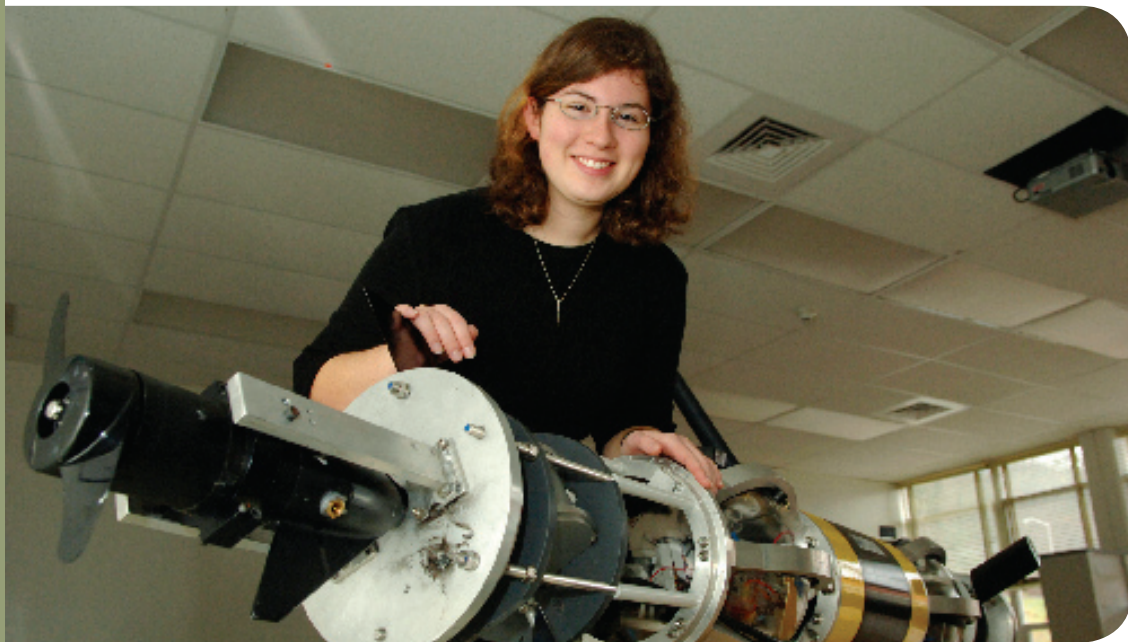


# EXPLORING THE DEEP

Practical Science and Education Come Together with the Help of the Robot-Submarine Hokule'a  
by Rebecca Frank



**t**win beams of light play through deep green water, not quite reaching to the seafloor. As they travel onward, their source, a small yellow mini submarine, is illuminated. It is the only thing that fills the void of darkness and crushing water of the sea above an underwater volcano. Sound like a scene from a science fiction novel? It isn't. In fact, this scenario will become real in October 2006 because of the mini-sub project in the Kimmel School of Technology.

The sub effort represents the School's mission to bring graduate-level opportunities to undergraduates. The robot-sub Hokule'a is the backbone for many student projects, not only at Western Carolina University but also at the Florida Institute of Technology in Melbourne. As electrical engineering and engineering technology students work their way through school, they gradually progress from simple robotics projects to working on the submarine.

Students in classes such as Circuits 1 are all given hands-on projects to bring to life the information they are learning. Using model kits and some individually designed pieces, newer students create small robot "Cybugs" that they use to learn simple circuits and programming. These robots are light and touch sensitive and have primitive programming that allows them to recharge themselves.

As the students progress, they create more advanced robots with simple artificial intelligence programming. These robots are placed in a "robotic habitat"—a small square area constructed of plywood with a place for the robots to recharge. Here they are observed to see how quickly they can learn certain behaviors; for example, where to "feed" in an area that's charged with 12 volts of electricity.

By the time students reach junior and senior level they are expected to be able to design, build, and program one of these little robots. Students finally reach the ability level to work on the sub. Engineering technology students created a three-dimensional computer model of the vehicle, and a plastic replica has been fabricated from this to show the capability of the modeling system. This will allow future work on the sub to progress faster because tests can be run on the computer for initial fit and weight.

Students are now readying the sub for its second expedition: an exploration of the caldera of the underwater volcano, Loihi, located off the coast of Hawaii. This mission has been years in the making. There are many purposes for sending Hokule'a to Loihi. The sub will be depth tested to confirm that it will work in the caldera environment. It will make a general audio, video, and chemical recording as it makes passes across the caldera. It will also be used to record data from a hydrothermal vent.



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Dr. Brian Howell

Hokule'a began its life as a surface vehicle at the Florida Institute of Technology. Originally used as a shallow water vehicle for monitoring water conditions, it became in 1995 a project for students who were assigned to harden it for use at greater depths. For its first mission, it needed to be useful at a depth of 1,000 meters to explore and collect mostly chemical samples. For its second mission to Loihi, it must be operable at 3,000 meters to collect both chemical samples and audio/visual data. The sub has been hardened to withstand the pressure at 7,000 meters, or full ocean depth. It contains two modules of instruments. The control set includes a compass, motor, and global positioning system (GPS). The other set is the sensor payload, with capabilities for gathering chemical and audio/visual information. The sub will include a long-range acoustic modem/communication device and a high sensitivity magnetometer (measures the strength of magnetic fields and used to find iron). The instrumentation is stored in glass spheres, which have the highest compressive strength of any comparative material. It also contains an internal navigation system that will allow it to operate and move in any direction without control from the surface. The sub is capable of operating for two to four hours and has a top speed of four knots, or roughly five miles an hour. It will be able to make several passes across the caldera of Loihi, where it is planned to go in October of 2006.

Funding has become an issue for the Hawaii Undersea Research Lab, and the Loihi mission may not go through. However, even if the mission does not come to fruition, the sub should be completely tested and capable by the end of August 2006. The first year of Hokule'a's operation will involve coral reef navigation in the Florida Keys, shallow testing in the Pamlico Sound and Nantahala Lake, and ocean testing off of Charleston, South Carolina. It will also be used to do coral reef studies in Florida, to track down wrecked ships, find sources of pollution, and follow pods of dolphins.

Dr. Brian Howell, who brought the sub to Western Carolina from Florida Tech, is pleased with the way the sub has been integrated into the undergraduate program here. "The biggest thing for me with the sub is that it serves two purposes," he said. "Not only is it a useable for real science, like exploration, but it is also meeting an educational goal. It is a tremendous tool to reach a large number of students under three different degree programs here. The sky, or really the ocean bottom, is the limit."

## students in action

**Karen Watrous**, a senior geology major in the Department of Geosciences and Natural Resources Management, has been working with Cheryl Waters-Tormey on a project studying the tectonic history of the Southern Appalachians. Karen is studying two fault zones that developed during the continental collisions that built the Appalachian mountain belt. The fault zones are exposed at the earth's surface southwest of Hot Springs, N.C., which is her field area. She and Dr. Waters-Tormey are collaborating with the North Carolina Geological Survey on a new geologic map of the region. In Karen's field area, the two fault zones actually merge into one zone. Karen is trying to determine whether the two fault zones were active at the same time, or if they were active during two separate tectonic events. To do this, Karen has collected and is analyzing rock samples from the two fault zones to determine the fault type and identify metamorphic minerals (which will tell her the temperature and depth of the fault zone when it was active). This information indicates how these fault zones helped to build the mountains in this area. Karen presented her results at the southeastern section meeting of the Geological Society of America in March 2006.