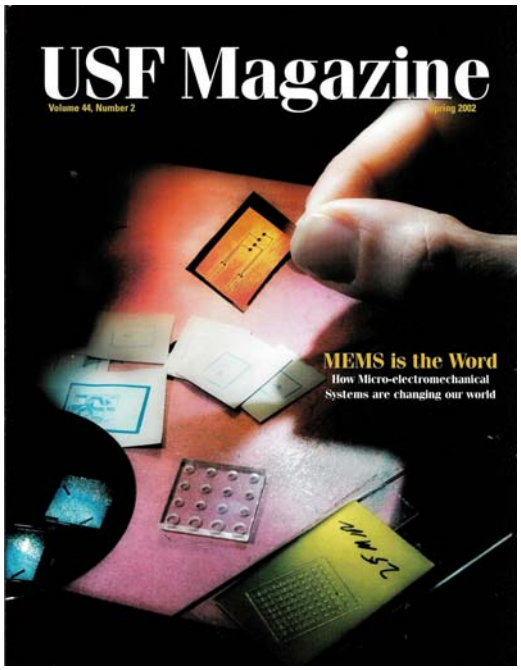
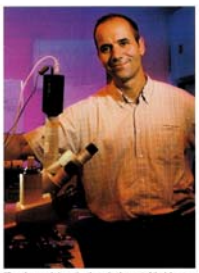
Intelligent Micro Patterning, LLC in the News

USF Magazine





"One of our goals is getting the technology out of the laboratory and into the field," says David Fries, who leads MEMS research in the Center for Ocean Technology. Fries developed a technique for creating MEMS devices that is now commercially available.

water sample using its fluidic system. A tiny electronic pump would push the sample to another part of the chip where the DNA would be extracted and amplified. Then, the fluid would be fed to the testing section where an electromechanical system would analyze the DNA and send a signal back to scientists in a laboratory in St. Petersburg if harmful riliterials were detected.

Depending on what's found, the vehicle might then perform some kind of action, such as radioing for cleanup to make the area safe.

MEMS research at USF, in fact, began to take shape in 1994 when Peter Betzer, who was chairman of what was then the Department of Marine Science in the College of Arts and Sciences created the Center for Ocean Technology. The center was created because Betzer believed that for the marine science program to be competitive it had to have an engineering component, and he began hiring faculty and staff to create novel underwater instruments.

Around the same time, USF's marine scientists received a grant from the U.S. Navy to develop sensors that could find mines in the water, a need that was identified during the Persian Gulf War.

Fries, who now leads the Department of Defense project, came to USF in 1996 and drove the MEMS effort in the Center for Ocean Technology. The first contract was awarded in September 2000, and the center now holds $13.1 million in grants for MEMS research.

The relationship and research evolved away from mine sensors to the creation of underwater chemical, biological and physical sensors for a variety of uses. It has most recently evolved into miniaturizing those sensors.

Already, the COT has developed a Bottom-Stationed Ocean Profiler or BSOP, a 10-by-7-foot platform that holds chemical, biological and physical sensors that give information about the safety of the water. The profiler sits underwater, so it is not as noticeable as a buoy, and surfaces on command to collect data and radio it back to a person in an office.

But the BSOP is macro-sized, and the vision of the future calls for smaller vehicles that are less expensive to produce and able to navigate small spaces or work in swarms. The newest autonomous underwater vehicles are as small as 5-by-24 inches. Fries is helping researchers at Duke University outfit their miniaturized AUVs with MEMS-based sensors.

The work requires a multi-disciplinary effort that involves dozens of faculty members and graduate students in engineering and marine science who are focusing on specific aspects of the system. For example, in the College of Engineering, Thomas Weller is working on the development of the radio frequency telemetry portion of the system, and Shekhar Bhansali is developing the power supply for ion traps that are necessary for the identification of unique molecular structures.

"MEMS technology for a long time has been focused on developing individual pieces for a very small machine. Now the industry is moving more toward creating whole systems, and that's our forte," says Carol Steele, business development manager of the COT.

Although Fries and his colleagues are focusing on the development of underwater sensors using MEMS technology, the sensors have wide-ranging applications.

"By addressing the most difficult cast of the ocean, where you have corrosion and pressure and vibration and fish and biology, we're designing a system that can easily be used in a factory or water treatment plant," Fries says.

Or, the human body.

"Many of the lessons learned making underwater sensors applies to putting sensors in space and the body," says Steele. "We believe if we can make it work with the saline solution of the ocean we can make it work in the saline solution of the body."

MEMS sensors are already being used for the development of diagnostic medical devices. Using MEMS, pacemakers, cochlear implants and retinal implants will get even smaller. Neural prosthetic devices will be used to repair spinal cord injuries and paralysis.

"A small integrated system that can go into the body and correct a deficiency or augment a capability is inevitable," Fries says.

Fries foresees an implantable insulin sensor and pump for diabetics that would monitor levels and release insulin as necessary.

A pharmacy on a chip, Fries call it. The "pharmacy" would need to be re-stocked, but probably only once a year. Now, diabetics are advised to prick their fingers and check their blood sugar several times a day.

Robert Nelson, M.D., a pediatrician in the USF College of Medicine, is working with the COT's MEMS researchers to develop an infant-sized mannequin outfitted with sensors that can be used to train physicians who treat premature babies in hospital neonatal units. Such mannequins already exist for adults, but until now there have been no sensors small enough to fit inside such a tiny model.

Dr. Nelson expects the mannequin to be available for commercialization in the next year. Commercialization of the technology is, in fact, a primary goal of the COT.

"One of the things we're focused on is getting the technology out of the laboratory and into the field," Fries says.

There has already been one entrepreneurial spin-off from the work done by Fries in the Center for Ocean Technology.

Jay Sasserath, a former executive at Unatix, a local technology company, has partnered with Fries to license a process Fries developed at USF.

Sasserath's St. Petersburg company, Intelligent Micro Patterning LLC, sells the SF 100, a machine built around technology created by Fries that manufacturers can use to make their own MEMS and other electronic devices. The company will also design, fabricate and test devices for people who want to use the technology but don't have the resources to set up their own laboratory.

"People who want to start working with MEMS can start working with us today," Sasserath says.

The 2-by-4-foot machine uses processes similar to those used for printing photographs to transfer a three-dimensional image onto a surface. Most commercial fabricators use silicon wafers, which are expensive and need to be handled in clean rooms.

"With our technology we can work with plastic, and glass and ceramics," Sasserath says. "We can work with non-silicon materials, which is a significant cost advantage."

To encourage similar collaborations, USF will open the southeastern region's first dedicated MEMS technology center, called MSTWorks, in September. At the 8,000-square-foot MSTWorks center, located in a Largo corporate park, scientists, engineers and technicians will work on projects for the Department of Defense and will be available to work in collaboration with tech companies throughout the region that want to incorporate this new technology into their own products.

"We are here to create instruments using MEMS technology that support marine science research. But we also are opening our doors to the community to show companies how that technology can be applied to their manufacturing processes and to new products," says Steele, who is charged with facilitating collaboration between the center and the business community.

In February, more than 200 local business people turned out for the Annual Business Technology Conference: Tampa Bay and MEMS.

Hosted by the COT, the City of St. Petersburg and the St. Petersburg Chamber of Commerce, the conference introduced MEMS technology to manufacturers and biotech companies in the Florida Hi-Tech Corridor.

Speakers included Roger Grace, who presented results of a marketing study that identified optics as the biggest MEMS market right now and biomedicine as the largest market for the future; Steve Walsh, who discussed the kinds of businesses, chief among these the automotive industry, that have embraced MEMS technology as part of their products; and Kurt Petersen, who discussed his latest MEMS-based company, Cepheid, which makes instruments used for DNA analysis.

Congressman C. W. Bill Young, R-Fl., a long-time supporter of marine science research, spoke about using MEMS to secure the nation's borders.

As is so often the case with new technology, the question with MEMS is can it scale up—can it be mass-produced inexpensively?

The answer is a resounding, "Yes."

"The cost allows you to make a lot of sensors for the price of what used to be one sensor," Fries says. "So you can deploy these sensors en-masse cost-effectively in the environment, or a hospital, or a factory in new modes and manners and create new ways of observing the environment.

The term that's starting to grow, says Fries, is "pervasive sensing."

"It's a twist on pervasive computing. You're starting to have computers in every office and home, even your car. We're seeing the possibility of pervasive sensing," Fries says.

To illustrate the advantage of pervasive sensing, he points to last-year's anthrax scare. The presence of the organism was detected when people showed up sick in hospitals. If the sensors were part of the construction of the building, the organisms would have been found long before anyone became ill.

"We're seeing the opportunity to take these cheap technologies and embed them across the board," Fries says. "Whether it's in a machine or in a building." Or a newborn-sized mannequin.

MEMS is the Word

MEMS stands for microelectromechanical systems. MEMS devices are made of tiny components—microscopic gears, hinges, and levers—about the width of a human hair.

• In 1988, a team from UC-Berkeley demonstrated a working electric motor that could be seen only with the help of a microscope. The motor's main spinning part measured 60 micrometers, or 60 millionths of a meter, across. If this were 10 times bigger, it would still have been only as wide as the head of a pin. Today, MEMS motors are even smaller and more powerful.

• Japanese scientists were the first to look at ways to propel machines inside a patient's body to deliver life-saving drugs. Micromachines are also being studied as a way to perform more precise medical diagnoses.

• MEMS technology is currently used in air bag sensors, pacemakers, ink jet printer heads, DNA analysis, computer disk drives, disposable blood pressure monitors, and to monitor air and water quality.

• In the future, MEMS sensors might be used to determine the locations and size of a passenger and calculate the response of the air-bag to reduce the possibly of air-bag induced injuries.

• In the late 1940s, the earliest electronic computers weighed as much as 30 tons. Using MEMS, more powerful computers can now be worn as part of your wristwatch.