Northwestern University

McCormick by Design

Robert R. McCormick School of Engineering and Applied Science

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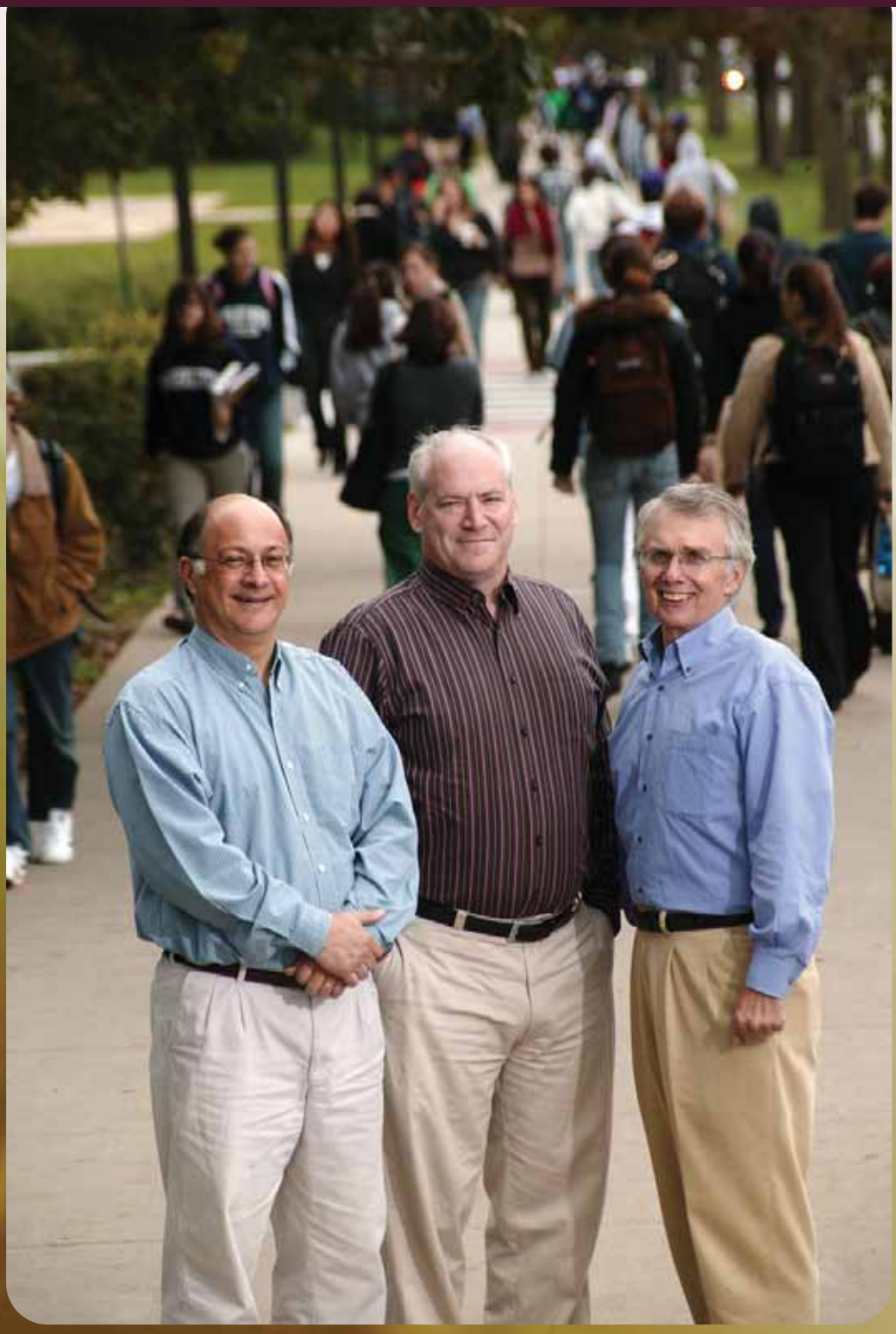

Leading global health initiatives

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McCormick by Design is published by the Robert R. McCormick School of Engineering and Applied Science, Northwestern University, for its alumni and friends.

on the cover: Partners in the global health initiative featured in the cover story are (from left) Mladen Poluta, director of the Healthcare Technology Management program at the University of Cape Town, and biomedical engineering professors Matt Glucksberg and Dave Kelso, director of the Center for Innovation in Global Health Technologies.

Editors: Gina Weber Myerson, Marianne Goss
Designer: Vickie Lata
Principal writer: Kyle Delaney
Contributing writers: Jack Bess, Megan Fellman
Cover photo: Andrew Campbell
Inside photos: Andrew Campbell, Jasper Chen, Kyle Delaney, Evanston Northwestern Healthcare, Hewlett-Packard, Kelly Janura, Sam Levitan, Thanan Lilaonitkul

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At McCormick we believe that the best response to concerns about America's technological leadership is a strong emphasis on fostering creativity in our classrooms. This op-ed I wrote for the July 1 *Chicago Sun-Times,* printed in lieu of a dean's message in this issue, clearly states our position. I welcome your feedback.

Fostering creativity key to safeguarding tech leadership

Imagine our world without some of the notable engineering feats of the past two centuries: electricity, telecommunications, computers, airplanes, automobiles, medical technologies, and the Internet. Engineering has changed our world and bolstered our economy with a great mix of ideas, technology, venture capital, and tolerance — even appetite — for risk.

But now, academics and business leaders have sounded the alarm in a recent report from the National Academies, "Rising above the Gathering Storm." It points to the growing number of engineers graduating in Asia and a steady decline in engineering enrollment. The United States ranks 17th worldwide in the number of engineering and science degrees among 18- to 24-year-olds, down from third in 1975. Compare that with China, where 50 percent of its undergraduates receive degrees in natural sciences or engineering.

Julio M. Ottino, Dean

Those sobering numbers hint at why so much focus has been put on the need to increase the number of engineers we produce in the United States. But even more important, we must focus on producing creative engineers. Engineers must be able to seamlessly traverse the areas of science, engineering, technology, and medicine.

Fostering creativity — at every level of education — is key to safeguarding America's technological leadership. That means starting at the grade school and high school levels and seriously fostering innovation at the university level. It is no wonder that young students, who often are asked to simply absorb information about math, equate engineering with a lifetime of memorization and regurgitation.

Science and engineering have a serious public relations problem. At its heart, engineering requires the ability to think about opportunities that others may have missed, to see challenges, and to identify possibilities. Engineering is closer to art than to science. Science is inevitable; technology, like art, is not. The better we portray that reality, the more likely students will choose engineering as an exciting course of study.

At the undergraduate and graduate levels, we must treat creativity as a core competency for success in our new global environment. Today's engineering graduates are just as likely to build careers in the service industries — health, consulting, law, business, information technology, etc. — as in traditional engineering manufacturing jobs. They must have a broad educational background that allows them to move among a variety of careers and disciplines — and we must change our curriculum accordingly.

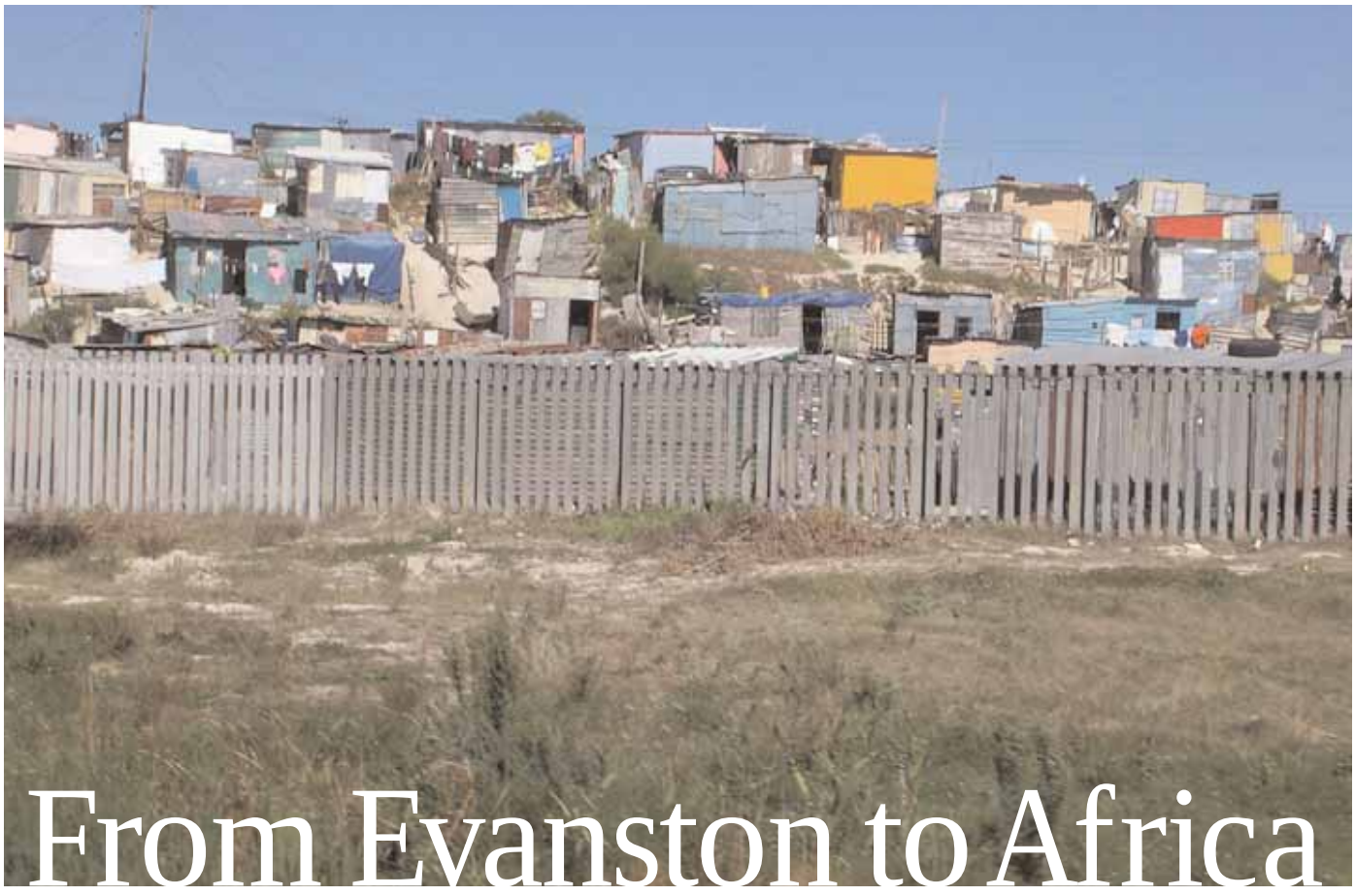
Infusing "design-think" into undergraduate and graduate curriculums is one approach of top engineering schools. Students are required to engage in the process of creating new products and processes. Given opportunities to think beyond algorithms and equations, they study challenges and identify opportunities. They create, rather than simply absorb, knowledge.

Our students at Northwestern, for example, start working with clients to develop solutions to real-world problems in their first year, on projects such as treating wastewater in developing countries and inventing devices to help individuals recover from strokes.

As we foster creativity among students, we also must be aware of actions that may discourage it. Take research funding. Often research proposals are based on top-down directives, which discourage the bottom-up approach. Though these directive approaches often reflect areas of critical importance, they must be balanced with opportunities to explore new areas that could lead to unforeseen breakthroughs. The biggest discoveries often are the result of a creative, even serendipitous exploration. The list goes from Archimedes' buoyancy principle (the famous Eureka!), to Velcro® and Post-it® notes.

As America awakens to the challenges of globalization, we cannot ignore the key qualitative differential that has led to our past success: creativity. As we address concerns over the falling numbers of students entering science and engineering, we must also consider what types of engineers we want to produce and commit the necessary resources at all levels of education. America has never had the most engineers in the world, but our engineers have been known as the most creative and the most innovative. We cannot lose that distinction.

— Courtesy of the *Chicago Sun-Times*



From Evanston to Africa

Global health initiatives reach across campus and around the world

Several years ago biomedical engineering professors Matt Glucksberg and Dave Kelso began to outline an ambitious vision for programs that would apply engineering expertise to the challenges of health care in the developing world. Now a new center and a new undergraduate study abroad program in South Africa have made their vision a reality.

These two initiatives in global health bring together faculty and students from across Northwestern, corporate partners, and international collaborators to address the unique challenges of global health. They provide the framework for Northwestern students and faculty to travel to the developing world and study problems firsthand, then use the resulting knowledge and relationships to develop appropriate and sustainable technologies and solutions.

As Kelso and Glucksberg wrote in a recent op-ed in the *Chicago Sun-Times*, an important part of the projects is collaboration with workers in the developing world. "There are armies of smart and resourceful Africans dedicating their lives to battling disease and the conditions that make people vulnerable to disease," they wrote. "What they need most from the industrialized world is the technological and organizational equipage to succeed."

These initiatives hope to address what Gluckberg and Kelso describe as an "obligation to help."

A new center for global health

Kelso is the director of McCormick's new Center for Innovation in Global Health Technologies (CIGHT), which recently received a four-year, $4.9 million grant from the Bill & Melinda Gates Foundation. The center aims to design medical diagnostics specifically for the developing world. Though many diagnostics are available for the diseases widely found in developing countries — such as HIV, tuberculosis, and malaria — few have been specifically designed for the clinics and health care centers in which they are needed.

To develop new diagnostics, CIGHT essentially is forming a small nonprofit biotech company. Engineers from McCormick work with existing intellectual property — much of it from corporate partners Inverness Medical Innovations and Abbott — to develop platform diagnostics. While they develop these products, partners from Northwestern's J. L. Kellogg School of Management, led by Daniel Diermeier, IBM Distinguished Professor of Regulation and Competitive Practice, will research the market dynamics, government issues, and distribution channels in the developing world. Richard Joseph, director of Northwestern's Program of African Studies, will consult on the cultural factors affecting these products. The partners will then work together to determine which diagnostics could have the most impact. In the final stages of development, researchers from CIGHT will work with collaborators at Northwestern's Feinberg School of Medicine, headed by Robert L. Murphy, John Philip Phair Professor of Infectious Diseases, to prepare field trials to make sure the designs work under real-life conditions.

While the Northwestern faculty and student participants will spend time in resource-poor environments, it is impossible for them to truly understand the users of their devices from their Evanston base. To ensure that the innovation process takes into account all necessary considerations, the center will rely heavily on international relationships.

"At this time the most important thing that we have is relationships with people in these countries," Kelso says. "As we go forward, we'll be able to work with them to find out what our device requirements are going to be and to get feedback from our ideas."

Dave Kelso

Using the University for R&D

Very few of the medical diagnostics that work in the developed world are as effective in resource-poor areas. Consider an HIV test. In the developed world, patients visit their doctor for an HIV test or can even take the test at home. The diagnostic is then shipped to a central processing facility and examined, and patients are notified of the results within a few days. If the result is positive, they visit their doctor to begin a drug regimen.

It sounds pretty straightforward, but the developing world is a stark contrast; there many parts of a seemingly simple process prove difficult or even impossible. Sending the results to a central location requires adequate infrastructure. Notifying patients of the results requires accurate patient records and the ability to contact a patient. The latter can prove difficult and time consuming when patients live in overcrowded and impoverished townships with little or no telephone capability.

"We hope to develop technologies that can provide a diagnosis at the point of care," Kelso says. "If a patient could be diagnosed and begin treatment all in one visit, that would be a huge improvement."

The reason for the lack of appropriate technologies is simple: These areas have not had the market potential to warrant the vast research and development costs associated with developing new technologies. If companies were to try to develop appropriate technologies, they would have little to no

Meredith Wilson and Daniel Diermeier

hope of ever recouping their investments — let alone making a profit.

"Part of the reason that drugs and diagnostics are expensive is because of the research and development costs," Kelso says. "If we can remove R&D from the price, a company can manufacture a product and sell it at cost. They're not losing money on every sale, so you don't have to worry about who's going to pay for this 20 years from now."

With his funding now in place, Kelso is busy hiring 10 to 12 staff members to form his research team at CIGHT. He says this new initiative is a return to the earlier days of his career; he had stints at several medical device companies prior to entering academia. And while he and his colleagues have been very busy, he says he wouldn't have it any other way. "This is the most fun I've had in a long time," he says.

Kellogg's contribution: An understanding of new markets

"Any good business needs to know its markets and its users in order to come up with new designs," Kelso says. But in the developing world, getting to know one's market is a particular challenge. In Africa alone, there are 52 countries — thus 52 different sets of government regulations and processes — and hundreds of languages. In order to guide the engineering team toward effective and appropriate products, students and faculty from the Kellogg School of Management are working to demystify these unknown markets.

Daniel Diermeier heads Kellogg's Global Health Initiative, part of its Ford Motor Company Center for Corporate Global Citizenship. Working with a student organization of the same name, his group aims to take advantage of existing opportunities to study global health problems throughout the Kellogg curriculum. By using class research projects, Kellogg's Global Issues in Management international trips, and student volunteers, the group has been collecting research and will interact with the engineering team to assist in product design.

"We have a wealth of research stored on our servers," says Meredith Wilson, cochair of the student organization. "Now we have to take that research and tailor it and apply it."

Wilson explains that Kellogg students may have several opportunities each quarter to select a class project. For instance, an operations management project may study distribution channels in sub-Saharan Africa, or a market research project may determine the market dynamics for HIV diagnostics in rural India. "It's a great way to bring people into global health, because people can work on projects in their existing classes," Wilson says.

In addition to valuable insight into the innovation process, Diermeier says that the

projects provide an excellent learning opportunity. "This gives students the experience of working in a medical device environment from cradle to grave," he says. "They do everything from initial market research to working with the engineering team to dealing with the myriad of implementation problems, all in a protected environment and on projects that have the potential to do a lot of good in this world."

Study abroad: Bringing undergrads into the field

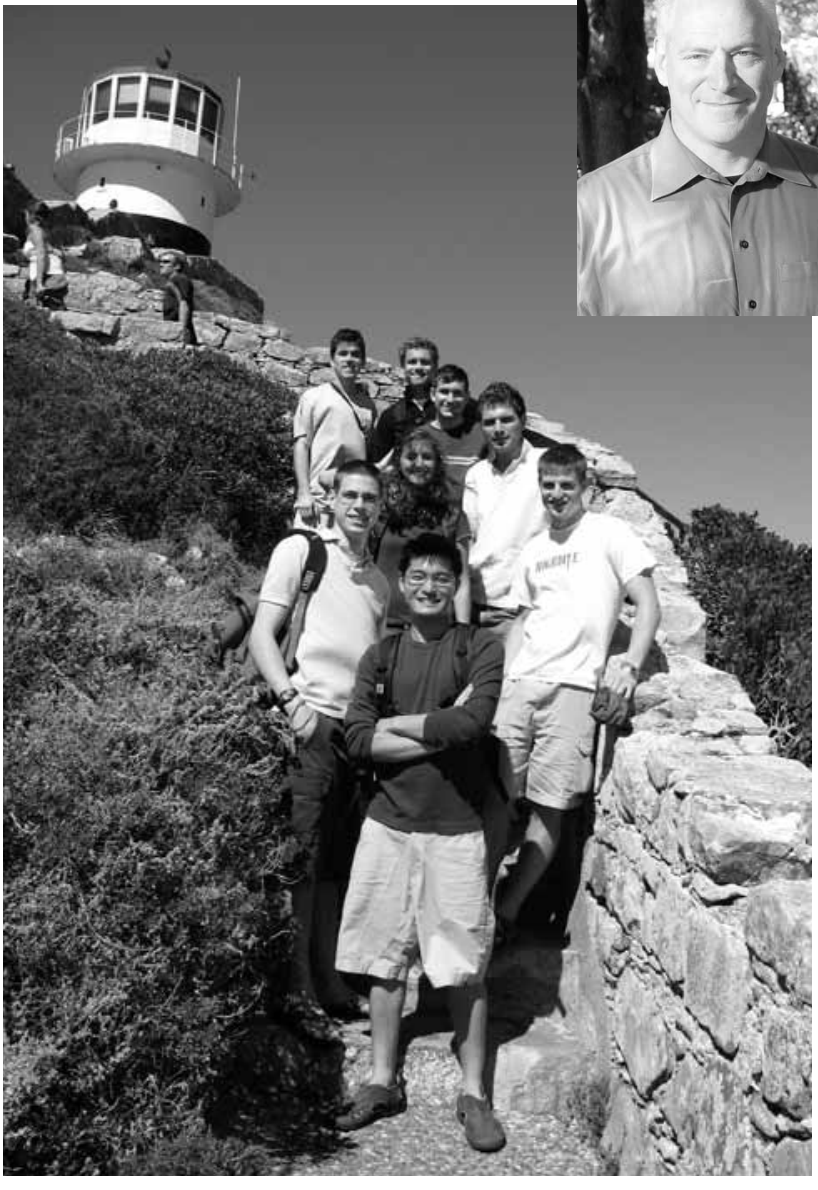
McCormick's new global health care technologies study abroad program is extending the initiative for global health to the undergraduate population. The program is run jointly by Kelso and biomedical engineering (BME) colleague Matt Glucksberg. For Glucksberg, the program provides an opportunity to enhance the type of projects already found in the senior design class.

"As we were teaching the design course, we noticed that the students were more interested in and had more success with projects that served under-resourced communities," Glucksberg says. "Those projects also communicated the design process better than others. Students have to figure out what the client's problem really is, rather than working with a client who knows exactly what they need."

In order to follow McCormick's philosophy of user-centered design, the department set up a phone room for teams to interview their clients in Africa, South America, and Asia. But Glucksberg says it became evident that students actually needed to get to places where they could meet face-to-face with clients and observe them in their workplaces.

While exploring ways to allow students to have firsthand experiences in global health, Kelso and Glucksberg connected with Mladen Poluta, director of the Healthcare Technology Management (HTM) program at the University of Cape Town. This is one of few HTM programs worldwide with teaching, research, and advocacy activities focusing primarily on the needs of resource-poor health systems. The program content covers the acquisition and utilization phases of the technology life cycle. "The most exciting aspect of the collaboration with Northwestern is the opportunity to engage with the innovation phase, allowing us to track safety and performance from development all the way through application," Poluta says.

Working with Poluta and other collaborators at the University of Cape Town,



Left: The 2006 participants in the global health technologies study abroad program: (clockwise from top) Jefferson Jones, Aaron Eifler, Kyle Sutton, Mike Hoaglin, Sam Pickerill, Thanan Lilaonitkul, James Bekeny, and Charlie Miller

Above: Matt Glucksberg (left) and Dave Kelso

Students in the global health technologies study abroad program express their loyalty to biomedical engineering.

Glucksberg and Kelso designed a quarter-long program that allows students to complete their senior design course in South Africa. McCormick's Murphy Society and Gore Medical Products provided funding to establish the program. Eight biomedical engineering students spent the spring quarter studying in South Africa. In addition to the design component of the program, they took courses in health care technology assessment and planning, as well as African identity, race, and culture. Students were also exposed to health care delivery challenges in resource-poor environments.

Working on design projects in South Africa allows students to gain an understanding of why many of the commonplace technologies in the developed world fail when they are applied to other environments. They benefit from Poluta's insights into African health systems based on his years of experience and research.

"I see my main role as being the 'what if' guy and exploring why things may not work," Poluta says. "People working on these projects come from an environment where things are assumed to work, but the technologies that you are developing and implementing are for an environment where such assumptions do not hold. Power failures, shortages of consumables, untrained health workers, poor maintenance infrastructures, and a lack of electronic information systems all impact the potential of the technology to make a difference. You have to see the bigger picture and build functionality and backup systems into the technologies to make them less vulnerable to an environment that is not enabling. If you do this well, you're on your way to a sustainable solution."

Next spring a group of 12 students, including many from other McCormick departments, will travel to South Africa.

As the program grows, Glucksberg hopes that interdisciplinary teams will be able to study both the technical and managerial aspects of health care problems.

Problems with premature infants

Jefferson Jones '06, who participated in the study abroad program last spring and is now in his first year at the Feinberg School of Medicine, learned firsthand how important it is to know the user's needs when designing a new solution.

Jones and classmate James Bekeny '06 chose to adjust a previous BME project, a low-cost incubator for premature infants in Bangladesh, for use in South Africa. But after some initial research, the pair discovered an entirely different standard of infant care in South Africa that is "just as effective as an incubator," Jones says. Called "kangaroo mother care," it gives premature infants constant skin-to-skin contact with the mother's chest, regulating the baby's body temperature and moisture. The only cost is the wrap for the baby.

Biomedical engineering students (from left) Thanan Lilaonitkul, Jefferson Jones, Mike Hoaglin, and Charlie Miller at a South African day-care facility

Views of South Africa (from top): housing in a Capetown township, the typical waiting room in a South African health care clinic, and a rally supporting HIV/AIDS awareness and prevention

"We really didn't need to add a costly technology when the baby is already being cared for in an ideal form," Jones says.

With that discovery the two abandoned their initial idea and looked for a related problem to pursue. They found that the primary cause of mortality in premature babies undergoing kangaroo mother care in Africa is apnea, a condition where a baby spontaneously stops breathing and dies. This often happens when the mother is asleep and unable to stimulate the baby to resume breathing. While a baby in an incubator would be monitored for apnea, there is no current monitor proven to work with kangaroo mother care. Jones and Bekeny had found their project.

They researched a variety of apnea monitors but found drawbacks to most of the current technologies — typically the monitor either wouldn't be able to attach to the baby or would confuse the breathing of the mother with that of the infant.

They connected with a South African engineer who was in the beginning phases of testing and marketing an at-home apnea monitor for infants. Although the product was untested with premature infants or with kangaroo mother care, Jones and Bekeny saw promise in it. With only two weeks left in their program, they quickly designed a small clinical trial for the device, obtaining the required approval for human study from the ethics committee of the University of Cape Town. Their experiment compared the new monitor with one currently used in incubators. Their results look promising, though further tests will be needed. Jones hopes that the next group of students may be able to pick up where they left off.

Tackling tuberculosis

Though it gets much less attention than many of the communicable diseases found in the developing world, tuberculosis remains a serious problem, especially when paired with HIV. Particularly challenging is the lack of any quick diagnostic for the disease — a problem Sam Pickerill '06 would like to solve.

Pickerill began work on a rapid tuberculosis test during the winter quarter senior design class and then continued his work during the study abroad program. His team began by reviewing hundreds of research papers about tuberculosis — research that paid off when it uncovered an interesting characteristic of TB infection.

"We found that there is a particle in the urine that can indicate TB infection," Pickerill says. "If you could detect that particle with a diagnostic, you would be able to tell if someone was infected."

The team was coached by Julian Gordon, an Abbott researcher who pioneered the home pregnancy test. Using his knowledge of lateral-flow diagnostics, the team developed a rapid diagnostic concept. Such a diagnostic for tuberculosis hasn't been developed because, like many of the other problems facing the developing world, it wasn't needed in industrialized nations. A better diagnostic would have a very small market for the company investing in it.

However, in the developing world, the lack of a rapid diagnostic perpetuates the spread of the disease. Those who are tested for TB must return home and wait days for a result. If it's positive, they risk infecting everyone with whom they come into contact before receiving treatment.

Five other students worked with Pickerill on this project, which won first place in the 2006 Margaret and Muir Frey Memorial Prize competition. Though the project shows promise, more work needs to be done, particularly in developing the correct antibody for the diagnostic. The program helped cement Pickerill's interest in global health. He received a Whitaker fellowship to continue research on this project in South Africa as part of a master's degree at McCormick.

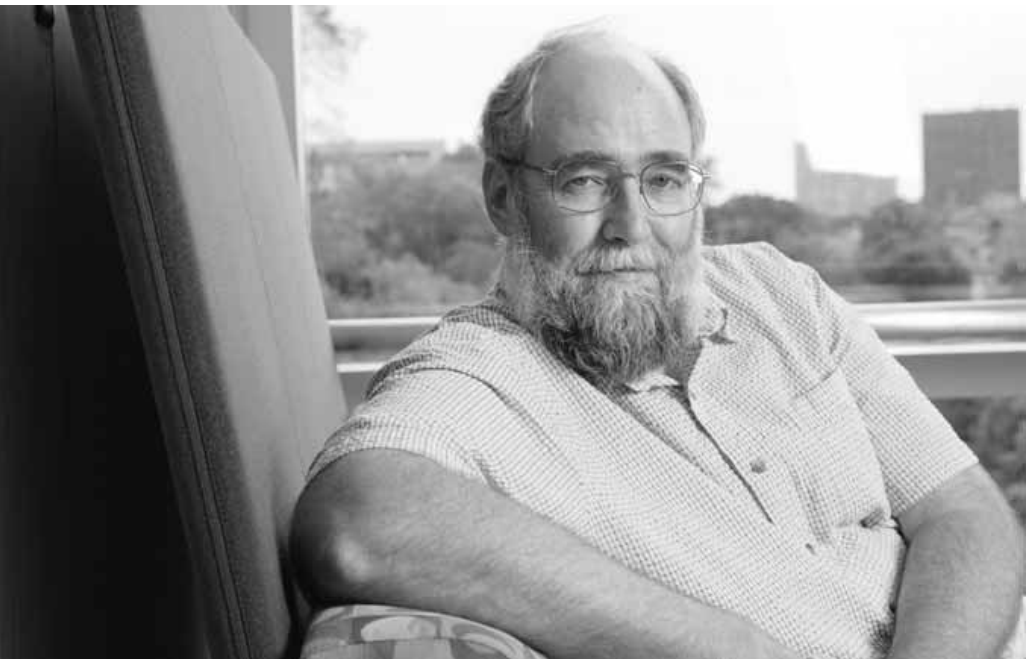
— Kyle Delaney

EECS research
Interdisciplinary reach, broad impact

When merging two departments to form the Department of Electrical Engineering and Computer Science in 2005, Dean Julio M. Ottino said, "This restructuring represents a new opportunity for all of us — a way to move forward toward a bright future for computer science and electrical and computer engineering research at the McCormick School." Recent research from this new department shows that the future is bright indeed.

Ken Forbus: Modeling the mind

Ask Ken Forbus, Walter P. Murphy Professor of Electrical Engineering and Computer Science, about his research, and his response is succinct: "We try to understand minds by building them."



Ken Forbus's work in artificial intelligence is unique: He attempts to re-create the whole mind, not just a portion of it.

Forbus has spent his career working in the area of artificial intelligence, attempting to understand how the human mind works by creating computer programs and simulations. His work is rare in that it tries to understand and re-create the whole mind, not just a portion of it. Most artificial intelligence systems have focused on aspects of cognition, such as skill learning. "That's a way to make a lot of progress, but skill learning is just a small piece of cognition," Forbus explains. "Hamsters get better at skills, but people have conceptual knowledge. They use that conceptual knowledge in all sorts of ways to deeply learn all sorts of things."

In order to create realistic models of how the mind works, Forbus partners with researchers in cognitive psychology. "There are incredibly valuable insights to be gained from psychology, especially cognitive psychology and other areas of cognitive science," Forbus says. For over 25 years he has worked with Dedre Gentner, professor of psychology in the Judd A. and Marjorie Weinberg School of Arts and Sciences, who also happens to be his wife. Their theories arise from the interplay of artificial intelligence and psychology, with Gentner doing experiments on people and Forbus building simulations as methods of testing their ideas.

The combination of computer simulation experiments and human psychological experiments provides more insights than either method alone. Each method has different strengths and weaknesses, giving researchers converging evidence for theories. Unlike traditional human psychological experiments, computer simulations provide the resources to test theories with a known set of variables. "We know what's in the memory of our computer simulation," Forbus says. "It's not the same as a human participant in an experiment. To be able to create something and know that these processes and these inputs will yield certain results is very powerful."

Forbus is currently working on "Companions Cognitive Systems," interactive systems with the ability for human-like learning. Central to Companions is the claim, from Structure Mapping Theory, that much of human learning is based on analogy. When presented with a new problem or situation, the mind identifies similar past experiences to form an action. A key element in this process is the ability to transfer knowledge from one domain, such as a subject area or skill set, to another. For example, if a person learns a lot about hydraulics, then parts of electricity should be easier to understand, since there are close analogies between the two subjects. Until now this type of learning was even more difficult for computers than for humans.

Forbus is working with the Educational Testing Service (ETS), the company that develops Advanced Placement (AP) and other standardized tests, to test Companions Systems' ability to learn AP Physics. ETS conducted an independent evaluation of a Companion, teaching it a small subset of AP Physics by giving it problems and worked solutions. "As you might guess, ETS is very good at generating problems," Forbus says. "There are different levels of transfer that have been identified: Can the system solve a problem it's seen before? Can it solve a problem with minor numerical variations? What if the numerical variations are so big that they actually change what happens?"

Forbus and his team started by giving a Companion a foundation of strategies and algebra skills but no knowledge of the equations of physics or when they should be used. When ETS would give the Companion a new type of problem, it would at first fail. But after giving it the worked solution, the Companion typically was able to solve many variations of the questions.

"When it sees a new problem, it figures out what would be a good analogy to something it has seen before, then tries to solve it. It solves problems very quickly," Forbus says.

In addition to being tested on AP Physics, Companions Systems has been challenged with problems drawn from tactical military games and strategy games, such as the popular open-source game FreeCiv. The initial success of these experiments provides hope for systems capable of general learning.

"We're trying to make a whole system that can learn about the domains it's working in, learn about the people it's interacting with, and learn about itself," Forbus says. Through his research, future computers may truly have a mind of their own.

Justine Cassell: Improving communication with and through computers

It's a common complaint: You call a company, only to be put through an endless series of computerized options. Your level of frustration continues to grow as you punch numbers and even tell an automated voice exactly what you want.

With all the frustration with computer communication, it's hard to imagine a future where computers might actually teach people a thing or two about communicating. Yet Justine Cassell, professor of communication studies and electrical engineering and computer science, hopes to do just that, not only improving how we communicate with computers but also using them to help people strengthen their ability to communicate with one another.

Cassell spent the early part of her career studying how people communicate with one another and since then has spent significant time studying how people interact with technology and use technology to interact with each other. Focusing on understanding natural forms of communication, Cassell works to develop technological methods to facilitate human-to-computer and human-to-human interaction.

"I think that for some time we've moved away from the metaphor of the computer as a tool toward the metaphor of the computer as a communication partner," she says. "My approach is, if the computer is our communication partner, it should know how to hold up its end of the conversation."

"If the computer is our communication partner, it should know how to hold up its end of the conversation."

Cassell's work is unique in that it combines her training in linguistics and psychology with her interest in computer science. Using her understanding of human interaction, Cassell has developed a variety of "Embodied Conversational Agents," virtual humans able to interact with their human counterparts. The work combines verbal and nonverbal communication to create systems with a wide variety of potential uses.

"Many people who build technology start by building technology. I start with human-to-human behavior when building human-to-computer interaction," Cassell explains. "I try to think of something that we don't know about human-to-human communication, yet we assume when building human-to-computer interaction."

Cassell is the graduate director for a new PhD program in technology and social behavior, which incorporates faculty from McCormick and the School of Communication. Her research group comprises students who study both communication and computer science. It has developed a variety of virtual peers, including several for children and an interactive kiosk called NUMACK that gives directions around the Northwestern campus. The NUMACK research group studied how humans use gestures in providing directions and talking about campus. By closely examining the use of gestures and speech in interacting, the group is able to build computer models that can generate appropriate verbal and nonverbal communication when engaged with a human user.

Some of the virtual peers that the group developed act as learning partners to children. For instance, the virtual peer Alex helps children

Justine Cassell with Sam, one of her Embodied Conversational Agents

who speak African American Vernacular English (AAVE) at home to transition to Standard American English for the school environment. "Children who grow up speaking AAVE often have problems with literacy, which leads to a huge achievement gap between African American and white children in school," Cassell says. "Part of the issue is that teachers may not understand that AAVE is a valid dialect of English, so they think the child is speaking incorrect English. With all good intentions, they tell the child to stop speaking incorrect English, but the children don't yet know the alternative. For success in school, they need to do code switching — speak AAVE at home and Standard American English in the classroom." Children build code-switching skills through interactive storytelling with the virtual peer.

Another virtual peer works with children with high-functioning autism, including Asperger's syndrome. This research group hopes that interaction with a virtual peer that can help develop both verbal and nonverbal communication skills, boosting a child's comfort level and leading to enhanced social activity and hence to increased learning in the classroom.

Cassell's development process, which starts with a principle of human communication and then uses computer science to re-create and test it, is a reflection of her own educational path. She holds master's degrees in literature and linguistics and a double PhD in linguistics and psychology — not a typical résumé in computer science. Her work with virtual humans began out of frustration with the lack of tools needed to evaluate her hypotheses on human-to-human communication. She applied for a grant to spend a year in a computer science department to build a virtual human — a project that shaped the course of her career.

In additional to developing virtual peers, Cassell has done extensive studies on how people interact with each other through technology. Long before Facebook, MySpace, and Friendster had entered the cultural lexicon, Cassell led the Junior Summit, an online kids-only community of 3,062 young people from around the world. She studied how young people formed community and chose leaders. Her work has made her an often-cited expert in the rapidly growing and highly discussed field of online social networking.

Cassell hopes her technological developments will have a broad impact on the way that humans use computers to communicate. "I hope that my work will make the computer accessible to a broader array of people — those who may not be just like us, who may not communicate through typing, who may not be literate, and who may have communication issues," she says. "This kind of technology can act as a stepping-stone to full communication equality."

Selim Shahriar: Slowing down light to speed up communication

The speed of light is one of the few scientific parameters of which nearly everyone is aware. Light moves fast — $3x10^8$ meters per second, rapid enough to travel from the sun to the earth in just under 8.5 minutes. But the speed for which it is known is also one of the biggest obstacles to putting light to widespread use in practical applications such as high data-rate communication systems.

Selim Shahriar, associate professor of electrical engineering and computer science, is on the leading edge of answering the fundamental question of whether we can harness light. A significant part of his work focuses on "slow light," the technology that allows scientists to control light by slowing it down to as few as several centimeters per second. This research holds the promise for a wide variety of technological advances, including all-optical systems that could drastically increase communication data rates.

Most of today's communications systems use low-frequency electromagnetic signals transferred through copper wire during part of the communication process. These signals can be stored and rerouted to their final destination using common computer technology. But current systems have fundamental data-rate limitations and are quickly reaching their maximum capacities. On the information superhighway, they are the two-lane roads, with frequent bottlenecks.

All-optical systems — systems that replace low-frequency signals with optical information — could provide significant advantages. One major benefit is the ability to send signals on a large number of distinct channels through a single conduit, where each channel has more capacity than that of a copper wire carrying the low-frequency signals.

"In an optical fiber you can transmit light of many different colors simultaneously," explains Shahriar. "As long as they are slightly different in color, you could send a thousand or more kinds of light through one line, providing a huge increase in capacity."

Optical cables present a problem, however, even while providing incredible opportunities in terms of data rates. When a message arrives, it must be stored until it is determined where the message will ultimately land. In low-frequency systems carried by copper wires, digital information can be stored in computer memory, but current technology cannot store optical information as quickly as light can provide it.

This is where Shahriar's work in "slow light" comes in. He and other researchers studying slow light are developing ways to control and fine-tune the speed of light. The ability to adjust the speed of light provides the potential for broader use of optics in communication technology. The technology could allow for light to be slowed, rerouted, and delivered to an end user while maximizing the data rate.

Light slows down when traveling through a medium. For example, glass slows down light by a factor of about 1.5. However, the more light slows, the more it reflects off a surface, thus reducing the transmission. Most media can slow it only by a small factor (less than 10) before light reflects too much for a significant amount to pass through. This is hardly enough to provide real control.

One of the first breakthroughs in the field came when scientists were able to slow light to 17 meters per second with a new technique, using a cloud of ultracold sodium atoms, that does not suffer from this limitation. But "while the principle is helpful, it would be impractical to make anything out of a cloud of ultracold atoms," Shahriar comments.

Shahriar and his research group made the next breakthrough when they developed the ability to slow light using a crystalline matter. Building on the previous experiments with clouds of atoms, Shahriar's research was the first to use a solid material to slow light significantly, marking a step toward practical application of the technology.

Research in the field continues to expand, and scientists seek new advances in controlling light, such as the use of inexpensive materials or fiber-optic cables. Fundamental challenges must be overcome before it is realistic to plan for widespread use. As with any up-and-coming field, the applications for this technology are still under exploration. "Slow light is in its infancy, so we have to explore the ways that it can be useful," Shahriar says. "Eventually it should have applications that make people's lives better."

Slow light has the potential to provide communication systems that would enable computer transfers and downloads at data rates far beyond today's standards. It also has many applications in quantum information processing, which can be used to encrypt confidential information such as bank transactions.

While Shahriar's group continues with pioneering research in slow light, its studies have found other interesting ways to manipulate light. Using the same theories used to slow light, but in reverse, Shahriar's group can create light that appears to propagate faster than the normal speed of light. Although this "fast light" at first appeared to have no use, Shahriar has uncovered an interesting and potentially significant application, using it to enhance the sensitivity of rotation sensors in airplanes and missiles, thus making inertial navigation more accurate. The same effect could also be applied to test fundamental laws of physics with new precision and perhaps provide new insight into how nature works.

Whether being slowed down or speeded up, light has enormous potential for practical applications and improvements. Research at McCormick aims to take us closer to harnessing its power.

— Kyle Delaney

Selim Shahriar in his laboratory for atomic and photonic technologies

The Grosses make McCormick *a family affair*

When twins Carol and Susan Gross moved into their dorms as freshmen this year, they had a bit of an advantage over their peers. As the fifth and sixth members of their family to choose McCormick, they were much more acclimated than typical freshmen.

Clockwise from upper right: James, Mary, Carol, and Susan Gross

Sharing the McCormick experience with Carol and Susan are their parents, Tom ’77 and Louisa (Hollmeyer) ’77, and their older sister and brother, Mary ’06 and James ’08.

Despite the abundance of engineers in the household, Louisa says that she and Tom never pushed their children toward engineering or McCormick.

“They really enjoy math and science,” Louisa says. “But we try to stay neutral because they need to choose what is best for them.” Still, the couple is happy about the college and career choice of their first four offspring. “We’re glad to see our kids in engineering,” Louisa says. “There are so many opportunities.”

Tom and Louisa met in the Tech library while studying for circuits class — the only class they shared during their undergraduate career. The two married the summer after graduation and moved to Indianapolis to begin their careers, Tom as a cost researcher for a medical company and Louisa as a clinical engineer. Tom found he was interested in the medical information at work and applied for medical school one year later. He’s now a gastroenterologist, while Louisa stays at home with the youngest three of their seven children.

Not surprisingly, the children of two engineers have all shown promise in science and math. Louisa says that potential was nurtured through Northwestern’s Center for Talent Development (CTD), which provides a variety of summer and year-round programs for gifted students. After Mary, the oldest of the Gross children, attended the summer camp, she persuaded her parents to send her younger brothers and sisters.

“It’s a powerful place where kids are encouraged to grow beyond what they get in regular school,” Louisa says of CTD. “They connect with other kids like them, and it nurtures their interests.”

Mary says that spending summers at Northwestern also helped make the college choice a little easier. “I went to camp, so I felt comfortable on campus,” she says. “A lot of my student counselors went to Northwestern, so I knew that I liked some of the older students.” With his sister’s strong recommendation of the University, James also decided to attend Northwestern.

“Once Mary and Jim went there, I really hoped that the twins would, too,” Louisa says. But she tried to subdue her preference as Carol and Susan looked at many schools, including some quite far away from their Brownsburg, Indiana, home. The twins visited Mary and James at Northwestern, where Mary took them to events and even to her study group. She says she did the best she could to show the twins what life would be like at McCormick. “I was holding my breath after their acceptance letters came in, thinking, ‘Please choose my school.’”

In the end, that family connection made the difference. “I chose Northwestern based on the fact that my parents and my siblings are a lot like me,” Carol explains. “It was a good fit for them, so I figured it would probably be a good fit for me, too.”

Each member of the family has chosen a different discipline of engineering, and Carol and Susan are each excited to explore what area will be right for her. “We don’t know about all of the career options available,” Susan says. “I read an article that chemical engineers can be taste-testers and that sounds interesting, but I’m excited to learn about the options.”

Louisa says that having McCormick in common is a “bond her children will share for life.” And perhaps Susan and Carol won’t be the last of the Gross children to share that bond — there are three boys still at home.

— Kyle Delaney

Aaron Packman (right) with graduate student Jeromy Miceli

Legionnaires' disease
McCormick, Feinberg join the fight

In 2001, 800 people were suspected to have contracted Legionnaires' disease after being exposed to the bacteria *Legionella pneumophila* near a hospital in Spain. Six people died. Similar outbreaks have occurred near commercial buildings and health-care facilities in Toronto, Philadelphia, Norway, France, and the United Kingdom. After intense investigations of each outbreak, the incidents were found to share one cause: faulty cooling towers.

Aaron Packman, associate professor of civil and environmental engineering, and Nicholas Cianciotto, professor of microbiology and immunology at Northwestern's Feinberg School of Medicine, are combining their expertise to study disinfection practices for cooling systems in the hope of providing tools to prevent future outbreaks of Legionnaires' disease.

Studying pathogens in large industrial systems requires expertise in several areas, providing an ideal opportunity for collaboration between McCormick and Feinberg. "I've studied *Legionella pneumophila* for over 20 years, but I don't know much about cooling towers and the engineering aspects," Cianciotto says. "I would have never embarked on this myself, but Aaron brings engineering expertise as well as some microbiology experience."

In order to formally study the efficacy of different cleaning techniques, Packman and Cianciotto's teams developed a unique laboratory setup in Tech. "We set up 10 cells to operate like rooftop cooling towers, replicating what you have in a real building," Packman explains.

The setup gives the team the ability to expose multiple cooling systems to the same pathogens and then compare pathogen growth for each disinfection and cleaning protocol side by side.

"Nobody else has equipment like this," Packman adds. "We're doing microbiology experiments on a large laboratory scale, trying to bridge the gap between basic microbiology and engineering applications in real building systems."

Just like in large industrial and commercial buildings, the cooling towers developed in the lab work by using evaporation. Water is pumped through a hot water system, then dripped across a block of material while air is blown across it, cooling the water. This warm, moist environment is unfortunately ideal for the growth of many pathogens, including *Legionella pneumophila*, which is transmitted through tiny droplets of water. These systems have the potential to expose large numbers of people to the organisms.

To prevent outbreaks of *Legionella pneumophila*, technicians put cooling towers through a battery of cleaning procedures each year. "There are recommended industrial treatment measures, but they've never been formally evaluated," says Packman. "There's a lot of debate as to exactly how stringent a control measure — like a biocide [a chemical capable of killing all biological life] — you need to prevent outbreaks."

U.S. standards require continuous low-level chlorine with occasional biocide added, but other countries require stronger measures, including hyperchlorination or even disassembly of the cooling unit to clean the cooling material. These stronger measures, however, have their own set of drawbacks, particularly for those concerned with the maintenance and longevity of these expensive systems. "You have the potential for damage and downtime," Cianciotto explains. "So it comes down to a very practical question: Is there a good reason to disassemble the cooling units?"

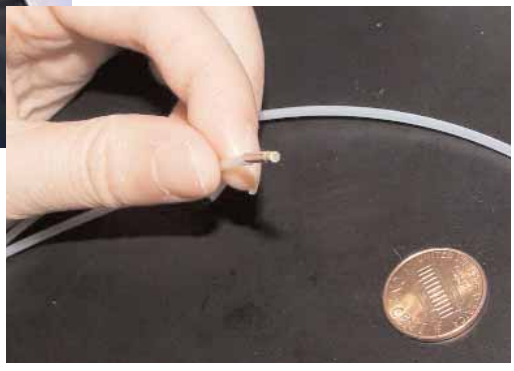
To set up the specialized equipment, Packman and Cianciotto benefited from the work experience of graduate student Jeromy Miceli. Before enrolling to study for a master's in environmental engineering, Miceli had responsibility for testing systems for water contaminants for a large water utility company. Using his knowledge of the systems, he set up the miniature test cells and developed protocols for the experiment in Tech.

With the system up and running, the researchers will introduce the organisms that affect real-life systems, including, says Packman, "organisms that form biological coatings, amoebas that prey on these biological coatings, and then *Legionella pneumophila* to infect the amoeba. All together we will introduce five organisms to make a realistic microbial system that you would find in a building's hot-water loop."

After evaluating current maintenance procedures for cooling towers, Packman and Cianciotto hope to expand their joint research. Future projects may identify even better cleaning procedures to eliminate not just large outbreaks of Legionnaires' disease but also other illnesses. "Now that we've established this partnership and built this unique equipment, we hope to use it for years," Cianciotto says. "This project is just the first step."

— Kyle Delaney

New alternative to colonoscopy succeeds in clinical trials



Ask anyone who has had a colonoscopy, and the answer is the same: it's no fun. With a day of dietary restrictions and bowel prep, followed by sedation for the procedure and an uncomfortable recovery, it's no surprise that only 15 percent of Americans who should get a colonoscopy actually do. That low number contributes to colon cancer's status as the second leading cause of cancer death for both men and women — particularly disturbing given the success rate of early detection and treatment.

"Many people don't realize it, but we aren't winning the battle against colon cancer," says Vadim Backman, professor of biomedical engineering. Backman aims to make a big impact on colon cancer detection by changing the way medical practitioners screen for the disease.

A novel alternative screening procedure developed by Backman and being tested in collaboration with Hemant Roy, associate professor of medicine at Northwestern's Feinberg School of Medicine and director of basic and clinical research for the gastroenterology section at Evanston Northwestern Healthcare, is a step closer to widespread use by medical practitioners.

As described in the spring 2005 issue of *By Design*, the procedure uses optical technology to screen the base of the colon for precancerous changes. Knowing that small changes occur in the entire organ when precancerous polyps develop at any point of the colon (a phenomenon called "the field effect"), Backman's research team designed a 1 millimeter probe that can be inserted at the base of the rectum to detect small cellular changes that can signal cancer. The test can completely replace the traditional colonoscopy for patients who show no signs of polyps.

When *By Design* reported on Backman's work in 2005, the test using a technique called four-dimensional elastic light-scattering fingerprints (4D-ELF) showed great promise. A new breakthrough has given the research team even better results recently. Backman and then–graduate student Young Kim, PhD '05, were the first to observe low-coherence enhanced backscattering (LEBS) in tissue. Although LEBS had been well documented on hard media, it was previously thought of limited value for obtaining data from weakly scattering media such as tissue. Backman's discovery opened the door to new tests with increased sensitivity.

"We can use this technology to derive information about the nanoscale architecture of tissue," Backman says. "This technique actually allows you to probe the nanoarchitecture of cells, which was previously impossible."

Clinical success

Over the past year Backman has worked with Roy at Evanston Northwestern Hospital to implement clinical trials for the technology. Testing the procedure with patients already undergoing a colonoscopy, the team compares its results with those of the gastroenterologist. So far tests with more than 500 patients have yielded impressive results.

The studies have shown a perfect rate of identifying individuals with no polyps in the colon. "When I first saw the results, I thought they were too good to be true," Backman remarks. "Not a single patient who has tested positive in the colonoscopy has tested negative with our screening."

When the test indicates that someone may have a polyp, it is right about 70 percent of the time. But those false positives aren't a major concern to Backman and Roy, because such a patient would undergo a colonoscopy for further examination. "While it is important to find a relatively noninvasive way to say that someone has a polyp, it's even more important to find a noninvasive way to say that they don't have a polyp," Roy says.

Colonoscopies are recommended every 10 years for people over age 50. As the population of Americans who should have colonoscopies grows — the number is about 75 million now — it's become

Photos at left: Hemant Roy (left) and Vadim Backman. The optical probe Backman designed as an alternative to colonoscopy is only 1 millimeter wide.

impossible for everyone who needs a colonoscopy to actually get one. If everyone received a test every 10 years, the annual cost would rise to $10 billion, and gastroenterologists would not be able to meet the demand. Clinics are already nearing their capacity with only 15 percent of eligible Americans undergoing the procedure.

Expanding the research

As a physician, Roy appreciates Backman's thoughtful approach to finding a clinically relevant application for his work. He explains that almost everyone working in biomedical optics for colon cancer has been working on an optical biopsy for use during a colonoscopy to determine if a polyp needs to be removed.

"It's important work, but from a practical point of view, I don't know if it helps me take care of my patients," Roy says. Because doctors know that 90 percent of polyps are removed, standard practice today is to remove all polyps without determining if they are cancerous.

"Vadim's work is a paradigm shift," Roy says. "We don't just want to know what the pathologist can tell us tomorrow; we want to address the major clinical issue by getting the right people screened. Then we can use our endoscopic capacity to make a real dent in colon cancer mortality."

Backman and Roy have secured funding from the National Institutes of Health to run clinical trials for 3,000 patients over the next three years. They're also working to expand their study to other medical research centers. If the data continue to be as promising as the initial results, the team will apply for FDA approval and pursue options for widespread distribution. Ideally, the technology would be used by a primary care physician to determine if a patient needs a colonoscopy.

In the meantime, Backman is working to apply his techniques to other kinds of cancer. He recently received a grant from the V Foundation for Cancer Research to apply the technology to pancreatic cancer and is in the preliminary stages of applying it to lung cancer.

In addition to clinical trials, Backman hopes to gain an understanding of the field effect on which his screening techniques are based. Little is understood about why all cells in and around an organ change if cancer is present.

"If you want to save lives, it's not important that you understand the biological and molecular mechanisms behind this technology," he explains. "But if you figure them out, perhaps it could lead to an understanding of cancer or the discovery of new therapies."

— Kyle Delaney

Mark Hersam honored in White House ceremony

Mark Hersam, professor of materials science and engineering, was honored at the White House on July 26 as a recipient of the 2005 Presidential Early Career Award for Scientists and Engineers (PECASE).

The award, established in 1996, is the highest honor given by the U.S. government to outstanding scientists and engineers who are beginning their independent careers.

Eight federal departments and agencies join together annually to nominate young scientists and engineers whose work is of greatest benefit to the nominating agency's mission. Nominated by the U.S. Army Research Office, Hersam will receive $500,000 over five years.

Hersam was cited for outstanding research in applied science; silicon-based molecular electronics; nanoscale optoelectronics and atomic-resolution processing; and characterization of electronic, organic, and biological materials and molecules using scanning probe microscopy. He also was honored for outstanding teaching and outreach in the fields of nanoscale science and engineering, including curriculum development, mentoring of undergraduate research, and development of the Global Nanotechnology Network, which disseminates nanotechnology educational materials via the Internet.

Hersam's research focuses on developing scanning probe microscopy techniques that enable sensing, characterization, and actuation at the single-molecule level. It impacts many fields, including materials science, chemistry, biology, physics, and electrical engineering.

Hersam, who joined Northwestern in 2000, has received many awards during his career. Recent awards include the American Vacuum Society Peter Mark Memorial Award (2006), the Minerals, Metals, and Materials Society's Robert Lansing Hardy Award (2006), the Office of Naval Research Young Investigator Award (2005), the Army Research Office Young Investigator Award (2005), a Sloan Foundation Fellowship (2005), the National Science Foundation CAREER Award (2002), and the Beckman Young Investigator Award (2001).

— Megan Fellman

Advice from two alumni

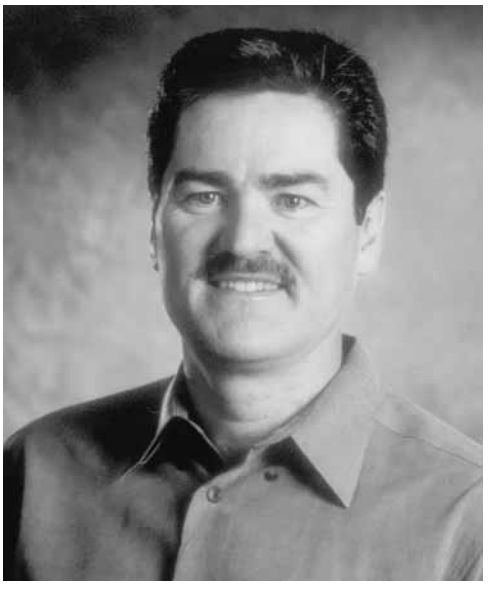
Think broadly

A McCormick education promotes creativity and versatility, preparing students to excel in a top job in engineering or in a number of other fields and disciplines. Two McCormick alumni, Gregory Fraser '77, MS '78 and Robert Wayman '67, Kellogg '69, have achieved success in high-level corporate management positions in the technology sector.

Fraser cofounded Faro Technologies in Lake Mary, Florida, where he was CFO from 1997 to 2005 and currently serves as executive vice president, secretary, and director.

Wayman has been CFO at Hewlett-Packard Company in Palo Alto, California, since 1984 and is also executive vice president. He has forged strong ties with McCormick, where he is a member of the McCormick Resource Development Board and the Murphy Society, a recipient of an Alumni Merit Award, and the donor of an endowed fund.

Both alumni laud McCormick for encouraging them to think beyond algorithms and flex their creative muscles.



Greg Fraser

Strength in diversity of skills

Greg Fraser and McCormick were a great match from the beginning. Mulling the range of engineering schools in the early 1970s, Fraser knew he didn't want to be "just another" engineer. He chose McCormick because it was one of the few schools at the time offering courses in biomedical engineering.

Helping Fraser keep his interests in perspective was his adviser, Professor Jack Lewis, who split his time teaching civil engineering and serving as project director for orthopedic implant research at Northwestern's Rehabilitation Engineering Research Program. Lewis urged him not to narrow his choice of courses to a single field.

"Following some great advice from my adviser, I did all the work in biomedical that I wanted but graduated with a 'traditional' mechanical engineering degree," Fraser says. He further diversified his expertise by earning his master's degree in civil and environmental engineering at McCormick in 1978. And he remained an avid learner, even earning a PhD in mechanical engineering in 1982, the year he also cofounded Faro Technologies.

Creating a new company and helping it achieve success put Fraser's diverse skills to the test. His biomedical engineering education served Faro's initial purpose, which was developing new products for orthopedic diagnosis and computer-aided surgery. But lining up "angel" investors to fund Faro's start-up and organizing the company's first sales force and marketing department required entrepreneurial ability, he says. Fraser also helped to coordinate financing with a venture capital company before the company's initial public offering. And when Faro decided to move away from medical markets and develop computerized measurement devices for use in automotive, aerospace, and other industries, that shift "involved a retooling and international expansion that required even more diverse skills," Fraser says.

The change that Fraser says may be "the most dramatic departure from my engineering education" came in 1997, just before Faro went public, when he became the company's chief financial officer.

But regardless of how Faro and Fraser have changed over the years, the company stays on top of its game, an example of the McCormick ideal of robust entrepreneurial spirit. "We are a pioneer and leader in our market," Fraser says. "One of the reasons we stay in the lead is that we 'obsolete' our products by issuing new generations every four to five years."

His education at McCormick has aided him immeasurably when it comes to problem solving, making decisions, and "thinking through" business processes, he says. And that helps

Faro keep ahead of the curve in such a competitive and unpredictable industry as computer-based inspection technology.

"The process-based thinking that I learned at McCormick translates into a disciplined implementation of company controls and processes that is seen by most nonengineering entrepreneurs as a necessary evil," Fraser says. "The fact that my co-founder was also an engineer means that Faro has had a very good decision-making and process-control environment."

Fraser will bring considerable knowledge and experience into the next chapter of his life. He will transition out of Faro in 2007 and into a second career, which he says will include business-growth consulting, charitable "give-back," and perhaps some teaching — maybe even at his alma mater.

Comfort zone: Do not enter

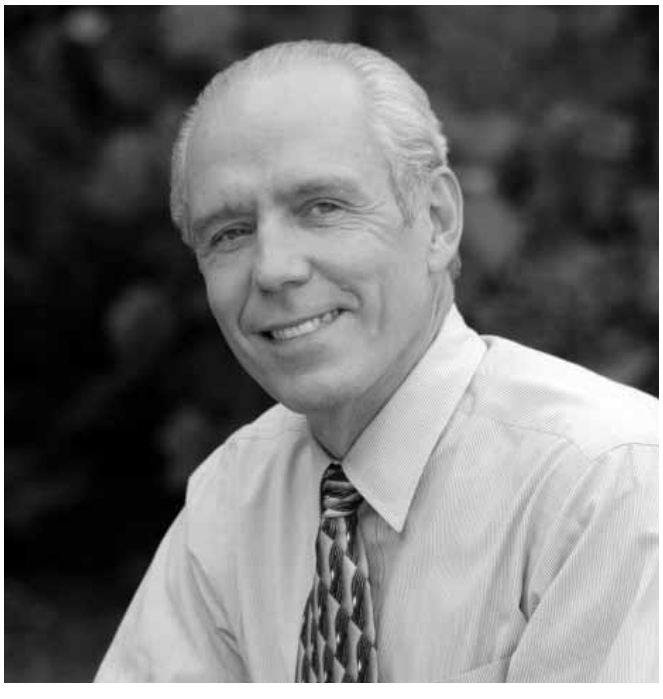
Robert Wayman's words of advice to graduating McCormick students at Convocation on June 17 were more personal than the audience realized.

"Be versatile," Wayman told them. "The worst thing you can do as an engineer is to atomize yourself, to lock yourself in your own silo. The best engineers are the ones who can see the big picture, who have the broadest range of experiences to bring to any conversation." Then he offered examples for broadening one's outlook: "When you leave here, hang around an art school. If you don't know how, learn how to write software. … Practice speaking in public. Live constantly outside your comfort zone. You won't regret you did."

Little did they know that speaker Wayman, a self-described "numbers guy [who] liked working in the backroom and coming up with the answer," used to be afraid of public speaking. But early on in his career at Hewlett-Packard, Wayman realized that speaking was going to be part of his life. So he embraced it, consciously seeking out speaking engagements, getting practice by talking in front of small groups, and eventually finding the confidence to stand at podiums before thousands of people.

A willingness to challenge yourself, versatility, and the ability to learn from new experiences are at the heart of what it means to be an engineer. A McCormick education means preparing yourself to ride the rapids of change. Not long after joining Hewlett-Packard in 1969, Wayman saw with the creation of the handheld calculator how swiftly the landscape could change by the introduction of "things no one had envisioned yet." The handheld calculator went from an idea to an instrument in a matter of months, skyrocketing in popularity and soon accounting for 40 percent of the company's revenues.

McCormick stressed the importance of being versatile, an ability that has served Wayman well in his HP career. Given how rapidly things change, "you never know what skills are going to be called for," Wayman says. So, he adds, you have to be able to creatively apply your knowledge, especially in the global economy. "There are clearly lower-cost sources of engineering than U.S. engineers, particularly ones who graduated from McCormick, so you need an edge. That edge is partially described by creativity and entrepreneurial forces and values."



Robert Wayman

Clear, disciplined thinking is another important skill taught at McCormick. "I absolutely believe that engineering is an excellent background for business problem solving," Wayman says. "I attribute a lot of the confidence that I gained in problem solving to the core of understanding I got in engineering school."

Among the ways he has given back to McCormick is creating the Robert and Susan Wayman Endowed Fund in 1998. It has helped provide state-of-the-art technology to the industrial engineering and management sciences department. But as important as technology is, Wayman knows it's just part of a larger picture. "Turning knowledge into a better life for people is what engineering is all about," he says.

— Jack Bess

Across the nano divide

EDC students design nanoscience lessons for middle schools

Bob Chang's passion is teaching the fundamentals of nanotechnology to the next generation of scientists and engineers. It's a mission for which he has secured more than $15 million in funding and been recognized as an NSF Director's Distinguished Teaching Scholar.

When Chang, professor of materials science and engineering and director of the National Center for Learning and Teaching in Nanoscale Science and Engineering (NCLT) at Northwestern, was asked to teach a section of Engineering Design and Communication (EDC), he saw an opportunity to use McCormick students to help bridge the gap between scientists and middle-school students. He had the EDC students work with local middle-school teachers to develop a two-week curriculum in nanotechnology and then test activities with the middle-school students.

"I realized that it would be fantastic for the young people to do nano education," Chang says. "There is no way that I could do a good job communicating to middle-school kids, but a younger generation could. Some of the students have siblings in middle school, which is perfect."

Focusing efforts on middle school provided advantages over high school, according to Chang. "In high school the curriculum is such that students really don't have time in their schedules for something new and different," he says. "In middle school there is less structure and fewer exams. Middle-school teachers told the students that they could design something that would be taught for two weeks. The curriculum is very open and flexible."

Michelle Lee at Springman Middle School

Chang cotaught two sections of EDC with Penny Hirsch, lecturer and associate director of the Writing Program in Weinberg College, and Emma Tevaarwark, a postdoctoral researcher working at NCLT. The class projects provided a good opportunity for students to study both the engineering and communication processes emphasized in EDC. "The nano projects were wonderful for teaching communication," says Hirsch, "because students had to design lessons and write explanations for different audiences, such as middle-school students, middle-school teachers, and their own EDC peers."

There were eight EDC teams divided between two key concepts in nanotechnology: measurement, including scanning probe microscopy, and surface-area-to-volume ratio (SVR). Students developed and tested their two-week curricula within these broad parameters.

Understanding measurement

Measurement is a key concept for all areas of science, but teaching the basic concepts of measurement at the nanoscale can be challenging. "When you deal with things that you cannot see, such as in the nano range, the question becomes, what instruments do you use?" Chang says. "We wanted the students to think how to measure and how to estimate the size of something. That gives a framework to say, 'If I don't have a ruler, I can still estimate the size.' That kind of notion is very important."

First-year McCormick students Keanan Ryan, Kari Nigorizawa, Eric Bertram, and Michelle Lee, who made up one EDC team, say they had to prepare extensively to work well with middle-school students, since they lacked background in education as well as nanotechnology.

"We did a lot of background research about how people learn, middle-school curricula, and the atmosphere of middle-school classrooms," Lee says. "We tried to get in the mindset of a middle-school student."

The team developed a curriculum that introduced students to the basic components of measurement, culminating in the introduction of the scanning probe microscope, a key tool for exploring nanotechnology.

Bob Chang (center) and students (from left) Stephen Wylie, Siu-Hin Wan, Joey Hsu, and Lee Lamers test "Nanocos," an educational card game the students developed.

Understanding how to measure requires developing a frame of reference. To achieve this goal, the team developed the "white globes activity" for its class at Springman Middle School in suburban Glenview. Each of four groups was given a white Styrofoam® ball, stickers, and markers. After placing stickers anywhere on the globe, the middle-school students identified a zero point and frame of reference that would allow another group to determine where the stickers were. As some students struggled to communicate their sticker locations, they began to understand the need for a clear and concise measurement system.

In addition to the white globes activity, this EDC team developed and tested a "budget" scanning probe microscope. "It's a lot cheaper and easier to use in more classrooms," says Ryan. "It's a model scanning probe microscope made out of the most basic materials so students can put it together and understand how it works."

Developing the curriculum helped this group of EDC students become more aware of the importance of teaching nanoscience concepts to younger ages. "In the future there are going to be a lot of consumer products that are based on nanoscience," says Nigorizawa. "We won't be able to design those projects without the interest and knowledge of future generations — and even our own generation."

Ratios and reactions

"Surface area-to-volume ratio is a basic and interesting concept to teach young learners. It's not a trivial thing — it will follow them all the way to graduate school," Chang says. "Much of chemistry happens on the surface, so it's very important that they take surface into account in experiments. And the concept of SVR is enhanced when the size of the material is very small."

In order to teach middle-school students the concept, first-year McCormick students Siu-Hin Wan, Lee Lamers, Stephen Wylie, and Joey Hsu used an unconventional idea based on the popularity of card games such as Magic and Pokemon. The group developed "Nanocos," which Lamers describes as "essentially a two-person game with object cards, each of which has a surface area-to-volume ratio.

"The students really start getting engaged in calculating the numbers in order to beat their opponents," he says.

To teach the specific concepts, the team needed to start with the big picture, breaking the lessons down into volume, surface area, ratios, and then surface area-to-volume ratio. They then got into the more complicated aspects of how a chemical reaction will take place more readily on surfaces than the bulk, so reaction rates are usually higher for materials with large surface-to-volume ratio.

Lamers observes that a card game is a powerful educational tool. "Once they knew the math, they really enjoyed the game," he says. "Students actually came up to us during the passing period to ask if they could play the game again."

Putting the ideas into practice

At the end of the quarter each of the eight teams presented its curriculum, including worksheets, student and teacher handbooks, and evaluations, to their mentor teachers and all members of the class. Four students continued working on the projects as 2006 NCLT Engineering Scholars, distilling the best pieces of all the projects down to two good units or modules. Chang hopes that their work will lead to curricula that teachers can begin implementing in their classrooms as soon as possible.

"Career interests for young people are pretty much decided by the middle of high school. … The [McCormick] students are doing all the right things to communicate science to a middle-school student."

— Bob Chang

"Career interests for young people are pretty much decided by the middle of high school," he says. "Looking at the projects, I was thrilled. The students are doing all the right things to communicate science to a middle-school student."

Chang continues to receive major funding for his pursuits, including a recent $6.9 million grant to develop a national center at McCormick for his Materials World Modules. As his work progresses, Chang hopes to continue using McCormick students as he pursues his passion of developing a nano-literate generation.

— Kyle Delaney

New faculty

José Andrade, assistant professor, civil and environmental engineering (specialty: geotechnics)
Matthew Grayson, assistant professor, electrical engineering and computer science (specialty: solid-state nanoelectronics)
Dean Ho, assistant professor, mechanical engineering (specialty: bionanotechnology/neural engineering)
Wendy Murray, assistant professor, biomedical engineering (specialty: biomechanics)
Yu (Marco) Nie, assistant professor, civil and environmental engineering (specialty: transportation)
Justin Notestein, assistant professor, chemical and biological engineering (specialty: molecular engineering/catalysis)
Christopher Wolverton, professor, materials science and engineering (specialty: computational materials science)

Faculty honors

Jan Achenbach, Walter P. Murphy Professor and Distinguished McCormick School Professor of Mechanical Engineering and Civil and Environmental Engineering, presented the plenary lectures at the International Conference on Computational and Experimental Engineering and Sciences and the Mechanical Waves in Solids.
Luis Amaral, associate professor of chemical and biological engineering, has been named a Distinguished Young Scholar in Medical Research by the W. M. Keck Foundation.
Guillermo Ameer, assistant professor of biomedical engineering, has received part of a $3.5 million Illinois state grant that will fund three stem cell research projects. Ameer also has received a 2006 National Science Foundation CAREER Award.
Zdeněk P. Bažant, Walter P. Murphy Professor of Civil and Environmental Engineering, has received an honorary doctorate from the Technical University of Vienna, Austria, and was honored in a special issue of the *International Journal of Fracture*. Bazant presented plenary keynote lectures at the 16th European Conference on Fracture; the European Conference on Computational Modeling of Concrete Structures (EURO-C); the Seventh International Conference on Creep, Shrinkage, and Durability of Concrete and Concrete Structures; the National Concrete Convention; and the Structural Engineering Convention of India. He also delivered the Mindlin Lecture at the Quadrennial U.S. National Congress of Theoretical and Applied Mechanics.
Randy Berry, associate professor of electrical engineering and computer science, presented the keynote lecture at the Second Annual Workshop on Resource Allocation in Wireless Networks.
L. Cate Brinson, chair and Jerome B. Cohen Professor of Mechanical Engineering, has received a Friedrich Wilhelm Bessel Research Award from the Alexander von Humboldt Foundation.
Linda Broadbelt, associate professor of chemical and biological engineering, has been awarded the Fulbright Distinguished Scholar Award.
Fabian Bustamante, Yan Chen, and **Aleksandar Kuzmanovic,** assistant professors of electrical engineering and computer science, and **Peter Dinda,** associate professor of electrical engineering and computer science, have won a Microsoft Trustworthy Computing 2006 Award.
Wei Chen, professor of mechanical engineering, has received the Ralph R. Teetor Educational Award of the Society of Automotive Engineers International.
Isaac Daniel, Walter P. Murphy Professor of Civil and Environmental Engineering and Mechanical Engineering, is the recipient of the M. M. Frocht Mechanics Educator of the Year Award of the Society for Experimental Mechanics.
Mark Daskin, professor of industrial engineering and management sciences, has been inducted into the Edelman Academy. Daskin has been offered a visiting appointment at the University of Kent Business School and elected a fellow of the Institute of Industrial Engineers.
Charles Dowding, professor of civil and environmental engineering, has received the Distinguished Alumni Award of the University of Illinois Department of Civil and Environmental Engineering.
Ken Forbus, Walter P. Murphy Professor of Electrical Engineering and Computer Science, has joined the new NSF-funded Spatial Intelligence and Learning Center.
Bartosz Grzybowski, assistant professor of chemical and biological engineering, has been named a 2006 Pew Scholar in the Biomedical Sciences. He also received the American Chemical Society Division of Colloids and Interfaces Unilever Award.
Dongning Guo, assistant professor of electrical engineering and computer science, has been elected a member of the Institute for Mathematical Sciences at the National University of Singapore.
Lawrence Henschen, professor of electrical engineering and computer science, has been included in *Who's Who among America's Teachers.*
Mark Hersam, professor of materials science and engineering, was honored at the White House as a recipient of the 2005 Presidential Early Career Award for Scientists and Engineers. (See page 15.) This year Hersam also received the American Vacuum Society Peter Mark Memorial Award and the Chicago Area Undergraduate Research Symposium Faculty Research Award.
Seyed Iravani, associate professor of industrial engineering and management sciences, has won the IIE Operations Research Division Teaching Excellence Award.
A. K. Katsaggelos, professor of electrical engineering and computer science, presented a plenary lecture at IEEE WirelessComm and the opening keynote lecture at the 2005 Pacific-Rim Conference on Multimedia.
David Kelso, associate professor of biomedical engineering, has received a four-year, $4.9 million grant from the Bill and Melinda Gates Foundation for the new Center for Innovation in Global Health Technologies. (See page 2.)
Chung-Chieh Lee, professor of electrical engineering and computer science, has been named SBC Research Professor.
Debiao Li, professor of biomedical engineering, has been elected a fellow of the International Society for Magnetic Resonance in Medicine.

Thomas Mason, professor of materials science and engineering, has won the 2006 Ceramic Educational Council Outstanding Educator Award.

Phil Messersmith, associate professor of biomedical engineering and of materials science and engineering, has received the National Institutes of Health MERIT Award. (See story at right.)

Hooman Mohseni, assistant professor of electrical engineering and computer science, has received an NSF CAREER Award.

Jorge Nocedal, professor of electrical engineering and computer science and of industrial engineering and management sciences, has been appointed to the editorial board of *SIAM Review.*

Don Norman, professor of electrical engineering and computer science, presented the keynote lecture at the International Symposium on Intelligent Environments and the Allan D. Shocker Lecture to the New Product Design and Business Development Program at the University of Minnesota.

Greg Olson, professor of materials science and engineering, has been named ASM International's Edward DeMille Campbell Memorial Lecturer for 2006.

Monica Olvera de la Cruz, professor of materials science and engineering, has been elected to the Solid State Science Committee of the National Research Council.

John Rudnicki, professor of civil and environmental engineering and mechanical engineering, has been awarded the Maurice A. Biot Medal of the American Society of Civil Engineers.

Rodney Ruoff, professor of mechanical engineering, has been named editor of a special issue of *Composites Science & Technology*.

Peter Scheuermann, professor of electrical engineering and computer science, served as vice general chair of the International Conference on Management of Data of the Association for Computing Machinery's Special Interest Group on Management of Data.

Mary Silber, professor of engineering sciences and applied mathematics, has been elected vice chair of the Society for Industrial and Applied Mathematics Activity Group on Dynamical Systems.

Karen Smilowitz, assistant professor of industrial engineering and management sciences, has been appointed Junior William A. Patterson Professor in Transportation.

Peter Voorhees, chair and professor of materials sciences and engineering, provided testimony to the U.S. Senate's Commerce, Science, and Transportation Subcommittee on Science and Space.

Jay Walsh, senior associate dean and professor of biomedical engineering, has received the 2006 William B. Mark Award from the American Society for Lasers in Surgery and Medicine.

Ying Wu, assistant professor of electrical engineering and computer science, has been appointed to the editorial board of *Machine Vision and Applications.*

Messersmith's research honored with MERIT Award

Phil Messersmith, associate professor of biomedical engineering, has received a MERIT (Method to Extend Research in Time) Award from the National Institutes of Health (NIH). He will receive up to $3.6 million over the next 10 years.

Less than 5 percent of NIH-funded investigators are selected to receive MERIT Awards, which recognize superior research competence and productivity. MERIT awards provide long-term support to investigators with impressive records of scientific achievement in research areas of special importance or promise.

The National Institute of Dental and Craniofacial Research, which is funding Messersmith's "Biologically Inspired Polymer Adhesive" research, selected Messersmith to receive the award.

Messersmith's research focuses on the development of bio-inspired novel adhesive biomaterials for dental and medical applications. His team of researchers is studying the adhesive strategies of mussels with the hope of using the information to design new adhesive synthetic polymers for use in medical implants. Marine mussels can adhere to virtually all inorganic and organic surfaces, sustaining their tenacious bonds in saltwater, including turbulent tidal environments. Little is known, however, about exactly how the bivalves achieve this amazing feat.

Messersmith's is the first-ever single-molecule study to focus on the key amino acid 3,4-L-dihydroxyphenylalanine (DOPA), a tyrosine derivative that is found in high concentration in the "glue" proteins of mussels.

The research team attached single-DOPA amino acids to an atomic force microscope tip and measured the strength of interaction between DOPA and inorganic and organic surfaces. They found that on an inorganic metal oxide surface DOPA interacts with the substrate by a coordinated noncovalent interaction, which is over an order of magnitude stronger than hydrogen bonding but still completely reversible.

On an organic substrate, DOPA can form even stronger, and irreversible, covalent bonds when it is oxidized by seawater. This helps to explain the remarkable versatility of mussels to adhere strongly to many different materials.

On neither substrate could tyrosine alone mimic such a strong binding interaction, which highlights that the modification of tyrosine residues to form DOPA during mussel glue processing is critical.

"Our results point the way toward new applications for our mussel mimetic polymers," says Messersmith, who has designed a versatile two-sided coating that sticks securely to a surface and prevents cell, protein, and bacterial buildup. "For example, we may be able to take advantage of the reactivity of oxidized DOPA to form covalent bonds between adhesive DOPA-containing polymers and human tissue surfaces."

His research was published online the week of August 14 by the *Proceedings of the National Academy of Sciences.*

— Megan Fellman

David Eckert (right) with Dean Ottino

Dear McCormick alumni and friends,

As chairman of the Walter P. Murphy Society, I'd like to thank and recognize the many alumni, parents, and friends who have supported the McCormick School of Engineering and Applied Science during academic year 2005–06. We are grateful for the contributions and leadership of nearly 250 Murphy Society members and hundreds of other donors whose names are listed on the following pages. To those who are not currently Murphy members or donors, I extend a warm invitation to join us and make a gift this year to the McCormick Annual Fund.

As you might know, the Murphy Society honors the legacy of Walter P. Murphy, the benefactor whose gifts supported the construction of Northwestern's Technological Institute. Murphy Society members make annual gifts of $1,000 or more and have a unique opportunity to assist Dean Julio Ottino in making decisions to fund faculty and student projects through the Murphy Society Selection Committee. In past years the Murphy Society has encouraged the support of curriculum innovations such as Engineering First® and the Institute for Design Education and Applications (IDEA), as well as hands-on design projects such as the solar car competition.

Beginning with the new academic year, Murphy Society members are also being recognized as members of the Northwestern Leadership Circle. The Leadership Circle, a pan-university giving society, is composed of Northwestern's most loyal friends and alumni and offers members a number of unique benefits.

We are very grateful for your contributions to the McCormick School and to the broader Northwestern community. Your annual support of the McCormick Annual Fund enables the dean to respond to unanticipated needs that arise during the academic year and provides important resources that will help the school achieve new levels of excellence.

Sincerely,

David A. Eckert '77
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HOW HAS A McCORMICK EDUCATION PREPARED YOU FOR YOUR CAREER?

"In today's work environment everything is a team project."

Lee Dayton '87, MMgt '96, investment associate, UBS

"Four things come to mind. First, McCormick showed me that you can solve a large, complex problem by breaking it down into a bunch of small, manageable problems. That has applied all throughout my career. I analyze companies. If someone said, 'Analyze General Electric,' I would first break down the company into its major and minor businesses. That's how you get things solved.

"Second, McCormick taught us to embrace computers. That was in the early '80s, and personal computers weren't an integral part of daily life. Today my life revolves around the computer. I couldn't function without it.

"Third, an engineering degree from McCormick guaranteed a grasp of complex mathematical concepts. This skill has proven invaluable in complex financial analyses and investment recommendations.

"Lastly, McCormick encouraged teamwork. Kellogg took it to the next level. In today's work environment everything is a team project that requires the ability to work and communicate with others. In my office there are eight of us within about 20 feet of each other, with no walls. To be successful, we all work together."

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HOW HAS A McCORMICK EDUCATION PREPARED YOU FOR YOUR CAREER?

"I'm very clearheaded... I look at what the problem is"

Kelly McCollum '95, head coach, Northwestern field hockey team

"You learn a lot about perseverance and rising to the challenges in such a rigorous program. I studied chemical engineering, and it took a lot of time and effort to succeed. It definitely prepared me for what I do now because the results you see as a Division I coach are in direct proportion to the amount of time you put in.

"It also helped with developing analytical thinking and using logic. I'm very clearheaded when I'm managing a group and problem solving. I look at what the problem is and what factors need to be changed in order to have a solution, instead of going on a hunch. It's what I did in engineering, and it carries over now, whether I'm on the field or managing a team dynamic off the field. If you go through a logical process that makes sense to people, it helps them see why you are doing what you're doing.

"At McCormick we had a lot of group projects where I worked with students from various backgrounds. That's just what you do with an athletic team. I bring players in from all over the country, and they're from different backgrounds and have different upbringings, and we have to work together to find success. It was the same thing at McCormick, where the ultimate goal was success. At the same time as you're working with people and managing the group dynamics, you try to find how all the pieces fit together. That's definitely something I draw on in what I do every day."

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Madoka Mitsuoka
Carol J. Mizuno
James Mobed
Ronald L. Moeller
James R. Mogle
Laura J. Mohr
Sean A. Mollohan
Jonathan S. Montgomery
Michael I. Morris
Barratt Moy
Michael J. Muilenburg
Robert E. Mullen and Alice R. Mullen
John D. Munger
Joseph F. Murphy
Gina W. Myerson
Joel B. Myklebust
Nicole B. Narcisco
Louis G. Neudorff II
Charles J. Neuhauser
Donald W. Neukranz
William Neumann
Randall C. Newman
Kim Nee Newton
Michael Niecestro and Karen Niecestro
William Nieman
Frank M. Nigh and Valerie Swett Nigh
William L. Nighan
Ellen Eshbach Nordby
Thomas A. Nowicki
William I. Nowicki and Elizabeth R. Nowicki
Daniel R. Noyd
John Robert Nuckols
Declan O'Riordan Jr.
Dennis M. O'Shaughnessy
Min-Seok Oak
John R. Obermeyer
Iyabo A. Oladehin
Leslie Mongin Olds
Wayne Raymond Olson
Craig M. Ono and Claire S. Ono
Lucien G. Osborne
Diane Yuen Overland
Henry S. Owen
Jeffrey S. Owen
E. James Owens
Rajeshkumar C. Oza
S. Francis Paik and Won Yi Paik
Henry H. Pak and Helen E. Pak
Paul Pak
David C. Palter
V. R. (Sivan) Parameswaran and Thangam Parameswaran
Christopher O. Park
Paula Wolfe Parker
Laurie Y. Parness
Paul V. Pastorek Jr.
Tej Pinakin Patel
Benjamin L. Paterson
Gaige R. Paulsen
Wayne M. Paulson and Lynne Paulson
Vartan Paylan
Kevin A. Pendleton and Michelle Riley Pendleton
Andrew C. Peng
Anthony Pennington and Heather Pennington
David S. Perelman
Jason Michael Perlewitz
William H. Perloff Jr. and Barbara Bruske Perloff
Joseph J. Perona
Eric J. Peter and Gina Peter
Louis J. Petrovic and Judith A. Petrovic
Charles W. Pfingsten
Richard A. Phelan and Edith Phelan
Kendra Frances Phillips
J. Bradley Phipps
Charles J. Pieper
Charles E. Pierce and Sarah Lyn Gassman Pierce
Vitorino A. Pinto
Alexander T. Plonsky
Joseph David Plunkett
Edward Poa
Charles A. Pokoski
Stanley J. Polcyn
Caroline Beth Pollak
Colin M. Pollard
Marie-Noelle A. Pons
Benjamin Taylor Porter
Catherine Posner
Robert O. Posniak
Mark S. Potter
Panos D. Prevedouros
Bradford R. L. Price
David R. Price
Maurice C. Prottengeier
J. Douglas Quick
James E. Quinn
Marshall Rafal
John Ragalis
Timothy A. Randall
Harish G. Rao
Alan F. Raphael
Mark Warren Rasmussen
Sridhar Reddy
Thomas L. Reitz
Joseph John Rencis
Michael S. Repko
Keith C. Rheinhardt
Adam E. Rhuberg
Curtis M. Richards
Roger A. Rieckman
Joseph Lawrence Riehle
Robert L. Robben
Marshall Alan Robers
Allen J. Robertson
Quentin K. Robinson
Amy F. Robison
John G. Robson
Charles L. Rogers
Raymond Rogers and Lynne Neeley
John J. Rohr
Mikko Roland
James Paul Ronnander
Michael J. Rosen
Robert V. Rouse
Ronald M. Rubin
Paul Rula and Stephanie Rula
John E. Rumel
Garth Richard Rummery
Richard T. Russell
Amyn Saleh
Paul George Sanders and Jennifer Louise Sanders
Kurt L. Sauer
Melvin A. Schechtman and Ellen Rae Cohen Schechtman
Mark H. Scheibe and Margaret R. Scheibe
William Franc Schell
Elmer L. Scheuerman
Don B. Schiewetz
John H. Schmertmann
John K. Scholvin
William P. Schonberg
Steven M. Schorr
Linus Schrage
William E. Schultz
David L. Schwartzbard and Michelle R. Schwartzbard
Vance L. Scott
William S. Sedlacek
Joseph Elmer Seitz and Holly K. Seitz
Anant Achyut Setlur
Maytal Ryan Shamir
Sherman M. Shand
James J. Sheehy
Dinesh K. Shetty
Yutaka Shimada
Kenichi Shimokogawa
Joseph E. Shipley
Gregory D. Showalter
Robert Silver
Charles E. Silverblatt
Jeff S. Sliwa and Lisa Sliwa
Edward D. Smith III
Parntipa Smith
Paul C. Smith
Jonathan W. Song
Rohit Sood
Sharon R. Stampfl
Lisa Statland
Eric J. Steffe
Michael V. Stein

Timothy J. Stelly
Julie M. Stewart
Leonard I. Stiel
Ranee A. Stile
Douglas N. Stotland
Marcel Strebel
Debra J. Streich
Mark Allen Strickel
Olgerts J. Svilans
Ross F. Sweeny Jr.
Irwin S. Sylvan
Mary L. Szymkowski
Pak-Chung Tam
Rodney D. Tansimore
David R. Tapley
Ronald R. Tarica
Russell P. Taub
W. Myles Taylor Sr. and Janet Taylor
Juan M. Tellez
Cyril B. Tellis
Bimal V. Thakkar
Nelson B. Tharp
David J. Theobald
Ike Ulysses Therios
Scott W. Therrien
Sharon Lindner Thoms
Matthew P. Thorpe
David A. Tietje
John Chao-Kun Ting
Matthew V. Tirrell III and Pamela Anne Lavigne
Benedict Tiseo
Paul M. Todd
Jennifer Kimiko Toguri
James Edward Tollar
Andrew Wai Tong
Douglas L. Tong and Alethea R. Tong
Eric Edward Torgersen
Stephen Joseph Toth
William J. Tronsen
Amos Tsai
Jared Tuberty
Alan Tung
Robert A. Turner
Tara Rae Turner
Jeffrey W. Tuttle
Bruce R. Ukockis
Dennis B. Ulrich
Stephen F. Utley Jr.
James M. Utterback and Margaret Utterback
Jeffrey J. Vaitekunas
Lynn Valcarcel
David Robert Vasselin
Carla S. Vaughan
Vinod N. Velakaturi
James E. Velkavrh
Enrique R. Venta
Mukesh K. Vij
Richard A. Volz and Mary J. Volz
Edward R. Vrablik and Bernice G. Vrablik
Paul J. Wade
John R. Wagner
Sidney P. Wagner Jr. and Susan F. Wagner
Ronald A. Wahl
Yuwen Wang and Xiaorui Wang
Chris D. Wanha
Charles E. W. Ward and Ann L. Ward
Gene Charles Warman
Theodore R. Watson
R. Ian Arthur Webb
David K. Weber
Robert Alan Weber and Linda Brown Weber
Sheldon M. Wecker
Theodore R. Wedell
Andrew T. Wedepohl
Ted C. Wedepohl
Johannes Weertman and Julia R. Weertman
Roland George Weiss
Stephen J. Wersan
Jack L. Wert
Donna H. West
John David Westwood
Randall J. Whalen
Tsung-Chuan Whang and Lai Yu-Fen Whang
Yong Whang
Dan W. Wheeler
John R. Wickstrom and Anne C. McKinley
F. William Wiffen
Jeffrey D. Wilen
Roger J. Williams and Tara F. Williams
Richard M. Wilson
Frank T. Wimmer
Gregory Allen Winchell
D. J. Wissuchek
Jeffrey G. Witwer
Richard B. Wodnik
Larry M. Wolfrum
Donald K.O. Wong
Thomas T.Y. Wong
Paul H. Woodhouse
Keith N. Woods
Matthew C. Wright and Laura J. Wright
Alden Thayer Wulff and Elizabeth Williams Wulff
Walter F. Wundrow
Yinyi Xie and Wie Wang
George T. Ye
Yoshiaki Yoshimi
Ronaldo A. Young Jr.
Andrew David Zacharias
James R. Zagel
Alan I. Zagoria
Niraj Zaveri
Michael S. Zedalis
Wei Zhang
Weiping Zhang and Hongxian Zhang
Louis Zitnay
Richard D. Zorowitz
David S. Zuby

HOW HAS A McCORMICK EDUCATION PREPARED YOU FOR YOUR CAREER?

"McCormick teaches you... how to think like a good engineer"

Aaron Markworth '00, founding partner, Custom Spine

"McCormick teaches you not just what you need to know but also how to problem solve and think like a good engineer. The best class I had was my senior design project in biomedical engineering. Our client at the Rehabilitation Institute of Chicago asked my team to design a shock-absorption pylon to go between an artificial foot and the knee of an amputee. I learned a lot about how you incorporate customer input into your design to meet user needs. It's really exciting to see a concept go from thin air into something you can see or hold in your hand. I don't think I could have had that great learning experience at any other school than McCormick.

"The Walter Murphy Cooperative Education Program allowed me to get real-world work experience in the area of industry that I was targeting for my career. Unconventionally, I had two co-op experiences. One was with the medical school's physical therapy department; it taught me research and technical writing skills that I've used authoring engineering analyses in my past and current jobs. The other was with Johnson & Johnson DePuy Orthopaedics, where I got a great background in the development and manufacturing of knee implants, as well as the overall business of the orthopaedic industry.

"My first job after Northwestern was with Stryker Spine, one of the world's largest medical device manufacturers. I was granted two patents and designed a cervical spine implant and instrument system that was Stryker's 2004 product of the year. Since then I have become a founding partner in Custom Spine, a start-up company that designs spinal implants for victims of trauma, tumor, and degeneration. We have over 10 patents pending and have cleared our own next-generation spinal implant system with the FDA and launched it and have three more in development.

"My education at McCormick didn't just prepare me well for my career; it is directly responsible for the successes I've had and hopefully will have."

— all Giving Report interviews by Jack Bess

1940s

James H. Pomerene ('42) has received the Eckert-Mauchly Award from the Association for Computing Machinery and the IEEE Computer Society for innovations in computer architecture.
Lester Crown ('46), chairman of Material Service Corporation, has sold the company to Hanson PLC for $300 million in cash. Crown was ranked 54th in *Chicago* magazine's "Annotated *Forbes* 400" list.

1950s

John Peavey ('57), owner of Flat Top Sheep Ranch in Idaho, was profiled in *Range* magazine.
H. Perry H. Driggs Jr. ('59) has been appointed chairman and chief executive officer of Michigan Heritage Bancorp.

1960s

George J. Zanotti ('62) is president and owner of Financial Objectives Group, an investment advising firm in Bloomingdale.
Dennis Chookaszian ('65) has been named to the board of directors of LoopNet.
Michael Moses (MS '65, PhD '68), an associate professor of management at New York University's Stern School of Business, in April was recognized by the Investments Management Consultants Association with the 2006 IMCA Journalism Award.
Dwight Beranek ('68) has been named vice president and operations manager for Michael Baker Jr., an engineering unit of Michael Baker Corporation in Alexandria, Virginia.
John E. Anderson ('69, '74) was recently promoted to technology fellow at CH2M Hill in Oakland, where he serves as global geotechnical and foundation discipline lead. He is also president-elect of the Geo-Institute of the American Society of Civil Engineers.

1970s

Alfred Eckert III ('71) was the subject of an article in the March 6 *Pensions and Investments* about how he built his private equity and debt investing firm GSC Partners.
Richard Sevcik ('71) has retired as executive vice president and director of Xilinx.
Yoshio Aoki (MS '72, PhD '76), president and chief executive officer of Optware Corporation, has been interviewed by the media about the company's new Holographic Versatile Disc, a single-beam holography system.
Richard W. Gochnauer ('72) chief executive officer of United Stationers, was number 53 on *Crain Chicago Business*'s list of the "Fortunate 100" top-compensated chief executive officers at Chicago-area companies in 2005.
A. Gerson Greenburg (PhD '72) has become vice president of medical affairs at Massachusetts-based Biopure Corporation.
James Cornfeld ('74) has joined the Buckingham Family of Financial Services as an investment adviser.
Promod Haque (MS '74, PhD '76) was number 62 on *Forbes* magazine's "Midas List" of venture capitalists.
Mary T. Klinefelter ('75) has joined Prairie State College in Chicago Heights as dean of business and technology.
Aristides Patrinos (PhD '75) has been named president of Synthetic Genomics in Rockville, Maryland.
Kevin J. Gross ('77) has joined the Pennsylvania-based hospital management company Universal Health Services as senior vice president and president of the acute care division.

Dean Julio M. Ottino (center) celebrates at the Northwestern Alumni Association 2006 Alumni Awards Banquet with awardees from the McCormick School. Promod Haque (left) (MS '74, Kellogg '83) received an Alumni Merit Award in recognition of his highly successful career as a venture capitalist. Haque has appeared three times on *Forbes* magazine's annual "Midas List" of top-10 dealmakers. Warren Haug (right) (MS '63, PhD '65) received an Alumni Service Award in recognition of his service to McCormick and Northwestern. After a distinguished 30-year career at Procter & Gamble, Haug returned to Northwestern as an adjunct professor. He is a life member of the McCormick Advisory Council.

David Speer ('77), chief executive officer of Illinois Tool Works, was number 80 on *Crain Chicago Business*'s list of the "Fortunate 100" top-compensated chief executive officers at Chicago-area companies in 2005.
John C. Ziegert ('78), president of Tetra Precision, holds the Timken Company Chair in Automotive Design and Development at Clemson University.
Kathleen Flaherty (PhD '79) is a nonexecutive director to the board of Inmarsat.
Larry Schessel ('79) has been appointed chief technology officer for NexTone Communications in Gaithersburg, Maryland.

1980s

Mark R. Jicka ('82) is managing director for North American corporate credit trading for Barclays Bank.
Joseph Rencis ('82), professor and head of mechanical engineering at the University of Arkansas, has received the 2006 James L. Meriam Service Award from the mechanics division of the American Society of Engineering Education. He also serves as vice chair of the American Society of Mechanical Engineers' department heads committee for the United States.
Christian Cabou ('83, L '90) has joined San Diego-based Illumina, a provider of genetic analysis tools, as senior vice president and general counsel.
William Schonberg (MS '83, PhD '87), chair of the civil, architectural, and environmental engineering department at the University of Missouri–Rolla, has been named the interim dean of UMR's School of Engineering.
James N. White ('85) is the managing director of Sutter Hill Ventures and has joined the board of Shutterfly, an online photo service.

What's happening in your life?

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

Ajay Bansal ('85) has been appointed senior vice president and chief financial officer of Tercica, a biopharmaceutical company based in Brisbane, California.
Ruby Chandy ('85) is president of marketing at Thermo Electron Corporation and has been named to the board of directors of Idex Corporation.
Jeffrey M. Summers ('87) has joined Savo Group as a senior vice president of marketing.

1990s

Robert. G. Abboud ('90), president and chief executive officer of RGA Labs, is the village president of Barrington Hills, Illinois.
Michael Maley (MS '90) has joined Connecticut-based Fuel Tech as senior vice president for international business development and project execution.
Matt McCall (MS '92) is a venture capitalist with Portage Venture Partners and has launched a blog, VC Confidential (www.vcconfidential.com).
Tim Noffke ('92), vice president of the life sciences division of the Burr Ridge, Illinois, consulting firm Integrated Project Management, was interviewed by *Crain's Chicago Business* about the redesign of the company's web site.
James Brailean (PhD '93), cofounder and chief executive officer of Packet Video, was recently honored with the Mobile Entertainment Forum's annual Special Recognition Award for his pioneering work in developing mobile video.
Kok Hoo Yeap (PhD '93), a software designer in Fremont, California, became a U.S. citizen during the Bay Area's largest Independence Day naturalization event.
Eugene Inseok Chong ('94), a principal at Oracle in Nashua, New Hampshire, received the Best Industrial Paper Award at the 22nd Institute of Electrical and Electronics Engineers International Conference on Data Engineering in April.
Brian Wee (MS '95) has been promoted to project management office administrative director at the National Ecological Observatory Network in Washington, D.C.
Cory Daehn ('96) was recently named director of information technology architecture for Chicago-based Navigant Consulting.
Michael Ellsworth ('96) has been named to the board of directors of Schmitt Industries.
Daryl Morey ('96) has been named assistant general manager of the NBA's Houston Rockets.
Brad Kinsey (MS '98, PhD '01), a University of New Hampshire mechanical engineering professor, was one of 10 people worldwide to receive the Society of Automotive Engineers International's Ralph R. Teetor Education Award this year.
David Smith ('98) was a Republican candidate for the U.S. Senate in Ohio, losing to Mike DeWine in the May primary.

2000s

Robert Wolcott (MS '01, PhD '02) was quoted in an article in *Crain's Chicago Business* about how Motorola's early-stage accelerator teams review three new ideas a day and 1,000 a year.
Charles Goodall ('02) has been promoted to divisional vice president of pharmacy technology services for Walgreen Co.
Jay Goyal ('03) was a Democratic candidate for state representative in Ohio.
David P. Cerra ('04) recently joined Reedsburg, Wisconsin-based Sound Devices, an audio manufacturer, as an electrical engineer.

In memoriam

Paul A. R. Redmann '30
James M. Mitchelhill '34
Jack R. Halvorsen '45
Paul W. Stade Jr. '45
Robert W. Heinze '47
Patrick W. O'Brien '47
Leonard Fergin '48
Robert H. Johnson Jr. '48
Donald W. Dooley '49
Charles S. Houha '49
Kenneth B. Cox '51
William H. Rux '51
John K. Cottingham '54
Endrick Noges '54, MS '56, PhD '59
Price Forsythe '56
Robert E. Hulse '56
Sherman H. Janke '56, '75
Theodore A. Rodgers '57
Arthur M. Schulz '59
Richard N. Daniels '61
Stephen V. Pizzica '62
Michael Elliott '63
Meldon Human '75
Carl E. Grad Jr. '76
William J. Spyhalski '85
Thomas P. Kisala '90

George Desh ’07 and Enrique Carral ’07:

Published researchers — and still undergrads

The 2006 edition of the *Northwestern Undergraduate Research Journal* included four articles from McCormick students — two-thirds of the total journal. Considering that more than half of engineering undergraduates participate in research on campus, McCormick’s strong representation is no surprise.

George Desh ’07 and Enrique Carral ’07, who both published work in the journal this year, say that research has been an important part of their undergraduate experience and helps prepare them for careers in medicine (George) and consulting (Enrique).

George Desh (left) and Enrique Carral

How did you get involved in undergraduate research?

Enrique: I did my research for a probability and statistics class for my major, chemical engineering. We were asked to write a paper on any topic related to the class, and it led me to this research.

George: I became involved in research in the summer after my sophomore year. For the first two years, I worked as a lab aide in the undergraduate chemistry lab. This helped me get acquainted with the scientific process and was a stepping-stone to more in-depth independent research. From then on I tried to pick projects that would help me explore various areas of biomedical engineering.

How did you choose your area of research?

Enrique: I wanted my research to help me learn about how statistics is applied in engineering and used in the quality control of a production line.

George: My major, biomedical engineering, has many different directions and specializations. I tried to find research projects that would allow me to explore areas that I enjoy learning about, such as biomaterials and body mechanics, in greater depth.

Can you describe your research?

Enrique: I studied how Genichi Taguchi, a well-known statistician and engineer, had created a system of controlling the quality of the output in a production line. In one of his papers he stated that his system was better than more classical tools, but he never proved it. I decided to create an analogous method using these classical tools to see if he was right. The paper compares the two methods in a simulated process. It turns out that he was right.

George: I am currently involved in research in Dean Linzer’s lab [Daniel Linzer of the Judd A. and Marjorie Weinberg College of Arts and Sciences], where I am studying the binding of a cell membrane receptor. My previous projects included working in a virtual reality lab at the Rehabilitation Institute of Chicago [RIC] to study the effects of visual motion on posture, as well as working on medical implant encapsulation in Cork, Ireland.

How do you think research has helped prepare you for your career?

Enrique: My research was a very fulfilling experience. It improved my ability to synthesize information from different sources and to use creativity in finding a solution to a problem under a lot of restrictions. I also now know a lot more about quality control in the manufacturing industry.

George: I feel that all of my projects helped me better understand various facets of the medical profession, where I would like a career. My current work is helping me learn lab techniques and different cell functions. My work in Cork introduced me to how biological materials could be applied in various ways to the human body. My research at the RIC allowed me to learn from patients and help their rehabilitation efforts.

The Gross sisters, who are featured with their brother on page 12, wear their McCormick sweatshirts. To see the full line of McCormick products, visit http://northwestern.bkstore.com and access the McCormick Shop in the Campus Shop section of the site.

Products are also available on campus at the Norris Center Bookstore.

NORTHWESTERN UNIVERSITY

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