Taft High 7-12

R.U.W.E

Robotic **U**nder **W**ater **E**xploration

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Robotic Under Water Exploration
Taft High 7-12
Lincoln City, Oregon
United States



Hunter Bishop (left) is the CEO and one of the engineers. Hunter would like to major in engineering at Oregon State University or Oregon Institute of Technology. His expected graduation date is 2018.

Kyle Macrae (center) is in charge of marketing and design. Kyle plans to attend college but is unsure of his major at this time. His expected graduation date is 2017.

Eneki Trujillo (right) is the pilot and one of the engineers. Eneki also wants to attend Oregon State University or Oregon Institute of Technology and major in engineering. He plans to graduate in 2018.

Our classroom instructor is Noah Lambie and Ashley Niemi is our head mentor.

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Abstract

There are many areas under the ocean's surface that are dangerous, if not impossible, for humans to explore. One specific area of interest is that of oil. As oil becomes harder and harder to reach, companies will have to go to more dangerous places; places too deep for divers to explore. Fortunately, ROV's (remote operated vehicles) are available to help.

R.U.W.E. (Robotic Under Water Exploration) is our ROV team. We are a group of students from Taft High 7-12 that has enjoyed putting this project together and troubleshooting along the way. Work began on our ROV last September. The ROV was built to mimic tasks used in real situations such as oil mining in the Atlantic Ocean. Our team designed tools to measure and move pipes using PVC pipe. We also added a light just in case things got dark. Our tools to complete the missions were thought out and designed to be multi-purpose, yet effective.

In the end, we have designed an ROV that is functional and easy to maneuver. One of the great things about engineering is that as our ideas have evolved, we have been able to make changes to our ROV. We have also learned about growing as a team and respecting other people's ideas.

The completed ROV.

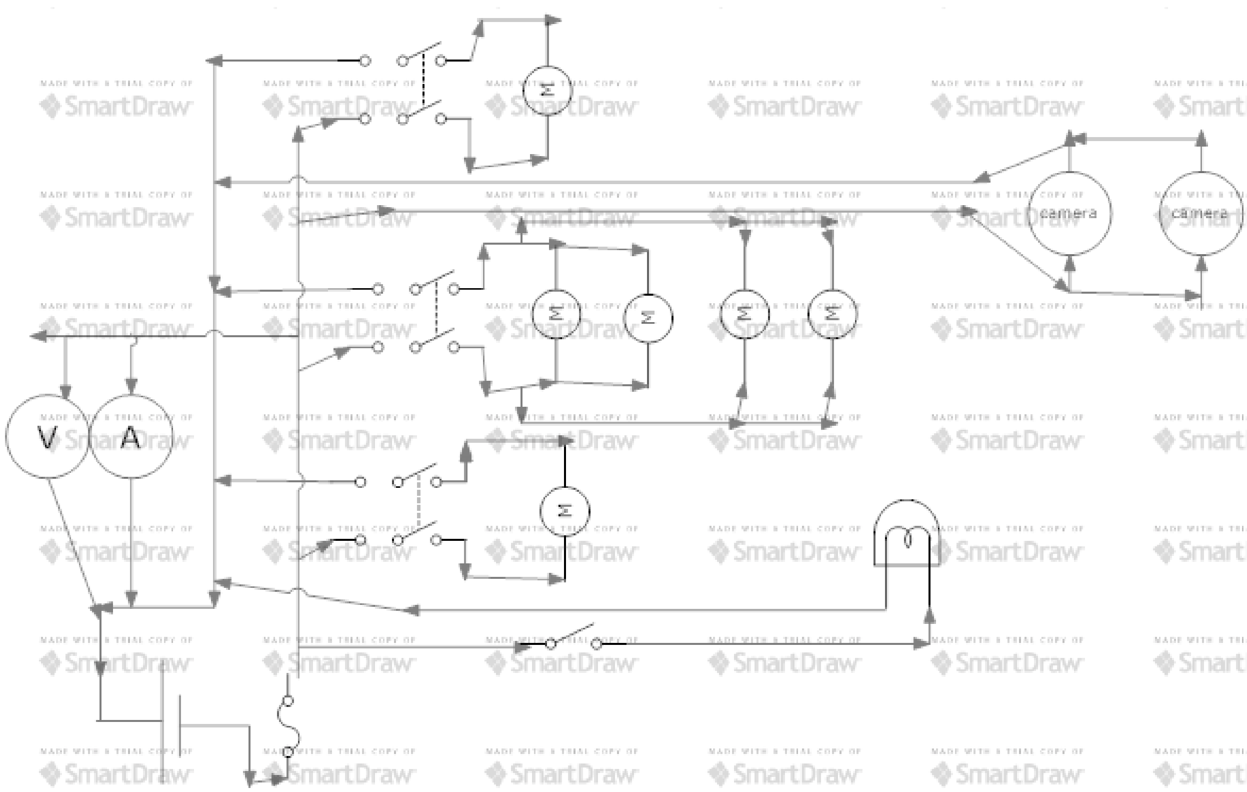
Project Costing

Item	Cost	Listing
1250 GPH motors(2)	35$ each total: 70$	Purchased
700 GPH motors (4)	29$ each total: 116$	Purchased
2 Backup camera+monitor	13$	Purchased
12 volt batteries (4)	23$ each total: 92$	purchased
light	6$	purchased
bike inner tube	5$	purchased
PVC 8ft	.75$ ft total: 6$	purchased
electrical wire 150 ft	20$ per 50 ft total: 60$	re-used
Pufferfish kit	200$	donated
	Total: 568$	
	Income/Donations	
Eagles lodge	2000$	donated/fundraised
Go-fund me	3100$	donated
Taft ASB	500$	donated
Donations	To be determined	donated

Budget

Item	Cost	Total cost
½ in PVC 10 ft	.75$ per ft	7.50$
cameras (2)	13$ each	33.50$
1250 GPH motors (2)	35$ each	103.50$
700 GPH motors (4)	30$ each	223.50$
bike inner tube	5$	228.50$
12 volt batteries (4)	23$ each	320.50$
Light	6$	326.50$
150ft electrical wire	20$ per 50 ft	380.50$
pufferfish kit	200$	580.50$
Total ROV cost		580.50$

System Interconnection Diagram (SID)



Design Rationale

Our team built our ROV to be small and fast. We wanted our ROV to be able to go into small spaces, but still powerful enough to lift objects. We also added custom paint so when the ROV is deployed in the water the fish do not get spooked and swim away. Some of our ROVs special features include: a light to see in murky and dark waters, two cameras and a way to switch between them so we can get the best view. The ROV also has a voltage meter and an amp meter to make sure we don't harm the battery. We also have a 25 amp fuse to help protect the electronics from higher voltage surges.

Control System: The control system for our ROV is the basic puffer fish kit with an added switch for our light. We decided to stick with the basic design because it is user-friendly. It didn't seem to have any major issues and would be easy to fix if problems did arise.

Frame: Our ROV was tested primarily in rivers where there are a lot of factors to think about. First, the ROV needed to fit under logs and into small crevices (just as it would need to fit through a hole in the ice at competition). Second, the ROV needed to be able to let water flow past and through it. If the current caught the ROV it would get thrown around and we would lose control. By letting water flow through, less drag is created. The frame was also painted to create a camouflage that fish and other creatures would not see as easily as they would if we were to leave it white.

Flotation: The proper amount of flotation is crucial when performing these missions. The ROV has to be able to maintain a neutral buoyancy so it will stay at the level it is positioned in the water. When trying to retrieve an underwater object, the ROV must be able to move in forward and reverse directions without going up or down. We used a bike tire inner tube along the top of the ROV to provide flotation. We chose an inner tube because the air inside an inner tube is equal in all areas and so it will not tilt the ROV. It is easy to read the pressure of the inner tube using a tire gauge and we can quickly make adjustments as needed. This gives us the ability to control the pressure each time the ROV is deployed. It is also very advantageous when switching from freshwater to saltwater or varying water temperatures because we are able to fine-tune the amount of flotation by adjusting the pressure in the inner tube.

Motors: Our motors are bilge pump cartridges and are rated in Gallons Per Hour. Our more powerful 1250 GPH motors were used for our forward/reverse functions. We chose to use more power in this area so that we have more speed to complete the missions. It also helps the ROV be more maneuverable. Our slightly less powerful 700 GPH were used for elevation control. We would have used 1250 GPH for all of our motors but due to power consumption limits, we had to limit some of the motors.

Cameras: We have 2 cameras on our ROV. Having multiple cameras helps us get a better view of key areas including underneath the ROV. One of the cameras used is a rear view car backup camera. This camera is located near the back of the ROV and looks down toward the center of the ROV so we can see what is below. The other camera is an underwater fish camera. This camera is located at the front of the ROV and gives us the ability to look directly in front of the ROV. Both cameras can be adjusted manually as needed throughout the missions.

Lights: Originally, we had a simple 12 volt lightbulb with PVC housing bolted to the frame of the ROV. The water pressure was too much for the housing and it cracked. After reviewing our options, we decided to replace it with an aluminum light housing. The aluminum light housing was fully sealed so that it would not crack or leak. The light is attached towards the front of the ROV so that we can see in low-light conditions.

Attachments: We have multiple attachments used to help complete different missions. Our measuring device is a PVC pipe sticking out from the front of the ROV. It is 30 centimeters long and is marked every 5 centimeters. It is positioned so that we can see the measurements using the front camera. Another PVC pipe measuring 10 centimeters can be attached and is used to pick objects up, including the corroded pipeline. It can also remove the cover for the wellhead. Our other attachment is the net placed at the top of the ROV. It is used to collect algae samples. The net design works well because it doesn't create any drag while performing the missions.

Safety

Safety is always a concern when working with electronics, and you must be even more aware when there is water involved. We took many precautions to ensure the safety of our team and any observers. One example is that when we soldered, we made sure to have the proper equipment including a wet sponge, gloves, eye protection, proper ventilation and a safe place to set the soldering iron so it wouldn't burn anything. Where our solders were on the tether, we looped and tied a knot to relieve stress on the tether in that area. This helps keep the tether from ripping apart. On our main power inlet and on the monitor we have 25 amp fuses to keep the current running steadily. If there are any power spikes, the fuses will blow before any equipment is damaged. When working with the ROV, our team always makes sure to be aware and focused, watching and listening for any clues that safety is compromised. As an additional precaution, we clean the ROV after each use so that no rust forms. This also helps prevent bacteria from growing on it.

Challenges

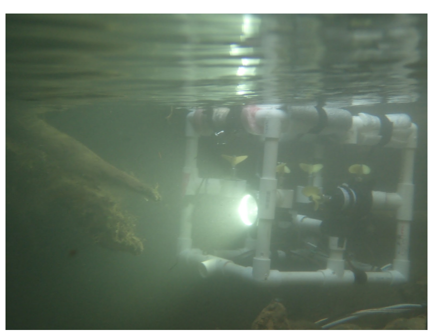
Our team encountered many challenges whether technical, communications, money, or clashing ideas. Time was our biggest problem. We always overestimated the amount of time we had and were never able to correctly guess how long a project would take. Time is a hard thing to overcome and you can never be spot on. Planning and guessing how long something would take is the only thing we could do to be on time. There were lots of long nights and many last minute quick fixes. Paying attention to deadlines became crucial to our success. Although we still struggle with getting things done on time, we have improved a lot. Part of the reason we struggle in this area is that we are having so much fun working on the ROV that we tend to lose track of time and put off working on the other aspects of the competition.

Working out the calculations at the Regional Competition.

Lessons Learned

The biggest lessons the team learned was that teamwork and communication are key when trying to work towards a common goal. Whether you're working on a school project or building a skyscraper, you have to be able to communicate ideas and be able to let other people voice their opinions. We found we struggled the most when we began working on a project without discussing it with the rest of the team first. One person would have one idea in their head but when another person came to help with their own idea, often the ideas were very different and neither person could visualize what the other person was trying to do. After explaining their thoughts, the team was able to choose one direction and work together to achieve the goal.

An indirect lesson we weren't expecting to learn was all the knowledge we gained about salmon. Most of our ROV testing was done in the river alongside the Salmon River Watershed District. With their help, we learned how to distinguish different species of salmon and how salmon habitats have been changed by human interaction. We were able to show them how their efforts were helping salmon habitats by going in the river with the ROV and taking pictures of the salmon that were using the man-made spawning ground.



The ROV in the field

Future Improvements

We have many ideas for future improvements to the ROV. Our most desired improvement is to include a manipulator or claw for greater dexterity when trying to move objects or complete other mission tasks. Also, we would like a better way to route wires down to the ROV. As it is now, the wires are strung out and we have to be careful not to get snagged on surrounding objects. Next year, we would like to wrap all the wires in a single cable so they are contained. Lastly, we are discussing switching all of our controls to switches that use “H” and “Y” bridges. This is useful in more than one application; easier repairs can be done on the spot, it allows for as many switches as you want, and finally, this type of switch lets you easily distinguish which wires are going where.

Reflection

Our team as a whole decided that the ROV experience is a great thing to be involved in. ROVs are getting more and more recognition for their use in real-world applications. We believe that being involved in an area that is expanding can bring you experience in a field that many people may not have the chance to study. The greatest part of this experience was actually seeing our ROV at work in the river helping adults in our community. Our ROV bridged a gap between high school students and the watershed district in a way that otherwise wouldn't have been possible. Allowing us to help in their project gave us a way to gain experience while at the same time providing them useful information.

References

http://www.homebuiltrovs.com/

Acknowledgements

We would like to thank the Salmon River Watershed Council for giving us grants and field time, especially Graham Klag, REEF Education Coordinator. Once we found out we would be traveling to Canada, the amount of support from our local community was overwhelming. Our financial sponsors include Subway, Ace Hardware and the Cruise Inn, in addition to many individual donors. The Lincoln City Eagles Lodge was a tremendous help with our fundraising efforts and and matching donations for our trip to Newfoundland. We would also like to thank the MATE Center for providing us with the opportunity to participate in ROV competitions while learning about engineering. Last, but not least, we would like to thank our instructor Mr. Lambie and our parents, who all acted as mentors in one way or another.