

Design Your Own Underwater Remotely Operated Vehicle (ROV)

By Brian Lien

[The project] will excite your students, and you as the teacher will get a new outlook on your teaching career.



Mark and Kyle are making final adjustments to their underwater ROV.

While looking for labs for my pre-engineering class, I came across an idea for a marine engineering project from the Future Scientists and Engineers of America website. I thought the lab looked fun, and it was not too expensive. These were two important criteria as I chose labs for the class. Another important criteria I had for implementing labs into the class was whether or not I could incorporate both science and math concepts into the lesson. I felt I could develop a connection between both science and math with technology and engineering as I developed the lab. What really clinched the development of the project for me came when I saw Robert Ballard speak at the 2008 ITEA conference in Salt Lake City. As he talked about his experiences in ROVs and his JASON Project, I knew this lab was one my students needed to do.

I knew developing this lab would take me out of my comfort zone. However, I feel for a teacher to become a better teacher, he or she must learn new things. This, in turn, frustrated one of my students who told me she thought I should know everything. She thought I should have done the lab first and worked out all of the problems in order to anticipate the problems students would have and be able to provide answers. I explained that when she gets a

job and her boss approaches her with a problem that she can't immediately solve, she will have to use the skills she is learning now to help her solve problems later. She was OK with the explanation; however, she still thought the teacher should know all the answers.

The lesson began with the purchase of two kits from FSEA (www.discoverycube.org/fsea.aspx). I read through their material, which gave good instructions on how to build the project but did not incorporate the science and math skills I wanted the students to use. So, I bought *Build Your Own Underwater Robot and Other Wet Projects* by Harry Bohm. This book contained some good background information about the history of underwater devices and some of the science and math skills I wanted to teach my students to better understand marine engineering. I used this book to develop my opening-day activity sheet. I wanted to introduce students to undersea devices and to develop a timeline using the CAD system as their output means. I wanted to show them how a CAD system could be used as a design tool to output a drawing other than the traditional two- and three-dimensional drawings they were used to. I gave them hints on what to look for, but in my redesigned handout, I further refined some specific devices I wanted them to look for. These devices started about 1200 AD and went through the JASON Project's ROVs.

Once they learned about the history of these devices, it was time for the science. In the book, *Build Your Own Underwater Robot and Other Wet Projects*, there is a section on Archimedes' Principle. I used this section to help the students with the concept of buoyancy. Next year, as my "hook" to this activity, I am going to have a clear bucket or tub filled with water. I will have 5-10 different objects and have students tell me if each object will float like a boat, submerge—but not sink, or sink like a rock. To confuse them I will also have a piece of ebony wood and Pumice rock. These two materials act differently than most other types of wood or rock. Once they see what the objects do in water, I will introduce them to Archimedes' Principle and the terms, "positively buoyant," "neutrally buoyant," and "negatively buoyant." I will then relate these terms to the project they are going to design. You can even talk about Newton's First Law of Motion during the course of this lab. Once student ROVs are neutrally buoyant, it will not take much effort to get the ROV moving.

After the history aspect is complete, students can begin the build process. I gave them the design problem of having to pick up five steel washers from the bottom of the shallow end of a pool using a supplied electromagnet.



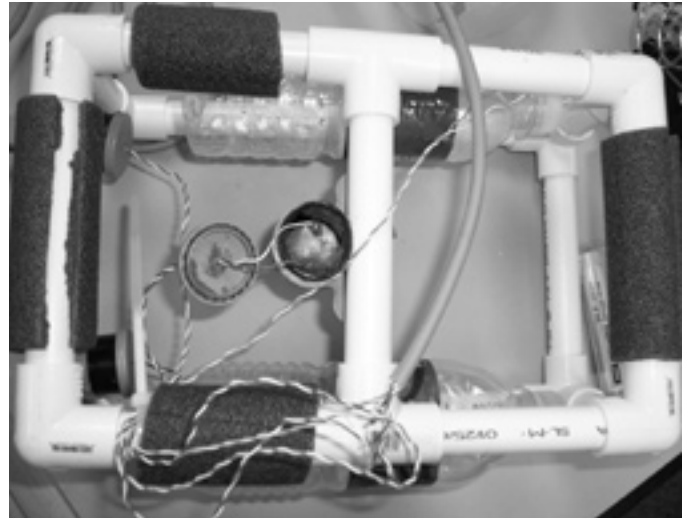
Trevor is adjusting the electromagnet. He is using the extra weight of the electromagnet to make his project neutrally buoyant.

They had ten minutes to do this task. I had the students use the engineering design method. First the students had to research small ROVs. You could incorporate this into your timeline if you wanted to condense the time frame of the lab. Students were asked to determine if any projects like this had been done before. When I started the research, I discovered several great websites—including information about a regional and a national contest with a device very similar to what we were designing. The contest is by Marine Advanced Technology Education Center (MATE), with information at www.marinetech.org/rov_competition/index.php.

Next, students brainstormed ten ideas and made a CAD drawing of their final idea. They had to use Microsoft Excel® to make a parts list and total the cost of their project before I would give them any supplies. I gave them a list of



Zach practices “flying” the day before the contest.



This is an example of how we waterproofed the 12-volt DC motor. We used petroleum jelly to seal the small hole where the shaft extends through the bottom of the film canister. To seal the rest of the motor in and the rim of the lid, we used wax toilet bowl sealer. We used the pipe insulation to help make it neutrally buoyant.

supplies I would provide and anything else they would need to purchase. I had them include the cost of the controller also. They had to use my costs to complete their sheet, keeping the total under \$40. That sounds like a lot; however, I, the controller, was included as part of the build cost. Once the parts list was complete, students had three days to build the project. Next they had four days in our pool to test their projects. We needed that time; however, if they built the project small enough, they could have taken the project home to do testing in their bathtubs. This was even a comment made by one of the students on the year-end evaluation—the desire for additional testing time. Taking the projects home to test could potentially cut out a day or two of testing at school. For the actual competition, I invited local media, both print and video, into the pool area. I also suggested inviting science and math students to see the event as a way to promote our classes for next year.

Take lots of pictures. I took several pictures each day while the students were in the design and build stages. I also took several pictures and video clips while they were in the pool. Our school posted the pictures on its website and I emailed the link everywhere that came to mind. Fellow ITEA Idea Gardeners replied with how they did the MATE competition. I used their expertise to improve my lesson for next year. Here is one comment I received from Celeste

Baine, the author of *Engineers Make a Difference*: “The interesting thing is that his project is considered marine engineering. Marine and ocean engineering are important branches of engineering, especially since we are studying all aspects of the ocean environment to determine our effect on the oceans, the ocean as a natural resource, and its effect on ships and other marine vehicles. For me personally, water is relaxing, and the ocean has always beckoned. I’m sure there are many students who feel the same way. A career being outside enjoying the water would be especially appealing. This line of work is a welcomed defiance to most of the stereotypes about what engineers do all day.” Debra Shapiro, an associate editor from the National Science Teachers Association, read the blog and ran a story on the NSTA website. My administration and parents really loved the lab. Best of all was that this lab was listed as one of the top two labs by my students. They really liked the project. They wanted me to teach it earlier in the year so they would be more willing to do a better job on it.

Some of the problems I encountered with the lab included having a power supply break the day before I was to go to the pool for testing. To overcome that problem I used old cell phone charging units. I found a couple of 1-amp units that worked, but not as well as the real charger would have. You really need a 6-amp charger or a marine deep cycle

battery for the project to work well. By the time you turn on three 12-volt motors and the electromagnet, the ROV draws about 2.5 amps on dry land. When you put it into the water, it will draw even more amperage. I would make the electromagnet differently than the version supplied by FSEA—its magnet is very heavy. I would make my own magnet. Propellers were another big challenge for my students. I bought 40 propellers for the project, and we went through all 40. The students kept breaking them. They had a very hard time gluing the propellers to the shaft. They finally started experimenting with different glues, but it wasn't until the propeller fell off the shaft for the third and fourth time that I suggested trying a different method for propeller attachment. Trying to keep the students "thinking small" was a challenge. However, two of my most successful projects were my largest projects. The cost of the project is expensive for the first year. If you make a controller for each ROV, the cost will be about \$50-\$55 per unit; however, reuse of the controllers allows subsequent yearly costs to remain minimal. If you keep all of the ROVs, you can reuse 95% of the projects. The most expensive part, other than the controllers, is the 12-volt motor. They cost about \$8.00 each, and you need at least three per ROV. These can be reused from year to year also.

There are several variations you could do to make this project work without a pool. You could make them really small using very thin PVC and fly them in any large baby pool or deep sink you might have. You could also not use the electromagnet and use the pool hoops. The challenge would be to fly down and gather the hoops off the bottom of the pool using some arm hanging off the end or bottom of the ROV. Get creative with the project. It will excite your students, and you as the teacher will get a new outlook on your teaching career. It really excited me and kept me going through the final weeks of the school year. 🌀

Resource

Bohm, Harry. (1997). *Build your own underwater robot and other wet projects*. Vancouver: Westcoast Words. ISBN: 9780968161005.



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