Spring 2007

McCormick

Northwestern Engineering

Robert R. McCormick School of
Engineering and Applied Science
Northwestern University

Leading the way to excellence

McCormick is at the center of innovative University-wide programs

McCormick and the major leagues

See page 10

Some comments about our new design

In this issue we launch a new graphic identity for McCormick and a new design for our magazine.

Our goal for the new graphic identity is to better link the name of our school with Northwestern and engineering in all of our print and electronic communication; we want you to easily identify communication from McCormick wherever you see it.

Our goal for the redesign of the magazine is to make it more coherent, visually appealing, and easier to read. You will notice larger photos, both on the cover and in the body of the magazine; this allows us to give more prominence to our excellent photography. You will also notice a tighter, more readable font treatment in our feature stories. We feel this new design augments the thought-provoking content.

What remains the same is our dedication to showcase the outstanding research and accomplishments of our faculty, students, and alumni.

—The Editors

Greetings from McCormick

Two years into my tenure as dean, it seems an appropriate time to reflect on the progress that we have made at McCormick. We have launched several new initiatives — in collaboration with the deans of other schools and with the support of Northwestern's administration — that will take McCormick to the "Next Level of Excellence."

I have spent much of the past two years talking to students, faculty, staff, alumni, and colleagues about the importance of engineering in today's world. It is our belief that engineering is the driver of innovation, and that it is key to America's economic success. Studying engineering — and molding the disciplined and powerful thinking that results from the study of engineering — offers our students a way to acquire timeless skills that will allow them to prosper in a variety of fields and settings in our ever-changing world.

These conversations have resulted in the development of four new initiatives — with more to come — that will provide our constituencies with the infrastructure, curriculum, and inspiration necessary to retain our competitive advantage:

• The Segal Design Institute, funded by a generous gift from Gordon and Carole Segal, will enhance McCormick's strong reputation for design, expanding it from the undergraduate level to the graduate level and beyond and linking us with the J. L. Kellogg School of Management and other schools within Northwestern.

• The Certificate in Managerial Analytics, offered in conjunction with the Kellogg School of Management, will provide a new undergraduate business option for McCormick's most quantitatively and analytically capable students.

• The Center for Entrepreneurship and Innovation will prepare students to be successful innovators and foster University-wide curriculum development. A new course developed through the center, Medical Innovation, will link students from McCormick, Feinberg, Kellogg, and the School of Law.

• The Northwestern Center for Engineering Education Research, a collaboration with the School of Education and Social Policy, will ensure that McCormick's programs are on the vanguard of engineering education.

Our key indicators show that we're on the right track. Our donor base has grown, and our alumni are actively engaged in many of our new initiatives. Undergraduate applications rose significantly over last year, media coverage for McCormick is up, and research funding continues to grow despite decreases in available funding. This year we welcomed seven new faculty members to McCormick, and the percentage of accepted offers nearly doubled over years past.

In this issue of the magazine you will find a broad sampling of the exciting and innovative research at McCormick. Our emphasis on interdisciplinary collaboration — whether within the University or with other organizations — remains strong. We highlight two alumni — Bob Shaw and Ed Voboril — who have been instrumental in supporting our new initiatives.

It's been a very busy, yet very rewarding two years as dean. I look forward to sharing even more of our exciting progress with you as we move forward to moving McCormick to an even higher level of excellence.

Julio M. Ottino, Dean | April 2007

Leading the way to excellence

Announcing four new initiatives at McCormick

Julio M. Ottino has been dean of the McCormick School for two years now — time enough for him to develop several new initiatives that will have a positive long-term impact on the school and its constituent groups. We outline four of them here and will continue to bring news about future initiatives to you in the next issues of the magazine."We are pleased to announce these new initiatives to the McCormick community. They are directly linked to enhancing the quality of our students' educational experience, and they support creativity and innovation — vital components for our success at McCormick," says Ottino.

From left Dipak C. Jain, dean of the Kellogg School of Management, Gordon Segal, Carole Browe Segal, and Julio M. Ottino

The Segal Design Institute

McCormick has long been a leader in design. In the 1990s the school launched its first initiative in design education: Engineering Design and Communication, in which first-year students take on the challenge of designing new products to solve real-world problems. In 2002 it began the Master's of Product Development. In 2003 it formed the Institute for Design Engineering and Applications, which provides the curricula and facilities for an education in engineering design. And in 2005 it opened the Ford Motor Company Engineering Design Center, a state-of-the-art facility that houses McCormick's design programs.

Now a significant donation from Gordon and Carole Segal, cofounders of Crate and Barrel, establishes a new institute for design that will ensure that McCormick remains a leader in the field. The generous gift will create The Segal Design Institute, which will significantly expand McCormick's existing undergraduate design curriculum, support the development of new master's degree programs, and fund research on design.

"Design entails starting with poorly understood situations containing broad, imperfectly shared ideas, and gradually structuring these ideas to come up with solutions to problems," said Julio M. Ottino, dean of McCormick. "We see design-think as a process that opens horizons and opens minds. For us, design-think provides a pathway toward innovation."

"We are very excited to make a contribution to Northwestern that will enhance its reputation as a leader in design," said Gordon Segal (Kellogg '60), CEO of Crate and Barrel and member of the Northwestern University Board of Trustees. "Companies such as Crate and Barrel need graduates who have been exposed to the principles of design. Design is probably the biggest competitive advantage the United States has in a rapidly changing and highly competitive world."

"We need to create and nurture individuals who can anticipate, identify, and fill the needs of society," added Carole Browe Segal (Weinberg '60), vice president of civic affairs of Crate and Barrel. "The Segal Design Institute will support creative design education for Northwestern students to meet those needs today and well into the future."

The cross-school institute will foster curricular development and research in design across all schools at Northwestern. Ottino and Dipak Jain, dean of Kellogg, have worked to develop new cross-school graduate programs in design that build on Northwestern's world-class programs in business education.

"At Northwestern we have students who receive a broad-based education that allows them to be innovative, and this institute will assist us greatly in those efforts," said University President Henry S. Bienen. "It is a way to cross-link disciplines — engineering, business, medicine, communication, humanities — around a common objective."

"We are very appreciative of this gift from Gordon and Carole Segal and their continuing support of the University, as well as their recognition of the importance of innovative design," added Bienen.

The codirectors of the institute will be Ed Colgate, a professor of mechanical engineering who is a leading researcher in the field of robotics, and Don Norman, professor of electrical engineering and computer science and of psychology and author of numerous popular books on design, including *The Design of Everyday Things.*

Undergraduate Certificate Program in Managerial Analytics

A newly announced undergraduate certificate program will allow McCormick to leverage the strength of the Kellogg School of Management and McCormick's quantitative edge to present an exciting new curricular option for McCormick students. The program — the Undergraduate Certificate Program in Managerial Analytics — will build on the analytical strengths of McCormick undergraduates and provide them with content relevant for careers at the nation's elite management consulting firms and product or service companies.

"This program will provide better cross-linking with Kellogg and enhanced name recognition for McCormick due to Kellogg's excellent reputation in the business world," says Ottino. "More than 40 percent of our students go into consulting and finance, and an undergraduate business certificate program will better meet their needs."

While the Undergraduate Certificate Program in Managerial Analytics provides a unique opportunity for McCormick students, rigorous prerequisites in advanced mathematics, probability, and statistics will ensure that participants are drawn from McCormick's most quantitatively capable students. Approximately 40 candidates will be admitted to the program in fall 2008.

The Kellogg School is also offering a Certificate Program in Financial Economics in partnership with the Judd A. and Marjorie Weinberg College of Arts and Sciences beginning fall 2007. This program will focus on corporate finance, capital markets, and securities pricing and has been developed for undergraduates with a strong foundation in analytics, mathematics, and economics. McCormick students pursuing a double major in economics will be able to apply for the Weinberg program.

"During my visits with corporate recruiters around the world, I've heard them express the need for college graduates who have a strong quantitative background rooted in the liberal arts and who are infused with business acumen," says Dipak C. Jain, dean of the Kellogg School of Management. "The Kellogg faculty is very supportive of the new undergraduate certificate programs."

The Kellogg course work will give McCormick undergraduates the opportunity to build on and apply their analytical skills in the context of finance, marketing, operations, and strategy. The program will require students to take a minimum of four courses chosen from a menu of six courses. Additional courses will be developed for the certificate program, primarily through the Department of Industrial Engineering and Management Sciences at McCormick.

"This program should attract the most highly qualified high school graduates to McCormick," says Ajit Tamhane, professor and chair of industrial engineering and management sciences. "We will be providing them a unique opportunity to participate in an innovative curriculum that has few peers in the country."

Between their junior and senior years, students in the certificate program will pursue either a business internship or a research project with a faculty member. After students have completed their certificate requirements, Kellogg will help them with internship and job placement.

"We expect that the enhanced internship and job placement opportunities will assist our students in becoming McCormick's future leaders," says Ottino. "This is a win-win proposition for McCormick, Kellogg, and — most importantly — for the entire Northwestern community."

Center for Entrepreneurship and Innovation

The McCormick Advisory Council — the body of top advisers made up of executives, entrepreneurs, and academics, many of whom are McCormick alumni — met last fall with Dean Julio Ottino and charged him with a task: Find a way to educate McCormick students and faculty about entrepreneurship and innovation that capitalizes on the considerable strength of McCormick alumni in this area.

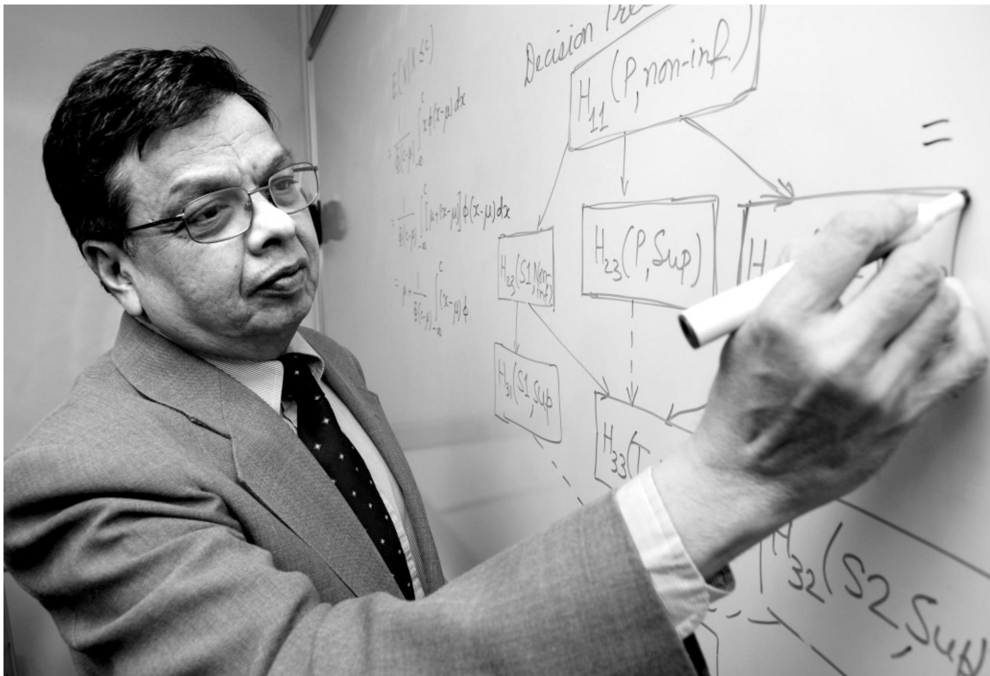
Ottino has found a solution: A new McCormick entity — the Center for Entrepreneurship and Innovation — will work to evolve engineering beyond the applications of the sciences to the creation of businesses that capitalize on innovations. The center will empower McCormick engineers with the skills to be successful entrepreneurs and intrapreneurs.

"Engineering is the application of the pure sciences," says Ottino. "Science oftentimes is incomplete, and engineering thinking has to fill the gaps; that's where innovation and entrepreneurship come in. We are investing in these areas by providing additional course work and a structure to coordinate related activities across the University."

McCormick is well positioned to establish a new standard for engineering education by retooling many of its existing programs with a greater focus on innovation and entrepreneurship. "Design-think" — which is already in place at McCormick — will be greatly enhanced when students learn how their efforts can grow existing businesses (intrapreneurship) or create new businesses (entrepreneurship).

The new director of the Center for Entrepreneurship and Innovation, Mike Marasco, has more than 20 years' experience as an entrepreneur, intrapreneur, and innovation consultant. The center will focus on interdisciplinary curriculum development; empowerment of students, faculty, and alumni to think and work innovatively; corporate and community outreach; and research.

"We saw the need to develop a structure that will support the expansion of our undergraduate and graduate curriculums to include more exposure to innovation and entrepreneurship. We want to be



Ajit Tamhane

the catalyst for bringing together faculty, students, and alumni with interest in these areas," says Marasco, who is a clinical associate professor of industrial engineering and management sciences.

A new academic partnership under the Center for Entrepreneurship and Innovation, NUvention, will expand Northwestern's tradition of interdisciplinary study by piloting new courses that allow students to become entrepreneurs within a class setting. The first course supported by NUvention, Medical Innovation, will be offered this fall and will draw students from four Northwestern schools (McCormick, Kellogg, the School of Law, and the Feinberg School of Medicine) who are interested in turning ideas into new medical technologies. The course was developed through the active involvement of a new student organization focused on entrepreneurship, InNUvation. McCormick alumnus Ed Voboril (see related story on page 24) has joined NUvention's team as chair of the program.

Student involvement with entrepreneurship at Northwestern is high. A recent event supported by the center, Applied Research Day, drew more than 40 students who shared their entrepreneurial research with fellow students, faculty, venture capitalists, and representatives from industry. And NU Venture Challenge, a business idea competition sponsored by alumnus Bob Shaw (see related story on page 25) and scheduled for May, has already attracted more than 200 applicants.

Marasco plans to create networking opportunities for McCormick alumni; a speaker program for faculty, students, and alumni to foster a culture of innovation; and workshops on relevant topics in the field. "We want to create new cross-school initiatives and better utilize our many successful entrepreneurial alumni," he says.

> **"Science oftentimes is incomplete, and engineering thinking has to fill the gaps; that's where innovation and entrepreneurship come in. We are investing in these areas."**
>
> —Julio M. Ottino

Northwestern Center for Engineering Education Research

Engineering and engineering education in the future will be radically different. The engineering profession will require technical expertise combined with creativity and tempered by a sophisticated appreciation of human needs. That view is quite different from the "traditional" concept of an engineer: the introvert who is good at math and science and is content to work alone to solve problems. In contrast, engineering solutions to modern technological needs require ongoing collaboration and teamwork, leadership, and adaptability.

The mission of the new Northwestern Center for Engineering Education Research (NCEER) is to be a catalyst for transforming engineering education locally, nationally, and globally. It aims to build a community that conducts leading research on how to best educate engineering students as adaptive experts who can predict and solve global technological challenges. The center will support interdisciplinary research in engineering education, cultivating relationships within McCormick, across Northwestern, and with other universities with similar aims. It will be an authoritative resource and disseminator for new research about engineering education.

The center is codirected by Rob Linsenmeier, professor of biomedical engineering and neurobiology and physiology, and Ann McKenna, director of education improvement at McCormick. They have worked with Steve Carr, associate dean for undergraduate engineering, to develop the center and have invited 50 faculty and staff members from four Northwestern schools to become "NCEER Scholars."

This community of scholars will create the infrastructure needed to carry out and evaluate experiments in engineering education. Thus, the Northwestern Center for Engineering Education Research will be one of the premier research communities investigating engineering thinking and determining how to cultivate this aptitude in students. Among the initial group of scholars are faculty already working on funded research projects in the areas of bioengineering education, nanotechnology education, spatial learning, design education, and "agent-based" modeling.

"We feel that we need the expertise of faculty and staff across the University in order for us to develop the most effective engineering educational practices," says McKenna.

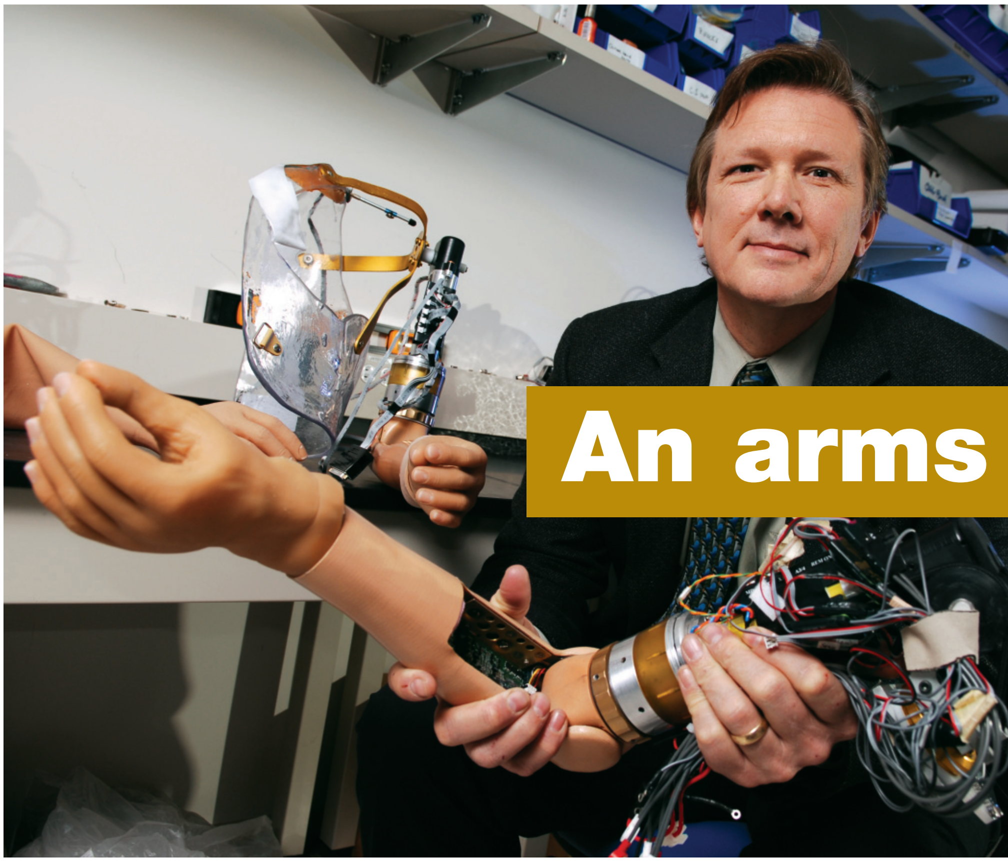
NCEER is off to a good start. Northwestern recently received a $940,000 award from the National Science Foundation to explore the role of computational adaptive expertise in design and innovation. All of the principal investigators on the award are NCEER Scholars.

"Cross-school collaborations of this sort enhance the national impact of the educational research that we conduct at Northwestern," says Penelope Peterson, dean of the School of Education and Social Policy and a member of NCEER's development team.

A near-term goal for the center is to invite speakers to a seminar series at Northwestern. NCEER is working with the Searle Center for Teaching Excellence to cohost distinguished lecturers over the next few years. In doing so, NCEER will bring in leading figures in engineering education and lend recognition to the innovative research in engineering teaching and learning at Northwestern.

"We want to bring experts in educational practice to McCormick and provide ideas about where we should go next," says Carr. "Our goal is to give visibility to our excellent but dispersed education programs and provide support for new pedagogical and curricular change in engineering education."

—Gina Myerson



An arms

As you hold this magazine, you're probably not thinking about the thousands of electrical signals traveling between your fingertips and your brain. These signals control your hands' grip on the magazine and produce motions to adjust it to the right angle or to turn the page (though hopefully you're not ready to do that just yet). They also provide an equally rich amount of data back to your brain that constantly refines your movement and allows you to feel the weight and temperature of the paper. These very same electrical signals may someday help arm amputees control their prosthetic hands and arms just as you control yours — without even thinking about it.

Researchers at McCormick, in collaboration with members of Northwestern's Feinberg School of Medicine and the Rehabilitation Institute of Chicago (RIC), are exploring ways to build and control better prostheses for arm amputees. Some truly revolutionary breakthroughs here have given hope to people who have lost limbs and are playing a major role in the rapid advancement of prosthetic technology.

The need for improved prostheses is driving a $48.5 million national push from the Defense Advanced Research Projects Agency (DARPA). Todd Kuiken (PhD '89, Feinberg '90), associate professor of biomedical engineering and physical medicine and rehabilitation and director of the Neural Engineering Center for Artificial Limbs at RIC; Richard Weir (MS '89, PhD '95), clinical professor of biomedical engineering and research associate professor of physical medicine and rehabilitation; Michael Peshkin, professor of mechanical engineering; and Ed Colgate, Pentair–D. Eugene and Bonnie L. Nugent Teaching Professor and professor of mechanical engineering, are pursuing collaborative research that aims to speed the development of a lifelike prosthetic arm and hand.

Engineering from both sides

It's one of the first rules of engineering design: design with the user in mind. But what if you can also modify the user to better interact with the design? That's the key concept in Todd Kuiken's work in nerve transfer, which began almost 20 years ago when he was a PhD student at McCormick.

Kuiken takes the nerves that would have gone to a missing arm and transfers them into the pectoral muscle, which no longer has a purpose once the arm is gone. The nerves then grow into the new muscle, telling it to contract and relax based on the signals that would have controlled the missing arm. The signals from nerves that have not been transferred are too small to measure reliably for long periods of time. By rerouting the nerve endings into the pectoral muscle, the signals become stronger, and Kuiken and his team are able to use sensors to detect them. Using these signals, the patient is able to intuitively control a motorized prosthetic arm. A patient's thought to "close my hand" becomes a command to close the prosthetic hand.

"This process has a number of advantages," explains Kuiken, "the biggest being that you use muscle as a biological amplifier as opposed to relying on hardware. It never breaks down and has an infinite energy supply — as long as you eat your Wheaties."

Kuiken's first challenge was to decode the meaning of the electrical signals, differentiating the signals that cause the hand to open from those that cause it to close. One of his first collaborators at McCormick was Allen Taflove, professor of electrical engineering and computer

Left Todd Kuiken
Right Richard Weir

Building better prosthetic limbs

science. "I went to Allen and told him I was interested in using finite-element modeling and wanted his help," Kuiken says. "He was wonderful in helping me to get started, figure out the modeling, and get our first grant. He was so generous with his time, support, and enthusiasm during a very critical time."

Kuiken spent several years working through decoding problems and doing the bench work and animal studies necessary to prove the feasibility of his concept. Ready to begin clinical trials, Kuiken identified his first patient: Jesse Sullivan, an electrical line worker who burned his arms so severely that both were amputated at the shoulder. Following his successful nerve transfer in 2003 and the fitting and implementation of new prosthetic arms, Sullivan has been dubbed the world's first "bionic man" and serves as a living example of the promise of this technology.

After transferring four of Sullivan's nerves into his pectoral muscle, Kuiken had modest goals: to allow Sullivan to open and close his arm and bend and straighten his elbow in a natural way. Using sensors that picked up the electrical signals rerouted to Sullivan's chest to operate the three-motor prosthetic arm, Sullivan was able to control his arm so well that Kuiken set his sights even higher.

Working with Richard Weir — whom Kuiken met when they were both PhD students at McCormick — and other collaborators from around the world, Kuiken developed a six-motor arm that provided six degrees of freedom. This was a vast improvement over the three-motor arm but still fell far short of the 22 degrees of freedom in a human arm. Cobbling together an elbow from Boston, a shoulder from Scotland, a hand from China, a rotator from Vienna, and humeral rotator from Weir's lab, Kuiken and Weir created a new arm with twice the functionality of Kuiken's original model.

"In the first two weeks, Jesse did remarkably," Kuiken says. "He's an absolutely wonderful guy to work with. Those results got us going and got us excited."

Unexpected results

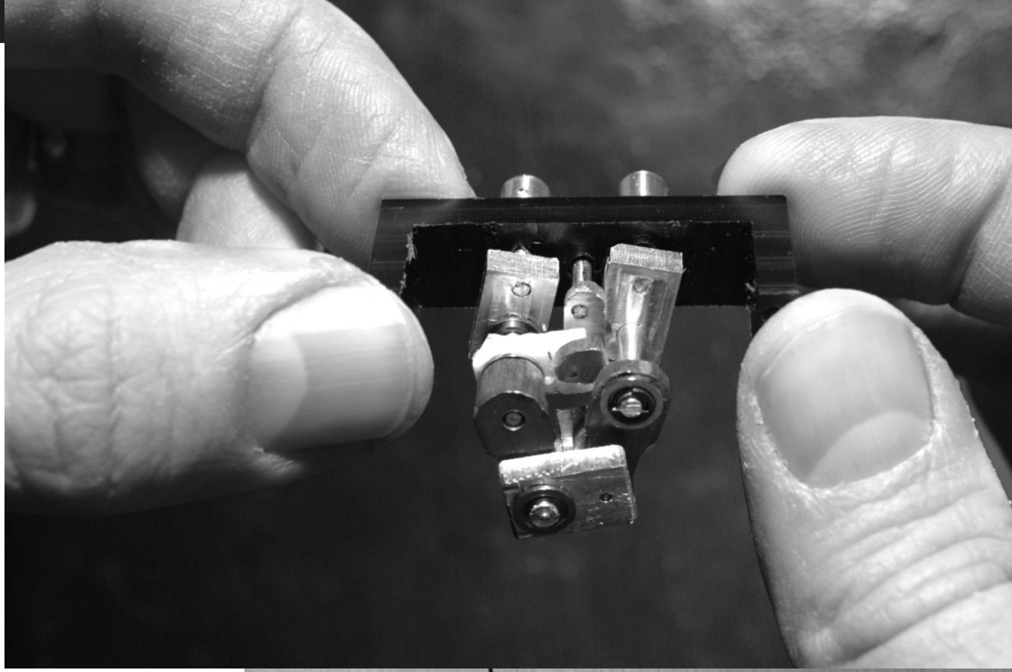
While nurses prepped Jesse Sullivan's chest with rubbing alcohol during one of his many visits to RIC, a remarkable thing happened: Sullivan felt the cooling effect of the alcohol as though it were on his hand. Searching for an explanation for this phenomenon, Kuiken discovered that the nerves transferred into Sullivan's chest actually grew into the skin on his chest, a process known as targeted sensory reinnervation. Both the outgoing and incoming nerve signals for the arms had regrown into the pectoral muscle and skin. With this unexpected finding, Kuiken saw even greater potential. "This gives you a portal to let the person feel what they touch as if it were in their missing hand," he says.

While Kuiken was excited about this advance, he knew that he didn't have the expertise to put it to work. Richard Weir and Jon Sensinger, a PhD student in biomedical engineering, worked to develop a proof of concept for a device that could communicate the sense of touch to a patient's chest. After seeing that it could work, the team connected with Michael Peshkin and Ed Colgate in the mechanical engineering department at McCormick, who have based a significant part of their research on the study of haptics, or the sense of touch, mostly in relation to robotics.

Colgate and Peshkin are now developing tactors — microrobots that can convey haptic sensations to a patient's chest — for use in conjunction with prosthetic arms. Using inputs from the prosthetic arm, these tactors recreate the same sensation on a scale appropriate to the area of skin on the chest where the nerves have reattached.

While the research is still in its early phases, the results have been remarkable. The device can apply force in several directions and even heat up and cool down based on temperature sensors. In testing, Sullivan and Claudia Mitchell, a single-arm amputee who became the first woman to be outfitted with the bionic arm, have been able to differentiate between satin ribbon and sandpaper and feel temperature changes. This advance has both practical and social importance.

"When I asked Jesse what he wanted to do with a sense of touch, he said he wanted to be able to hold his wife's hand," explains Colgate. "A big part of that is warmth. There's a big social dimension to this work that is sometimes underappreciated."



While developing the tactor, Colgate and Peshkin have struggled with a variety of unique challenges. The device must be thin enough to fit in the vest that holds the prosthetic device in place, it must consume as little energy as possible, and it must stay in the appropriate place despite being on a moving body. "At this point it is very experimental. You want to try different capabilities to see what you actually need," Peshkin says. "Yet even at the experimental level, it's very tricky engineering."

A friendly competition

As Kuiken's research began its clinical phases, the Pentagon also started planning a push for more realistic prosthetic devices. The need for better prosthetic limb systems has become increasingly important as a result of the continuing casualties in Iraq and Afghanistan. Improved body armor and medical treatment have led to higher survival rates: About 90 percent of those injured in Iraq and Afghanistan survive. However, those who survive are increasingly likely to have lost a limb. And while hand and arm amputees make up just 5 percent of civilian amputees, nearly a quarter of the amputees who come home from Iraq have lost an arm or hand.

All four researchers are working on both major projects that have been funded by DARPA to accelerate the pace of prosthetic research — and at times, based on the differing roles and approaches to the project, they even find themselves in competition with one another. Colgate and Peshkin — through their company, Chicago PT — and Richard Weir are developing two different designs for prosthetic arms and hands.

Weir and his colleagues are working on an intrinsic design, meaning that all of the motors and gears are located near the point of use. For example, the prosthetic hand they are designing has 15 miniature motors, with another three in the wrist. Weir's team works with a variety of corporate and academic partners, including Otto Bock, the leading manufacturer of prosthetic devices. They recently completed their first prototype — a model that brings together a variety of components already in development. As they test that model with patients at RIC, they are busy developing an improved second prototype.

Weir points to one major benefit in their team's design: It is adaptable for different levels of arm amputation. Because the motors are located near the place of use, they don't require additional space for a central motor. However, that also limits the amount of space for their equipment. "We have to fit everything into the space of the hand and do it in a form for an average female while providing enough strength for an average male," says Weir. "It's very challenging."

Colgate and Peshkin's work focuses on developing an arm based on their work in cobotics, a class of robotic devices intended for direct physical collaboration with human operators. In contrast to Weir's

Clockwise from top
A model of a tactor; Ed Colgate (left) and Michael Peshkin (right); Jesse Sullivan with his bionic arm

arm, their prosthetic hand is an extrinsic design that runs off of a central motor in the forearm to control the hand through a series of simulated tendons. One major advantage of this technology is that it is inherently flexible, allowing the arm to have a similar amount of give as a human arm.

Like Weir, Colgate and Peshkin also struggle with space and weight issues. Any prosthesis must weigh less than a real arm because it isn't attached to the shoulder like a real arm. "As an engineer, it feels unfair," says Peshkin. "In biological systems the actuators are above the body part. Both our actuators and the power supply have to be in the space of the arm itself. Compared with biological systems, you're always at a disadvantage. It's really an uphill battle."

Despite the challenges, the team sees promise in their work."I think this project may really advance the state of the art," says Colgate. "Coupled with Todd Kuiken's research, it has a shot at being really helpful."

New possibilities for user control

Kuiken's research in nerve transfers has presented new possibilities for the development of other prosthetic technologies for patients with upper-arm amputations. Other ongoing research between McCormick, Feinberg, and RIC has the potential to provide similar improvements for those who lose their hands, lower arms, or even legs.

Weir is studying one exciting possibility: wireless sensors that could be implanted into the muscle to detect electrical signals and control a prosthetic device. The wireless sensors convey the muscle signals to an external coil around the limb and could be applied to amputees who have lost part of their hand or forearm. Weir hopes that in addition to cutting down the number of wires required for the prosthesis, they will provide a more robust system of reading the body's electrical signals. In order to better interpret those signals and understand the desired motion of the user, the group is working with Wendy Murray, a new assistant professor of biomedical engineering at McCormick, to conduct fundamental research into the nature of neuromuscular control.

While the research into upper-arm prosthetics is progressing at a rapid pace, Kuiken is also keeping his eye on other opportunities to help amputees. "I have a lifetime of work ahead of me with the arm, but the leg is an exciting area to try as well," he explains. "There are 10 times as many leg amputees as arm amputees. They've just come out with the first motorized legs, and we think we can add steering to them."

As researchers continue to make revolutionary advances in this field, it's almost easy to overlook the significance of each step. "I got a call from people working at our company, Chicago PT, telling me that they had tested our tactors and that they had successfully conveyed the sensation of touch to Jesse," Peshkin says. "I realized that they had done something really special that day. Working with Todd and Jesse gives you the opportunity to do things that never have been done before."

—Kyle Delaney

Joe Girardi hits a home run in his return to McCormick

Joe Girardi went from studying statistics as an industrial engineering and management sciences major to creating them as a major league baseball player and manager. He returned to campus in February to receive the Distinguished Alumnus Award from the Department of Industrial Engineering and Management Sciences.

At Northwestern, Girardi played baseball and was a three-time Academic All-American and two-time All–Big Ten selection. After graduating in 1986, he made his Major League Baseball debut in 1989 and played for 15 seasons as a catcher with the Chicago Cubs, Colorado Rockies, St. Louis Cardinals, and New York Yankees. Girardi was a member of three World Series championship squads in New York and, while playing for the Cubs, was named to the 2000 All-Star team.

After retiring as a catcher in 2004 Girardi became a commentator for the YES Network and hosted the youth-oriented *Kids on Deck.* Girardi then began his coaching career as a bench coach and catching instructor with the New York Yankees.

In 2005 Girardi accepted the manager position for the Florida Marlins, replacing Jack McKeon. As a first-time manager, he guided the Marlins to surprising Wild Card contention (finishing with a 78–84 record), despite having the lowest team payroll in Major League Baseball. Girardi was awarded the National League Manager of the Year Award in 2006. He now works as a broadcaster for Fox and the Yankees' YES Network.

During his visit to Northwestern, Girardi met with small groups of students, faculty from the industrial engineering and management sciences department, and Dean Julio M. Ottino. At the conclusion of the day, Girardi spoke to nearly 100 members of the Northwestern community about how his Northwestern education helped prepare him for a successful career.

"You think about industrial engineers as problem solvers. In baseball, that's what you do. Situations come up all the time where you use the skills you've learned to solve problems," he said. "I also have three children, and there's a lot of problem solving when you have children."

Girardi found his analytical background to be particularly useful when it came to using statistics to his advantage. As a catcher, he had to calculate a pitcher's strength and a batter's weakness in order to succeed. "They give you so many statistics in baseball today that some players become paralyzed, but I loved it," he says.

Girardi owes many of those statistical skills to Ajit Tamhane, who was one of Girardi's undergraduate statistics professors. Now department chair, Tamhane was excited to welcome Girardi back to campus as a distinguished alumnus. "Joe has had a fantastic career," Tamhane says. "He exemplifies our talented alumni body, many of whom have gone on to pursue diverse career paths and achieve great success in their fields."

Speaking to students, Girardi's advice was to make the most of their time at Northwestern. "What you're going to miss most about Northwestern are the people," he said. "When I think about my four years at Northwestern, I think about my friendships. You have to take time to invest in your relationships. Work as hard on your relationships as you do on your schoolwork."

—Kyle Delaney

New faculty update

Predicting geological behavior

When José Andrade left his home in Ecuador to study civil engineering in the United States, he had every intention of returning for a career as a structural engineer. Ten years later it's safe to say that his plans have changed as he settles into his role as a new assistant professor of civil and environmental engineering.

Andrade is in good company. This year seven new faculty members joined the school — one of the largest entering classes of new faculty in recent memory. According to Dean Julio M. Ottino, that's no accident.

"One can't overstate the importance of hiring the right faculty," says Ottino. "It's a very competitive process among top universities, and we made significant efforts to improve our hiring process. We had great success this year, signifying that McCormick continues to be a top destination for talented faculty."

Despite the competition for top prospects, McCormick saw approximately 80 percent of its offers for new faculty accepted — something of a coup for the school. Traditionally hiring averages have hovered closer to the 45 to 50 percent mark.

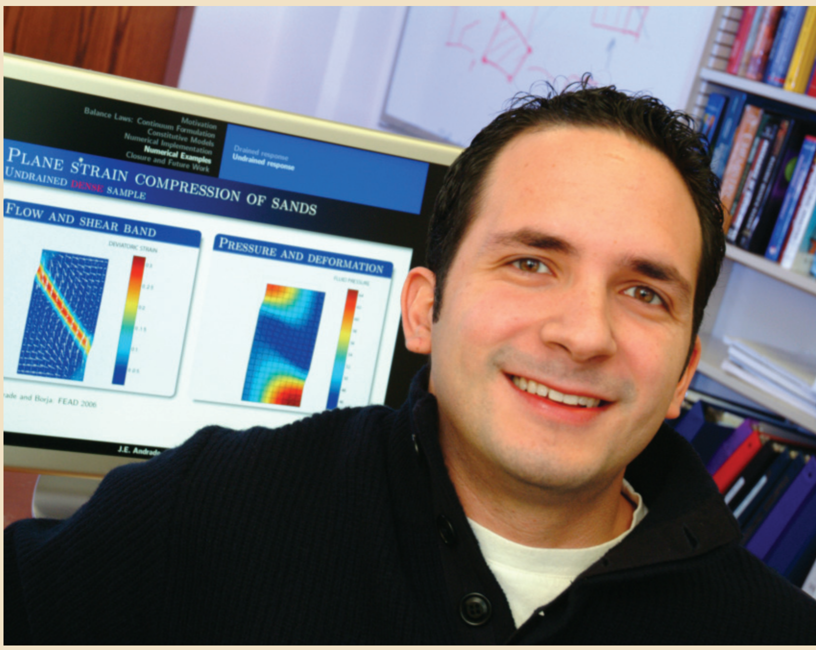
For Andrade the choice to come to Northwestern was easy. "I had always admired Northwestern," he says. "In geotechnics and mechanics, they've had an extremely successful team dating back a very long time."

At McCormick, Andrade will continue his research in geomechanics, a subject combining elements of civil, environmental, and mechanical engineering. Andrade attempts to model the behavior of geomaterials under load-bearing conditions. In developing a predictive model, he hopes to be able to avoid the building catastrophes that often happen in the aftermath of natural disasters.

He points to the 1964 earthquake in Kobe, Japan, as a classic example.

"After the Kobe earthquake, buildings toppled because of soil liquefaction," he says. "The soil that sustains these buildings literally becomes a liquid. There's nothing wrong with the buildings themselves, but they sink and fall over. You want to be able to predict those problems so that you can map regions that are potentially at risk. Right now, we don't have a good quantitative way of doing that."

Andrade's research focuses on building a model that could apply to all geomaterials. "We're trying to take a step back and find a framework that applies to all three areas of geomaterials [rock, soil, and concrete]," he says. "We believe that a common pattern is a granular structure, which is present in all of these materials at some scale."



In order to develop a common framework, Andrade must find ways to bridge computational models at the granular scale with those that are proven to work at a larger scale. To test his theories, he runs his model on completed experiments to compare his predictions to established results.

Andrade didn't intend to pursue a career in academia, but the option kept presenting itself throughout his education. After leaving Ecuador to study undergraduate engineering in Florida, he connected with a professor who taught soil mechanics. That relationship sparked an interest that Andrade pursued during his graduate studies at Stanford, eventually inspiring him to pursue an academic career.

"You fall in love with what you do, and then you consider your professional options to support that love," Andrade says. "It was clear that if I wanted to stay close to cutting-edge models and research, academia was the obvious way to go."

In addition to teaching undergraduate courses in engineering mechanics, Andrade is developing new graduate courses in geomechanics. "I love teaching and interacting with students," he says. "I try to tackle teaching and research in a combined way. You let your research inform your teaching, and vice versa."

Andrade couldn't be happier with his new role. "When I found out that there was a position open here, I told my wife that it would be too good to be true," he says. "I was right — it has been."

—Kyle Delaney

At the center of materials research

A history of interdisciplinary research at Northwestern

When Monica Olvera de la Cruz first came to McCormick in 1986 as an assistant professor, she received funding for her first graduate student from the Materials Research Center (MRC). Twenty years later, Olvera de la Cruz is the director of Northwestern's historic center, assuming responsibility for leading Northwestern's researchers as they tackle new challenges in materials research.

"My first student went on to become a successful professor at MIT," says Olvera de la Cruz, now professor of materials science and engineering. "I've always been attached to the MRC. It has been an integral part of my career development, and it has played an important role in materials research at Northwestern for a very long time."

The MRC may in fact be a major reason that Northwestern has developed such a strong international reputation in interdisciplinary materials research. It is one of the oldest continually funded research centers of its kind in the country, tracing its history back over four decades.

The MRC was founded in 1960 after Northwestern received $1.25 million from the Defense Advanced Research Projects Agency (DARPA). The grant provided resources to fund doctoral students, purchase significant amounts of new equipment, and hire new faculty to pursue interdisciplinary materials research. The center was one of three national centers in materials research funded by DARPA at that time.

The infusion of resources and new faculty that came with the MRC soon propelled materials research at Northwestern to the top of the field. Key to this success are the facilities the MRC built with the support of governmental funding. The center manages 16 shared experimental laboratories and facilities occupying more than 25,000 square feet of space. These facilities provide faculty, students, and industrial partners with opportunities to use state-of-the-art equipment to solve problems of common interest. More than 500 students use the advanced facilities at the MRC each year.

"The shared equipment provided by the center allows faculty to do their research without having to build and maintain a multimillion dollar facility," says Bruce Wessels, Walter P. Murphy Professor of Materials Science and Engineering, chair of electrical engineering and computer science, and director of the MRC's materials processing and crystal growth facility. "The center allows you to use state-of-the-art equipment without having to purchase it."

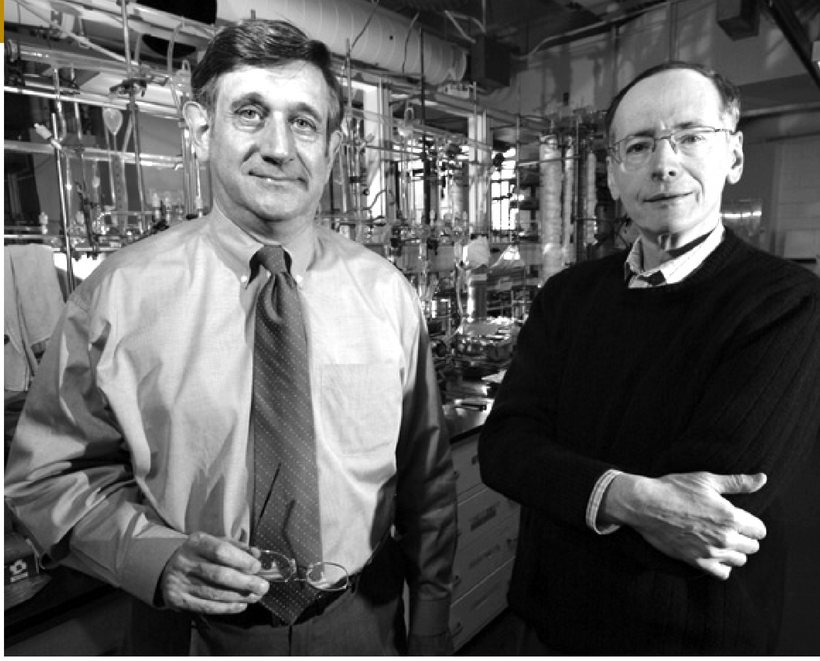
A focus on interdisciplinary research

Since its inception the MRC has provided a unique interdisciplinary environment that allows members to undertake materials research of a scope and complexity that would not be feasible without group funding. Today MRC members represent eight departments in McCormick and the Weinberg College of Arts and Sciences and actively collaborate with other materials groups on campus as well as with colleagues in the Feinberg School of Medicine School, the School of Education and Social Policy, and the Kellogg School of Management.

"The MRC gets faculty from different departments talking to each other and collaborating," says Tobin Marks, professor of chemistry and materials science and engineering. "It can be hard to find a mechanism that supports working together, and the MRC is one of the best mechanisms I know of for interdisciplinary collaboration."

Marks is an excellent spokesman for the MRC. Throughout his career at Northwestern he has been extensively involved in MRC

Left Monica Olvera de la Cruz
Right Bruce Wessels and Tobin Marks



research and has formed many successful relationships with faculty members in other disciplines. One key example is his collaboration with Bruce Wessels.

Wessels and Marks began collaborating in the late 1980s, when high-temperature superconductors were of key interest. "I had a novel approach for making thin films," Wessels says. "He had the chemical precursors needed to make them. We teamed up and were able to make a whole host of high-temperature superconductors, and we received several of the early patents on them."

That early MRC-supported success helped spawn a new National Science Foundation–funded center for superconductivity — one of many Northwestern centers with roots in the MRC. The ability to capitalize on new breakthroughs and build on them has been a key strength of the center. "It's served as a breeding ground to stimulate faculty to do a few 'proof of concept' experiments and then start their own centers," Marks says. Among the MRC offspring are such strong interdisciplinary research endeavors as the Center for Catalysis and Surface Science, the Nanoscale Science and Engineering Center, and the Center for Surface Engineering and Tribology.

Wessels and Marks have continued to collaborate over the past 20 years and are both involved in an interdisciplinary research group at the MRC on complex oxides. "The center brings people from diverse areas together, and each person has their own approach to advanced materials research," Wessels says. "It adds new dimensions to what you do."

Reaching out to future researchers

In addition to its emphasis on pioneering research, the MRC has a mission to provide educational and outreach opportunities for students and educators. As a result, the center funds summer research experiences for undergraduate students, as well as a similar program for high school teachers. (See "Why is red paint red?" on page 14.) These programs have grown dramatically in the past decade: Since 1993 expenditures on education have increased sevenfold. Like the research programs, many of the educational programs have grown into centers of their own.

For example, Bob Chang, professor of materials science and engineering and former director of the MRC, developed a variety of educational programs within the MRC that have taken on lives of their own. His Materials World Modules program, which creates curricula for middle school and high school students to learn about materials science and nanotechnology, grew from a small program in the MRC to a national center funded by the NSF. (See *By Design,* fall 2006, for more on Chang's programming.)

The MRC also sponsors a joint research experience program with University College Cork in Ireland, that provides undergraduate students with international research experience. Locally, the MRC works with Northwestern's Center for Talent Development to provide learning experiences to gifted students from across the country and sponsors an after-school mentoring program for at-risk students at Chute Middle School in Evanston.

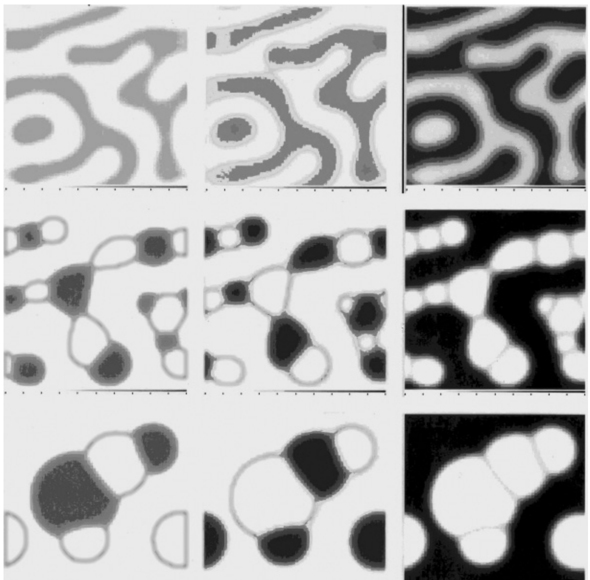
Looking to the future

Last year the Materials Research Center successfully renewed its funding for the next six years, receiving $12.8 million from the NSF. The center is reviewed every six years by the agency, at which time the center's leadership team reevaluates its research priorities.

With her arrival this year as director, Olvera de la Cruz has the challenge of taking the MRC to the next level of excellence. "It's unique for a center to maintain continuous funding for such a long period of time, and I think that's due to Northwestern's excellent management of the center," she says. "I look forward to working to strengthen our current areas of research and to pursue new areas that may provide even greater contributions to our society."

—Kyle Delaney

In addition to her role as director of the MRC, Monica Olvera de la Cruz is a professor of materials science and engineering whose research in the MRC has focused on blends and polymers and modeling the compatibility of different polymer mixtures. "It's difficult to make mixtures with polymers that are incompatible," she says. "Our research looked at copolymers to make various polymer blends compatible." Understanding how polymers blend is of key importance to creating new materials, she explains. The patterns created by the blending of materials affect the final microstructure of the material and, thus, its performance.



Students explore the intersection of science and art

Why is red paint red?

Students at Deerfield High School in suburban Chicago began their chemistry course with an unusual activity: painting. It was part of teacher Lisa Backus's innovative curriculum designed to engage students in science through the exploration of art — a curriculum inspired by her summer research experience at Northwestern.

Last summer was Backus's third participating in the Materials Research Center's Research Experience for Teachers, a program that invites science teachers to spend the summer working in a Northwestern professor's lab. (For more on the Materials Research Center, see pages 12–13.) Backus split her time between the lab of Katherine Faber, professor of materials science and engineering at Northwestern, performing materials analysis on ancient Chinese jades, and working with Francesca Casadio, Andrew W. Mellon Conservation Scientist at the Art Institute of Chicago, studying pigments in watercolors by American painter Winslow Homer. During her research Backus also spent time developing ideas she could take back to her classroom.

While at Northwestern, Backus found additional inspiration for her art-based curriculum in a somewhat unlikely venue — a seminar on nanotechnology led by Mark Hersam, professor of materials science and engineering. "Listening to Mark, I began to realize that there was a strong connection to art. The more I learned about nanotechnology, the more I saw how many art techniques they are using. They're stamping, printing, and using lithography."

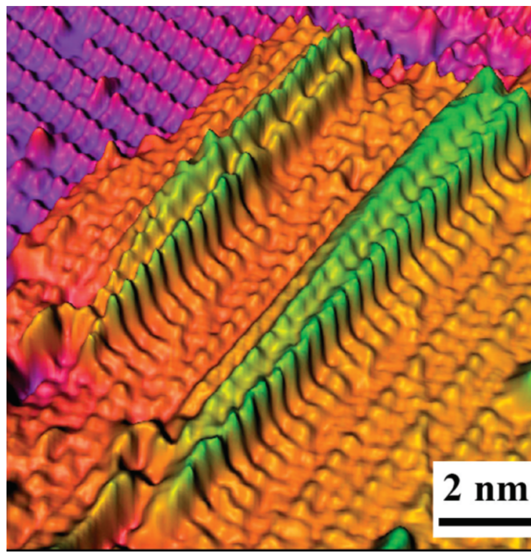
Backus developed those thoughts into a nine-week curriculum including lessons such as "Why Is Red Paint Red?" and "The Art of Science and the Science of Art." Students began the unit by painting posters about lab safety, then were challenged to create their own paints from natural materials. Their attempts — using materials such as honey, marshmallow fluff, spices, and flowers — led to a discussion of the fundamentals of pigment and what gives rise to color. Students explored atoms, transition metals, light, reflection, and absorption in their search to understand pigment. According to Backus, the practical applications of the curriculum helped to engage students in the hard science they covered along the way.

"No one says 'Who cares?' or 'Why do we need to know this?' because the entire time we were trying to figure out why the paint was red," Backus explains. "That helps people who aren't science driven. We learned a lot of heavy chemistry without feeling like we were learning heavy chemistry."

After gaining an understanding of the fundamentals of paint and color, students explored a variety of art techniques, such as photolithography (sun prints), wax stamping, stamp rolling, and spin coating. Then, using a presentation that Hersam developed for Northwestern's National Center for Learning and Teaching in Nanoscale Science, Backus showed students how top-level scientists use some of those same techniques when studying nanotechnology.

"That lecture is really in-depth, but we had done all of these things," Backus says. "It helps to be able to say, 'This is from Northwestern, and look at what they're doing: They're doing stamp rolling and photolithography, just like we've been doing in class.'"

Backus is excited to use the new curriculum again next year and may share it with her colleagues. Her success comes as no surprise to Faber. "At the end of the summer, I was really blown over by what Lisa had done," Faber says. "She had the whole study unit laid out in terms of what I think is really important — the method of inquiry. She starts with the basics of paint, then discusses what makes a good paint, and then explores the chemistry at work. Hearing about the sophisticated synthesis analytical techniques at Northwestern, she was able to come up with clever classroom activities. It was inspiring listening to her plans."



Scanning tunneling microscope image of one-dimensional arrays of styrene molecules on a silicon surface. These molecular arrays were patterned with atomic precision using feedback-controlled lithography. Lisa Backus was able to relate these cutting-edge techniques to activities performed by students in her class.

Exploring the depths of space

Research helps solve key problems for missions to Mars, Saturn, and beyond

"To boldly go where no man has gone before."

It's a lofty goal, and a logistical nightmare. As scientists prepare spacecraft to explore the universe, they are challenged with designing for environments where there are often more questions than answers. Two projects from Richard Lueptow, professor and interim chair of mechanical engineering, are providing tools to help NASA and the European Space Agency clear key hurdles in their quest to explore our universe through manned and unmanned space missions.

One of the foremost challenges facing NASA engineers preparing for a manned mission to Mars is the ability to provide clean drinking water for the astronauts. "These missions are projected to be two to three years long, with at least three astronauts, probably more," explains Lueptow. "When you have a crew of that size, it's impossible to bring enough water along."

In order to make a long-term space flight possible, washwater, flushwater, humidity condensate from the cabin atmosphere, and urine must be recycled. While there are a variety of ways to purify and reuse water, few meet the demanding needs presented by spaceflight — such as the ability to operate in zero gravity.

One common purification method here on Earth is reverse osmosis, a process in which water molecules are forced through a membrane with subnanometer pores that are impermeable to contaminants. Lueptow and his research team have developed a prototype water filtration system that makes reverse osmosis a viable option in space by using a cylindrical rotating filter. As Lueptow explains, the secret to their success is in the swirls.

"The rotation of a cylindrical filter generates vortices, or swirls, that constantly wash the dirt and contaminants off of the reverse osmosis membrane. If you don't have these swirls, the pores eventually plug up with contaminants, or the contaminants build near the surface of the membrane."

Using the advantages of the rotating filter, Lueptow's system purifies water more efficiently than others. Traditional reverse osmosis typically recovers only 20 to 30 percent of the water; his prototype system is able to recover 80 to 90 percent. And at just six inches wide and four inches tall, the prototype filter module also saves space — an important consideration in the crowded confines of a spacecraft.

Left The Cassini orbiter
Right Rich Lueptow

"These missions will be two to three years long, with three astronauts. When you have a crew of that size, it's impossible to bring enough water along."

After eight years of work on the prototype filter, Lueptow and his team have transferred the technology to NASA's Johnson Space Center in Houston for further testing. There, the Exploration Life Support Team will test the system under conditions that would be typical for space flight.

In addition to water recovery for manned space missions, Lueptow's research has also found application for unmanned probes exploring the moons of Saturn. After publishing a paper about his work with NASA on the development of acoustic sensors for detecting gases in spacecraft cabin atmospheres, Lueptow was contacted by a team working on the Cassini-Huygens space probe to see if the same analytical techniques could be used to predict acoustical properties in the atmosphere of Titan, one of Saturn's moons. The Cassini-Huygens mission is a collaboration of NASA's Jet Propulsion Laboratory and the European Space Agency and consists of the Cassini orbiter and the smaller Huygens landing probe.

"We considered the gases that are present on Titan and thought we could absolutely predict the acoustics there," Lueptow says. "The reason that this is important is that often there are acoustic sensors on these probes. For instance, on the Huygens probe, there's a sensor that tracks changes as the probe moves through the atmosphere and lands on the surface."

While some past probes have used acoustic sensors, they haven't been standard on spacecraft, and there hasn't been a clear understanding of the acoustics in different atmospheres. Lueptow's modeling techniques, which are based on quantum mechanics and the kinetic theory of gases, gave scientists the tools they needed to predict the acoustical properties of an atmosphere in order to better use the data captured by the sensors. During descent, measurements of the speed of sound provide information on atmospheric composition and temperature. In addition, the sensors provide the ability to acoustically monitor thunder related to electrical storms, which can provide important data about an atmosphere.

Lueptow describes this project as an unintended yet exciting result of his collaborations with NASA. And his work is providing solutions that may bring us one step closer to a deeper understanding of our universe.

—Kyle Delaney

New research may save fertility for cancer survivors

Collaboration pioneers field of oncofertility

For women battling cancer, the objective is clear: survive. Yet the lasting effects of cancer treatment can have a significant impact on the rest of a woman's life. Of particular concern are the side effects to chemotherapy and radiation treatments — the very therapies that have so effectively helped increase survival — that may cause the loss of fertility. While male cancer patients have a number of viable options to preserve their fertility, fewer options exist for female patients.

Research from Lonnie Shea, associate professor of chemical and biological engineering, and Teresa Woodruff, Thomas J. Watkins Memorial Professor of Obstetrics and Gynecology at the Feinberg School of Medicine, may provide women with options to help preserve their fertility. Using new techniques, Shea and Woodruff are able to create an ex vivo environment in which a young follicle — an egg and the spherical group of specialized cells that surround it — can grow and mature to a stage at which it can be fertilized and implanted into the uterus. This technique could allow women to cryogenically preserve ovarian tissue containing follicles prior to treatment, which could be used to obtain mature follicles (oocytes) when they are ready to start a family.

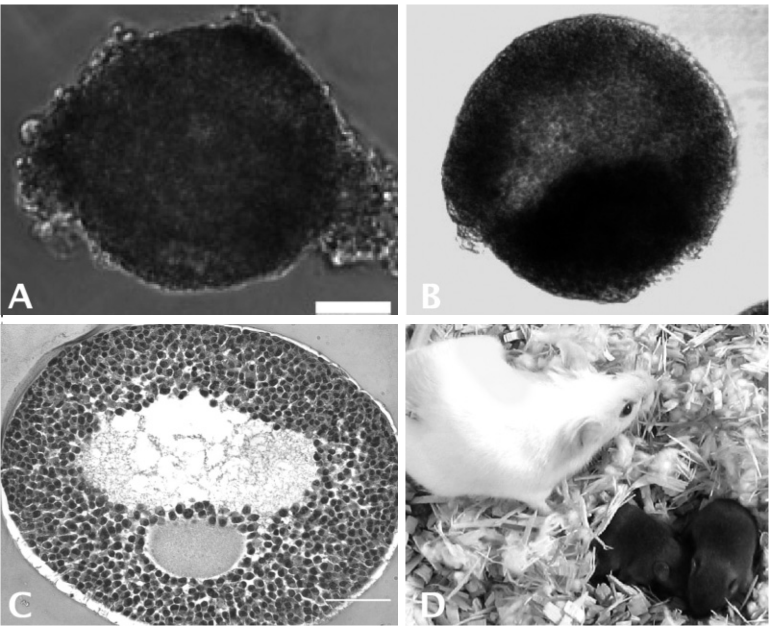
A novel technique

At any given point, the ovary has follicles in many stages of development, with only a small percentage of the most mature ready to be fertilized. Shea and Woodruff aim to take that plentiful supply of young follicles and allow them to mature by placing them into a gel. The gel creates a three-dimensional culture system, a novel technique that differs from the two-dimensional cultures that had been previously researched. "Without the gel the collection of cells falls apart," Shea says. "We maintain the cell-to-cell connections within the follicle, which allows for the coordinated growth of the follicle. Upon maturation, we can remove the oocyte, and it is ready to be fertilized."

At the core of this new technique is alginate, a naturally occurring compound in brown algae that can be found in everything from antacids to jellies and even prosthetics. By using varying concentrations of alginate gel, the researchers are able to recreate phenomena found in the ovary.

Shea and Woodruff put their theory to the test with mice, allowing young follicles to develop ex vivo, fertilizing them, and then implanting them into a surrogate mother. The pups were born without incident and appeared to be completely healthy — and the success rate was a drastic improvement over related studies. "People had gotten live births before, but their success rate was about 3 percent," Shea says. "Our success rate was 25 percent, which is comparable to the success rate with in vivo matured eggs — approximately 35 percent."

Further research showed that even very young follicles could successfully develop into viable eggs, though the team determined that the culture system varied based on the developmental stage of each follicle. Recently the team has turned to freezing ovarian tissue, thawing it, then isolating the follicles and getting them to develop in the culture system. Early results show that the follicles can develop after being frozen, though the team hasn't yet taken the mature follicles all the way through implantation. These results mark an advance because fully developed eggs rarely survive the process of being frozen and thawed.



Left Teresa Woodruff and Lonnie Shea

Above Development and differentiation of secondary follicle in alginate scaffold. (A) At day 0, a multilayer secondary follicle with a centrally located immature oocyte and some attached theca cells was isolated and encapsulated in an alginate hydrogel. (B) The follicle maintained its three-dimensional structure and formed an antrum at the end of the culture. (C) The follicle displayed an in vivo preovulatory phenotype, a spherical shape with a central fluid-filled antral cavity, an oocyte within tightly compacted cumulus cells, and layers of granulose cells outside. (D) Oocytes can be fertilized normally in vitro and implanted into the oviduct of a pseudopregnant mouse to produce a live birth.

Shea and Woodruff are now working with researchers from across the country to bring this technology closer to application. They are currently adapting the technique for rhesus monkeys, cows, dogs, and cats. Those steps are important as researchers try to bridge the gap between the follicles of mice and those of humans, which can grow to be 10 times as large as mouse follicles.

Woodruff is also leading a clinical trial in which women will have one of their ovaries frozen. Scientists will use 20 percent of each ovary for further study, with the remaining 80 percent stored for possible future use by the patient.

Filling a significant need

Shea and Woodruff's technique may provide a significant new opportunity for female cancer patients to preserve their fertility. Currently, these women may freeze and store unfertilized eggs or undergo emergency in vitro–fertilization treatment and have their embryos frozen. However, such treatments may require additional hormone therapy, which can potentially speed the growth of certain kinds of cancer, including breast cancer. Success rates for pregnancy in these instances are also less than ideal, ranging from 10 to 25 percent for frozen embryos and just 3 percent for frozen eggs.

An additional concern is pediatric cancer, where there are extremely limited options for preserving fertility in prepubescent females. As survival rates for these patients improve, there is an increasing focus on preserving their fertility.

According to Woodruff, the potential uses of the technique she and Shea are working on could expand even further. "This breakthrough may permit not only the potential of fertility options for women and girls with cancer but also can be applied to normal in vitro–fertilization patients," she says. "This procedure, when fully developed, could radically change the way infertility is viewed, reduce and eliminate embryo storage, and provide better options for women who do not respond to hormonal therapy."

This research has played a large role in Northwestern's efforts in oncofertility — a term coined at the University. In addition to the Northwestern's Center for Reproductive Research, which coordinated this research project, the Feinberg School of Medicine has founded the Division of Fertility Preservation. Feinberg was also recently recognized as a Fertile Hope Center of Excellence, one of only five centers honored by Fertile Hope, a nonprofit organization that assists cancer patients with infertility.

Meeting more than halfway

One key to the research team's success has been the interdisciplinary collaboration between faculty at McCormick and Feinberg. Even the funding agency for this research, the National Institutes of Health, has shown its support for this kind of collaboration. Elias Zerhouni, NIH director, commented on it in a recent article in the *NIH Record.* "This achievement opens up a new realm of exciting possibilities, from preserving fertility for patients to protecting endangered species," he said. "This interdisciplinary effort — between materials scientists and reproductive specialists — yielded a promising new technique that researchers from either field, if working alone, probably would not have developed."

Shea and Woodruff began collaborating several years ago thanks to successful research matchmaking by Steve Rosen, director of Northwestern's Robert H. Lurie Comprehensive Cancer Center. Shea says that Rosen had a "great vision" for applications of engineering when introduced to the problem. After discussions with Woodruff, who had been working on two-dimensional cultures, they merged their ideas and began working on the mouse model.

In addition to the unique properties of their three-dimensional culture system, Shea credits the collaboration with Woodruff for the success of the project. "We met each other more than halfway," he says. "I learned a lot more about reproductive biology than I ever would have, and she learned more about biomaterials than she would have."

In addition, Shea and Woodruff have enlisted Laurie Zoloth, director of Northwestern's Center for Bioethics, Science, and Society, to help determine how and when to make this technology available to women. As research progresses, they hope to also have economists and educators work to explore the implementation processes and implications of this technology.

While Shea and Woodruff work on refining their technique, they've also been laying the groundwork for further study. They hope to broaden their research through a national consortium that includes the University of Pennsylvania; the University of Oregon; the University of California, San Diego; and Baylor University.

—Kyle Delaney

Manijeh Razeghi's interdisciplinary Center for Quantum Devices

The consummate collaborator

It's immediately clear when visiting the Center for Quantum Devices (CQD) that Manijeh Razeghi genuinely cares about each member of her lab. As they file into her office for an interview, her enthusiasm is undeniable as she introduces each person, pointing out their educational backgrounds, areas of expertise, and home countries. Part professor, part doting parent, Razeghi beams as she describes the work of her "geniuses."

Razeghi has provided lunch for the meeting, and she walks around the room with bottles of soda, making sure everyone has everything that they need. She assists students in setting up several examples that have been brought in for the meeting, all the while continuing to welcome more of the two dozen researchers trickling in from their offices.

After getting settled, Razeghi, Walter P. Murphy Professor of Electrical Engineering and Computer Science and CQD director (see related story on the center's research on page 20), wastes no time in getting down to business. Her team — forming a circle around her entire office — quickly follows her lead and prepares to share their impressive research portfolio. It's clear that while Razeghi's lab can at times resemble an extended family, it's a group that knows how to work hard and work well together.

Perhaps that's why her lab has consistently been at the top of the world of optoelectronics — the field concerning devices that enable control of the interactions between light, matter, and electricity at the nanoscale level. Since her arrival at McCormick in 1992, Razeghi has been determined to create a center of excellence in optoelectronics and nanotechnology by exploring research paths inspired by nature. After a few short minutes with her group, it's easy to see that she has definitely succeeded.

Crystal power

At the heart of Razeghi's research are the crystals that power semiconductor science. She describes the work of her lab as atomic engineering — building crystals atom by atom, layer by layer. By adjusting the thickness of each layer, her group can control the wavelengths of light emitted or detected by the crystal, allowing them to fabricate devices that deal with wavelengths from the far infrared to ultraviolet.

Razeghi's group is unique in that it takes ideas from fundamental theory through fabrication, implementation, and testing. "It's very unusual," she says. "We study all of the pieces that go into making these devices. Most big groups have only one subject. We cover everything from the theory to the materials and fabrication. There's rapid feedback from one member of the group to another. That's what we've come to expect."

The members of the lab hail from many different disciplines and countries. Ranging from undergraduates just beginning their research experience to postdoctoral students on foreign exchange to research professors, they have a wide variety of expertise that allows members to easily seek help and test their ideas. "If you want to find an expert, you just have to look next door," says Darin Hoffman, a graduate student who joined Razeghi's lab after working at Los Alamos National Laboratory.

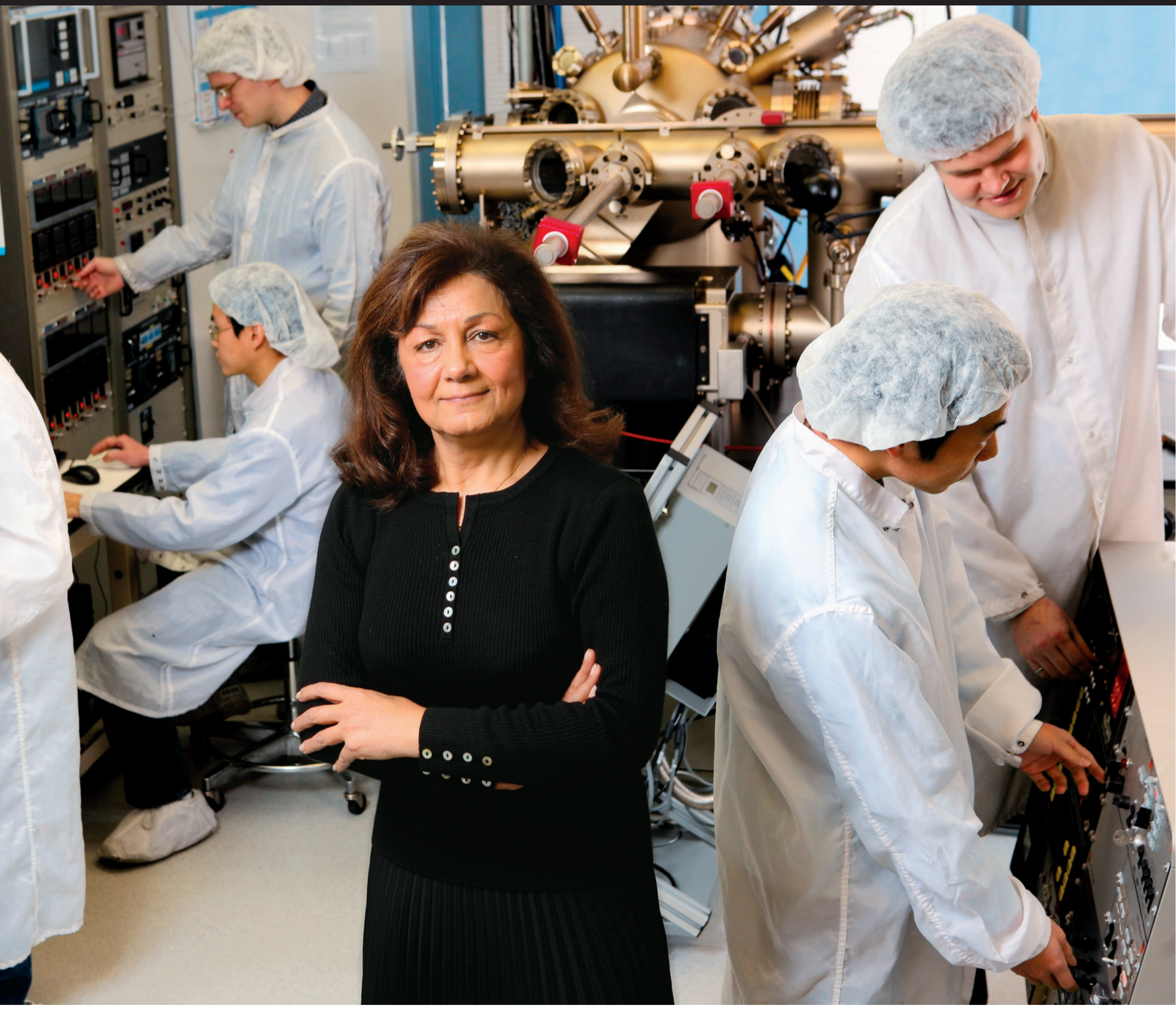
The collaboration among researchers isn't accidental. Though her lab varies in size from 30 to 40 members, Razeghi has put significant effort into creating an environment that allows students to explore their interests in the context of a larger goal. "All of the groups in the lab work on the same infrastructure and systems," Razeghi says. "They have to learn how to work with each other, respect each other, and help each other."

In addition to collaboration within the group, Razeghi places a high value on partnerships with research laboratories and corporations around the country, including many of the biggest names in the defense industry: Motorola, Raytheon, Northrop Grumman, and Lockheed Martin, to name only a few. "We're always sending samples and comparing results with other companies and groups," says Hoffman. "They'll test our samples to make sure that our measurements are correct. People are shocked that we get the results that we do."

While the many devices that Razeghi's group has produced are in high demand, Razeghi is cautious about turning her group into a production line. "I always keep the projects geared toward exploratory research, never the production of devices," she says. "I don't want our group to be under pressure for production. We always focus on new ideas, and that is the reason that we are ahead of the current science."

To stay ahead of the curve, Razeghi's lab also benefits from a steady schedule of visitors. On her door in the fourth floor of Cook Hall are photos from seven Nobel Laureates in physics who have visited her lab. Her guest book also contains names of high-level executives, visiting academics, program managers from various funding agencies, and researchers from around the world.

One main attraction for visitors is the equipment in the lab. "The systems that we have are custom designed for our specifications," Razeghi adds. "Everything is tailored to our needs in collaboration with the companies that make the equipment."



One graduate student, Jean Nguyen, focuses on optimizing the use of one type of the group's equipment. Her research specialty is the dielectric devices that provide the atomic control key to the group's success, and few places provide the experience with highly specialized equipment that she is gaining in Razeghi's lab. "Very few people have the same equipment that we do, and no one has all of the equipment that we have here," Nguyen says.

Given the number of one-of-a-kind multimillion dollar machines in the lab, the group has rigorous standards to ensure that each piece of equipment is kept in top shape. Razeghi requires that the group keep meticulous records of each activity on each piece of equipment. Not only does the log provide a history of machine maintenance and activity, but it also provides a record of the research breakthroughs in her lab.

A hard-earned reputation

While her state-of-the-art laboratories are a draw, the reason most visitors come to the lab is Razeghi's international reputation. She has written 10 books on optoelectronic devices, published hundreds of papers, filed more than 50 patents since joining McCormick, and gives dozens of invited lectures each year. The status that she and her group have established has been hard earned.

"Building a reputation is hard, and we have to be very demanding," she says. "Controlling things atom by atom is not an easy task. While other people spend their summer at the beach, these people are inside the clean room. It's a passion."

Razeghi is known for her tireless commitment to both her students and her research. "You don't find many faculty members as committed as she is to her science and engineering and her students," says Abe Haddad, professor of electrical engineering and computer science and a colleague since Razeghi joined McCormick. "She's always doing something creative and something important."

Though she is demanding, Razeghi is also devoted to her students. During an interview with her group, she constantly asks students to explain the details of their work, paying careful attention to ensure that everyone has participated in the session.

"One of my best achievements at Northwestern has been my undergraduate students," she says. "I try to give students the opportunity to discover themselves. You can say that our objective is to train great leaders, great mentors, and great humans."

At the close of the interview, Can Bayram, a graduate student who came from Turkey to join Razeghi's lab, explains what brought him to McCormick. "My father always told me that people are like a good cloth," Bayram says. "A good tailor can turn cloth into a beautiful dress, and it is perfect. However, a bad tailor turns the cloth into a rag. My motivation to come here was to find the very best tailor. This group is like no other in the world. Professor Razeghi is always motivating us. She's open to new ideas, and she always guides in the right directions."

For Manijeh Razeghi, the success of these students is likely the highest award she will ever receive.

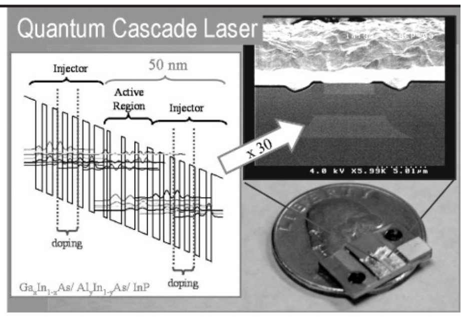
—Kyle Delaney

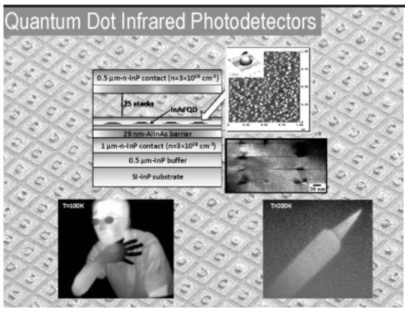
Ongoing CQD collaborations

Through atomic and bandgap engineering, Manijeh Razeghi's Center for Quantum Devices has been pursuing exploratory multidisciplinary research on III–V compound semiconductor quantum optoelectronic devices capable of operating from the deep ultraviolet to the infrared and terahertz spectral bands. Here is a sampling of their projects.

Infrared photon detectors and focal-plane arrays. This group's pioneering and unique research on type-II superlattice devices operating from the midwave infrared to the very long-wave infrared spectral bands has tremendous potential in medical imaging, where excessive heating or cooling in the body can indicate trouble, such as inflammation, circulation issues, or even cancerous tissue. Uncooled sensors based on this compound semiconductor material system are capable of handheld operation and are faster than existing cooled-sensor technologies, which are critical factors for situations such as night vision, missile defense, and fire rescue. Cooled sensors, on the other hand, typically utilize liquid nitrogen for cooling to minus-200 degrees Celsius, making the sensors expensive and bulky.

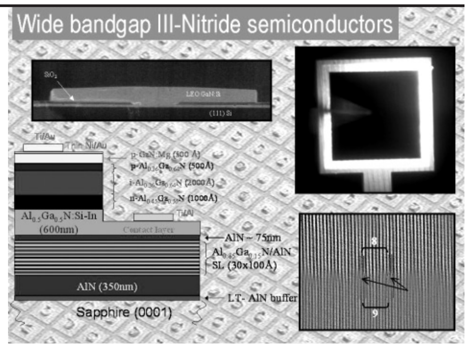
High-power quantum-cascade laser diodes. Researchers in this group have developed the highest-power room-temperature quantum-cascade lasers (QCL) in the world by making great strides in laser design, material growth, and diode-laser fabrication technologies. QCLs can access extremely important mid- and long-wave infrared (3–20 micron) wavelengths in order to target potential applications, including spectroscopy (pollution monitoring and chemical warfare agent and explosives detection), communication (free space optical links), and defense (missile protection for military and commercial aircraft). Previously, diode lasers at these wavelengths needed to be cryogenically cooled; the group's ability to produce lasers at room temperature enables smaller and less expensive systems. Further, like diode lasers in laser pointers and CD players, this technology has potential for mass production. The CQD was the first university group to demonstrate this technology in 1997 and is recognized as a world leader in the field.





Quantum-dot infrared photodetectors. This group's research in quantum-dot infrared photodetectors — based on quantum dots, or artificial atoms — represents a fundamentally different approach to sensing infrared light for imaging applications, especially from space. By exploiting the physics of nanotechnology in tiny quantum dots, CQD researchers have demonstrated sensitive imagers responding to selected narrow regions of the infrared spectrum. Combining precisely engineered nanostructures would allow the measurement of multispectral images with a single camera. In addition, such sensors are capable of operating at higher temperatures than competing technologies. This group's work was recently recognized with a best paper award at the prestigious 25th Army Science Conference.

Wide-bandgap III-nitride semiconductors. With numerous first and unique device demonstrations, this group has been a pioneer in research in this novel material system for future compact and inexpensive optoelectronic devices in the UV spectral region. UV photodetectors, avalanche photodiodes, and focal-plane arrays realized by CQD researchers are intrinsically able to take advantage of low background UV level on earth to sense any potentially harmful UV rays from the sun that could cause skin cancer, detect dangerous radioactivity levels, or monitor flames and electrical arcs in the atmosphere. In addition, the deep ultraviolet light-emitting diodes also developed by the group are suited for the detection of biological agents, such as anthrax, or for water and surface purification.



Regional conference a huge success

"SWEet Home Chicago"

When current seniors in McCormick's section of the Society of Women Engineers (SWE) attended their first regional conference during their freshman year, they knew that they wanted to see Northwestern host the conference by the time they were seniors. "All of the upperclassmen thought we were crazy, but from that moment on we knew it was something we wanted to achieve," says Kelly Migliazzo (manufacturing and design engineering '07), cochair of the conference. Three years and hundreds of hours of planning later, SWE members are celebrating the success of the biggest conference in regional history.

McCormick's section of SWE played host to more than 635 women engineers from 39 schools and 62 companies as part of the 2007 Region H Conference in January, giving participants a taste of their theme, "SWEet Home Chicago." In addition to events in downtown Chicago, the group hosted information sessions and a career fair at the Norris University Center on Northwestern's Evanston campus.

Students secured presenters from a wide variety of industries, representing the diverse career paths available to today's engineering graduates. Attendees learned about everything from nanotechnology to salary negotiations from more than 60 speakers, including McCormick students and faculty.

Participation in the conference was highly subsidized — student participants paid only $25 for the conference and lodging — thanks to the successful fundraising of McCormick's SWE section. The group raised more than $190,000 from corporate sponsors — the most ever for Region H. Platinum-level sponsors for the event, who donated $10,000 or more, were Caterpillar, Ford Motor Company, ITW, Honeywell, Pepsico, Littelfuse, and McCormick.

Leading the fundraising effort was Jessica Donato (biomedical engineering '08). Her team contacted companies who had sponsored previous SWE conferences or McCormick events and worked with the McCormick Office of Corporate Relations to solicit donations from new contacts. "We e-mailed over 200 companies and spent a lot of time following up with each one," Donato says. "The experience really opened my eyes to the workings of the corporate world. I had to be very realistic about our ability to raise money because the plans that we made were dependent on meeting our fundraising goals."

The SWE regional conference executive team

The conference featured an opening reception and closing banquet in downtown Chicago with keynote speeches from Barb Samardzich, vice president of powertrain product development for the Ford Motor Company, and Vicki E. Panhuise, vice president of commercial and military helicopters for Honeywell Aerospace. The conference also included a career fair with more than 50 companies for students seeking employment.

While the entire SWE section at McCormick worked to put on the event, a group of 13 students formed the executive team. These students tied their conference planning into a classroom experience with Mark Werwath, adjunct professor of industrial engineering and management sciences, addressing strategies for negotiation, risk management, and project management along the way.

"Professor Werwath volunteered his time to help us prepare for this conference from a project management point of view," says Migliazzo. "We learned statistical skills to plan our logistics and to prepare for 'what if' scenarios. He helped us establish a project plan to keep to key dates and timelines, as well as offered an outside point of view from someone who had never attended a SWE conference."

"An outstanding experience, thanks to the great planning, creativity, and hospitality of the SWE section at Northwestern."

Their planning paid off with one of the most successful conferences in Region H history — in terms of attendance, fundraising, and participant response, it was a hit. Both the executive director and president of SWE were in attendance, as were many McCormick administrators.

"The Region H conference was a huge success," says Betty Shanahan, executive director of SWE. "Everyone who attended the conference had an outstanding experience, thanks to the great planning, creativity, and hospitality of the SWE section at Northwestern."

For the graduating seniors who wanted to host the conference for four years, the success of the event will remain a "sweet" memory. "Planning this conference has been a very rewarding experience," says conference cochair Jessica Schein (applied mathematics '07). "It's a special event, and I'm proud to attach my school's name to this conference."

—Kyle Delaney

Citric acid a key in Guillermo Ameer's search for new biomaterials

What does a vascular graft have in common with an orange? Or a ligament replacement with a lime? According to Guillermo Ameer, assistant professor of biomedical engineering, they could have quite a bit in common — namely, citric acid, which produces that tart citrus taste and which Ameer uses to produce revolutionary new biomaterials.

"Although citric acid is very common, it's an interesting molecule," Ameer says. "Chemically, it's very convenient because it has three or four reactive groups that can form a basis for biodegradable biomaterials. It's a platform technology that can produce a wide range of materials."

Ameer uses citric acid as the base for new polyester biomaterials that hold the promise of helping the body accept medical implants, develop replacement ligaments for injuries, and even deliver pharmaceuticals within the body. Citric acid occurs as a natural metabolic product in the body, so the materials Ameer creates are expected to be inherently biocompatible.

Ameer points to the low cost of citric acid in addition to its compatibility with the body. It is widely available and already used in consumer products such as shampoo, toothpaste, and soda. Ameer produces his materials at relatively low temperatures when compared with the synthesis conditions of other polyesters and is exploring ways to cure the materials using light, with the goal of low-cost production. And the materials are flexible and have a wide range of degradation properties, a vast improvement over other prosthetic materials. "We focus on materials that match the physical and chemical properties of tissues, something that was ignored for many years," he says.

One potential application for Ameer's new biomaterials might provide the ability to produce scaffolds to facilitate the development of replacement ligaments. A flexible scaffold to replace torn ligaments — such as the commonly injured anterior cruciate ligament (ACL) in the knee — would allow patients to recover from the injury without relying on replacements from cadavers or a second surgery to remove another tendon in the body.

"You can develop our materials into strong scaffolds to implant into the knee," Ameer explains. Cells then invade the scaffold and begin to form tissue. As the scaffold degrades, the body is left with a replacement ligament.

Ameer also focuses on using his materials to improve vascular grafts. In patients with peripheral artery disease, blocked arteries are replaced with veins from other parts of the body or with prosthetic grafts. Using his biomaterials, Ameer hopes to improve the functionality of those grafts and even create a new class of tissue-engineered grafts.

Ameer received a highly competitive grant from the Illinois Regenerative Medicine Institute — which was organized by the state of Illinois to fund stem-cell research — to study the use of adult stem cells to improve prosthetic grafts. He uses the stem cells as progenitor cells in combination with his biomaterials to develop thin layers of endothelial cells on prosthetic grafts. The layers of endothelial cells — which naturally line blood vessels — assist the body in accepting a prosthetic graft. "These cells do two things: They secrete factors that inhibit cell growth, preventing the overproliferation of smooth muscle cells in the area, and they secrete factors that signal to the body that everything is okay and working properly," he says.

In addition to improving prosthetic grafts, Ameer's research team is also exploring methods to create its own grafts. "The idea is to develop a graft from scratch, using our material as a biodegradable scaffold for the cells," Ameer says. "Prosthetic grafts don't work as replacement small-diameter arteries. This idea could provide a living graft with improved results."

Applications for Ameer's biomaterials are still in development, ranging from new types of bone screws and pins to possible patches for in vivo drug delivery. Ameer collaborates extensively with faculty at Northwestern's Feinberg School of Medicine to develop clinically appropriate uses for the technology. So far his techniques have been successful in gaining a wide variety of funding and recognition. Over the past year he has received an NSF Early Career Development Award, an Established Investigator Award from the American Heart Association, and the Illinois Stem Cell Award, to name only a few. With continued success, he hopes to develop small-scale clinical trials in 5 to 10 years.

So the next time that you enjoy a lemon or a lime, just think: The citric acid that produces that tart flavor could also be instrumental in treating your future health conditions.

—Kyle Delaney

Allen Taflove recognized as McCormick teacher, adviser of the year

Allen Taflove, professor of electrical engineering and computer science, has been honored as McCormick's Teacher of the Year and Adviser of the Year for 2005–06. He is the first faculty member to receive both awards in a single year — and according to the many students who nominated him, it's a well-deserved honor.

Student nominators lauded Taflove for his excellent teaching and dedication to students. His review sessions for the Engineering Analysis course are well-known across the school. One nominator wrote, "Students from all the other sections would rearrange their schedules to attend a 50-minute review that somehow clarified all the points covered in the last two weeks." The nomination goes on to say that the sessions are so popular that students "were left standing around the sides of the room, but it was always worth it for the information gained."

Taflove is known for going out of his way to help students. "Professor Taflove cares more about his students than any other professor I've met here at Northwestern," wrote one student. "His office door is always open, and he will rearrange his schedule in order to help students."

"Taflove is an inspiring man who has built initiative and excitement into the hearts of all his students," wrote another student. "It was a pleasure to have met this man, and I only hope that more people experience the opportunity to be a part of Taflove's magic."

"Allen Taflove exemplifies McCormick's goals of innovative teaching and research," says Dean Julio M. Ottino. "He has a highly respected body of research but has also become a leader in undergraduate education. This is unusual. As a frequent adviser to McCormick student organizations, his dedication to all McCormick undergraduates is admirable."

Taflove is the faculty adviser of the *Northwestern Undergraduate Research Journal* and McCormick's Honors Program in Undergraduate Research, Undergraduate Design Competition, and the student chapters of the Eta Kappa Nu and Tau Beta Pi honor societies. His accomplishments as a teacher and mentor were previously recognized when he was named McCormick's Adviser of the Year for 1990–91 and a Northwestern University Charles Deering McCormick Professor of Teaching Excellence for 2000–03. In addition, he was selected to Northwestern's Associated Student Government honor roll of best teachers for 2002, 2003, 2004, and 2005. From 2000 to 2005 he also served as the faculty master of the Science and Engineering Residential College at Slivka Hall.

An alumnus of Northwestern (BS electrical engineering '71, MS '72, and PhD '75), Taflove joined McCormick's faculty in 1984. He is recognized for having pioneered finite-difference time-domain computational electrodynamics, which has emerged as one of the most powerful and widely used methods to solve the fundamental Maxwell's equations for scientific and engineering problems. Current applications range across the electromagnetic spectrum from ultralow frequencies (analysis of geophysical phenomena) to microwaves (military stealth technology, cellphones, high-speed computer circuits, medical imaging) to visible light (microlasers, photonic microchips, early-stage cancer detection). Approximately two dozen companies market software based on fundamental research first published by Taflove.

Taflove is the author or coauthor of 5 books, 20 articles or chapters in books and magazines, more than 115 refereed journal papers, approximately 300 conference papers and abstracts, and 14 U.S. patents. He is one of only 28 Northwestern faculty listed on ISIHighlyCited.com, a listing of the world's most-cited researchers. He cites collaborative research with Vadim Backman, professor of biomedical engineering, as his most exciting current project. This work studies how to use minimally invasive techniques to detect deadly human cancers of the colon (and potentially the lung) at a very early stage via measurement of the spectrum and direction of light backscattered from living cells located at a distance from the dangerous lesion. If this research is successful, it has the potential to save many lives.

—Kyle Delaney

Alumni help steer innovation at McCormick

Ed Voboril comes full circle

For some time Ed Voboril had been discussing with Bill White, professor of industrial engineering and management sciences, the possibility of teaching at McCormick, even though Voboril and his wife had just started calling Arizona home. At the McCormick Advisory Council meeting in October 2006, the decision to teach was still not certain — until a disturbing phone call came from Voboril's neighbor in Arizona. "I don't know how to tell you this, but your house just burned down," he recalls his neighbor saying.

"My wife, Melanie — a Northwestern alumna — and I had to make some important decisions right away," says Voboril. In spite of what they had lost, they weighed their options and decided to take lemons and make lemonade. They have now made Chicago their home, where they can be close to family, and Voboril has committed to start teaching at McCormick. He also has become involved with a newly formed interdisciplinary group that is developing a cross-school course focused on the development of medical technology.

Voboril grew up in Braidwood, a small central Illinois town, and attended a high school with a graduating class of less than 25. A basketball coach told him about Northwestern — specifically about the Walter P. Murphy Cooperative Engineering Education Program. "There were many obstacles for me being from such a small town and school," says Voboril. "In fact, there weren't many math courses offered at my high school. As a result, I ended up taking correspondence classes, and Northwestern gave me credit for the work. I received a scholarship from Northwestern soon after."

Then as now, the co-op program at McCormick allowed students to work with major corporations to receive hands-on training in their respective fields. Students alternate quarters in the classroom with quarters spent on the premises of major companies applying their newfound skills. Voboril credits his early days at his co-op sponsor, General Motors, as an integral part of his path to success. "Without the opportunities provided by GM via Northwestern," he says, "I'm not quite sure where I'd be."

Voboril graduated from McCormick in 1965 with a degree in industrial engineering and was then offered another great opportunity — a Harvard Business School fellowship through a GM-sponsored program. In 1967 he graduated in the top 1 percent of his class as a Harvard Baker Scholar. Armed with top honors from Harvard in addition to the robust engineering knowledge and experience gained at Northwestern, Voboril entered the job market. He returned to GM, working in the electromotive division for some time and then as a consultant. In 1969 he became the vice president of sales and marketing for a Chicago-based medical x-ray company, beginning an almost 40-year career in medical technology. Then, following stints running medical-device businesses in large companies like Honeywell and General Electric, he made the decision to help grow a smaller company.

In 1990 Voboril became CEO of Greatbatch, a company most notable for its founder's significant medical invention, the pacemaker. Wilson Greatbatch created the well-known implantable cardiac device and went on to receive the National Medal of Technology and become a member of the Inventor's Hall of Fame. At Greatbatch, Voboril worked to develop improved power sources for implantable medical devices, including pacemakers, defibrillators, drug pumps, and neurostimulators. In 1997 he became chairman of the board at Greatbatch when he led a leveraged buyout of the company. Three years later the company went public on the New York Stock Exchange. Voboril also continued his connection of many years with Northwestern as a member of the McCormick Advisory Council.

Voboril recently became chairperson of NUvention, an interdisciplinary program of McCormick's Center for Entrepreneurship and Innovation that brings together

faculty from McCormick, the School of Law, the Feinberg School of Medicine, and the Kellogg School of Management to develop courses where students experience the entire innovation/business life cycle from ideation to prototyping and business plan development. He is actively involved with InNUvation, a student organization at Northwestern focused on entrepreneurship, which has been the driving force behind the creation of NUvention. (See page 4 for more on InNUvation and the Center for Entrepreneurship and Innovation.)

When asked about his seemingly karmic return to Northwestern — as adjunct professor of biomedical engineering — Voboril emphasizes the importance of remaining a force in the development of future engineers and entrepreneurs.

"When I started in my field, you were an engineer, you were a finance person, or you were a salesman," he says. "There was a sense of developing managers, not leaders. My involvement here at Northwestern is to help students see that they can be all of these

Left Ed Voboril
Right Bob Shaw

the nature of these disciplines often leads to a focus on independent study," says Shaw. "However, it is important to remember that complex engineering concepts have to translate to real-life situations."

While Northwestern was instrumental in building Shaw's communications skills, it was his postgraduate Navy experience that elevated both his engineering expertise and personnel management abilities. As an electrical and communications officer

> **"My involvement here is to help to build vital skills, especially communication and team building."**
>
> —Ed Voboril

things and to create interdisciplinary communities to build vital skills, especially communication and team building."

His recent involvement with NUvention is a continuation of Voboril's commitment to the development of good, reliable design that results in effective medical solutions. While working with these Northwestern students, he is helping to remove barriers to innovation and pave the way for future developments.

Bob Shaw navigates a multifaceted career

Since 1970 Bob Shaw's mechanical engineering degree from McCormick has taken him from a nuclear submarine to an innovative diagnostic medical instruments company. He attributes his adaptability to the key teamwork and communication skills he gained in the undergraduate English and communications courses that were required of him as a McCormick undergraduate — and he is glad to see continued emphasis on these skills in the core engineering curriculum.

"Many students go into engineering because they enjoy science and math, and

on a nuclear submarine, Shaw was quickly immersed in the practical application of his education, learning the intricacies of engineering and leadership. In his role as an officer, he managed issues associated with complex systems and supervised 15 subordinates.

"Failures of the electrical systems or the propulsion plant on the sub could endanger the lives of the entire 120-man crew," Shaw says. "It was critical to the mission of the submarine to maintain constant communications, even while submerged, and be able to respond within 15 minutes to a potential call to launch all 16 of its ballistic missiles.

"The submarine force was also one of the first to employ global positioning systems, various environmental control systems, and desalination equipment. It was my job to analyze these machines and their ability to execute critical tasks. To manage and communicate proficiently in these multifaceted systems was a challenge."

After five years in the Navy, Shaw moved on to a unique opportunity when he acquired a portion of Milex Products Inc., a medical device company centered on women's health. The company brought Shaw aboard in 1979 as coowner, quality-assurance director, FDA regulatory specialist, and sales and marketing strategist. His background in engineering — specifically product design and improvement — was most applicable when assessing the accuracy of measurements to safely develop devices treating conditions such as infertility and cancer screening.

"McCormick gave me the tools necessary to assess basic methods of approaching and analyzing problems," says Shaw. "I learned to quantify solutions and look at best overall approaches. One example of this was when I moved a number of products from latex to silicone, reducing the risk of allergic reactions. Changes in cancer screening device designs allowed physicians to perform tests in the office that had previously required hospitalization."

In 1978 Shaw returned to Northwestern for a master of management degree with a dual management and marketing major. At this point in his career, he had more than 200 employees reporting to him and felt the need for the added academic background in management and personnel issues. His courses at the Kellogg School of Management refreshed skills he had gained as an undergraduate.

Shaw now serves as a consultant at McCormick, assisting with the evaluation of undergraduate engineering design programs. He also provides donor and advisory support for the school's Center for Entrepreneurship and Innovation (see related story on page 4). He is a member of the McCormick Advisory Council and has served on its subcommittee evaluating professional engineering programs.

"My best advice for McCormick students is to learn how to express ideas and develop problem-solving skills with a team," he says.

Those skills have allowed Bob Shaw to successfully navigate the challenges of two very different careers and serve him well in his ongoing role as an adviser to McCormick.

—Lina Sawyer

Faculty honors

Zdeněk Bažant, McCormick School Professor and Walter P. Murphy Professor of Civil and Environmental Engineering, was elected a foreign member of the Accademia Nazionale dei Lincei (see below) and presented the opening plenary lectures at the International Conference on Damage in Composite Materials at the University of Stuttgart and the 18th International Conference on Computational Mechanics in Lublin, Poland.

Ted Belytschko, Walter P. Murphy Professor of Mechanical Engineering, received an honorary doctorate from the University of Lyon, France.

Randall Berry, associate professor of electrical engineering and computer science, was the keynote speaker at the Second Annual Workshop on Resource Allocation in Wireless Networks.

Linda Broadbelt, professor of chemical and biological engineering, was elected a fellow of the American Association for the Advancement of Science.

Fabian Bustamante, assistant professor of electrical engineering and computer science, received the National Science Foundation (NSF) CAREER Award.

Justine Cassell, professor of electrical engineering and computer science, gave invited talks at the AI for Human Computing Workshop in Hyderabad, India, and the Computer-Supported Collaborative Learning Workshop in Lausanne, Switzerland.

Yan Chen, assistant professor of electrical engineering and computer science, won an NSF CyberTrust Award and an Early Career Award from the U.S. Department of Energy.

J. Edward Colgate, professor of mechanical engineering, was appointed the Pentair–D. Eugene and Bonnie L. Nugent Teaching Professor.

Isaac Daniel, Walter P. Murphy Professor of Civil and Environmental Engineering and Mechanical Engineering, received the P. S. Theocaris Award of the Society for Experimental Mechanics and was named an honorary member of the society.

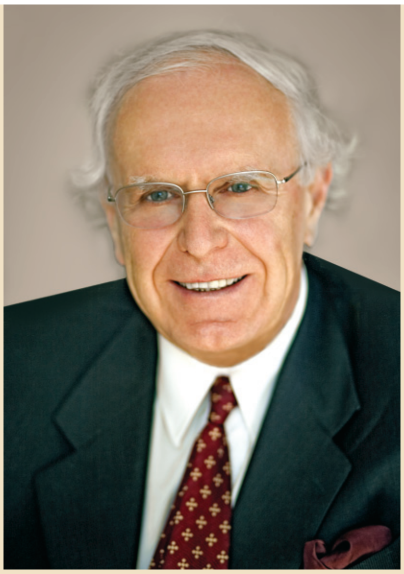
Mark Daskin, professor of industrial engineering and management sciences, was the keynote speaker at the Operations Research Society of China national conference and was named the Bette and Niesen Harris Chair of Teaching Excellence.

Horacio Espinosa, professor of mechanical engineering, will receive the 2007 Young Investigator Medal from the Society of Engineering Science.

Ken Forbus, Walter P. Murphy Professor of Electric Engineering and Computer Science, was elected a fellow of the Association for Computing Machinery.

Bartosz Grzybowski, assistant professor of chemical and biological engineering, received the Sloan Fellowship Award.

Bažant inducted into the Accademia Nazionale dei Lincei



Zdeněk P. Bažant, McCormick School Professor and Walter P. Murphy Professor of Civil and Environmental Engineering, has been elected a foreign member of the Accademia Nazionale dei Lincei. The induction ceremony will take place in Rome in June.

The Accademia Nazionale dei Lincei, known as the Italian National Academy, was founded in 1603 and is the oldest honorific scientific academy in the world. Located in Palazzo Corsini in Rome, across the Tiber River from the Vatican, the academy counts Galileo among its earliest members.

"This is a tremendously prestigious honor for Zdeněk and a wonderful acknowledgement of his contributions to the understanding of size effects in quasi-brittle materials," says Brian Moran, chair of civil and environmental engineering. "Galileo himself was a pioneer in the field of strength of materials, and we are thrilled for Zdeněk that his own contributions to the field have been recognized by the academy of which Galileo was a member."

Bažant discovered the nonstatistical (energetic) size effect on the strength structures consisting of brittle heterogeneous materials such as concrete, fiber composites, tough ceramics, rock, and sea ice, and he is known as a world leader in the research on scaling in solid mechanics. He is a member of the National Academy of Sciences, the National Academy of Engineering, the Austrian Academy of Sciences, the Engineering Academy of Czech Republic, and the Accademia di Scienze e Lettere (Milan). Bažant is the recipient of numerous awards and honors and has received six honorary doctorates.

—Kyle Delaney

Dongning Guo, assistant professor of electrical engineering and computer science, received the NSF CAREER Award.
Walter Herbst, adjunct professor of mechanical engineering, was the keynote speaker at the MIT Enterprise Forum of Chicago in September 2006.
Michael Honig, professor of electrical engineering and computer science, received a Humboldt Research Award for senior U.S. scientists from the Alexander von Humboldt Foundation.
Yehea Ismail, associate professor of electrical engineering and computer science, was elected editor in chief of *IEEE Transactions.*
Bill Kath, professor of engineering science and applied mathematics, was elected a fellow of the Optical Society of America.
Aggelos Katsaggelos, professor of electrical engineering and computer science, was a corecipient of the best paper award at the Institute of Electrical and Electronics Engineers (IEEE) International Conference on Multimedia and Expo.
Sridhar Krishnaswamy, professor of mechanical engineering, was elected a fellow of the American Society of Mechanical Engineers.
Todd Kuiken, associate professor of biomedical engineering, received a Da Vinci Award for Innovative Engineering from the National Multiple Sclerosis Society.
Aleksandar Kuzmanovic, assistant professor of electrical engineering and computer science, won an NSF CyberTrust Award.
Lincoln Lauhon, assistant professor of materials science and engineering, received the Sloan Fellowship Award.
Tobin Marks, professor of chemistry and materials science and engineering, was elected to the German Academy of Natural Sciences Leopoldina.
Bernie Matkowsky, John Evans Professor of Engineering Sciences and Applied Mathematics, was elected a fellow of the American Physical Society.
Gokhan Memik, assistant professor of electrical engineering and computer science, was named the Lisa Wissner-Slivka and Benjamin Slivka Chair in Computer Science.
Don Norman, professor of electrical engineering and computer science, presented the keynote lectures at the Nielsen Norman group conference in Seattle, the Korean Advanced Institute of Science and Technology conference in Daejon, and the Florida Institute for Human and Machine Cognition in Pensacola. He also presented a lecture to interactive design students at the Royal College of Art in London. Norman has joined the editorial board of the international journal *Design Research Quarterly* and presented an inaugural speech for the Microsoft Research Chair on Intelligent Environments at the Katholieke Universiteit Leuven in Belgium.

Volpert receives NAA teaching award

Vladimir Volpert, professor of engineering sciences and applied mathematics, received a 2006 Northwestern Alumni Association Excellence in Teaching Award. The award recognizes outstanding faculty selected by the Northwestern Alumni Association with the help of the University's deans, students, and alumni.

Volpert has taught at all levels of applied mathematics since joining the Northwestern faculty in 1992. Whether it's teaching introductory calculus to freshmen or differential equations of mathematical physics to graduate students, his philosophy is the same: "I attempt to provide my students with the tools necessary to study real-world problems rather than merely train them to perform mathematical exercises with no connection to science and technology."

A PhD graduate of the Institute of Chemical Physics of the former USSR Academy of Sciences, Volpert came to the United States in 1990 as a two-year visiting scholar at Northwestern. He joined the McCormick faculty in 1992 and became a full professor in 2002. His awards include McCormick School Teacher of the Year in 1999–2000. He has received research grants from the National Science Foundation, NASA, and the U.S. Department of Energy. He is the author of two books and numerous journal articles, serves on two editorial boards, and has been a reviewer for many journals.

Thrasos Pappas, professor of electrical engineering and computer science, was elected a fellow of the International Society for Optical Engineering.

Bryan Pardo, assistant professor of electrical engineering and computer science, received the NSF CAREER Award.

Manijeh Razeghi, Walter P. Murphy Professor of Electrical Engineering and Computer Science, was elected a fellow of the American Physical Society.

John Rudnicki, professor of civil and environmental engineering and of mechanical engineering, received the 2006 Maurice A. Biot Medal from the American Society of Civil Engineers.

Rod Ruoff, professor of mechanical engineering, was appointed managing editor of *NANO,* the first journal on nanoscale science and technology to be published in Asia.

Alan Sahakian, professor of biomedical engineering and electrical engineering and computer science, was elected a fellow of IEEE.

David Seidman, Walter P. Murphy Professor of Materials Science and Engineering, received the Albert Sauveur Achievement Award from ASM International.

Surendra Shah, Walter P. Murphy Professor of Civil and Environmental Engineering, was honored by a symposium held in his honor at the European Conference on Fracture.

Randall Snurr, professor of chemical and biological engineering, gave a plenary lecture at the Sixth Brazilian Meeting on Adsorption.

Allen Taflove, professor of electrical engineering and computer science, gave a plenary lecture at the 2006 annual meeting of the Applied Computational Electromagnetics Society.

Jack Tumblin, assistant professor of electrical engineering and computer science, was the keynote speaker at the 2006 Human Vision and Electronic Imaging Conference.

Focus on: McCormick business administrators

Behind every strong department is a strong business administrator.

The McCormick business administrators manage the business operations of the departments, including faculty administrative support, financial management, undergraduate and graduate student assistance, staff supervision, event planning, and facilities management. From thousands of annual purchase and payroll transactions to daily last-minute requests, their effort defines excellence in project management and multitasking.

Back from left: Beth Siculan, department assistant, engineering sciences and applied mathematics; Deneen Bryce, business administrator, electrical engineering and computer science; Mary Anne Peruchini, business administrator, biomedical engineering; Karen Healy Stover, business administrator, mechanical engineering. *Front from left:* Teresa Tabamo, business administrator, civil and environmental engineering; Peggy Adamson, business administrator, materials science and engineering; Edla D'Herckens, department assistant, engineering sciences and applied mathematics; Laura Gerety, business administrator, chemical and biological engineering. *Not pictured:* Beth Abbot, business administrator, industrial engineering and management sciences.

1940s

James Krebs ('45) married Mimi McClellan in January 2006.

Kenneth Weaver ('49) wrote *Rising from Rubble ... Germany Revisited,* a memoir of his service in the Army Signal Corps in Europe.

1950s

Richard Pepper ('53) and his wife, Roxy, were recently recognized by the Illinois Humanities Council and the Barrington, Illinois, village board for their many civic contributions — including work that garnered them the Studs Terkel Humanities Service Award.

1960s

Ted Clarke ('65, MS '68) and Northwestern professor emeritus David Lynn Johnson completed building a catamaran, Tigercat II, in 2004. They started planning the boat in 1968, when Clarke was a graduate student in Johnson's class. Much of Clarke's research can be found in articles in *Microscopy Today* and *Modern Microscopy.*

Martin Wachs (MS '65, PhD '67) became the director of the RAND Corporation's transportation, space, and technology program in May 2006. He previously served as director of the Institute of Transportation Studies and the Transportation Center at the University of California, Berkeley.

Edgar Hotard ('66), an independent investor and consultant, was elected a director of Albany International.

Robert Wayman ('67, Kellogg '69) announced that he will retire from his position as chief financial officer of Hewlett-Packard.

David Mertz ('68) retired from his position as advisory engineer of the Bechtel Bettis Atomic Power Laboratory in 2005. He completed numerous engineering and management assignments, advancing the technology of naval nuclear propulsion.

1970s

Charles S. Pawlak ('73) was named vice president and managing director of the Phoenix office of real estate firm Binswanger.

Peter Barris ('74) of New Enterprise Associates was 32nd on *Forbes* magazine's "Midas List" of the best deal makers in high-tech life science.

Geoffrey Levine (PhD '78), a retired pharmacist, health physicist, and board-certified nuclear pharmacist, was elected a fellow of the American Pharmacists Association. He serves as a consultant at the University of Pittsburgh, works part time as a nuclear pharmacist at Hope Pharmaceuticals, and has started his own company named 900 Communications.

Thomas J. Riordan ('78) was hired as president and chief operations officer of Terex Corporation, a manufacturing company based in Westport, Connecticut.

Michael E. Friduss ('79) participated in the 199-mile relay from Calistoga to Santa Cruz in California with the Running Noses, a team from the Stanford University department of otolaryngology–head and neck surgery. The team finished in 29 hours.

1980s

Clint Cibler (PhD '81) is senior vice president and chief information officer of the Cincinnati-based insurance firm Western & Southern Financial Group.

Martin Maskarinec (MS '86, PhD '89) was recently promoted to full professor in the department of computer science at Western Illinois University.

Julie Owen Remington ('86) became the parent of triplets — Adam Robert, Cole Patrick, and Samantha Frances — on December 10, 2005.

William J. Bliss ('87) was named chief technology officer of Klir Technologies in Seattle.

Thomas Howell (MS '88) was named chief technology officer for Additech, based in Houston.

Daniel S. Katz ('88, MS '90, PhD '94) is an assistant director for scientific computing systems and software in the Center for Computation and Technology at Louisiana State University. He is also an associate research professor in the university's electrical and computer engineering department. He remains a faculty part-time principal at the Jet Propulsion Laboratory at the California Institute of Technology.

What's happening in your life?

Please let us know by sending an e-mail to magazine@mccormick.northwestern.edu.

1990s

Panos Sarantopoulos ('90) became managing director of Champagne Krug, one of the world's leading cuvées.

Eric Kirby ('91) was appointed senior vice president and general manager of Merkle|Quris, the Denver-based e-mail marketing division of marketing company Merkle.

Amie Nylund Verhasselt ('91) and Greg DePere are parents to Eric Benjamin (born April 3, 2006), Adam, and Ryan.

Sakinah M. Alhabshi
(civil and environmental engineering ’04),
project engineer, Sarawak, Borneo, Malaysia

On her career: As a project engineer for Malaysia LNG (a subsidiary of PETRONAS Malaysia, the second largest liquefied natural gas plant in the world), Alhabshi manages civil engineering–related facilities improvement projects. She was selected to attend General Electric’s Oil & Gas University in Florence, Italy, where she is completing a six-month course on leadership and management in the oil and gas industries. She was one of only two women out of 26 participants from around the world.

What she learned at McCormick: “Although I don’t necessarily apply the textbook knowledge to my day job, McCormick taught me valuable problem-solving and critical thinking skills.”

Her involvement and connection to McCormick: During her four years at Northwestern, Alhabshi served as president of the Environmental Engineering Undergraduate Society, was founder and president of the Malaysian Students Association (Cilipadi), and president of the Women’s Residential College. She also worked with the University’s Academic Technologies unit and helped manage employees at the various computer labs on campus. In her second job as a research assistant with Engineering Design and Communication (EDC) faculty, she helped analyze and improve the program curriculum. In December 2006 she returned from Malaysia to visit Northwestern.

Best McCormick moment: Her EDC project. Alhabshi and her team built a multipurpose desk for a young girl who had Down’s syndrome and attention deficit disorder, making sure the desk was safe as well as functional. “Our team worked hand-in-hand with the end user to construct a desk that possessed all the necessary traits: a built-in easel, multiple drawers, and magnetic surfaces. The look on the faces of family members when we presented the desk made all the effort worthwhile.”

Words of advice to current students: “Make the most of your time at Northwestern. Work hard, play hard, stay in touch with the people in your life, and figure out how you can contribute and give back to the community around you.”
—Lina Sawyer

Derek B. Wall (’91), a general surgeon, is a lieutenant commander in the U.S. Navy on his third deployment to the Middle East. Wall became head of the surgery department at Naval Air Station Lemoore in California in September. He and his wife, Alesia Wilburn Wall, are parents of Sophia Cai-Min (born February 3 and adopted October 24, 2005) and Simone.
Kathleen Neumann (PhD ’92) is chair and professor of the computer science department at Western Illinois University.
Mark F. Wegener (’92) is a transportation engineer and planner at Jacobs Civil in Bellevue, Washington. He and Rosemarie Buchanan became parents of Annika Sophie on February 17, 2006.
James H. Kim (’93), president of Korean software company Innotive, was featured in an article in the *Financial Times* about the company’s work to develop presentation software to rival Microsoft’s PowerPoint.
Eric Landis (PhD ’93) was named the 2006 Maine Professor of the Year by the Carnegie Foundation for the Advancement of Learning and the Council for Advancement and Support of Education.
Brooke Aldendifer Mac Lean (’93) and her husband, Duncan, are parents of Alister Charles (born March 1, 2006), Lochlan, and Rowan.
Charles Blumberg (’95) was promoted to manager of billing systems at Kemper Auto and Home Insurance in January 2006. He is also pursuing an MBA at the University of Florida.
Chris Kapuscinski (’95, MS ’97, Kellogg ’05) and **Marnie Kalmus Kapuscinski** (’96) are parents of Ryan Thomas (born April 5, 2006) and Kyra.
Scott Norquist (’95) and **Penny Norton Norquist** (’96) are parents of Wesley Scott (born June 14, 2005) and Natalie Susan.
Narinder Singh (’95) was profiled by *BusinessWire* as an executive of Appirio, an enterprise software company based in San Francisco.
Stephen John Van Horn (’95) and **Stephanie Brownlie Van Horn** (’97) are parents of John “Jack” Richard (born May 2, 2006) and William Moreland.
Elizabeth Wright Cronin (‘96) and Craig Cronin are parents of Katherine Mary (born March 5, 2006) and Emily.
Chelsea Stoner (’96) of Boston is a senior associate at Battery Ventures, a Boston-based venture capital firm.
Erin Kiedaisch Turley (’96, Kellogg ’04) and her husband, Stephen, are parents of Ella Breen, born May 10, 2006.
Victoria Lane Paulsen (’97) and her husband, Stuart, are parents of twins, Spencer Lane and Erik Ronald, born October 6, 2005.

Alan Fliegelman ('98) and Stephanie Gaswirth became parents of Benjamin on April 25, 2006.

Charlene Gener ('98) married Peter Kim on July 3, 2005.

Marilyn Griffin ('98) of Pittsburgh began her residency at the University of Pittsburgh Medical Center in general pediatrics, adult psychiatry, and child and adolescent psychiatry in June 2006. She received a medical degree from the University of Illinois College of Medicine at Rockford in April 2006 and was inducted into the college's Gold Humanism Honor Society. She also received the David Mortimer Olkon Scholarship for excellence in psychiatry.

2000s

Margaret Korona ('00) married Scott Scheuber on May 6, 2006.

Romil Patel ('00, Feinberg '06) began his four-year diagnostic radiology residency at St. Luke's–Roosevelt Hospital Center in New York in July 2006 after completing his internship in medicine at Evanston Hospital. In 2005 he graduated from Mount Sinai School of Medicine.

Anthony D. Tuesca ('01) married Molly Allen on October 15, 2005.

Benedict F. Figuerres ('02) started an orthopedic surgery residency at the University of Illinois College of Medicine at Chicago. He received his medical degree from Southern Illinois University School of Medicine in Springfield in May 2006.

Alan Johnson ('02) is continuing his medical training as an otolaryngology and head and neck surgery resident at the University of Minnesota after graduating from the University of Minnesota Medical School in May 2006. He married Katy Hansen on May 26, 2006.

Caleb Brenneman ('03) and Nancy Ketsche Brenneman became parents of Simona Lucille on June 12, 2006.

Jay Goyal ('03), a newly elected Democratic state legislator in Ohio, was profiled by the Associated Press as one of the few elected lawmakers in the United States of Asian Indian heritage.

Shaoping Xiao (PhD '03), assistant professor of mechanical and industrial engineering in the Center for Computer-Aided Design at the University of Iowa College of Engineering, is collaborating on a one-year $100,000 contract from the U.S. Army Research Office to develop a CAD software analysis tool.

Fen Yang (MS '03, PhD '06) was named assistant professor of chemical engineering at West Virginia University College of Engineering and Mineral Resources.

Mary Szymkowski (computer science '85), veterinarian, Raleigh, North Carolina

On her career: Prior to becoming a veterinarian, Szymkowski was a programmer at IBM, designing and implementing communications software for network controllers. "I followed my passion for treating animals and pursued pre-vet course work while still at IBM." She took a programming job at North Carolina State University (NCSU) College of Veterinary Medicine, where she designed and implemented an online medical record system. She continued working as a programmer part-time after being accepted to the NCSU veterinary program.

What she learned at McCormick: Valuable analytic skills and patience to work through a problem. "In my current role, I think doing surgery is probably closest to my engineering background. You have something to 'fix' and the 'parts' in front of you to work with."

How she stays connected: Szymkowski worked with the Northwestern Alumni Association in the late 1980s to start a Northwestern Club in the Raleigh area. She also has spoken to high school students at the Society of Women Engineers Career Day — once about working at IBM and once about medical technology just before she started veterinary school.

Best McCormick moment: Having to write an assembler in one of her programming classes — in assembler code: "When the program finally ran correctly, it was a truly great experience. At that time, we were still coding on Hollerith cards. I still have the two boxes of cards with code keyed on them in my attic." Szymkowski also has fond memories of working with Carolyn Krulee, former assistant dean: "She was such a profound role model for me. I learned about work/life balance and was given the opportunity to take a leadership role with other women in engineering. It was a real confidence builder."

Most unlikely application of engineering background: Szymkowski once had to fashion an oxygen tent for an asthmatic cat using a cat carrier, heavy plastic, duct tape, and an oxygen tank: "The cat did great, and it was quite the sight!"

—Lina Sawyer

Chemical engineering major Midori Greenwood-Goodwin ('07) learns through teaching

Having an outstanding academic record of her own isn't enough for Midori Greenwood-Goodwin: She's also worked hard to make sure that other McCormick students find the same success. As academic excellence chair for the National Society of Black Engineers, Greenwood-Goodwin has worked to improve the organization's review sessions, which are held prior to midterms and finals. She's spent three years working as a facilitator for the Gateway Science Workshops, a peer education program run by Northwestern's Searle Center for Teaching Excellence, and is actively involved in volunteer opportunities with the Society of Women Engineers and the Society of Hispanic Professional Engineers. She's also found time for a summer research experience at the University of California, Berkeley, and is working on research in Professor Annelise Barron's lab at McCormick. Now, as a graduating senior, Greenwood-Goodwin is looking for ways to incorporate all of her varied interests.

—Kyle Delaney

How did you choose to major in chemical engineering?

I really enjoyed freshman chemistry, and I came into McCormick thinking that I was going to do chemical or biomedical engineering. That's never really changed — I'm still in the biomedical track within chemical engineering. I wanted to complete my undergraduate degree in chemical engineering to keep my options open.

Tell us about your involvement with the Gateway Science Workshops.

This is my fourth year with the program — one year as a student and three as a facilitator — and I think it's been one of the best things I've done at Northwestern. The program recruits students who have done well in the large introductory engineering and science courses — such as the engineering analysis sequence, general and organic chemistry, and biology — and hires them as facilitators. Every week the facilitators get a worksheet to go through with a group of students in the course. It's a small group, and the emphasis is on facilitating, not teaching. You're there to help students interact with each other and to lead a study group. It really helps students work through the conceptual ideas behind problems.

Why has this experience been valuable?

It brought me to a new level of thinking. You never really know something until you can explain it well to someone else. As a facilitator, that's what you get from the program. You're expanding your knowledge in a subject that you did well on. It forces you to really understand what the problems mean. The experience has affected my future. Now I want whatever I do to involve some aspect of education.

What are your future plans?

At this point my plans are to take a year off. I definitely plan to apply to graduate school and want to get my PhD, but I'm still debating between applying for chemical and biomedical engineering programs. I'm looking for research laboratory positions as an intermediate step to help me figure out which PhD program I would want to pursue. I've also explored taking a teaching fellowship for a year.

What are your research interests?

Honestly, my interests change almost every week. I'm always reading new papers and talking to different professors and graduate students about what they're doing. At the moment, I'd like to see if there is a relationship between the oculomotor system and the muscle activation patterns that you see in the leg, like the gait patterns of walking. Most biologists believe that the visual system is a major control point for decision making in motor tasks, and I think that anything that we see as passive activity is likely to be controlled by something that first happens with the eye. It's really interesting to think about the "what came first" question of whether activity in the eye triggers activity in your leg, or if the signal to move your leg signals changes in eye movement in the direction of motion. That's my current interest — but that will probably change by the time you print this.

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On the cover, from left
Dipak C. Jain, dean of the Kellogg School of Management, University President Henry S. Bienen, and Julio M. Ottino, dean of the McCormick School of Engineering and Applied Science.
Photo by Nathan Mandell.

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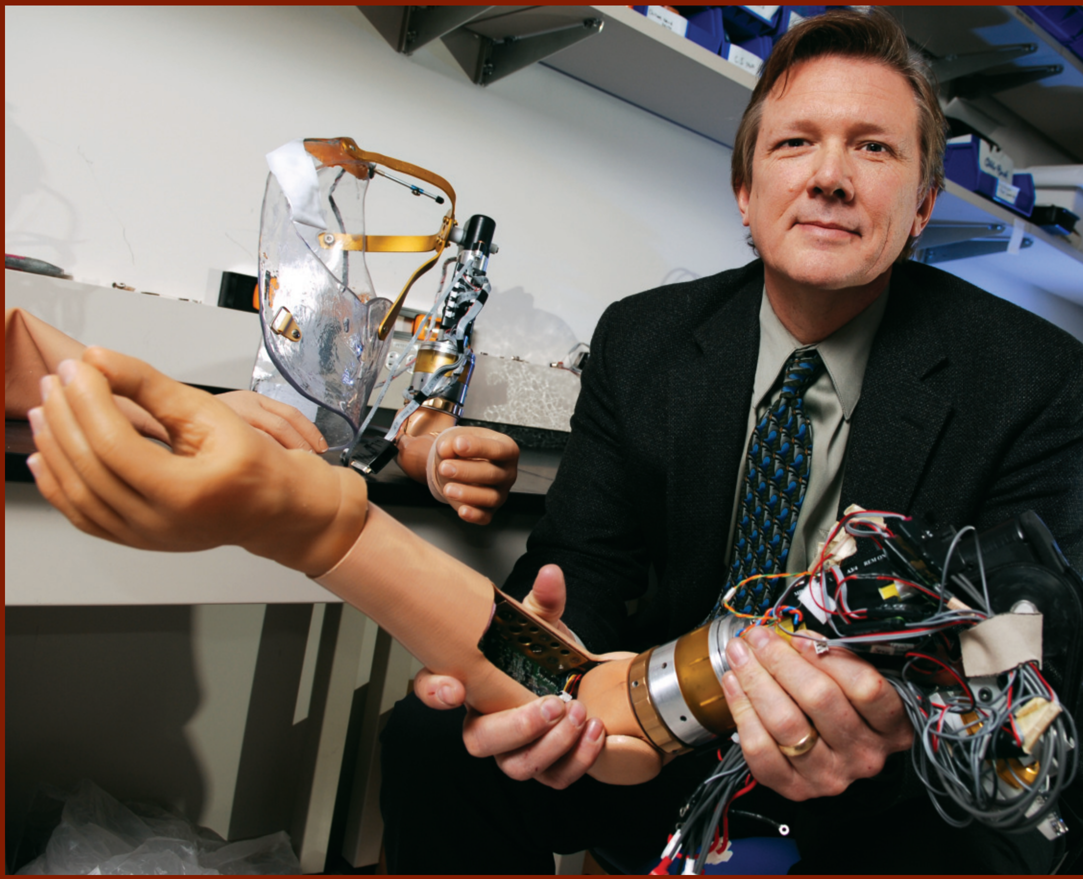
From left to right Michael Marasco, Ann McKenna, Dean Julio M. Ottino, Rob Linsenmeier, and Steve Carr lead several new initiatives at McCormick.
See stories on pages 2–5.

Todd Kuiken (PhD ’89, Feinberg ’90), associate professor of biomedical engineering and physical medicine and rehabilitation and director of the Neural Engineering Center for Artificial Limbs, is working with faculty at McCormick and the Rehabilitation Institute of Chicago on groundbreaking prosthetics research. See story on pages 6–9.



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