in minimally invasive medical procedures, while beneficial for patients, create a unique challenge for surgeons: operation without sight. To see inside a patient without open surgery, doctors use a laparoscope, or a camera attached to a small tube that is inserted into the body cavity receiving the operation. However, the surgeon’s view is limited to the camera’s angle. The operating team must stop the procedure to move or turn the laparoscope whenever it needs to adjust the view. The National Science Foundation has awarded Assistant Professor Hongrui Jiang a $400,002 Faculty Early Career Development Award (CAREER) to give doctors a dragonfly’s-eye view of surgery.

Dragonflies, like other insects, have compound eyes—eyes made of thousands of tiny lenses, called ommatidia, arranged in a hemisphere. Each ommatidium captures light from one specific angle. The information from all the ommatidia combines to form an image, like pixels on a screen. The spherical shape gives dragonflies a very wide field of view and excellent motion detection. However, these eyes lack one important feature: They cannot focus. Without the muscles that tune human eyes to see objects at different depths, insects see things at low resolution, depending on the number of ommatidia and proximity to an object.

Jiang’s project combines the merits of compound eyes and camera-type eyes. Leveraging liquid microlens technology he has developed, Jiang and his research team plan to build spherical arrays of tiny lenses that use hydrogels like artificial muscles to focus. “Each individual lens is tunable, so that we can zoom in and zoom out within a certain range to maintain the high resolution,” says Jiang.

If successful, a laparoscope with one of these artificial compound eyes could cover a complete cavity while fixed in one place, making surgery even less invasive while giving surgeons better sight. “If you want to focus on a certain area, you can zoom in that part of the lens,” says Jiang. The technology could also be applied to other medical imaging, such as endoscopy, or to surveillance or military purposes.

The NSF CAREER awards, among the most prestigious given to faculty members who are just beginning their academic careers, are granted to creative projects that integrate research and education effectively.
It has been another great year for the department. Faculty, staff and students have once again excelled in research and teaching. This newsletter highlights some of these accomplishments and other changes that occurred in the department in the past year.

Research productivity continues to be exceptional. In 2006-2007, faculty, staff scientists and students co-authored 145 journal and 172 conference papers. They were also very successful in securing extramural funding for their research. Our research expenditures were approximately $16 million in 2006-2007. Faculty and students continued to receive prestigious awards for their research work.

Professor Thomas Lipo is among the 65 engineers and nine foreign associates elected to the prestigious National Academy of Engineering in 2008.

Professor John Booske was elevated to the rank of an IEEE Fellow in 2007.

Assistant Professors Jack Ma and Hongrui Jiang received the 2008 Young Faculty Awards from the Defense Advanced Research Projects Agency for their research in the microelectronics area. Professors Kewal Saluja and Barry Van Veen received best paper awards at major conferences in their respective areas.

In the area of teaching, the department and the college are actively involved in a large-scale project called COE 2010. The goal of the project is to update the engineering curriculum to better prepare our students to work in the global environment in the year 2010 and beyond. The newsletter highlights one such effort led by Professor Susan Hagness. Professors Giri Venkataramanan and Franco Cerrina also are involved in education projects under the COE 2010 umbrella.

There are several changes in the department faculty. Professor James E. Smith retired from UW-Madison and joined Google. Assistant Professors Seapahn Megerian and Annette Muetze decided to move to other institutions; Megerian joined Google and Muetze has been instrumental in forming and leading two power-focused research entities, the Wisconsin Power Electronics Research Center and the Wisconsin Electric Machines and Power Electronics Consortium. He has authored more than 200 journal articles and holds 36 patents.

Among his numerous honors, Lipo is a fellow of the Institute of Electrical and Electronics Engineers (IEEE) and a fellow of the Royal Academy of Engineering, the United Kingdom equivalent of NAE. He was the founding editor of...

Thomas Lipo elected to national academy

Granger Professor of Power Electronics & Electrical Machines Thomas Lipo is among the 65 engineers and nine foreign associates elected to the National Academy of Engineering (NAE) in 2008, joining the ranks of 2,227 of the most distinguished engineers in the nation. NAE members are peer-elected for their outstanding contributions to engineering research, practice or education.

Lipo is known in the field of power electronics for designing and developing variable-speed drives. The focus of his research includes the study of power-conversion systems, including resonant, multilevel and matrix converters, special machines that operate with solid-state frequency converters, and control and stability in electrical drive systems.

He received his bachelor’s and master’s degrees from Marquette University in 1962 and ’64 and his PhD from UW-Madison in 1968. Prior to joining the College of Engineering in 1981, he spent 10 years as an electrical engineer at General Electric and taught at Purdue University. In his career at UW-Madison, Lipo has been instrumental in forming and leading two power-focused research entities, the Wisconsin Power Electronics Research Center and the Wisconsin Electric Machines and Power Electronics Consortium. He has authored more than 200 journal articles and holds 36 patents.

Among his numerous honors, Lipo is a fellow of the Institute of Electrical and Electronics Engineers (IEEE) and a fellow of the Royal Academy of Engineering, the United Kingdom equivalent of NAE. He was the founding editor of...
Associate Professor Giri Venkataramanan believes that learning involves doing. A hallmark of Venkataramanan’s classes is the balance of instructional material with practical application. Within his project-based pedagogy, his students gain hands-on experience building products from battery chargers to wind turbines. On evaluations, students describe his courses as “a pleasure,” “a class that really makes you think like an engineer,” and “the most practical, applicable course I’ve ever taken.”

For his outstanding educational efforts, Venkataramanan was presented with the 2008 Benjamin Smith Reynolds Award, an annual award honoring faculty who contribute to the instruction of engineering students at UW-Madison. In addition to practical projects, he is known for his knowledgeable, fluent and engaging lectures—which he typically delivers without having to refer to notes, even in a 75-minute class. A colleague tasked with assessing Venkataraman’s teaching said, “I was struck by his mastery of both the course content and the instructional materials.” Unimpressed with available textbooks, he prepares notes in the form of technical papers to compliment classroom lectures.

Students, on-campus and off, know that they always can find study help and sage advice from the man they call “Professor Giri.” He is remarkably invested in his students, quick to respond to E-mail queries and making himself available for one-on-one help to any student who seeks him out. He also makes a special effort to interact with distance-learning students, videotaping all his lectures for off-campus pupils.

However, Venkataramanan is not content to limit his teaching innovations to his own classroom. He is the chair of the ECE curriculum committee, was a member of the provost’s committee on evaluating and developing campus-wide guidelines for resources for teaching and learning excellence, and has given more than 40 presentations and workshops for interdisciplinary teaching.

While on sabbatical during the 2005-2006 school year, Venkataramanan participated in several wind-turbine-building projects in rural areas of three countries. His experiences inspired him to develop curriculum that would allow students to explore community-based sustainable energy solutions. In the spring of 2007, he taught a section of Introduction to Engineering (InterEgr 160) that focused on small-scale wind turbines. Students in the course not only learned about the engineering principles behind wind energy but also experienced building and installing wind turbines as a class project. Such coursework is the beginning of a movement toward a Certificate in Engineering for Energy Sustainability, an initiative that Venkataramanan spearheads.

“I think that these projects can be seen as a new application of the Wisconsin Idea to integrate research, teaching and outreach in energy conversion in a way that can attract and energize students to use engineering to change lives,” says a colleague. “That is, I think that Giri is opening up a new context for engineering education that realizes and renews the traditions of our university.”
“This course helped me decide to get the additional Technical Communication Certificate (in engineering) because it helped me realize that I really enjoy the presentation and communication aspect of this field,” says Kamin.

Class activities also challenge students to consider more than just technical issues when developing solutions to engineering problems.

“Engineering is fundamentally a design process with both technical and nontechnical constraints,” says Hagness. “We’re trying to emphasize the importance of a broad perspective: Engineering solutions are influenced by political, environmental, ethical, legal and social constraints.”

“That perspective will help students in all of their future coursework here as well as wherever their career takes them.”

The course is funded by the College of Engineering 2010 Initiative, which seeks to increase cross-disciplinary research and education on campus to respond to changes in the engineering field, such as technological advancements and global competition.

“The long-term vision is to expand the offering of this course to students from all over campus,” says Hagness. “Having a more diverse environment in the classroom would help the engineering students, because ultimately, they are going to be working on technologies that have to be embraced by the public.”

That message resonates with Kamin. “The most valuable thing I learned in this course is that the communication of information is just as important as obtaining that information in the first place,” she says. “Without being able to communicate your research or the effect it will have on society, it is impossible to get people excited about your work.”

GRAND CHALLENGES:

Professor Susan Hagness conceived of the course as a way to show students the bigger picture of what engineers do for society. “The course is a combination of the NAE project and an inclination I’ve had for awhile that there are students out there who would make wonderful engineers who need to know more about the important impact engineering has in the world,” says Hagness. “It’s not about making cool high-tech gadgets. It’s more than that.”

The course reaches out to students early in their engineering education because studies suggest that students who see the role of engineering in society are more likely to stay with the field, Hagness says.

Mike Lucas was one of the first-year students in Grand Challenges. Lucas says he entered UW-Madison confident he would be an engineer, but partway through the first semester of classes, he was unsure he wanted to continue. “I was just not exposed to much engineering,” he says.

His adviser, College of Engineering Assistant Dean for Engineering General Resources Donald Woolston, encouraged Lucas to try the Grand Challenges course.

The class helped. “It gives you a good idea of what engineers do and the specifics of what the different disciplines do,” Lucas says. He says studying engineering now feels like a concrete decision and plans to pursue a degree in engineering mechanics.

Freshman course teaches students how engineering benefits society

(Continued from front page)

The course also makes an effort to reach out to women—and nearly a quarter of the enrolled students were female. Samantha Kamin was one of them. A first-year student, Kamin was interested in engineering before taking the course, but Grand Challenges helped her pinpoint biomedical engineering as the discipline she plans to study.

The course structure offers students a taste of different engineering disciplines while enabling them to examine broad engineering issues, says Hagness. “Instead of structuring the themes based on specific NAE grand challenges, we came up with societal themes based on scale, starting with engineering challenges at the personal level and getting larger and larger,” she says.

Course sections rely on a team of faculty members who each present a theme and case studies to students, who work with two of the themes over the course of the semester.

Within each course section, students work in teams to develop oral and poster presentations. In the “megacity” group, for example, current projects include underground high-speed transportation to reduce congestion in cities and turning megacities into self-sufficient “eco-cities.”
In April, the College of Engineering awarded 10 undergraduate students Grainger Power Engineering Awards. The students’ interests range from power generation, conversion, transmission and control to issues related to alternative energy and sensing technologies, among others. Sponsored by The Grainger Foundation, the awards honor students for their academic success in the field of power engineering. Pictured (from left) are: Gloria Sinclair (The Grainger Foundation), Dean Paul Peercy and student recipients Beau Brossman, David Nosbusch, Jonah Paul, Jon Hart, Matt Burton, Matt Endres, Mike Schindelwein, Billy Young, Eric VanderZanden and Dan Molzahn, and David Kendall (The Grainger Foundation).
A project by UW-Madison researchers has come one step closer to making fusion energy possible. Headed by Professor David Anderson and research assistant John Canik, the team recently proved that the Helically Symmetric eXperiment (HSX), a unique-looking magnetic plasma chamber called a stellarator, can overcome a major barrier in plasma research: stellarators lose too much energy to reach the high temperatures needed for fusion. Published in Physical Review Letters, the new results show that the unique design of the HSX in fact loses less energy, meaning that fusion in this type of stellarator could be possible. To read more, go to www.engr.wisc.edu/news/headlines/2007/Mar09.html.

If efforts now underway by a team of UW-Madison engineers pan out, the age of the nanomechanical computer may be at hand. Instead of relying on solid-state transistors and other electronic components to compute ones and zeros, such a machine would depend on moving parts to create switches, logic gates and memory units, the building blocks of digital computers. Lynn H. Matthias Professor Robert Blick published a paper in the New Journal of Physics that outlines a plan for making a computer based on microscopic moving parts. Conventional devices use electrons that travel in circuits to push and pull of millions of microscopic parts to control the flow of electrons. News of this development was featured by news outlets around the world, including azonano.com, technologynewsdaily.com, nanowerk.com and BBC. To read more, go to www.engr.wisc.edu/news/headlines/2007/Aug03.html.

Duane H. and Dorothy M. Blumke Professor John Booske has been named a fellow of the Institute of Electrical and Electronics Engineers (IEEE). Booske, also of the Materials Science Program, pursues a broad range of research interests involving electromagnetic fields and waves; specifically, IEEE cited his contributions to vacuum electronics and microwave processing of materials as reasons for the honor. Fellow is the highest grade of membership the IEEE offers.

Professor Susan Hagness is among co-authors of a paper that has received the IEEE Transactions in Biomedical Engineering 2007 Outstanding Paper Award. The journal published the paper, “Confocal microwave imaging for breast cancer detection: Localization of tumors in three dimension,” in its August 2002 issue. Authored with colleagues Elise C. Fear, Xu Li (a former student, now an assistant professor of biomedical engineering at Northwestern University) and Maria A. Stuchly, the paper describes techniques for detecting and localizing small tumors using microwave imaging, with demonstrations by computer and physical model systems. This paper was the most-cited journal paper during the last five years. Hagness also received the 2007 M.E. Van Valkenburg Early Career Teaching Award, sponsored by the IEEE Education Society. The honor cites her holistic approach to engineering education, which includes approaching subjects from many sides, and emphasizing human impact. She accepted the award at the IEE/ASEE Frontiers in Education conference in October.

The Defense Advanced Research Projects Agency (DARPA) has awarded a $1.1 million grant to a team of UW-Madison researchers.

Led by Professor (from top) Dan Botez, Assistant Professor Irena Knezovic, Professor Luke Mawst and Chemical and Biological Engineering Professors Thomas Kuech and Paul Nealey will develop and perform research on quantum-box semiconductor lasers emitting the mid-infrared(mid-IR) with 25 times higher electrical-to-optical power conversion efficiency than conventional mid-IR lasers. This work will develop the first practical mid-IR lasers for a vast array of applications ranging from defense to medical diagnostics. The team members’ broad expertise includes nanophotonics, nanopatterning, nanofabrication, crystal growth and nanodevice modeling. The project will benefit from technologies developed in the Reed Center for Photonics and the NSF-funded Nanoscale Science and Engineering Center (NSEC).

Engineers Australia, the professional engineering society of Australia, has awarded Professor Ian Hiskens the grade of fellow. Hiskens received his BEng, BAppSc and PhD degrees in Australia and is a chartered professional engineer of that continent. His research interests include system dynamics and control of nonlinear (hybrid) systems, with power systems applications. He also is an active fellow of the Institute of Electrical & Electronics Engineers (IEEE).

On June 21, Grainger Professor of Power Electronics and Electric Machines Thomas Jahns received the 2007 IEEE Power Electronics Society Distinguished Service Award. This honor recognizes members of the Power Electronics Society for dedication, achievement and service. Throughout his career to date, Jahns has served in a number of leadership capacities within the Power Electronics Society, including president; and IEEE, including Division II director. He is currently the leader of the Sustainable Building Initiative at the Center for Power Electronics Systems (CPES) and co-director of the Wisconsin Electric Machines and Power Electronics Consortium (WEMPEC).

Professor Susan Hagness is among co-authors of a paper that has received the IEEE Transactions in Biomedical Engineering 2007 Outstanding Paper Award. The journal published the paper, “Confocal microwave imaging for breast cancer detection: Localization of tumors in three dimension,” in its August 2002 issue. Authored with colleagues Elise C. Fear, Xu Li (a former student, now an assistant professor of biomedical engineering at Northwestern University) and Maria A. Stuchly, the paper describes techniques for detecting and localizing small tumors using microwave imaging, with demonstrations by computer and physical model systems. This paper was the most-cited journal paper during the last five years. Hagness also received the 2007 M.E. Van Valkenburg Early Career Teaching Award, sponsored by the IEEE Education Society. The honor cites her holistic approach to engineering education, which includes approaching subjects from many sides, and emphasizing human impact. She accepted the award at the IEE/ASEE Frontiers in Education conference in October.

Pictured from top: Assistant Professors Hongrui Jiang (also biomedical engineering) and Zhenqiang (Jack) Ma are among the 39 honorees to receive 2008 Young Faculty Awards from the Defense Advanced Research Projects Agency (DARPA). This is the program’s second year of recognizing non-tenured faculty who are rising leaders in microsystems technology. Jiang and Ma will each receive $150,000 to develop his project over the next year. Jiang’s project, “Super artificial eyes,” aims to develop hemispherical arrays of microlenses, much like an insect’s eye, for military surveillance applications. These arrays of individually tunable lenses would offer a wider field of view than a traditional camera lens. Ma’s project, “Toward 3-D Si photonics,” will develop monolithically integrated ultracompact distributed Bragg reflector-free vertical-cavity surface-emitting lasers for practical on-silicon light sources using manufacturable semiconductor nanomembranes. Success could lead to high-density silicon-based 3-D photonic-electronics systems.

**ECE NEWS**
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With colleague James Thorp, Virginia Tech Professor Emeritus Arun Phadke (PhD ’64) received the Benjamin Franklin Medal in Electrical Engineering at Drexel University for the pair’s work on reducing the frequency and severity of blackouts. A story about the award appeared on collegiatetimes.com.


Identity theft prevention is most often associated with protecting financial assets. However, in an age of biometrics data—fingerprints, iris scans, DNA profiles and the like—identity theft could mean much more than a lost credit card number.

If credit card information is stolen or the company’s database hacked, the company simply issues a new card with a new number. “But if that happens to your fingerprint, you’ve got a problem,” says Assistant Professor Stark Draper.

Draper, who joined the department in fall 2007, works with a novel type of data encryption for biometrics. This type of encryption prevents hackers from accessing original biometrics data stored in a database or security program.

For example, a user could set up a fingerprint-scan lock on his or her computer. Using Draper’s “secure biometrics” approach, the computer can verify the user’s fingerprint based on stored data. “But if someone broke into your computer and looked at the data that was stored there, they couldn’t replicate your fingerprint,” says Draper.

“That’s different from how current biometrics systems work. Right now they just store your info.”

Draper came to UW-Madison from the Mitsubishi Electronic Research Lab in Cambridge, Massachusetts. He has also taught at University of California, Berkeley, and University of Toronto, Canada. Draper had his first experience with UW-Madison when he met ECE faculty members Associate Professor Akbar Sayeed and McFarland-Bascom Professor in Engineering Robert Nowak at conferences for fields where their research interests overlap. “There’s a strong group of people in related research areas, and there’s a good match in my core research area. That was a big attraction,” says Draper.

Biometric security is only one research area the MIT alum is pursuing. Signal processing, optical transport networks, streaming media, wireless communications, and air correction coding are also active research areas. Many of these areas revolve around the problem of transporting information reliably from one point to another, whether through submarine fiber-optic cables or over wireless connections.

“How do you reliably get bits across the backbone of the Internet, from Madison to Boston or Tokyo?” asks Draper.

Since his research overlaps with other departments—most notably, computer sciences, statistics and medical informatics—another factor that drew Draper to UW-Madison was its collaborative spirit, both within the College of Engineering and across campus. “I saw a many people engaged in interdisciplinary research,” he says. “The faculty here take advantage of being at such a broad university.”

ALUMNI RECEIPTIONS offer opportunities to reconnect

In 2007, the ECE department hosted or co-hosted five receptions across the United States especially for alumni. “The receptions are meant to give us a chance to reconnect with our alumni and also to give them the opportunity to tell us about what they are doing,” says Lori Burrow, the academic department manager for ECE.

The two-hour events also offer alumni a chance to learn about updates in the department, reunite with classmates, network and build collaborations with other engineers. “They are always a lot of fun,” says Burrow. “We have a hard time getting people to leave!”

Receptions are being planned various cities throughout 2008, including Chicago; Santa Clara, California; Washington, D.C.; and Milwaukee and Madison, Wisconsin, among others. To receive information about receptions near you, keep your address current with the Wisconsin Alumni Association at www.uwalumni.com, and watch the department website—www.engr.wisc.edu/ece—for bulletins.
Making the connection for cell-signaling networks

Though McFarland-Bascom Professor Robert Nowak initially developed a model that could trace telephone networks for intelligence purposes, he learned recently that he could apply it in an area outside of information technology. In collaboration with Genetics Professor Audrey Gasch, Nowak is applying his model to a network that has long baffled biologists: cell protein signaling.

In living cells, networks or signaling proteins communicate information from the cell surface to the nucleus, prompting certain genes to turn “on” or “off.” Thus, cells can adapt to environmental changes. If scientists could understand and regulate this gene modulation, it could open new research opportunities into areas of human disease and cell growth, biosensor development and biofuel manufacturing.

Unfortunately, it is impossible to directly measure protein signaling interactions on a large scale in vivo. Current knowledge of cell signaling networks is limited to datasets gathered by cell-study technology and theory based on knowledge of protein reactions. “With our technique, we can mine that data and look at it collectively from a network-centric perspective,” says Nowak.

Currently, scientists can determine which proteins are involved in a pathway, but not their order. By applying his network tomography model, Nowak can reconstruct cell signaling networks from genomic datasets and show the most likely sequence of proteins in a pathway. The model also can show how closely certain proteins interact. For example, if two proteins appear together in a number of pathways, they are more likely to operate closely in sequence. “Roughly speaking, cell signaling networks are not very different from the telephone network or the Internet,” says Nowak.

Next, Nowak hopes to optimize the model by augmenting information from genomic datasets with knowledge from other cell-study methods.