**Chandler High Wolfgang Robotics**

# M.A.T.E. ROV Competition Tech Report 2006

Submitted By The Chandler High School & Si Se Puede R.O.V. Team:

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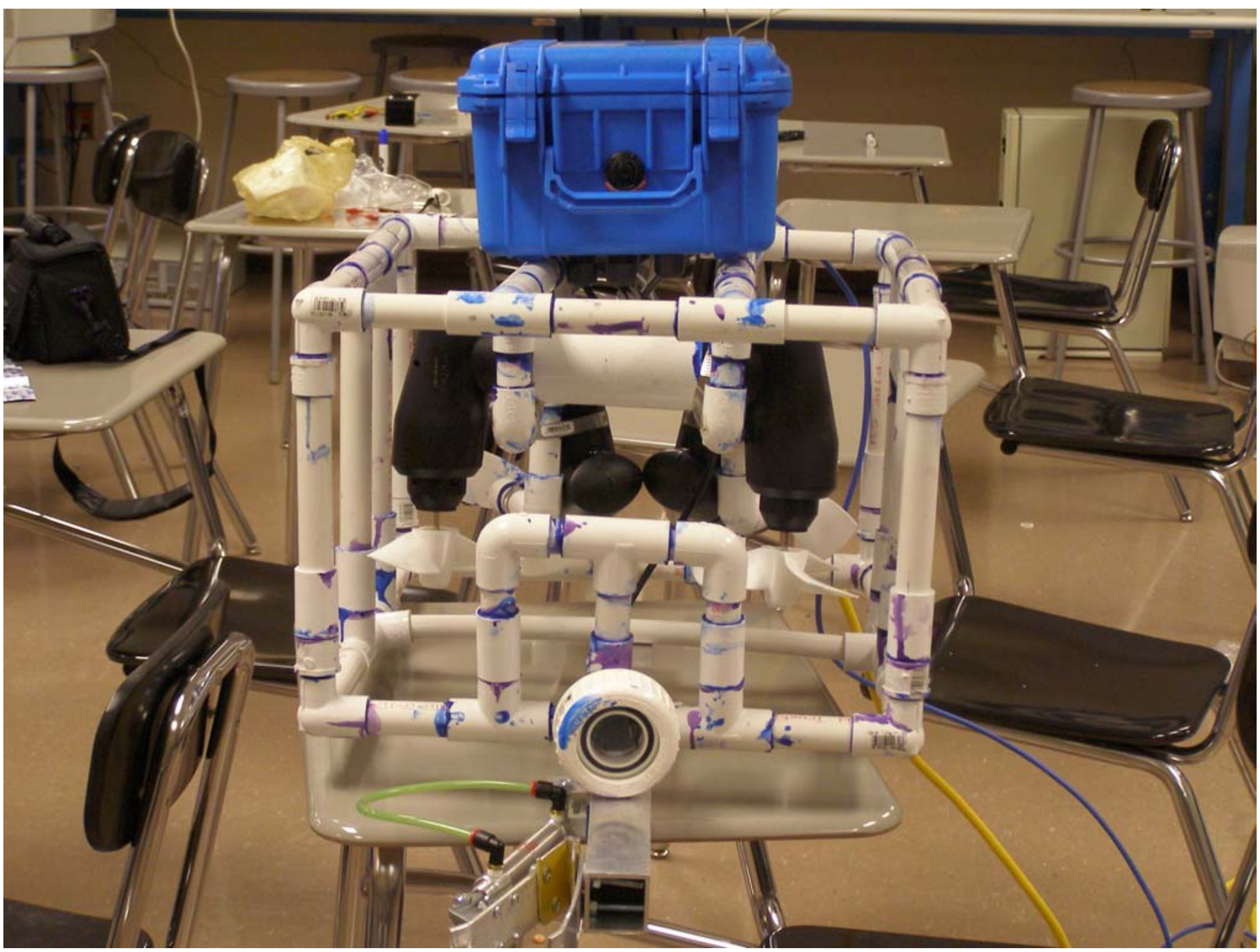


# Abstract


The Chandler High Robotics team has created an underwater remotely operated vehicle. This ROV contains certain benefits in its design to manipulate objects underwater. These benefits include the following: its energy budget, power-mass ratio, cost effectiveness, and simplicity of design.

To make this ROV effective, yet power efficient, four small motors are used for the vehicle's thrust. These motors allow it to maintain a quality energy budget. The low amount of amperage pulled by these motors is what makes this so. This reduces the need for speed reduction because the motors do not go over the power limitations allowed by the M.A.T.E. underwater ROV competition.

The power-mass ratio is suitable for this ROV because it has very little mass. In order to apply an effective amount of thrust we found motors that have a small mass and allowing it to produce more thrust from a minimal amount of power. This also gives it improved mobility throughout the under water operations. This improved mobility gives the driver ease when handling the ROV.

This ROV is cost effective. Most parts, such as each motor, cost under 50 dollars apiece. The cost effectiveness and readily available parts for this vehicles make it easier to fix when it comes to purchasing replacement parts.

Another example of a cost effective part of the ROV is the frame, which is made solely of PVC plastic. Although inexpensive compared to metal; its negative buoyancy isn't as great, it is easier to fix, it is hard, and it is durable. PVC is not only found on the ROV's frame but it is also the waterproof housing of the ROV's cameras which are effective in keeping water away from the cameras.

An important benefit to consider of the ROV is its simplicity of design. Parts on the vehicle can be replaced with ease. These parts include; the casing where the electronics are stored, the PVC frame, and the motors. Most parts of the ROV are in clear view and can be easily accessed for repairs.

This ROV's cost effectiveness, simplicity of design, power-mass ratio, and energy budget are the main benefits provided by this ROV to manipulate objects under water. These benefits will be seen at the 2006 M.A.T.E. ROV Competition.

## Design Rationale

We decided to create our frame out of PVC pipe. This material is very inexpensive and easy to replace or repair. This material is also very robust which adds to the rational of choosing PVC pipe.

Placing the vertical-thrust trolling motors in the front of the ROV was also a good idea. This would allow us to hold the electronic module of the trawl-resistant frame without the whole ROV shifting by providing the thrust to balance out the immense amount of leverage provided by the electronics module. Providing lift as close to the negatively bouyant effects of the electronic module will help keep our BG located over each other and increase stability.

Along with their placement, another aspect was also enhanced. Since the motors were positively buoyant after being watertight, placing these motors near the top of the ROV will widen the gap between the center of buoyancy and gravity; thereby decreasing the amount of yaw and tilt that may occur.

The strategic placing of the horizontal-thrust trolling motors is another aspect that was important to the effectiveness of the ROV. By angling the motors slightly outwards from the ROV, we will have an easier time turning by either using one motor or two thrusting in opposite directions to speed up the turning process. This angle also does not greatly hamper the horizontal thrust.

## An Interesting & unique challenge

A challenge the team faced when installing the motors was the question if they were waterproof enough. We found some motors that were pretty cheap, but considering that the motors were manufactured for bumper boats we did not think they would handle well if completely submerged. Bumper boat motors are usually on the surface after all. That problem made us realize that we should figure out methods to make the motors completely submergible.

In an attempt at fixing the problem we opened the motors outer casing to see what we could do. We figured that if we filled this casing with casting acrylic, then the motor would be watertight. We attempted this and it worked, though there was a small problem. The acrylic oozed out of the hole cut in the outer case for the shaft to exit but luckily didn't cause any problems. On the other propellers, we first tried to tape around the motor and put the outer cover over that. Unfortunately, the case didn't go all the way on and contained cracks. After scrapping that idea, we tried putting plastic epoxy around the motor instead and the case fit it perfectly, and when we poured in the acrylic, we faced no problems.

Overall we found this to be a unique and interesting challenge, which helped us in developing functional motors for thrust that could run well underwater without breaking down. Getting over this challenge was also of great relief to the team because buying new waterproof motors was now unnecessary.

# Skills Gained

To our Robotics team, building a robot is about more than learning to solder or hooking up the pneumatics. It's about learning life skills that apply forever, not just in this setting. Most of our team did learn those basics skills, such as how to set up electronics, pneumatics and even how to use power tools. The most important life skills we obtained were how to work under pressure, solve problems, and work together.

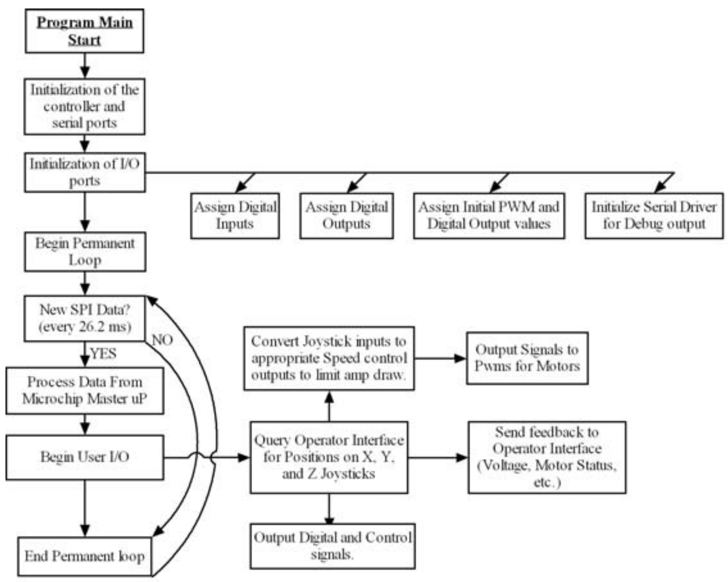
Constructing a robot is challenging enough, but when your running out of time, stressed out by other classes, along with an overload of work; the pressure gets to you. Working under pressure is a life skill invaluable to any job.

Another important skill we gained was trouble-shooting and solving issues. We came across multiple problems such as wires coming loose and water leaks, but by calming down and thinking things through, we got through any problems that were thrown at us. This will not only help us in future robotics years; it will also help us in life.

The most important skill learned was to work together as a team. Though everyone had there own little components, it all comes together for the big picture. Coordinating everything to fit is as difficult as getting everything to work separately. This requirement for teamwork also transfers over to piloting robot because we will have multiple people driving it in addition to someone holding the tether and a captain. Getting everyone to in sync is the hardest and most important skill in life because you always work with others.

Working under pressure, problem solving, and teamwork are all important life skills that we have learned from constructing this ROV. We also learn other technical skills such as wiring and soldering. Overall as team we have all grown in our own ways improving our skills.

# Programming Diagram



# Budget Expense

| Materials Purchased | | | | |
|---|---|---|---|---|
| **Item** | **Quantity** | **Unit Cost** | **Total Cost** | **Cumulative Cost** |
| Bumper Boat Motors | 4 | $40.00 | $160.00 | $160.00 |
| CCD Cameras | 2 | $90.00 | $180.00 | $340.00 |
| 1 1/2" PVC Unions | 2 | $5.00 | $10.00 | $350.00 |
| Misc PVC Fittings | 1 | $30.00 | $30.00 | $380.00 |
| PVC Primer and Glue | 2 | $15.00 | $30.00 | $410.00 |
| Cord Strain Relief Connectors | 14 | $0.63 | $8.82 | $418.82 |
| Watertight Pelican Case | 1 | $65.00 | $65.00 | $483.82 |
| 50' Extension Cord | 1 | $35.00 | $35.00 | $518.82 |
| Casting Resin | 2 | $25.00 | $50.00 | $568.82 |
| 3" Round Glass Windows | 2 | $2.00 | $4.00 | $572.82 |
| | | | Out of Pocket Cost: | **$572.82** |

| Utilized Materials Already Owned | | | | |
|---|---|---|---|---|
| **Item** | **Quantity** | **Unit Cost** | **Total Cost** | **Cumulative Cost** |
| F.I.R.S.T. Robotics Controller | 1 | $1,500.00 | $1,500.00 | $2,072.82 |
| Computer Power Cables | 5 | $5.00 | $25.00 | $2,097.82 |
| CAT 5 Cable (1 ft.) | 50 | $0.12 | $6.00 | $2,103.82 |
| | | | Complete Cost: | **$2,103.82** |

Our ROV was cost efficient for the out of pocket cost at only $572.82. This was mostly because we created our own watertight devices instead of purchasing plug and play units that were costly but already watertight. In order to accomplish this we had to use parts that we already had such as our robot controller and some cables. Even at a total cost of $2,103.82 our robot is still cost effective compared to a commercial unit being used for the same service our rov provides.

## Future improvements

Throughout our struggles we have found that there are some things we could have done better in the future to reduce errors or make the robots even more functional. These improvements fall under 3 main categories: fundraising, frame building, and planning.

Our team only had about a month to build this years ROV. We were sponsored by Honeywell but did not receive their check and have it available until about a month before this report was due. This greatly hindered our team since a majority of our members had physics and the large project associated with it at the end of the year. Other team members had grade problems they needed to attend to and did not make it to our meetings. If we could have started earlier in the year we would have had an opportunity to see mistakes and have a chance to fix them.

Many of our team members had never used PVC or the glue used to cement the pipes together. As we started to build the frame the students encountered problems such as the PVC setting up to quickly and portions of the frame being at wrong angles. They got better at this as they went along but another type of material that is still easy to work with such as pultruded fiberglass might have worked better. If we need to use PVC again we have a better idea on how to tackle the idea of putting the frame together.

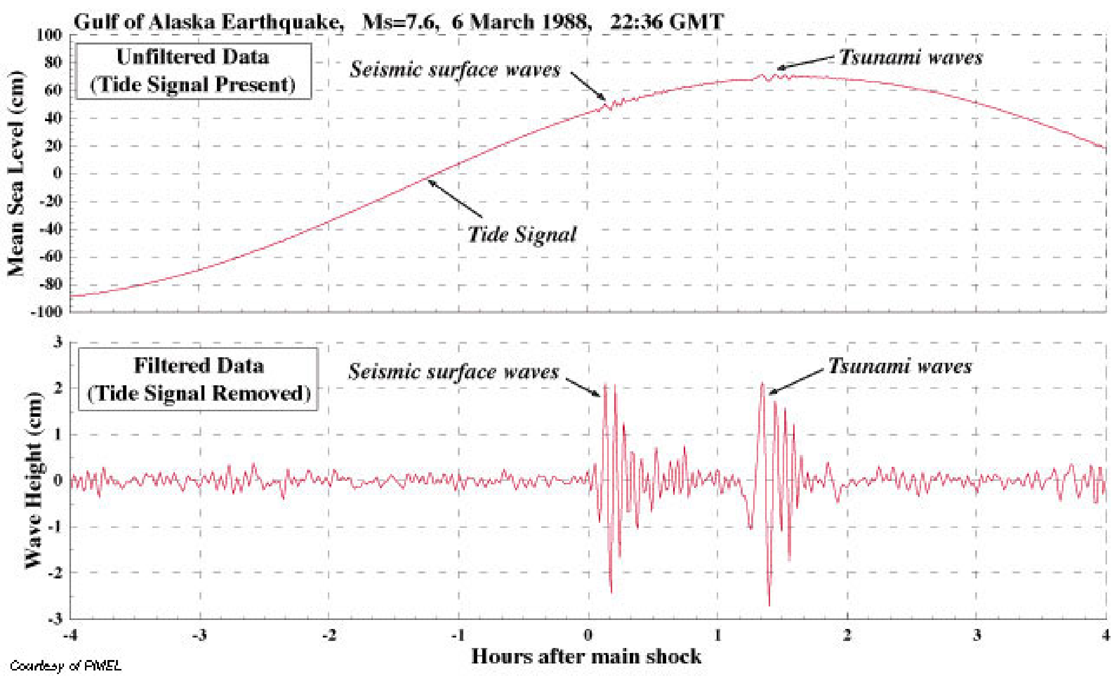
We had to change our ideas throughout the building of the frame and components. Next time we will have a better idea of how to plan all the portions of the build so we don't need to make split decisions as the building is occurring. Our manipulator design changed 3 times as we were building it and our camera that was already a fixed to the frame did not see it in the field of view. We will be adding our other camera to be able to see that now instead of a different plane of view like we had planned.

Next year we hope to have funding taken care of early in the year. After the funding is done we can plan better and have drawings ready to follow. Lastly, we have experience now in frame building. We can come up with better materials, attachment points, and methods of putting the frame together.

# Ocean Observing Systems

http://www.ndbc.noaa.gov/Dart/dart.shtml
http://www.ndbc.noaa.gov/Dart/milburn_1996.shtml

Deep-ocean Assessment and Reporting of Tsunamis (DART) Project is a program that uses multiple ocean observing systems in order to predict oncoming tsunamis and their severity accurately. Built in 1996 after four years with eight tsunamis on the Pacific Rim. Since the strength of the earthquakes could be potentially much higher in the near future, this spun the NOAA into action. Before, tsunamis were detected by shore-based seismic detectors, but had an error rating of 75%. The earthquakes that have large epicentral distances (meaning far from the effects of the tsunami) are the main focus of DART. Since these earthquakes take a longer time to reach land, the ocean observing systems are capable of detecting the potential tsunami and warning the public in advance to evacuate. The Pacific Tsunami Warning System issued in 1948, which uses size of seismic waves and fluctuations in the sea level to predict oncoming tsunamis, is not very accurate. This results in false alarms that can become costly but do err on the safe side to be sure or minimal fatalities. This is a sample of readings given by devices called bottom pressure recorders (BPMs) that can more accurately predict oncoming tsunamis:




Hopefully, in the future, DART and its new BPM technology will increase the effectiveness of tsunami detection.

# Troubleshooting

When something isn't working right we attempt to get to the root of the problem by close examination. Sometimes the solution can be as simple soldering two wires together or plugging in a cord but other times the problem can be a lot bigger.

One such problem that occurred when constructing a waterproof camera was that when the camera itself was glued in the wrong place when it was being water sealed. The reason for this is because the lens was sticking of the housing much to far for the glass to water seal it. When we trouble shot this problem we figured out that we had to salvage the camera, but we had to destroy the PVC housing and buy a new one. Through a measurement of where the camera was in the housing we were able to find the point in which we would have to cut the PVC camera housing all the way around.

Relying on breaking our resources apart isn't a primary step in our way of troubleshooting although we have encountered times when we have had to do it like the previous example to salvage important parts. Most problems didn't require such drastic steps but sometimes its necessary to save money.

We know that everyone makes mistakes. Instead of focusing on who did what wrong we focus on how we can fix the problem. The time spent blaming people could be better spent actually fixing the situation. Although we do prefer to know who did it so we can make fun of them on random occasions. This also enables us to know as much as we can about the problem so we can attain a solution.