwise. The propellers are also fiber glass reinforced at 52.5mm. The pitch is 63. The propeller for the up and down motor is a fan blade we took from a water bottle with a fan on the nozzle. It is a three bladed propeller.

Ballast:

For floatation, our ROV team is using Syntactic Foam that was donated to us by the Cummings Corporation that is located in Boston, MA. They also sent a Material Safety Data Sheet. The safety precautions we need to take are according to the Material Safety Data Sheet are as follows:

- Airborne limits for nuisance dusts: ACGIH TLV= 10 mg/m^3 OSHA PEL = 15 mg/m^3
  • Health Hazards: Primary Routes of Exposure: Inhalation of and contact with dust resulting from machining operations may be irritation to the eyes, nose or throat.

Certain individuals may develop skin irritation upon direct contact.

• First Aid: Inhalation: Move person to fresh air. Seek medical attention if irritation persists.
• Fire and Explosion Data: Clean-up Procedures: Product normally is inert and stable and required no routine maintenance. Dust, chips, or scrap particles resulting from machining operations should be treated as flammable material.
• Exposure Controls/Personal Protection: Work and Hygienic Practices: Handle in accordance with good industrial hygiene and safety practices. Avoid unnecessary exposure to dust by using good local exhaust ventilation. Remove dusts from eyes and skin immediately after exposure. Always wash contaminated work clothes separately from other laundry. Use vacuum equipment to remove dusts. Avoid sweeping or using compressed air as these techniques re-suspend dusts in the air. Have access to safety showers and eye wash stations.
• Stability and Reactivity: Hazardous Decomposition Products: May include carbon dioxide, carbon monoxide, hydrocarbons, dense smoke and water.
• Disposal Considerations: Waste Disposal: Material is classified as a non-hazardous waste under current RCRA regulations. Waste and scrap materials should be collected and disposed of in accordance with all federal, stare and local regulations.

Sensors:

For our video feed we are using a black and white, inferred, waterproof camera. We bought our camera from Supercircuits Inc. located in Liberty Hill Texas.

Resources:

Our ROV was built under budget this year. We purchased new PVC pipe tubing and new PVC fittings. We also recycled PVC tubing and extra fittings from the previous years. The floatation is made up of Syntactic Foam that was donated to our team by the Cummings Corporation. We have built a productive and functional ROV.

System Designs:

We designed out ROV to be smaller so it can maneuver in and out of smaller spaces. The smaller our ROV is, the more limited the space is. We used the available space to create ideas of where the motors could be used to their fullest potential and help us build the best ROV possible.

Challenges:

One of the biggest challenges we had to face this year would be the renovation of our school. With the constant construction, we did not always have the appropriate environment to work on our ROV. The remodeling of each individual classroom and moving from room to room also held a substantial challenge because we did not always have a proper place where the work could be done effectively.

Another challenge our team had to face was the fact that we did not have a sufficient and consistent number of members throughout the months we were constructing our ROV. We started out with a significant amount of people, but over the months, the number of dedicated members dwindled and increased with the passing months. There have also been personal conflicts of people. Personality clashes, behavior issues, and attendance have all been issues of our group. Now, as the competition approaches, we have three dedicated members. We also have a very determined team advisor and a calm and rational team mentor.

The lack of proper funding also presented us with another setback. We did not always have a perpetual source in which funds could always be gathered. We had a few organizations that were supposed to give grants but eventually fell through. Also the number of members dropping out and joining then quitting also was a factor in the lack of funding problem because all the fundraiser ideas we were thinking of had to either be held back of cut off completely due to the lowered numbered and non-committed members.

Time schedules conflicted with attendance of group members. Most members were involved in other after school activities and had other obligations outside of ROV. The team advisor also attends college, and her classes conflicted with meeting times.

We also faced the difficulties of sometimes not having the most suitable tools on hand to use to assemble the ROV.

When this team first started up, many of the members lacked strong knowledge about the basic concepts of ROV. It was a challenge to help each member gain a new understanding and respect of what ROV is really about. It was also difficult to fully comprehend all the components and all the hard work and thought process that goes into building a fully capable ROV.

Troubleshooting:

We spent a good few of our first meetings trying out different designs for our frame. The most trouble we had was not with the wiring, it was finding a manipulator that would accomplish the tasks that "Stolen" has to perform. The size of our ROV had to be rehashed repeatedly until one was found that was able to meet the standards of competition. Te motors had to be relocated for weight distribution, better configurations, and propellers had to fit the motors. We also switched to a new type of floatation, one that is less harmful to the group and others. Each member has taken part in the troubleshooting process. Andrew Holup helped with the frame designing and building, as well as soldering electrical components. Celeste Camino did the challenges, conversions, and skills and lessons learned. Amber Preston worked with the electrical schematics, design rationales, as well as the lessons learned. As a whole the group contributed for various parts that were used to build "Stolen", as well as chipped in money to buy pizza and drinks.

Skills and Lessons Learned:

We, as a group, learned to work together, and that communication is a key factor. As each member came into the group, he/she improved their outlooks on exactly what goes on behind the building of an ROV. We've also learned that building an ROV is tedious and basically involves commitment as well as working. Our main thing we learned was that even though it is hard and complicating, it is a lot of fun.

Future Improvements:

For future competitions, we will have to make sure that we have the funding in hand before anything is started. Another major improvement would be to choose our group members a little more wisely. Time is of value and little can be wasted on characters who will not work to ensure proficiency. We will more than likely keep a log book to sign in and keep record of who shows up for meetings and to make it easier to decide who the dedicated ones are to go to the competitions. A list of parts and money spent will also be recorded in a case something would to the ROV.

Mission to Europa:

Europa is one of at least sixty-three natural satellites orbiting the planet Jupiter. Galileo Galilee first viewed Europa in 1610. This discovery meant that like Jupiter, the Earth is merely another planet, not the center of the universe. This revolutionary notion forever changed the worldview of western civilization.

One of those moons, Europa, may be destined provide the answer to one of mankind's greatest questions. Are we alone?

Of all the sites studied or visited by humans, Europa may be the prime candidate in the Solar System to be the home for extra-terrestrial life. It has the key ingredient for life…liquid water. What we do not know is whether there is an energy source in the water in the form of volcanoes.

During the 1960's, it was noted that there would be a planetary alignment in 1977-79 that would allow a spacecraft using a "gravity assist" technique to conduct a fly-by of all four of the "giant gas planets". This alignment would not occur again for another 176 years. A decision was made construct and launch two spacecraft to take advantage of this alignment.

Voyager 2 launched on August 20, 1977, from Cape Canaveral, Florida aboard a Titan-Centaur rocket. On September 5, Voyager 1 launched, also from Cape Canaveral aboard a Titan-Centaur rocket. The Titan-Centaur rockets were only developed a few short years before the "window of opportunity" opened of this launch. No other rocket was powerful enough to provide the thrust needed for the trajectory required for this mission.

Voyager 1 arrived at Jupiter on March 5, 1979, followed by Voyager 2 on July 9, 1979. Our knowledge of Jupiter increased dramatically. Much of the interest was on Jupiter's Galilean moons.

Europa, the size of Earth's moon, is thought to have a crust of ice perhaps 100 kilometers thick which overlies the silicate crust. The complex array of streaks indicates that the crust has been fractured and filled by materials from the interior. The lack of relief, any visible mountains or craters, on its bright limb is consistent with a thick ice crust.

It is believed that the water ice crust is afloat on a planetary ocean.
Jupiter and the other large moons subject Europa to a gravitational tug-of-war that stretches and squeezes the satellite in much the same way that Earth's moon raises tides in our oceans. This generates enormous heat inside the moon, which may keep its ocean in a liquid state. That and the ocean's suspected location only a few kilometers beneath the smooth, icy surface may make Europa a prime target in the search for extraterrestrial life.

Two years before the Voyager reached Jupiter; the DSV Alvin submersible was on a series of geology dives in the remote equatorial regions on the Pacific Ocean. In February 1977, mankind’s understanding of terrestrial biology was about to change in one dive to the volcanoes on the floor of the ocean.

The major discovery of an abundance of exotic animal life on and in the immediate proximity of warm water volcanic vents prompted theories about the generation of life. Since no light can penetrate through the deep waters, scientists concluded that the animal chemistry here is based on chemo synthesis, not photosynthesis.

Up until about 30 years ago, it was believed that all life on Earth was dependent upon energy from the sun. Furthermore, it was thought that you would probably not find life where temperatures were extremely hot, like in geysers or hot springs, or extremely cold, like in the Antarctic desert.

These ideas changed when oceanographers explored hydrothermal vents, openings in the ocean floor where extremely hot, mineral-rich water erupts from the crust. Hydrothermal vents are located several miles below the surface, on the ocean floor, where the surrounding water is at or near freezing, it is absolutely dark and the pressure is high. In organized communities around the bases of these vents, scientists found clams, crabs and exotic, giant tubeworms measuring 2 meters long. The water coming out of these vents is 110 to 350 degrees Celsius.
The discovery of hydrothermal-vent communities showed that it is possible for life to evolve in places without light from the sun, and in other worlds without sufficient light from the parent star. In view of the discovery of hydrothermal vents, it may be possible that life exists on Europa; an icy moon of Jupiter, which scientists believe has a water ocean beneath its icy crust.

Our teacher, Mr. Ken Harasty, visited the hydrothermal vent sites at the Juan de Fuca Ridge on DSV Alvin dive #3464 in September 1999.

In the future, there may be a real space mission to Europa, not just high school kids Roves in NASA’s NBL. It was announced this week that the next big cooperative European-US space mission would be to Europa. A joint working team is being set up to consider what sort of spacecraft would be needed and what each side could do. Officials in Washington and Paris are keen to follow up the spectacular success of Cassini-Huygens at Saturn. Many scientists agree that Europa is now a high priority target for a major mission. A mission to Europa would launch no earlier than 2016.
The Americans had planned to go to Europa independently with their Jupiter Icy Moons Orbiter (JIMO), but the ambitious project, which would have used a nuclear propulsion system, has been shelved as NASA re-focuses its budget on a White House initiative that could take humans back to the Moon.

It may go down to Europa's cracked and blotchy surface, it is technically feasible to do so. But, it may be that if you want to look below Europa's ice, you can do that well with a radar orbiter.
Researchers at the German Aerospace Center are already developing a prototype technology that could be used to melt through Europa's ice sheet. Any water might be unreachable 20-30km down.
Once under the sheet, the probe would take samples and drop mass to begin a slow climb back up the ice column. On the surface, it could then send data to an orbiter or relay satellite for onward transmission to Earth.

But a key factor is likely to be power systems. Although solar panels will work on spacecraft at that distance, the desire for sufficient energy to drive many instruments means any mission would really need to go with radioisotope thermal generators (RTGs) - solid state electrical generators powered by the heat of radioactive decay. Europe has no expertise with RTGs - the Americans have, which makes a joint venture with the Americans likely.

"The attraction of Europa is that it is a water world; the surface is frozen, of course, because of its exposure to cold space, but not far underneath the ice is an ocean of warm water.

Geologist Peter Ward and astronomer Donald Brownlee from the University of Washington have proposed a hypothesis called, the Rare Earth Hypothesis, which states that life on Earth is unique. Their hypothesis states that a series of chance events or situations, such as living in the habitable zone of the sun, having a Jupiter-type planet to clear away comet and asteroid debris and having little mass extinction, has allowed life to develop on Earth and would be unlikely to happen elsewhere.

But a mission to Europa may discover no life after all because it may be that there is any life to be found there.

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