Grants fund research on underwater vehicles, high-tech materials

By Steven Schultz

Princeton NJ -- University engineers are among the leaders of two major projects funded by the U.S. Department of Defense to develop mobile unmanned networks of underwater sensors and to develop new high-tech materials.

The Department of Defense awarded one of the grants to a team led by Naomi Leonard, professor of mechanical and aerospace engineering, and the other to a team led by George Whitesides, a professor of chemistry at Harvard University, and Ilhan Aksay, professor of chemical engineering at Princeton.

The grants are among 31 that the military awarded under its Multi-disciplinary University Research Initiative (MURI). The grants each provide about $1 million per year for three years with an option to extend the grant for two additional years.

Leonard's project will build on her extensive work on programming the behavior of fleets of underwater vehicles that autonomously map temperature fronts and patterns of biological activities in the oceans (see a previous story online at <Web site>). The new project is intended to expand the effort to a larger number and wider variety of underwater vehicles with more advanced coordination between the vehicles.

A central question, said Leonard, is how to optimize the movements and "decisions" that the vehicles make so that they collect the most interesting data in the most economical way. This goal requires some vehicles to scan for the "big picture" and other vehicles to home in on specific areas that are undergoing rapid change or have other interesting characteristics.

"We don't want them to all rush to the same place," she

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said. "We want some to explore one area and others to explore another. It involves thinking about how to use feedback to keep our vehicles in some kind of pattern that makes sense and then optimize those patterns."

Leonard, who participated in a test of underwater vehicles at Monterrey Bay, Calif., in August 2003, anticipates con-ducting a smaller underwater test in 2005 and a larger experiment in June 2006. She is collaborating with researchers at the Scripps Institute of Oceanography, the Woods Hole Oceanographic Institute, Harvard University, the Cali-fornia Institute of Technology, the U.S. Navy, the Massachusetts Institute of Technology and the National Research Council of Canada.

The other MURI grant with Princeton involvement supports development of new materials based on "electret" technology. Electrets are materials that can be given a permanently uneven distribution of positive and negative charges. Many materials can have a temporary surface charge known as static electricity like a balloon that stores a charge when it is rubbed against a shirt. However, balloons and other normal materials return to neutral quickly.

Materials capable of retaining surface charges for extended periods have long been used in photocopying devices. The MURI grant will support research on new types of materials with long-lasting or permanent surface charges. The Princeton team is creating materials that could be useful in preventing corrosion of metals or in making "self-healing" materials that automatically repair breaks and fractures for use in airplanes or spacecraft.

The technology also may lead to very fast, very high-definition printers. The Princeton researchers are developing a way of making a microscopically thin jet of electrostatically charged ink. The charged ink could be manipulated with great precision by applying an outside electric field.

The project will investigate both solid and liquid

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electret materials and explore the basic science behind the distribution of electrical charges. "Nobody fully understands why the charge transfer takes a very long time in some materials," said Aksay. "As we understand the fundamentals better, a lot of applications will arise."

In addition to Aksay, other researchers at Princeton on the project are Dudley Saville, professor of chemical engineering, and Roberto Car, professor of chemistry.

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