

NETWORKS

DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING

Research Produces Results That Sparkle



Fraunhofer USA staff (from left) Thomas Schuelke, director of Coatings and Laser Applications; Lars Haubold, project manager; and Jes Asmussen, executive director and ECE University Distinguished Professor, at their research facility on campus.

Michigan State University was founded as an agricultural college, and research on growing better plants is still a hallmark of the university. However, the founding fathers probably never envisioned researchers growing diamonds. That's exactly what a team of ECE researchers are doing with the help of the Fraunhofer USA Center for Coatings and Laser Applications (CCL). The Center, located in the Engineering Research Complex (ERC), provides research and development services based on its expertise in coating technologies and laser applications and works closely with researchers at MSU.

The diamonds produced by this project probably will not end up on your ring finger. They are intended for use in electronic instruments, surgical and scientific tools, and for the fabrication of micro-electromechanical systems. However, Jes Asmussen, executive director of CCL and an ECE University Distinguished Professor, says that anything is possible. "We believe the best future application is industrial and in electronic materials, but as we develop different processes and fabrications, the applications may change," says Asmussen. The crystals are grown by microwave plasma-assisted chemical vapor deposition (CVD) using single crystalline seed crystals.

Asmussen has worked with diamond-making processes for most of his career. "In the 1980s, we finally recognized that we could grow diamond with the CVD process," says Asmussen, who was hired as a consultant to build a reactor using MSU patents that he

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Teachers Get Hands-On Research Experience

A new grant from the National Science Foundation with ECE assistant professor Xiaobo Tan as the project leader will expose middle and high school teachers to research with the hope of generating excitement in the classroom. The three-year grant will establish a Research Experiences for Teachers (RET) Site, the first of its kind in Michigan, on Bio-Inspired Technology and Systems (BITS). The NSF Engineering Research Center for Wireless Integrated Microsystems, or WIMS, will co-host the RET site.

The RET program will train a core group of leaders of middle and high school teachers in

the areas of science, technology, engineering, and mathematics. The idea is to engage them in cutting-edge research in diverse areas within the BITS theme, such as artificial muscles, robotic fish, biosensors, biomechanics, biofuels, digital evolution, and biomolecular engineering.

"This in turn is expected to lead to the development of innovative curricula in biology, physics, chemistry, and technology that excites precollege students and livens up classroom learning," says Tan. The program will partner with a number of schools in Michigan, including Holt Public Schools, Utica Community Schools, and the Detroit Area Pre-College Engineering

Program, and will work closely with industry leaders like Motorola, Consumers Energy, and TechSmith. Co-principal investigators on the

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Teachers from partnering organizations attended a three-hour Teacher Workshop in December as part of the RET program.



from the Chair

TIMOTHY GROTJOHN

I am sitting down to write to you on December 30, 2009, as the decade comes to an end. I looked up the number of students that graduated over the past decade and found that 1305 BS degrees, 415 MS degrees, and 119 PhD degrees were completed. These alumni, a large and very talented group, have started careers that are having a positive impact on our country and our world.

Over the past few years as the chair of the ECE department, I have had the opportunity to talk with many alumni who graduated both in this past decade and in previous decades, including several of you reading this newsletter. A common theme I hear is that the training you received in engineering has provided you with strong "problem solving" skills that have been critical for your success in a wide range of fields, including engineering, management, entrepreneurship, medicine, and finance, as well as other areas. In spite of this very positive message from you, the alumni, the interest in engineering on a national level has dropped as compared to the previous decade. We need to continue to look for ways to encourage the next generation to pursue engineering. To assist in exciting the next generation about engineering, the ECE department is proud that Professor Xiaobo Tan has been awarded a Research Experiences for Teachers (RET) Site from the National Science Foundation. This brings middle and high school teachers on campus to do research and develop curricula to bring back to their students. The program is described in this newsletter.

The decade has seen a number of major national and world events that have impacted the ECE profession. Energy has become a national focus with advances being pursued in alternative energy sources such as solar and wind power, new vehicles including electric vehicles and alternative engine topics, and a "smart" electric power grid. Security in its many forms has also become a major concern including cyber, transportation, and infrastructure security. Health care has technically advanced over the past decade with advances in sensors, diagnostics, application of robotics, and treatments. Such advances can be expected to continue, but equally important will be efforts to provide our advanced health care capabilities at a reasonable cost to all. ECE technology advances can also be used to help address these availability and cost issues.

Lastly, sustainability with regard to the environment and infrastructure is important as we move into the next decades. Work in areas such as sensors and sensor networks are key to having the data for making decisions that impact sustainability. As the next decade begins, the ECE department will be focusing its research and educational efforts in these important areas of energy, security, health care, and sustainability. You can read about some of the activities in these areas in this newsletter and on our Web site at www.egr.msu.edu/ece.

I wish each of you success in the next decade. Working with you, the alumni, and friends of the ECE department, we can graduate our next decade of students. ✨

Results That Sparkle (continued from page 1)

invented. "We built the reactor and it worked." Eventually the reactor was commercialized.

Fraunhofer came on the scene in 2002, looking to establish a U.S. base for its carbon-based coating research. Because there was an established team at MSU working in this area, Fraunhofer decided to locate its facility at MSU.

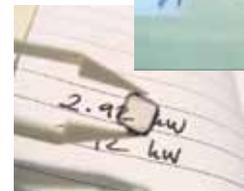
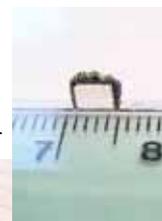
Tim Grotjohn, chair of the Department of Electrical and Computer Engineering, was involved in getting CCL integrated into the laboratory facilities in the ERC. "An important aspect of the success of the Fraunhofer Center was the decision early on to use the location in ERC," says Grotjohn. "This location has allowed strong research and educational interactions to occur between the MSU faculty and graduate students and the Fraunhofer engineers and other staff." It's one of those interdisciplinary projects for which MSU is well known.

The work with growing single diamond crystals has been ongoing for the past five years and has not been widely publicized. However, Asmussen, representing the research team, made a presentation entitled "Single Crystal Diamond Synthesis at High Pressures and High Power Density" at the Materials Research Society meeting in Boston during the first week of December. Other members of the team include Grotjohn; Donnie Reinhard, ECE professor; Kadek Hemawar, graduate student; Jing Lu, graduate student; and Yajun (Jerry) Gu, graduate student; as well as Thomas Schuelke, director of CCL's coatings technology division; and M. Kagan Yaran, project manager, both with Fraunhofer. Attendees appreciated the presentation and were particularly impressed by the data presented on the achieved diamond growth rates, which is a figure important to the commercialization of diamond materials.

The Fraunhofer Center offers a unique opportunity for new product and process development and integration of production and pilot systems because the lab provides a bridging step of developing and testing a product to confirm its suitability for production. "The advantage of the Fraunhofer lab is when we develop an application for a customer, we test it and we provide them with sufficient parts so the company can do field tests," says Schuelke. "We are developing not just the diamond process to make products, but we are also making the equipment to run the processes to make them."

The research team is discussing what to do with the ability to create these diamonds. Most likely, the technology eventually will be commercialized. "However, we have to get the cost down. Right now it is an exacting process that takes concentration and the discipline to do that," says Asmussen. "The goal right now is to learn how to increase the growth rate by a factor of 10 times, and this should help to get the cost down."

For more information on single crystalline diamonds, visit <http://www.ccl-diamond.com>. 🌟



These are two diamonds that have been grown at MSU. They have been polished on the front and back sides and are about 4 millimeters by 4 millimeters in size. The diamonds are near colorless.

2010 Visiting Committee

The ECE Visiting Committee is an advocate for the department, and in a broader sense for the College of Engineering and MSU as a whole. The committee serves in an advisory capacity and assists the ECE department in achieving its goals for students, faculty, and facilities. Committee members provide alternative perspectives on the issues confronting the department and provide a conduit for the exchange of information and ideas between the department and industry.

Current members of the committee include:

K. Venkatesh Prasad (chair), technical leader and head of Infotronics Research and Advanced Engineering, Global Product Development, Ford Motor Co., Dearborn, Mich.

James Anderson, executive manager of electric asset management, Consumers Energy, Jackson, Mich.

Jeffrey Cook, faculty member, Electrical Engineering and Computer Science Department, University of Michigan, Dearborn, Mich.

Jacqueline Toussaint-Barker, program manager and senior engineer at Sensors Directorate, Wright Patterson Air Force Base, Ohio

Jeffrey Hopwood, professor and chair of the Department of Electrical and Computer Engineering, Tufts University, Medford, Mass.

Linos Jacovides, retired, former director of Delphi Research Lab, Grosse Pointe Farms, Mich.

Gregg Motter, senior business consultant, Dow Chemical Company, Midland, Mich.

S. Hossein Mousavinezhad, professor and chair of the Department of Electrical Engineering, Idaho State University, Pocatello, Idaho

David Pahl, director of investor relations, Texas Instruments Inc., Dallas, Texas

Teachers Get Hands-On Research Experience (continued from page 1)

project are Evangelyn Alocilja, associate professor of biosystems and agricultural engineering, and Drew Kim, assistant to the dean for recruitment, scholarships, and K-12 outreach in the College of Engineering. Six other engineering faculty members are also involved in the project. The teachers will come to campus to work in the research labs and learn firsthand about ongoing research.

"Building the content knowledge, not necessarily changing what teachers teach, will give them an understanding as to how strengthening the content improves our teaching and methodology," says John Thon, a teacher at Holt Junior High School who has worked with Tan on research projects.

The \$500,000 award is funded under the American Recovery and Reinvestment Act of 2009, which is particularly meaningful considering the current economic situation in Michigan. "By exposing teachers to the cutting-edge research that has an impact on important global issues such as environment, energy, food, and health care, and by transitioning such knowledge and excitement to the classroom, we hope young students will see and pursue science and engineering-based learning and career paths," says Tan. In addition, undergrads and graduate

students will interact with teachers. "We hope this will give them a different perspective on the value of their work as well as the sense of importance in terms of science and engineering education," says Tan.

The first formal event for the project was held on December 11, during the college's Design Day. A three-hour Teacher Workshop, attended by 14 teachers from partnering schools, other local schools, and engineering faculty involved in the RET program, discussed research opportunities available in their labs. A curriculum on renewable energy, developed in pilot RET projects, was also disseminated to these teachers. Additional teacher workshops are planned.

"The event serves a few purposes. First, it is a channel for us to screen and recruit highly motivated and talented teachers for the program," says Tan. "Second, it disseminates curriculum materials and other resources to school teachers. These

teachers also bring students from their respective schools to experience Design Day." For example, while the teachers were attending the workshop, their students participated in hands-on design activities and interactive presentations, all organized by the College of Engineering's K-12 Outreach Office.

Major events for the spring will be the recruitment of the first cohort of BITS RET participants, who will start their research and curriculum development activities in the summer of 2010.

A Web site for RET is under construction and will be launched soon. 🌐



John Thon, a teacher at Holt Junior High School, talks with students in one of the engineering labs.

Alumni Networks

New Patent



Tim D. Reichard (BS '79), a senior principal systems engineer with Raytheon Company in Dallas, Texas, was recently awarded U.S. Patent Number 7,545,859, titled "Adaptive Channel Equaliza-

tion Technique and Method for Wideband Passive Digital Receivers." With a career spanning 30 years working for Texas Instruments, L-3 Communications, and Raytheon, Reichard has diversified experience developing innovative solutions for missile systems, electronic warfare sensors, and airborne radar systems. His expertise is in the development of signal processing algorithms, architectures, digital receiver techniques, modeling, and system simulation. He also has an MS degree in electrical engineering from National Technological University (NTU). Reichard is a Senior Member of the Institute of Electrical and Electronic Engineers (IEEE), chair of the Aerospace and Electronics Systems Society (AESS), Dallas chapter, and a member of MSU's Presidents Club. 🌟

MSU Alumni Association Awards



Gerald Reuben DeJean II (left) receives the **Distinguished Young Alumni Award** from **Scott Westerman**, the newly appointed associate vice president for alumni relations and executive director of the MSU Alumni Association.

DeJean is a researcher and electrical engineer with Microsoft Corporation in Redmond, Wash. In addition, he is an adjunct professor at Georgia Institute of Technology where he received his PhD in 2007.

At Microsoft, DeJean is at the cutting edge of the design and packaging of RF/Wireless technologies, and he has expertise in nanoantennas and 3D architectures on flexible organic materials, such as liquid crystal polymers. He has won many prestigious fellowships and has published journals articles, conference papers, and a scholarly book, entitled *Compact Broadband and Multiband Antenna Designs for Millimeter-Wave Applications*. DeJean has three patents and is a pioneer in the field of mobile communications, which is of critical importance to underdeveloped nations. He is also active in community affairs, volunteering to tutor youths in the Seattle area. 🌟

The MSU Alumni Association recently honored ECE graduate **Gerald Reuben DeJean, II** at the Grand Awards Ceremony in October at the Kellogg Hotel and Conference Center.

DeJean (BS '00) received the **Distinguished Young Alumni Award**, which is given to candidates who have distinguished themselves by obtaining a high level of professional accomplishment and high standards of integrity.

DeJean is a researcher and

Endowments/Donations

Gift Keeps Humanitarian Project on Track

George Lee Rock was a farm boy who had never thought about going to college. It was the advice from his captain as he was leaving the Army Air Force after World War II that sent him on his career path. When he returned home to Cadillac, Mich., he borrowed a car for interviews at MSU — then known as Michigan State College (MSC) — and that "other" school down the road. Rock never got beyond the MSU campus. He decided to pursue an electric engineering degree at MSU.



Vickie and George Rock

He not only got his BS degree in electrical engineering in 1949, Rock married his high school sweetheart and worked for Dow Chemical Company in Midland, while looking after the family farm in Cadillac. He worked at Dow 35 years in a career that took him around the world managing patents in the instrument field.

Now, more than 19 years after his retirement, he and his wife, Vickie, want to give back to the place that gave George his start. The Rocks recently made a gift to the ECE department (with a match from the Dow Chemical Co.) to fully fund a capstone humanitarian project for the spring 2010 semester. The project the Rocks are funding develops solar-powered computers that are installed in rural areas of Tanzania where there is no electricity to run a computer. The Rocks hope to continue to provide support to this project in the future.

Thank you, George and Vickie.

Student Networks

Board of Trustees Honors ECE Student



Graduating senior **Michael Carpenter** of Livonia was honored Dec. 11 for his academic achievements. Carpenter is one of six students university-wide who was recognized by the MSU Board of Trustees. These awards are granted at each commencement to graduating seniors having the highest cumulative grade point averages at the close of the semester prior to graduation. He had a 4.0 GPA.

Carpenter is the son of David and Linda Carpenter and is a member of the Honors College.

Best Paper Award in GLOBECOM 2009

ECE graduate students **Anthony Plummer** and **Mahmoud Taghizade**, along with their adviser Professor Subir Biswas, received a best paper award for their paper "Measurement Based Capacity Scavenging via Whitespace Modeling in Wireless Cognitive Networks." This work, partially funded by the Air Force Research Laboratory and the National Science Foundation, was presented during the 22nd IEEE Global Communication (GLOBECOM) Conference, held in early December 2009.

Best Paper Award on Mechatronics

Yang Fang, a PhD student who graduated in August 2009, and Assistant Professor Xiaobo Tan won the CSCD Best Paper Award on Mechatronics for their paper entitled "Design and Modeling of a Petal-Shaped, Conjugated Polymer-Actuated Micropump." The paper exemplified the creative integration of mechanical and electrical design in mechatronics systems. The award was presented at the 2009 DSCC in October 2009. Fang is now a research engineer with Southwest Research Institute in San Antonio, Texas. 🌱

More ECE News

The ECE department has a long tradition of excellence in teaching and research and is proud of its reputation as one of the premier programs in electrical and computer engineering. The department provides an outstanding environment for training the next generation of students and researchers. For more information on the latest news about the department, visit www.egr.msu.edu/ece 🌱

International Exchange Student Impresses



Stephan Lorenz (right), an international graduate student from Kaiserslautern, Germany, worked with ECE Professor Subir Biswas in the NeEWS Lab.

Stephan Lorenz, an international graduate student from Kaiserslautern, Germany, came to MSU in May 2009 as part of the College of Engineering's Exchange Program and quickly impressed his professors with his work. Under the supervision of ECE Professor Subir Biswas and in collaboration with other graduate and undergraduate research students in the NeEWS laboratory, Lorenz developed a new wireless content distribution protocol, called ACEP. ACEP is a context-aware content dissemination mechanism in which electronic objects, such as research papers, can be automatically delivered to appropriate recipients based on their interest profiles tracked autonomously by a wireless network.

In addition to developing wireless protocol syntaxes and their mathematical formulation for ACEP, Lorenz's primary role on the project was to develop a detailed software simulation system that can be used for performance evaluation of the ACEP system. This simulation system was extensively used for comparing the performance of ACEP from a large-scale software implementa-

tion with a prototype implementation in the lab. Part of his research is now in the process of being published. Lorenz returned to Germany in October to complete his master's program. Maggie Blair-Ramsey is coordinator of the college's study abroad and exchange programs. The exchange program brings international students, generally from universities participating in the study abroad program, to MSU for several semesters of graduate-level study.

Lorenz is enthusiastic about his future opportunities. "My work at the NeEWS laboratory not only has given me a wonderful opportunity to do research on a cutting-edge problem, but also has provided a unique perspective to graduate research in general," says Lorenz. "I plan to continue my graduate research in the near future, for which this exchange research experience will surely act as a definitive motivation."

For more information on the NeEWS laboratory, visit <http://neews.egr.msu.edu>. Information on the College of Engineering's international programs is available at <http://www.egr.msu.edu/study-abroad> 🌱

Faculty Networks

AGEP Faculty Mentor of the Year



Hassan Khalil

University Distinguished Professor **Hassan Khalil** received the Faculty Mentor of the Year award from the Alliance for Graduate Education and the Professoriate

(AGEP). Khalil was nominated for the award by **Alexis Ball**, an EE PhD student. Khalil has been Ball's adviser since she began work on her master's program. AGEP seeks to join together universities and colleges in the common mission of increasing the number of underrepresented minority students earning PhDs and positioning minority students to become leaders in science, technology, engineering, and mathematics (STEM) fields. The award was presented at the annual conference of the Institute on Teaching and Mentoring, held in Arlington, Va., in October.

Ball wrote in the nomination letter: "Dr. Khalil teaches his students how to think independently to arrive at solutions rather than memorize the theories or mathematical proofs themselves. His guidance was the catalyst for me to change my research, and ultimately my future career aspirations." She goes on to say that Khalil showed her how to juggle journal and conference reviews, while carrying a teaching load, along with grant writing.

"Dr. Khalil has pushed my endurance and scholarly aptitude beyond what I thought possible. His mentoring has directed many accolades my way. My expertise has been requested to review countless articles submitted to numerous journals and conferences. In addition, I coauthored three National Science Foundation grants with Dr. Khalil, all of which were funded. I believe that our mentoring relationship has come full circle, because during the fall 2009 semester I lectured for the course in which Dr. Khalil inspired me to take my current research path."

Ball's general area of expertise is nonlinear systems and control. "Specifically, I study sys-

tems with noise, and how that noise affects the system performance in the presence of feedback control using nonlinear estimators," says Ball. She will receive her PhD in 2010 and after graduation plans to enter the professoriate to further her research and mentor the next generation of engineers and scientists.

IEEE Fellow



Professor **Shanker Balasubramaniam**

was named a fellow of the Institute of Electrical and Electronics Engineers (IEEE) effective January 1, 2010. This

honor was awarded to Balasubramaniam for his contributions to time and frequency domain in computational electromagnetic.

His research interests include all aspects of computational electromagnetics, and electromagnetic wave propagation in complex media. He has authored/coauthored more than 70 journal articles and presented over 120 papers at conferences. He is an associate editor for the *IEEE Antennas and Wireless Propagation Letters* (AWPL).

NSF NeTS Grant



Associate Professor **Subir Biswas**, in collaboration with Professor **Ed Rothwell**, has been awarded a grant from the NeTS program at the National Science

Foundation, for their project on "Pulse Switching: An Ultra-light Multi-hop Network Paradigm without Packet Abstraction."

The grant will support research on developing an ultra-wideband impulse radio based pulse switched networking paradigm, which is considered to be a key enabler for packet-less embedded sensing applications including bio-medical body-area sensing and structural

health monitoring through ultra-light packet-less communication.

More about Biswas' and Rothwell's research can be found at <http://neews.egr.msu.edu> and <http://www.egr.msu.edu/em>

DURIP Grant



Ning Xi, ECE

professor, and Matt Mutka, CSE professor, have been awarded a grant from the Army Defense University Research Instrumentation Program

(DURIP) for a project entitled "Acquisition of a Multi-Robot Mobile Manipulation Systems." This project will investigate coordinated control and teleoperation of multi-robot systems.

DOE Awards \$2.5 Million to Build Advanced Hybrid Engine

Professor **Fang Peng** and Associate Professor **Elias Strangas**, in collaboration with ME faculty Norbert Mueller, Patrick Kwon, Indrek Wichman, and Tonghun Lee, are the recipients of a two-year, \$2.5 million grant from the U.S. Department of Energy's Advanced Research Projects Agency. The research team plans to begin working immediately to produce a vehicle-size engine/generator known as a wave disk generator (WDG) by building on existing modeling, analysis, and lab experimentation. The WDG would be smaller, lighter, and cheaper to produce than a traditional car engine.

"Our goal is to enable hyper-efficient hybrid vehicles to meet consumer needs for a 500-mile driving range, lower vehicle prices, full-size utility, improved highway performance, and very low operating costs," says Mueller, who is the principle investigator for the project. "The WDG also can reduce carbon dioxide emissions by as much as 95 percent in comparison to modern internal combustion vehicle engines."

STTR Contract Furthers Use of Self-Structuring Antenna



Monarch Antenna, Inc., based in Ann Arbor, Mich., will be part of a two-year Phase II Small Business Technology Transfer (STTR) contract to develop a smart antenna for astronauts based on Monarch's proprietary Self-Structuring Antenna (SSA) technology, patented by ECE Professor **Ed Rothwell**. The antenna will be worn by astronauts in NASA's planned missions to the moon and Mars in the next two decades, and is based on Monarch's GEN 2 design. Virtual EM Inc. (Ann Arbor, Mich.) is the prime contractor acting as the systems integrator, while Purdue University (West

Lafayette, Ind.) is the other subcontractor, developing state-of-the-art RF MEMS switches that will be used to configure the antenna aperture.

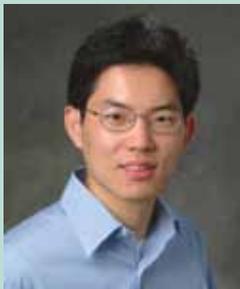
According to Andrew L. Benjamin, avionic technology manager at the Johnson Space Center, and the topic manager for this STTR Phase II contract, "Self-Structuring Antenna technology is a game-changer for wireless communication and is currently being considered for NASA's future long-duration missions to the moon and Mars." A NASA press release on the winning proposals also noted that, "These proposed smart antennas offer a high performance-to-cost ratio and may reduce the cost of mobile communications antennas."

Unlike a typical fixed antenna, Monarch's SSA continuously monitors its target wireless signal. A genetic algorithm, based on feedback from the radio, changes the antenna's electrical

"shape" by switching different sections of the antenna on and off through switches — allowing the antenna to adjust to changing signal direction and strength, for the best possible signal. This capability also allows the antenna to maintain a more reliable communication link and a high signal-to-noise ratio in situations where the performance of traditional passive antennas would suffer.

Monarch Antenna, Inc. is an independent company created in 2007 by Delphi Corporation, in partnership with Michigan State University and Automation Alley. Developed jointly by Delphi Corporation and Michigan State University, the SSA system is licensed exclusively to Monarch for uses in consumer, industrial, and aerospace products as well as uses by the military and homeland security. 🌱

Partnership Advances Robotic Fish Project



Assistant Professor **Xiaobo Tan** and Elena Litchman, an assistant professor of zoology based at MSU's Kellogg Biological Station on Gull Lake in Kalamazoo County, recently won funding from the National Science Foundation to integrate their research. Using advanced materials, Tan and Litchman are developing robotic fish that probe underwater environments.

"Fish are very efficient," explains Tan. "They can perform very efficient locomotion and maneuvering in the water." Robotic fish — perhaps schools of them operating autonomously for months — could give researchers far more precise data on aquatic conditions, deepening the knowledge of critical water supplies and habitats.

"The robotic fish will provide a consistent level of data that hasn't been possible before," says Litchman. "With these patrolling fish we will be able to obtain information at an unprecedentedly high spatial and temporal resolution. Such data are essential for researchers to have a more complete picture of what is happening under the surface as climate change and other outside forces disrupt the freshwater ecosystems. It will bring environmental monitoring to a whole new level."

The robotic fish will carry sensors recording such things as temperature, dissolved oxygen, pollutants, and harmful algae. Tan also is developing electronics so the devices can navigate and communicate in their watery environment. "The project will be very practical," says Tan. "We are designing the fish to be inexpensive so they can be used in various applica-

tions like sampling lakes, monitoring aquafarms, and safeguarding water reservoirs." The robotic fish might detect toxic algal blooms, for example.

To mimic how fish swim and maneuver, Tan builds "fins" for robotic fish with electro-active polymers that use electricity to change shape. Similar to real muscle tissue, ion movements twist and bend the polymer when voltage is applied. The effect works in reverse, too — slender "feelers" could signal maneuvering circuits in a sort of electro-active central nervous system. Infrared sensors also could be used for "eyes" to avoid obstacles.

Tan's earlier foundational work on the robots was funded by the Office of Naval Research and a Faculty Early Career Development, or CAREER, Program award from the National Science Foundation. Litchman's work on algal blooms also is supported by an NSF CAREER grant. 🌱

— Gordon Shetler



KEEPING IN TOUCH

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ECE senior Hassan Abdullahi talks to visitors about his team's capstone project during the College of Engineering's fall 2009 Design Day. Abdullahi and other team members worked on a project called "Power-Over-Ethernet for Wireless Home Automation." The project, sponsored by Texas Instruments, won second place in the Prism VentureWorks Prize competition (which includes \$1,000 split among team members). For more information on Design Day, visit www.egr.msu.edu/design-program/.