Leaks Happen

THE OCEANOGRAPHY SOCIETY features and celebrates interdisciplinary research that brings together one or more oceanographic disciplines to make scientific advances. In certain types of studies, new knowledge cannot be gained without the cross fertilization from experts in different fields. *Oceanography* magazine describes many of these studies and the articles often feature various tools and data-acquisition systems used to collect necessary data. The development, construction, and operation of these systems requires a different type of interdisciplinary activity. I recently had a first-hand opportunity to witness how difficult it can be to build equipment that reliably works in the harsh ocean environment—without leaking.

I was invited to be a judge at the 9th International Autonomous Underwater Vehicle (AUV) Competition, hosted and organized by the Association of Unmanned Vehicle Systems International (AUVSI) (http://www.auvsi.org/competitions/water.cfm). Twenty-one teams competed this year, representing 14 U.S. colleges and universities, four Canadian universities, a high school, and a team from both India and Japan. The competition tests teams' ability to design and construct an AUV to complete a mission designed to mirror real life obstacles that professional engineers face when developing autonomous systems. The AUV must first submerge and pass through an underwater validation gate by maintaining a heading, thereby showing a basic autonomous aptitude. Then it must complete three mission elements in sequential or random order. The first element is to "dock" with an underwater light station. This station consists of a bright red light and a submerged buoy. After physically touching the buoy, the vehicle must identify and follow an orange underwater "pipeline" and locate a series of breaks in the line. The vehicle identifies a break by dropping a marker. Finally, the vehicle must locate, home in on, and surface directly over an underwater pinger.

In order to successfully compete, the teams had to adapt a truly interdisciplinary approach using mechanical and electrical engineering, optics, computer science, and team building. Motors and thrusters were required to submerge, navigate through the course and surface, all of which required the vehicles to determine and maintain depth and heading. A camera and optical system was required to identify the lighted docking station and to follow the yellow pipeline. An acoustic system was required to locate and home in on the pinger. Of course, all the systems had to be integrated and work autonomously; once launched, there was no human intervention, until the course was completed, or the vehicle required recovery.

The most successful teams were not necessarily the ones with the largest budgets. They were the ones where the students learned to work as an interdisciplinary team that made use of individuals' strengths and talents. As the technological requirements of oceanographers increase, and the tools needed to gain access to the sea and obtain data become more sophisticated, we are becoming increasingly reliant on interdisciplinary approaches—not only for the science, but for the engineering and technologies that will provide the tools for conducting the research. It was gratifying to be part of the AUVSI educational program—a program providing hands-on experiences for students in constructing complex systems that operate underwater. But a major lesson was learned: no matter how sophisticated computer, electrical, and optical systems may be, compromised watertight integrity through a pin-hole leak can ruin your day, because leaks happen.

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