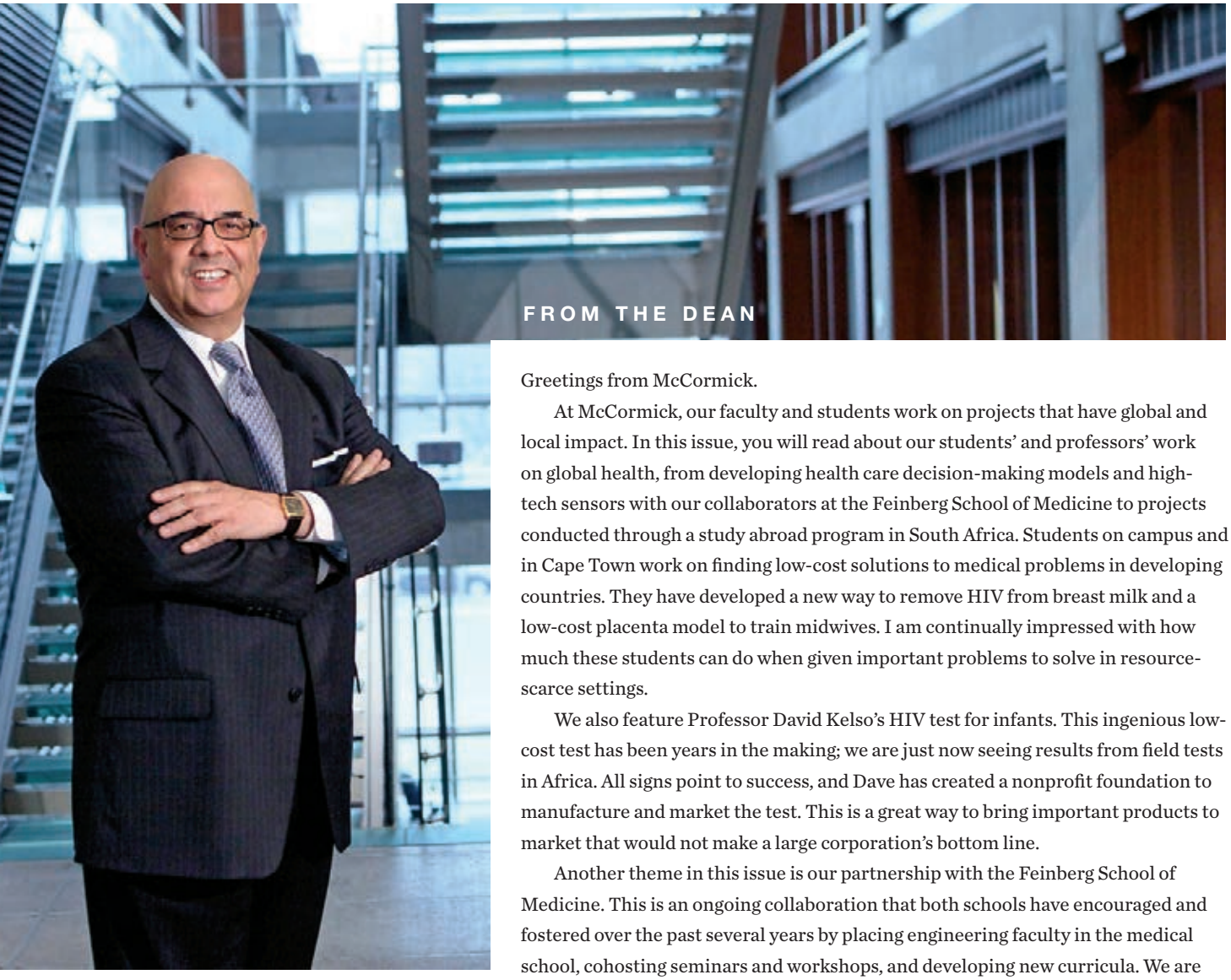
McCormick

magazine | fall 2011

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

IMPROVING HEALTH CARE

FACULTY AND STUDENTS MAKE A DIFFERENCE AT HOME AND ABROAD



FROM THE DEAN

Greetings from McCormick.

At McCormick, our faculty and students work on projects that have global and local impact. In this issue, you will read about our students' and professors' work on global health, from developing health care decision-making models and high-tech sensors with our collaborators at the Feinberg School of Medicine to projects conducted through a study abroad program in South Africa. Students on campus and in Cape Town work on finding low-cost solutions to medical problems in developing countries. They have developed a new way to remove HIV from breast milk and a low-cost placenta model to train midwives. I am continually impressed with how much these students can do when given important problems to solve in resource-scarce settings.

We also feature Professor David Kelso's HIV test for infants. This ingenious low-cost test has been years in the making; we are just now seeing results from field tests in Africa. All signs point to success, and Dave has created a nonprofit foundation to manufacture and market the test. This is a great way to bring important products to market that would not make a large corporation's bottom line.

Another theme in this issue is our partnership with the Feinberg School of Medicine. This is an ongoing collaboration that both schools have encouraged and fostered over the past several years by placing engineering faculty in the medical school, cohosting seminars and workshops, and developing new curricula. We are beginning to see the outcomes of these initiatives. Professor Sanjay Mehrotra is bridging operations research with medical decision making, and one of Sanjay's students, Jonathan Turner, was hired by Northwestern Memorial Hospital to continue to improve processes there. Other professors are collaborating to create better medical devices: Chang Liu is using his state-of-the-art sensors in medical applications, and several of our professors work with the Rehabilitation Institute of Chicago to create better prosthetics. We can expect many more innovations to come from the intersection of engineering and medicine.

We also feature NUvention: Web, an interdisciplinary course run by McCormick's Farley Center for Entrepreneurship and Innovation. NUvention: Web offers a unique curriculum that guides our students through the innovation and entrepreneurship processes. Several groups of students have created successful companies after the completion of the course. It's another example of our desire to form graduates with technical excellence balanced with a creative, innovative, and entrepreneurial skill set. In short, whole-brain engineers.

As always, I welcome your feedback.

Julio M. Ottino, Dean | November 2011

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

On the cover: The p24 HIV test for infants, developed in the lab of David Kelso, clinical professor of biomedical engineering. See story on page 8.

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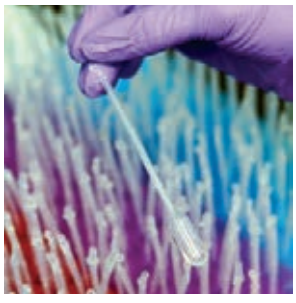

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McCormick news

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SOLAR PANELS INSTALLED ON FORD BUILDING

The Ford Motor Company Engineering Design Center, opened in 2005, was the first LEED-certified building at Northwestern. Now, thanks to some industrious students, it has burnished its green credentials: A solar photovoltaic array covering nearly the entire available roof of the Ford Building was installed last summer and has been connected to the building's electric grid, making it the University's first on-site renewable energy source.

Students from the campus groups **Engineers for a Sustainable World** and the **Northwestern Sustainability Fund** worked for two years to make the "solar system" a reality. Named the Centennial Solar Panel System, it honors the centennial of the McCormick School, which celebrated 100 years of engineering in 2009. The two groups raised more than $117,000 from on- and off-campus sponsors.

The 16.8-kilowatt panel display is expected to generate about 20,000 kilowatt-hours of electricity per year—enough to power a computer lab in the Ford Building.

RESEARCHERS USE CARBON NANOTUBES TO MAKE SOLAR CELLS AFFORDABLE, FLEXIBLE

Researchers have developed a solar cell material made of carbon nanotubes that provides an alternative to current technology, which is mechanically brittle and reliant on a relatively rare mineral. Solar cells comprise several layers, including a transparent conductor layer that allows light to pass into the cell and electricity to pass out; both of these actions require a conductor that is both electrically conductive and optically transparent. Currently, indium tin oxide is the dominant material used in such applications, but it is brittle and rare.

Mark C. Hersam, professor of materials science and engineering and of chemistry, and **Tobin J. Marks,** Vladimir N. Ipatieff Professor of Catalytic Chemistry and professor of materials science and engineering, have created an alternative using single-walled carbon nanotubes: tiny, hollow cylinders of carbon just one nanometer in diameter. They've also determined the type of nanotube that is most effective in transparent conductors. Metallic nanotubes, the researchers found, are 50 times more effective than semiconducting ones when used as transparent conductors in organic solar cells. The technology could pave the way for flexible solar cells that could be used by the military or incorporated into wearable electronics.

NEW FACILITY NAMED FOR WILLENSES

Ronald and JoAnne Willens have made a significant gift to Northwestern, enabling it to advance its leadership in the field of nanotechnology. In recognition of the unrestricted gift, the top three floors of the addition to the north side of the Technological Institute will be named the Willens Engineering Life Sciences Wing. The addition is expected to be completed in fall 2012.

The facility will house chemists and engineers whose work emphasizes the life sciences and their relation to engineering. Faculty research will advance biomedicine in areas such as neural engineering, bionanotechnology, and biomaterials.

Ron Willens is cofounder of the technology company Livingston Enterprises, which Lucent Technologies bought in 1997. The company made remote-access equipment and software that allowed hundreds of users to dial into large corporate networks or Internet service providers. JoAnne Willens is a retired technical illustrator.

McCORMICK TRAVELS TO SINGAPORE

Last summer University president **Morton Schapiro** and **Julio M. Ottino,** dean of the McCormick School, traveled to Singapore with a group of Northwestern officials. McCormick hosted an event in Singapore on July 1, welcoming more than 60 alumni and friends.

During the trip Dean Ottino and colleagues met with the president, provost, and other leaders from Singapore's Nanyang Technological University to discuss potential collaborations in nanotechnology, biomedical engineering, and materials science. They also met with the president of the National University of Singapore and executive management from A*STAR and the Economic Development Board.

The trip was part of Northwestern's continuing efforts to increase its global outreach, attract international students, and involve alumni who live outside of the United States. See a slideshow of photos from the event at www.mccormick.northwestern.edu/magazine.

ROMETTY NAMED CEO OF IBM, OFFERS LESSONS TO NORTHWESTERN COMMUNITY

McCormick alumna Ginni Rometty (computer science '79) was named president and CEO of IBM on October 25. She will step into her new role January 1, becoming the first female CEO in the company's 100-year history. She most recently served as IBM's senior vice president and group executive for sales, marketing, and strategy.

Rometty was at Northwestern last March to give the IBM Centennial lecture to a packed room of students, faculty, and alumni. It was the first of six lectures she gave at universities around the world. She selected Northwestern—the only US university on her tour—because she is an alumna and because, when she was here in the late 1970s studying computer science, she learned an important lesson that has guided her throughout her 30 years at IBM. "What I took away was how to think," she said.

In the lecture Rometty shared three lessons she's learned throughout her career: how to stay alive, how to make big bets, and how to create a corporate culture that becomes a competitive advantage.

IBM started in the meat-and-cheese-slicer business, but when it was taken over by Thomas J. Watson Sr. in 1914, he said, "We must never think what we have today will satisfy demand 10 years from now." And, indeed, IBM has stayed alive (Rometty's first lesson) by continually reinventing itself over the last century. What began as a hardware company eventually shifted to a service company when, in 2002, Rometty led the successful acquisition and integration of PricewaterhouseCoopers Consulting into IBM.

Acquiring a business of mostly human capital was risky, but Rometty says that when you make big bets (her second lesson), you must believe in what you're doing.

So what does IBM believe in? Globalization and integrating and innovating through technology, Rometty said. This belief led the company to launch what may be a new golden age of computing through Watson, a computer system capable of understanding and learning the nuances of language.

"The greatest measure" of any idea, she said, "is the impact it has."

McCormick
IN THE MEDIA

NUVENTION AMONG BEST NEW COURSES, SAYS *INC.*

Northwestern's NUvention courses, in which students from across the University work in teams to form businesses, were featured among the best new courses of 2011 in the April issue of *Inc.* magazine, a monthly for people who run growing companies. "Most entrepreneurs possess deep knowledge of their industries," stated the article. "So why shouldn't entrepreneurship classes be just as specialized? That's the logic behind NUvention, a group of classes that focuses on three verticals: medical devices, energy, and Internet businesses."

ALUMNI ENTREPRENEUR FEATURED IN *FORBES*

It's been a wild ride for **Nikhil Sethi** (electrical engineering '10), who was recently named one of *Forbes* magazine's All-Star Student Entrepreneurs. Sethi and fellow McCormick student Garrett Ullom founded their startup Adaptly in McCormick's NUvention: Web course last year. Adaptly is a service that allows businesses to buy ads simultaneously on multiple social network ad platforms. Now the company has 20 employees and a Manhattan office.

A profile in *Forbes* titled "All-Star Student Entrepreneurs: Social Media Ad Mogul" followed Sethi's entrepreneurial trajectory, stating, "Sethi projects 2011 revenues of at least $10 million, with explosive quarter-over-quarter growth of 70 percent. ... As companies and agencies scramble to find the best way to advertise on social media, Adaptly will surely encounter competition. But Sethi has very big dreams. 'I think we're in the beginning of building something really massive,' he says. 'Once you solve distribution, you can do anything with it.'"

NPR HIGHLIGHTS HARTMANN'S RESEARCH

Mitra Hartmann, associate professor of biomedical engineering and mechanical engineering, developed a model that will allow her to simulate how rats use their whiskers to sense objects around them. The model enables further research that may provide insight into the human sense of touch.

Hundreds of papers are published each year using the rat whisker system as a model to understand brain development and neural processing. Rats move their whiskers rhythmically against objects to explore the environment by touch. But there is a big missing piece that prevents a full understanding of the neural signals recorded in these studies: No one knows how to represent the "touch" of a whisker in terms of mechanical variables.

That's where Hartmann's team comes in. It aims to create a model that quantifies these mechanics. The team first studied the structure of the rat whisker array, the 30 whiskers arranged on each side of a rat's face. Using two- and three-dimensional scans, it defined the relationship between the size and shape of each whisker and its placement on the face of the rat. With this information, the team created a model that quantifies the full shape and structure of the rat head and whisker array. The model simulates the rat "whisking" against different objects and predicts the full pattern of inputs into the whisker system as a rat encounters an object. The simulations can then be compared against real behavior.

Hartmann's research was featured on National Public Radio's *Science Friday,* a weekly science talk show. Watch a video at www.sciencefriday.com/videos/watch/10375.

COMPUTER JOURNALISM STARTUP LAUDED IN *NEW YORK TIMES*

Narrative Science, a company started by two McCormick professors that uses a computer program to automatically generate news stories, was featured in a September article in the *New York Times.* The program, said the article, "offers proof of the progress of artificial intelligence—the ability of computers to mimic human reasoning."

The company was started by **Kris Hammond** (top), professor of electrical engineering and computer science, and **Larry Birnbaum** (left), associate professor of electrical engineering and computer science, to commercialize Stats Monkey, a software program that automatically generates sports stories using commonly available information such as box scores and play-by-plays. The program was the result of a collaboration between McCormick and Medill School of Journalism, Media, Integrated Marketing Communications.

Hammond and Birnbaum and students working in McCormick's Intelligent Information Lab created algorithms that use statistics from games to write text that captures the overall dynamic of games and highlights key plays and players. Generated along with the text is an appropriate headline and a photo of what the program deems the most important player in the game.

Hammond said he has high hopes for the technology. "In five years," he says, "a computer program will win a Pulitzer Prize—and I'll be damned if it's not our technology." See related story on page 22.

READ MORE AT WWW.MCCORMICK.NORTHWESTERN.EDU

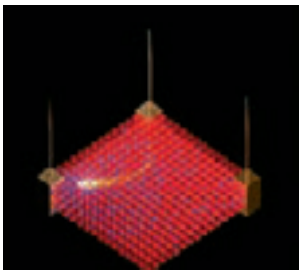
NANOSTRUCTURE PROMOTES GROWTH OF NEW BLOOD VESSELS

Tissue deprived of oxygen (ischemia) is a serious health condition that can lead to damaged heart tissue following a heart attack and—in the case of peripheral arterial disease in limbs—amputation, particularly in diabetic patients. Northwestern researchers have developed a novel nanostructure that promotes the growth of new blood vessels and shows promise as a therapy for conditions where increased blood flow is needed to supply oxygen to tissue.

Samuel I. Stupp, Board of Trustees Professor of Chemistry, Materials Science and Engineering, and Medicine and director of Northwestern's Institute for Bionanotechnology in Medicine, and his team have designed an artificial structure that can trigger a cascade of complex events that promote the growth of new blood vessels. The nanostructure mimics a protein called vascular endothelial growth factor (VEGF)—and in some ways surpasses it. Unlike VEGF, the nanostructure is easily injected as a liquid into the tissue, is relatively inexpensive to produce, and remains in the tissue for a longer period.

Stupp and his team created the nanostructure in the form of a fiber with a high density of peptides—potentially hundreds of thousands per fiber. The peptides mimic the biological effect of VEGF, initiating the signaling process in cells that leads to blood vessel growth. The large number of active peptides results in a very potent therapeutic agent, and the size and stability of the nanofiber ensure the structure is retained in the tissue after injection.

COULD A COMPUTER ONE DAY REWIRE ITSELF?



Scientists at Northwestern have developed a new nanomaterial that can "steer" electrical currents. The development could lead to a computer that can simply reconfigure its internal wiring and become an entirely different device based on changing needs.

As electronic devices are built smaller and smaller, the materials from which the circuits are constructed begin to lose their properties and begin to be controlled by quantum mechanical phenomena. Reaching this physical barrier, many scientists have begun building circuits in multiple dimensions, such as stacking components on top of one another.

The Northwestern team has taken a fundamentally different approach. It has made reconfigurable electronic materials—materials that can rearrange themselves to meet different computational needs at different times. "Our new steering technology allows us to direct current flow through a piece of continuous material," says **Bartosz A. Grzybowski,** who led the research. "Like redirecting a river, streams of electrons can be steered in multiple directions through a block of the material—even multiple streams flowing in opposing directions at the same time." Grzybowski is professor of chemical and biological engineering at McCormick and professor of chemistry in the Judd A. and Marjorie Weinberg College of Arts and Sciences.

The Northwestern material combines different aspects of silicon- and polymer-based electronics to create a new classification of electronic materials: nanoparticle-based electronics. Imagine a single device that reconfigures itself into a resistor, a rectifier, a diode, or a transistor based on signals from a computer. The multidimensional circuitry could be reconfigured into new electronic circuits using a varied sequence of electrical pulses.

The hybrid material is composed of electrically conductive particles, each five nanometers in width, coated with a special positively charged chemical. The particles are surrounded by a sea of negatively charged atoms that balance out the positive charges fixed on the particles. When an electrical charge is applied across the material, the small negative atoms can be moved and reconfigured, but the relatively larger positive particles are not able to move.

By moving this sea of negative atoms around the material, regions of low and high conductance can be modulated; the result is the creation of a directed path that allows electrons to flow through the material. Old paths can be erased and new paths created by pushing and pulling the sea of negative atoms. More complex electrical components, such as diodes and transistors, can be made when multiple types of nanoparticles are used.

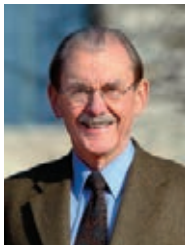
STUDENTS BUILD OFF-GRID "TINY HOUSE"

How much space does one person need? A one-bedroom apartment? A small studio? How about 128 square feet?

That is the size of the "Tiny House" that McCormick students have designed and built over the last two years. The 8 x 16–square-foot house, which sits on the back of a trailer, comes equipped with a bed, kitchen, and bathroom and can function completely off the grid. The design includes solar panels to generate electricity, a rainwater catchment and filtration system for potable water, a composting toilet, a shower with an extremely efficient shower head, a small fireplace, and a kitchen complete with sink, refrigerator, and one burner. They designed the house to be compatible with DC electricity (which comes from the solar panels) and made sure it would gather enough water in Chicago's climate for a person to use 8.6 gallons a day.

The team is in talks to exhibit the house at a Chicago museum.

ACHENBACH RECEIVES RARELY AWARDED HONORARY DEGREE IN CHINA



Jan D. Achenbach, Walter P. Murphy and Distinguished McCormick School Professor Emeritus of Civil and Environmental Engineering and professor of engineering sciences and applied mathematics and of mechanical engineering, has been awarded an honorary doctorate from China's Zhejiang University. He received the award in a September ceremony attended by the university's president, Yang Wei, in the Zhejiang Province.

The award is a rare honor, as Chinese universities bestow honorary degrees approximately once every five years, and their selections must be approved by state officials. Previous recipients of Zhejiang University's honorary doctorate include former United Nations Secretary-General Kofi Annan and former International Olympic Committee president Juan Antonio Samaranch. Achenbach is the seventh individual—and first engineer—to receive an honorary doctorate from Zhejiang University.

Born in the Netherlands, Achenbach became a member of Northwestern's faculty in 1963. Since then he has become highly respected for his work in the areas of wave propagation in solids and for pioneering the field of quantitative nondestructive evaluation. He received a National Medal of Technology in 2003 for his contributions to engineering research and education and for pioneering methods for detecting dangerous cracks and corrosion in aircraft, advances that led to improved air safety. Achenbach was also awarded a 2005 National Medal of Science, the nation's highest honor for innovation in technology and science. He was elected a member of the National Academy of Engineering in 1982, a member of the National Academy of Sciences in 1992, and a fellow of the American Academy of Arts and Sciences in 1994.

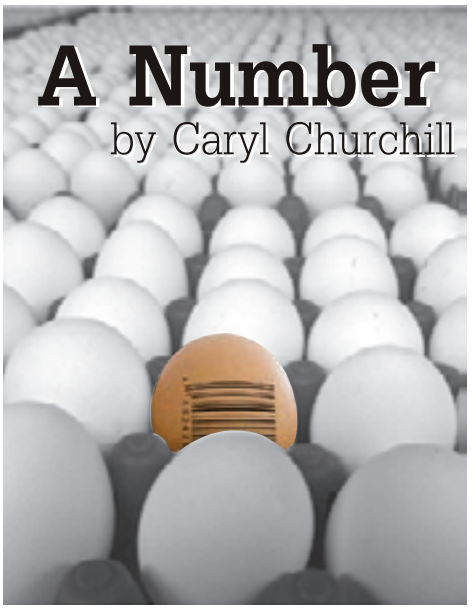
BELYTSCHKO ELECTED TO NATIONAL ACADEMY OF SCIENCES

Ted Belytschko, an expert in computational methods for computer simulation of mechanical events such as car crashes, drop tests, and other prototype testing, has been elected a member of the US National Academy of Sciences. Membership in the academy is one of the highest honors given to a scientist or engineer in the United States. Belytschko is among 72 new members and 18 foreign associates from 15 countries recognized this year for their distinguished and continuing achievements in original scientific research.

Belytschko was also awarded the Prager Medal for outstanding research contributions in theoretical or experimental solid mechanics. He was presented the award at the 48th annual technical meeting of the Society of Engineering Science in October.

Belytschko is the Walter P. Murphy Professor in mechanical engineering and professor of civil and environmental engineering. His main interests lie in the development of computational methods for engineering problems. He has developed methods that are widely used in crashworthiness analysis and virtual prototyping. Recently these methods have been instrumental in enabling the auto industry to replace physical prototype testing with computer simulation in crashworthiness design. These methods also have replaced prototype testing in many other industries, thus shortening the design cycle.

ETOPIA EXPLORES ISSUE OF HUMAN CLONING



A Number, a one-act drama by Caryl Churchill about the potential consequences of human cloning, was presented in October and November at McCormick.

Written in 2002—six years after the highly publicized creation of Dolly, the cloned sheep—*A Number* explores the conflicts that arise between a father and his adult son, who learns that the father may have allowed the son to be cloned when he was a child. The play delves into the personal consequences of human cloning and how the power of replicating genetic identity may have unintended consequences.

The play was part of ETOPiA: Engineering Transdisciplinary Outreach Project in the Arts, an initiative at McCormick with the goal of inspiring a cross-disciplinary dialogue about the role of science and technology in society. *A Number* was ETOPiA's fourth play at Northwestern. Previous ETOPiA productions have included *Copenhagen, Manya: A Living History of Marie Curie,* and *QED.*

"*A Number* presents a very human perspective on how relationships might be affected by the technology of genetic engineering and cloning," says **Matthew Grayson,** assistant professor of electrical engineering and computer science and the play's producer. "It's a personal, touching, and at times disruptive view of how this controversial science could change real lives."

Each performance included a postshow discussion led by Northwestern students and featuring a panel of faculty members and graduate students.

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OUTSTANDING MEMBERS OF THE CLASS OF 2011 RECOGNIZED IN JUNE

McCormick students were honored at graduation ceremonies in June, hearing from speakers such as Ken Porrello, principal of Deloitte & Touche; Barry Nelson, the Walter P. Murphy Professor and chair of industrial engineering and management sciences; and Gwynne Shotwell, president of SpaceX.

Among those honored was **Ryan Brock,** a materials science and engineering BS/MS student, who won the 2011 Harold B. Gotaas Undergraduate Research Award. The award, named in honor of the third dean of the McCormick School, is given to the senior who presents the best research paper in the competition. Brock developed transparent conductive electrodes based on carbon nanotubes and graphene, and his research has shown that metallic single-walled carbon nanotube anodes possess higher performance and stability than semiconducting nanotubes in a certain type of device. He conducted his research in the lab of Mark Hersam, professor of materials science and engineering and of chemistry.

Other finalists for the award included

- **Tejas Shastry** (materials science and engineering), who also worked in Hersam's lab; he designed, fabricated, and tested high-performance carbon nanotube field-effect transistors
- **Samantha Strasser** (biomedical engineering and applied mathematics), who worked with professors Allen Taflove and Vadim Backman to develop a novel technique to measure intracellular macromolecular concentration with nanoscale sensitivity based on near-field scanning optical microscopy
- **Alvin Tan** (materials science and engineering), working in the lab of Jiaxing Huang, fabricated composites for carbon solar cells and characterized them using scanning electron microscopy and atomic-force microscopy
- **Anthony Tan** (materials science and engineering), who worked in the lab of Katherine Faber and performed mass spectrometry and microstructural analysis to understand the role of additives in the electroplating process of copper on graphite
- **Gracie Wittman** (mechanical engineering), who worked in the lab of Peter Voorhees and calculated the effect of microgravity accelerations on particle sedimentation

McCORMICK FACULTY AWARDS

Michael Jewett, assistant professor of chemical and biological engineering, has received the Young Faculty Award from the Defense Advanced Research Projects Agency, part of the Department of Defense, and the Agilent Early Career Professor Award from Agilent Technologies Inc. Jewett joined the Northwestern faculty in 2009. He uses cell-free systems to create protein therapeutics and unnatural polymers for applications in materials, medicine, and nanotechnology.

The DARPA program identifies rising research stars in US academic institutions and introduces them to Department of Defense needs as well as DARPA's program development process. The Agilent prize is awarded annually to recognize and encourage excellence in measurement research, with a focus this year on the field of systems biology.

Jewett also recently received a 2011 Packard Fellowship for Science and Engineering from the David and Lucile Packard Foundation. He is among 16 promising science and engineering researchers nationwide to receive an unrestricted research grant of $875,000 over five years.

Leon Keer, Walter P. Murphy Emeritus Professor of Civil and Environmental Engineering and Mechanical Engineering, received the 2011 Raymond D. Mindlin Medal from the American Society of Civil Engineers. The award recognizes outstanding research contributions to applied solid mechanics.

Randy Snurr, professor of chemical and biological engineering, received the 2011 Institute Award for Excellence in Industrial Gases Technology from the American Institute of Chemical Engineers in October. The award recognizes sustained excellence in contributing to the advancement of technology in the production, distribution, and application of industrial gases.

Snurr's research focuses on the development of nanoporous materials to solve environmental and energy problems. Specific areas of interest include diffusion in nanoporous materials, adsorption thermodynamics, development of new adsorbents and catalysts, separations, and molecular modeling.

FOUR FACULTY MEMBERS RECEIVE CAREER AWARDS




Four faculty members affiliated with McCormick have received the prestigious Faculty Early Career Development (CAREER) award from the National Science Foundation. They are (above, from left) **Nicole Immorlica,** assistant professor of electrical engineering and computer science; **Paul Leonardi,** Allen K. and Johnnie Cordell Breed Junior Professor of Design and assistant professor of industrial engineering and management sciences and of communication studies; **Adilson Motter,** associate professor of engineering science and applied mathematics and of physics and astronomy; and **Hao Zhang,** assistant professor of biomedical engineering.

GLOBAL HEALTH

Faculty and students engineer solutions for the developing world

If an HIV-positive mother in the United States learned there was a 44 percent chance she could transmit the virus to her child through her breast milk, she would have a readily available solution to the problem: use formula.

In South Africa and other developing countries, however, the solution is not so simple. The World Health Organization recommends mothers breastfeed exclusively for six months not only because breast milk provides babies with essential nutrients and antibodies but also because formula is expensive in the developing world and could be mixed with unclean water. Yet more than 30 percent of pregnant women in South Africa are HIV positive, creating a dilemma for expectant mothers.

Enter students from the McCormick School of Engineering and Applied Science, who are eager to use their creativity to solve global problems like these. "The most pressing problems in the world, including global health, require both analysis and creativity," says Julio M. Ottino, dean of McCormick. "Over the past several years our students have used these skills here and abroad with excellent results."

McCormick students Fei Yin Luk, Aneesha Suresh, and Erica Pollock (clockwise from bottom left) with a new mother (center) and nurse Mitzi Franken (right) in Cape Town, South Africa

Each year more than a dozen McCormick undergraduate and graduate students spend a quarter in Cape Town as part of the Global Healthcare Technologies study abroad program. They spend their days taking classes or observing doctors in hospitals, and their evenings working on design projects ranging from simple ways to kill HIV in breast milk to the construction of oxygen masks that don't hurt the faces of premature babies.

"You hear about these problems, but seeing them up close is entirely different," says Aneesha Suresh, a biomedical engineering graduate student. "Having the opportunity to design solutions has been really great. You're given an opportunity and a responsibility."

While working with doctors and patients in South Africa is a life-changing experience for these McCormick students, the school's commitment to addressing the challenges of global health begins back on Northwestern's Evanston campus. There students and faculty work year-round on projects that include creating anatomical models to better educate midwives and devising new diagnostic tests for use in rural areas.

Perhaps the most successful global health project to come out of McCormick is the p24 HIV test for infants. Developed in the lab of David Kelso, clinical professor of biomedical engineering, the test is quick and easy to use. A doctor or nurse can take a drop of an infant's blood, place it on a plastic blood-separation membrane, insert it into a small processor about the size of an alarm clock, and get results within 30 minutes. The test is inexpensive—each will ultimately cost approximately $10—and will fill a niche.

Many HIV tests used in rural African clinics diagnose the virus by looking for HIV antibodies. Children of HIV-positive mothers are born with the virus antibodies even though they may not have the virus, so those antibody tests are useless in these critical cases. Other types of HIV tests can take weeks or months to produce results—too long for infants who need antiviral medications. Over the past six years Kelso and his lab, funded by the Bill and Melinda Gates Foundation, have developed a miniaturized, inexpensive version of the p24 test, which tests for antigens rather than antibodies.

"Sometimes mothers walk 18 miles to have their babies tested. Then they come back 30 days later and the test results aren't ready," says Kara Palamountain, executive director of the Global Health Initiative at the Kellogg School of Management and a collaborator of Kelso. "The new test translates into a lot of value for them."

Now Kelso and his collaborators have created the Northwestern Global Health Foundation to manufacture and help distribute the test. It's a new sort of business: a nonprofit biotech company that helps manufacture and deliver products that wouldn't turn enough profit to make the cut at traditional companies. "The foundation is the bridge between research and the marketplace," Kelso says.

"We're trying to make sure the technology that comes out of the lab actually makes it to the market," says Palamountain, who is also president of the foundation.

The Northwestern Global Health Foundation's first client is the Clinton Health Access Initiative through UNITAID, which ordered 10,000 p24 HIV tests for field testing in several African countries. Clinics involved in the program measured Kelso's portable test against their permanent testing equipment for accuracy. (Lab tests conducted before field testing began indicated the p24 HIV test was 96 percent accurate—much higher than required.) If successful, the test could be used in rural locations that don't have the money or electricity for big, bulky permanent instruments.

The foundation has other tests on the way: Palamountain traveled to Uganda this year to research the market for low-cost HIV viral load tests, which tell HIV patients how well their medication is working. "The more virus you have in your body, the more likely you are to transmit it to others," she says.

Kelso's lab has also developed a tuberculosis test that uses the same technology as the p24 HIV test. Now it is conducting research to learn more about the clients it aims to serve. "We need to know who we are designing for," Palamountain says. "We ask, Does the clinic have power? What is the temperature there? What is the skill set of the staff?"

The foundation's earnings will be poured back into research and manufacturing—an exciting prospect for Kelso and Palamountain, whose goal is not to profit but to get life-saving tests to those who need them most. They hope the successful launch of the p24 test will give them credibility in the

African market and allow them to move forward with the viral load and tuberculosis tests. "If the foundation works, I think it's an entirely new way to do business," Kelso says. "It's a new way to provide health care in an area that wouldn't make profits."

For Palamountain, visiting rural clinics where nurses see hundreds of patients a day for little money is motivation enough. "For me it's a responsibility to make sure that others have access to health care," Palamountain says. "The disparity between the haves and the have-nots really makes me want to do something about it."

HEAT TREATMENT FOR BREAST MILK

Northwestern students in Cape Town are doing exactly that through the Global Healthcare Technologies program. They began working on the problem of HIV-infected breast milk two years ago. Student teams began by building on the practice in use at Mowbray Maternity Hospital in Cape Town: flash-heat pasteurization. Doctors heat breast milk before feeding it to infants, which inactivates the HIV but leaves antibodies and proteins unharmed.

The hospital had its own flash-heat pasteurization system but asked students to improve the system's design so it could be used with greater ease at the hospital and in patients' homes. A year ago a group of Northwestern undergraduates designed a system that employed the previously developed practice of putting milk in a peanut butter jar, then placing that jar in a water-filled pot heating on a stove. They created a special indicator to let mothers know when the milk was hot enough to kill the virus. It seemed simple. But when a new group of students arrived in South Africa this past spring, it became apparent that the system had problems. The shape of the peanut butter jar wasn't optimal for heat transfer, most people in the Western Cape of South Africa used electric kettles instead of stoves, and people often heated the milk too long or too little. "If they heat it too little, they aren't killing the virus, but if they overheat it, they compromise the proteins in the milk," says Cassandra Harn, a biomedical engineering graduate student.

So the new group chose a smaller, more suitable jar—one from a widely available brand of jelly that costs the equivalent of a dollar—and rigged a frame using wires. They then hooked the wires onto the electric kettle and lowered the jar into the water. Then, when the electric kettle brought the water to a boil and clicked off automatically, the milk would be safe to consume. The system used resources that residents had ready access to and seemed easy to use.

The group's initial tests, however, were anything but easy. "The milk was on the verge of dumping out every time," Harn says. The team designed a new circuit to measure the milk's temperature and tweaked its wire design so it was shaped like a spring coiled around the jar. The total price of each wire-and-jar system was only $2. Further tests are needed to verify that the virus will be killed through the heating, though initial results look promising. "The design isn't glamorous, but it works for that locality," says Matt Glucksberg, professor of biomedical engineering and an adviser in the program.

"As Americans, we want to use the most advanced technology in our designs," says graduate student Aneesha Suresh. "But sometimes you just have to work on the most simple and cost-effective solution."

> "This class took our skills from engineering, global health, communication, and business and combined them into one project."
>
> KEVIN LI

Reaching that solution wouldn't have happened if the team hadn't traveled to South Africa, says Suresh. "It has been really beneficial to talk to the mothers and doctors here and assess the problem. Unless you're here, you can't understand what the problem is. We really wanted to be able to succeed and give back to the people we met."

MAKING MASKS FOR BABIES

When babies are born prematurely in South Africa, mothers are encouraged to practice kangaroo mother care. In this method babies are kept in constant skin-to-skin contact with their mothers, allowing the mother's natural body heat to regulate the baby's temperature. Doctors find that premature babies often become healthy more quickly in kangaroo care than in incubators, but the method also makes it more difficult to monitor babies.

Several projects by Northwestern students in South Africa have focused on this issue. Some of these include mobile sleep apnea monitors and phototherapy devices for jaundiced babies in kangaroo care. This year a team of students designed a system that keeps premature babies breathing.

Many premature babies suffer from respiratory distress syndrome and require continuous positive airway pressure (CPAP) therapy to maintain the structure of their airways. The therapy is administered through the baby's nose, either through a mask or prongs. However, the force applied by the mask or prongs (and the straps that hold them in place) can damage the baby's nose and cause pressure sores that lead to infection and scarring.

"We focused on a new attachment method to minimize the forces on the baby's face," says Fei Yin Luk (biomedical engineering '12). The team went to the newborn intensive care unit at the Mowbray Maternity Hospital and considered new solutions: perhaps a helmet or a face guard; perhaps something that attached to the bed frame and dropped over the baby's head. Soon the students had a whole binder full of idea sketches. They eventually settled on a device that could be fitted to the caps that local women knit for babies in the hospital. It featured a noseguard fed by oxygen tubes and held away from the baby's face by rigid aluminum straps. "It eliminated all that force on the babies' cheeks," Luk says.

Working in South Africa, the team found it difficult to create prototypes outside its usual shop in the Ford Motor Company Engineering Design Center at Northwestern. "It really opened my eyes and made me understand what engineering is like outside of the United States," says Eric Liu (biomedical engineering '12). "I have more of a global sense of engineering and see the benefits of collaborating overseas to get fresh ideas and to get feedback from people who have different needs."

The team was satisfied with its prototype, but the project will likely be refined next year. Doctors and nurses at the hospital say they have trouble keeping the caps on the babies' heads, and ideally the project would incorporate a design from another team: a visual force indicator that measures just how much force is being applied to a baby's face.

"It's difficult to do a study abroad experience in engineering," Luk says. "The South Africa program is a great way to combine relevant education with an out-of-your-comfort-zone experience."

EDUCATING MIDWIVES

Students back in Evanston are routinely challenged to move beyond their comfort zone as well. When a team of seniors in an undergraduate biomedical design course was assigned the task of creating a model placenta to help educate midwives in developing countries, the students had a few questions: What does a placenta look like? What does it feel like? Why is it important?

"I never even knew the placenta came out after the baby," says Kevin Li (biomedical engineering '11).

The students soon learned that the developing world has high rates of postpartum hemorrhaging, often because midwives—who usually assist at births—don't understand techniques for effectively birthing the placenta. If they pull too hard on the umbilical cord or fail to notice abnormalities, the consequences could be fatal.

The team set out to create a low-cost model that could help midwives learn how to handle the placenta. Students headed down to Northwestern Memorial Hospital and surveyed OB-GYNs. They had doctors use a force gauge to show how much force was needed to birth a placenta. They witnessed a birth and afterbirth, and they observed and felt a real placenta. They then headed to the lab of John Vozenilek, associate professor of emergency medicine and director of the Center for Simulation Technology and Immersive Learning. There Vozenilek uses realistic materials and sensors to create teaching models for medical students and doctors (see related story on page 14).

Under Vozenilek's supervision the students ordered several current placenta models. How heavy were they? What did they feel like? How was the umbilical cord attached? They decided their model placenta had to be more realistic and cheaper than those currently available. It had to include abnormalities such as blood clots or missing pieces so midwives would be prepared for any eventuality. And because it would be used in developing countries, the model couldn't rely on a power source. Then the students experimented with EcoFlex, a silicone-based rubber, and created several less-than-realistic models—some were too red, too brown, or too stiff—before finally getting the details just right.

Next the team set about creating a feedback mechanism that would tell midwives when they were pulling too hard. After designing and building one complicated device, the team hit on a much simpler solution: using magnets to attach the cord to the model placenta. That way, a midwife could practice pulling the cord, and if the magnets separated, she would know she pulled too hard. The team bought magnets from a local hardware store and, seeing that they worked perfectly, ordered specified-force magnets. The students brought their model back to the hospital for doctor testing, and then a group of Kellogg students took the model to Africa to get feedback there. "Everybody liked our model," says Tina Chaudhry (biomedical engineering '11).

"It is brilliant in its simplicity," Vozenilek says. "The students needed to design a model that was durable and inexpensive, and they were able to create a device that's highly useful for that environment."

The team entered its design in the Rice Global Health Technologies National Design Competition and won third place. That success led the students to take an independent study during spring quarter to write a scientific paper about the model and develop a business plan to market it. "We want to see where it can go," Chaudhry says. "We want to see it succeed. This project has the possibility to make a real difference."

Though they have all now graduated, the students agree that the project has helped prepare them for the workplace. "This course took our skills from engineering, global health, communication, and business and combined them into one project," Li says. "It was the first time I saw how all those elements came together to create a piece of work. What we accomplished still surprises me. It shows that students can definitely create devices with high impact."

M Emily Ayshford

Opposite: Mitzi Franken, a nurse, and Lucy Linley, neonatalist-in-charge at the School of Child and Adolescent Health at the University of Cape Town, with McCormick students Graham Marcy, Eric Liu, and Fei Yin Luk
Above left: David Kelso with the p24 HIV test processor
Left: Graduate student Cassandra Harn (right) in Cape Town

BUILDING A **GLOBAL CROSSROADS** FOR RESEARCH

Over the past five years McCormick's research enterprise has grown at an astonishing rate. Since 2005, expenditures have more than doubled, and the amount of research awards has increased 59 percent. This growth has fueled an increase in the number of graduate students, postdoctoral fellows, and research staff at the school.

In order to assemble teams made up of the very best individuals, McCormick recruits research talent from around the world. Over the past four years the number of visiting research appointments at McCormick has increased 83 percent. Researchers now come to McCormick from nearly 70 countries around the world.

The map at right visualizes the percentage of McCormick visiting researchers by nationality. It was created by Daniel Grady, a PhD student in engineering science and applied mathematics in the lab of associate professor Dirk Brockmann, using data provided by the McCormick Customer Service Center, which coordinates visa processing for researchers.

The word cloud below represents the breadth of research areas for these domestic and international scholars; the size of the word is proportional to the number of researchers in that field.

China	**356**	Iran	17	Denmark	7	Austria	3	Kazakhstan	2	Croatia	1
United States	**299**	Canada	15	Switzerland	7	Bangladesh	3	Latvia	2	Georgia	1
India	**109**	Netherlands	13	Vietnam	7	Belgium	3	Romania	2	Ghana	1
South Korea	**91**	North Korea	12	Thailand	6	Colombia	3	Sweden	2	Lithuania	1
France	**46**	Mexico	10	Argentina	5	Egypt	3	Ukraine	2	Nepal	1
Germany	**40**	Russian Federation	10	Hong Kong	4	Indonesia	3	Albania	1	Nigeria	1
Turkey	**31**	Brazil	9	Hungary	4	Malaysia	3	Algeria	1	Norway	1
Italy	**24**	United Kingdom	9	Poland	4	Portugal	3	Belarus	1	Pakistan	1
Japan	**24**	Greece	8	Saudi Arabia	4	Serbia	3	Bolivia	1	Puerto Rico	1
Spain	**21**	Israel	8	Singapore	4	Ecuador	2	Bulgaria	1	Slovenia	1
Taiwan	**21**	Czech Republic	7	Australia	3	Finland	2	Chile	1	South Africa	1

Engineering medicine

New collaborations at the boundaries of disciplines

Imagine you're one of the 16,000 people in the United States waiting for a liver transplant. Unlike those on the kidney transplant list, you cannot be treated with dialysis. Without a transplant your survival time is limited.

Then a call comes: a liver is available. But there's a catch: Because the deceased donor's heart could not be kept beating during organ extraction—a so-called cardiac death donation—the liver has been deprived of oxygen for longer than is typical and may have deteriorated.

Do you wait and take your chances that you'll receive a higher-quality liver? Or do you take the cardiac-death liver?

It's a problem with no easy answer—and it's an example of the type of problem that professors from McCormick and the Feinberg School of Medicine are teaming up to solve. From studying transplant allocation to creating anatomy models with sensors to developing new kinds of drug-delivery methods and prosthetics, faculty in the two schools are calling, e-mailing, and traveling across Chicago to create connections that will ultimately improve all aspects of medicine. In 2010 more than 100 McCormick and Feinberg professors authored papers together, and new programs like minisabbaticals—where McCormick professors spend a quarter at Feinberg doing research—are inspiring new partnerships at all levels.

HEALTH CARE ENGINEERING

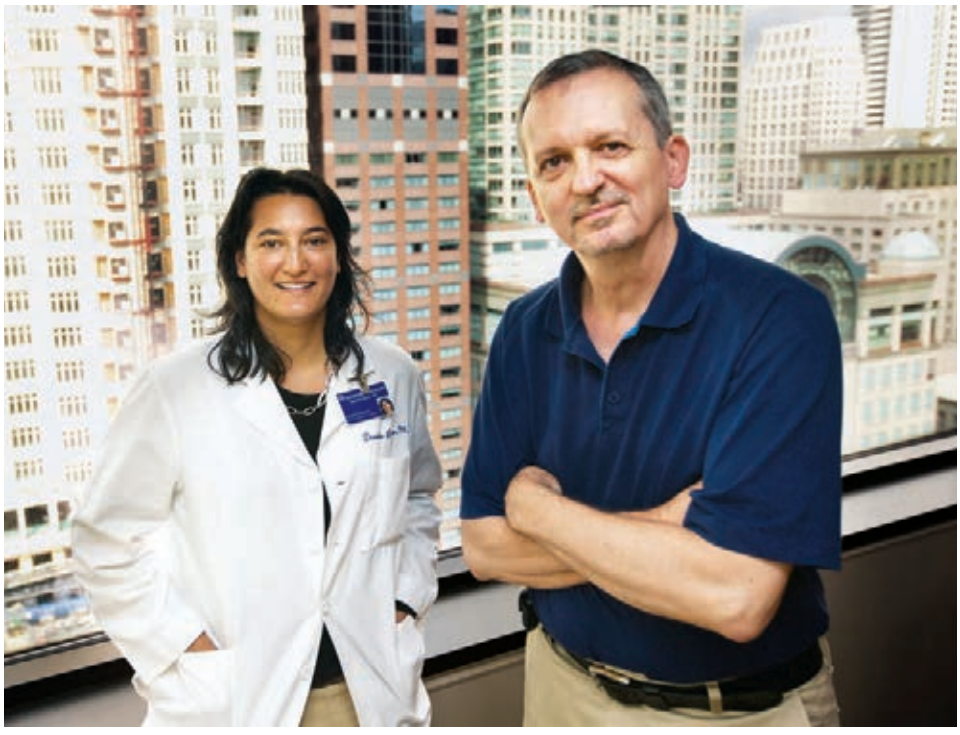
Nowhere is the McCormick-Feinberg connection more apparent than in the Department of Industrial Engineering and Management Sciences, where faculty members such as Sanjay Mehrotra and Gordon Hazen are part of a new initiative called health care engineering. It aims to apply methods from statistics, computer science, and operations research to a variety of health care problems.

Take the liver decision problem—an issue Hazen, professor of industrial engineering and management sciences and an expert on health care decision analysis, has studied. In response to the long liver transplant waiting list, the United Network for Organ Sharing (UNOS), the national organ donation organization, has started encouraging organ procurers to consider more of what physicians refer to as "donor after cardiac-death" (DCD) livers.

"More donations has to be better, right?" Hazen asks. "But is it really better? What sense does it make to increase the number of low-quality organs procured if most patients should decline them and wait for a better organ?"

To explore the problem, Hazen created mathematical models that take into account what happens to patients on the liver transplant waiting list, including patient mortality and morbidity. Those models were used to predict what would happen if the number of DCD livers available for transplant increases or decreases. Hazen's research showed that unless the liver patient is in critical need of a new liver, it doesn't make sense to take a DCD liver.

Hazen collaborates with surgeons at the Northwestern University Transplant Outcomes Research Collaborative (NUTORC) on the University's Chicago campus. Headed by Daniela



Daniela Ladner and Gordon Hazen

Ladner, assistant professor of surgery, the three-year-old initiative aims to connect transplant clinicians with cutting-edge researchers in seemingly disparate disciplines across campus. "If you want to find better solutions, you have to collaborate," Ladner says. "Collaborating with professors like Gordon Hazen and Sanjay Mehrotra helps us answer pertinent questions in the field of transplantation we couldn't otherwise answer. It will ultimately help in our daily decision making for individual patients."

While helping individual patients is, of course, a desirable outcome, the ultimate goal of the collaboration is to better inform and change transplant policy to reduce death rates of those on transplant waiting lists and improve decision making. "I began working in this area because I was interested in decision analysis but also because I wanted to do research in something grounded in reality," Hazen says. "Hopefully my models will help influence leaders and create change."

LEARNING THE LANGUAGE OF MEDICINE

While Ladner and her colleagues work with Hazen on risk prediction, they turn to Sanjay Mehrotra, professor of industrial engineering and management sciences and an optimization expert, for research on organ access and allocation throughout the United States. Over the past few years he has developed a half-dozen collaborations with Feinberg professors.

"I saw the value in this research," he says. "None of us wants a systems failure that affects our health. Industrial engineers and operations researchers have helped develop a large analytical toolkit over the last 50 years. Historically, we could not use these tools for health care problems because the data were not as widely available. That's changing. We can use our tools to better manage hospital systems, improve policy, and help make scientific discoveries."

With NUTORC, Mehrotra and his graduate student Ashley Davis have studied kidney allocation. Nearly 90,000 people in the United States are waiting for kidney transplants. The country is divided into 11 regions managed by UNOS, and most kidneys are distributed within the same geographic zone in which they are donated. As a result, there are major regional inequalities in access to organs: a person in one state might get a kidney within a year, while someone in another state might wait up to four years. Many people die while waiting. "It violates the 'Final Rule,' a government mandate about organ equity," Ladner says. Mehrotra and Davis have created a new politically viable kidney distribution model to promote kidney sharing between regions.

"We're using industrial engineering and operations research tools to fix this nationwide problem," Mehrotra says. "Working with the transplant community, we are discovering structured, implementable policy changes that will be acceptable to both leaders and the population at large."

In the course of researching the problem, Davis spends much of her time at NUTORC being mentored by Ladner and other clinicians. She

"If you want to find better solutions, you have to collaborate."

DANIELA LADNER

essentially went through a mini–medical school boot camp to teach her how to think as both an engineer and a clinician. "When you have people who understand both disciplines, you can open entirely new areas of research," Ladner says.

Mehrotra also realized he had to learn the language of physicians after he became interested in the field a few years ago following several bad experiences in the health care system. So he took an undergraduate organic chemistry course. "I was concerned I wouldn't survive the quarter," he says. "My lab partner was 30 years younger than I. But I took every single quiz, did every lab, and I survived. I learned the basic vocabulary."

He cast his net wide, looking for collaborations, and word got around. He began working with Heron Rodriguez, a vascular surgeon, and Debra DaRosa, vice chair of education, department of surgery, on scheduling surgical resident rotations. He began a project with David Liebovitz, chief medical informatics officer for the Northwestern Medical Faculty Foundation, considering how to best restrict unauthorized access to patient records. He is working with cardiologist Jeffrey J. Goldberger and emergency medical physician George Chiampas on better risk assessment of patients with cardiac conditions and on systems solutions that address the vexing problem of sudden death due to cardiac arrest, which kills nearly 400,000 people every year in the United States.

"Given the number of problems that need data-driven engineering solutions, we can engage students at every level," Mehrotra says. "Undergraduate students get real-world experience when working on their projects, and the collaborations are leading to new sources of funding for graduate students to work on practical problems while developing new methodologies."

HEALTH CARE ENGINEERING BEYOND GRADUATION

One of those graduate students was Jonathan Turner. A student of Mehrotra who received his PhD in May, Turner spent six months at Northwestern Memorial Hospital shadowing surgery residents and collecting data for what would ultimately become the subject of his dissertation: improving surgery education.

Surgeons at the hospital noticed that surgical residents gained varying amounts of experience. Often, the first time they met a patient was in the operating room—hardly a typical experience for a surgeon. "Residents spend only one or two months on vascular surgery rotation," Turner says. "The time between diagnosis and surgery is often three weeks. Probability models showed the vascular surgeons that without some logistical changes, the odds that a resident would be able to see the same patient for both diagnosis and surgery were very small."

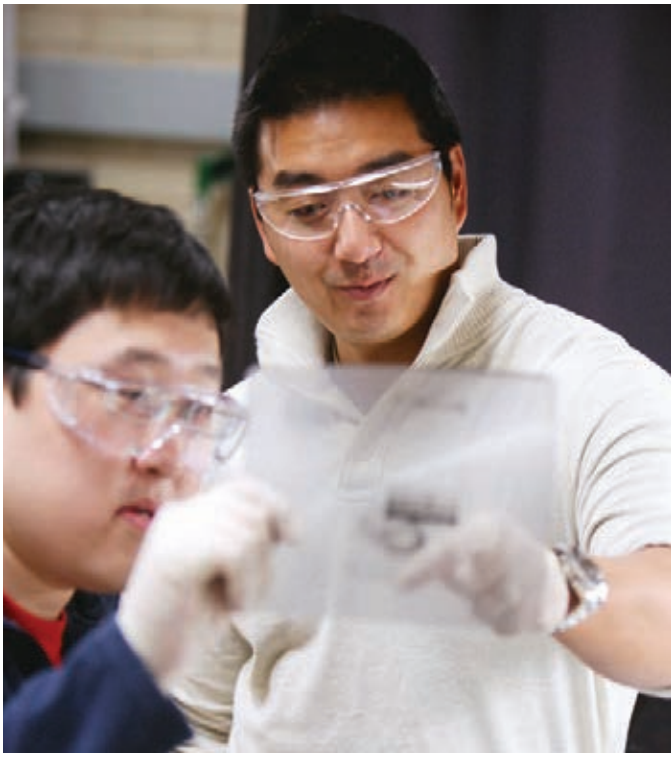
As a result of these findings, Turner created scheduling software that allows surgeons to match residents with patients. That means the resident is able to spend more time with the patient from diagnosis to surgery to follow up and results in a more realistic and valuable educational experience. Turner's software has been piloted at the hospital and an upgraded version is planned for the future.

"The software allows residents to have a sense of patient ownership they didn't have before," Turner says. "There is a story behind each patient. As care gets more and more fragmented, those stories get harder and harder to see. We can help doctors meet that challenge through scheduling assistance."

Feinberg and Northwestern Memorial Hospital were so impressed with Turner's work that they hired him as the hospital's first health care engineer manager for quality and innovation. "Our research goal is to leverage health delivery science and raise the value of health care delivery by improving process quality and patient outcomes while reducing cost," he says.

Turner's first projects involve finding ways to reduce handoffs of patients from doctor to doctor and reorganizing nurses' charts to avoid redundancies. Mark Williams, professor and chief of hospital medicine, and Turner, working with Mehrotra, have also proposed a Northwestern University Center for Value and Innovation in Health Care Delivery, which would further encourage McCormick-Feinberg connections.

"I want to be a facilitator," Turner says. "I want to say, 'Here is a problem, and here is the best person in McCormick to work on that.'



Opposite: Jonathan Turner and Sanjay Mehrotra
Right: Dean Ho and an undergraduate student in his lab

"Our research goal is to … raise the value of health care delivery by improving process quality and patient outcomes while reducing cost."

JONATHAN TURNER

I can distinguish whether a project might make a good dissertation or an ideal undergraduate assignment. I plan to make McCormick faculty aware of good research projects that are outside my skill set."

An added benefit is that the work of Turner and others isn't just advancing the field of medicine, it's also advancing the state of industrial engineering and operations research. "My ultimate hope is that these new methodologies will solve problems beyond health care," Mehrotra says.

BIO-INSPIRED RESULTS

McCormick connections with Feinberg go beyond operations research. Many biomedical and mechanical engineering professors have close relationships with physicians, surgeons, and rehabilitation specialists at the medical school. Dean Ho, for example, is using biomaterials for next-generation medicines.

Ho, associate professor of biomedical and mechanical engineering, is working on a project with Patrick McCarthy, director of the Bluhm Cardiovascular Institute and chief of cardiac surgery, and Sunjay Kaushal, assistant professor of surgery, to create a patch that can help the heart heal after surgery. (Ho met McCarthy through another McCormick-Feinberg connection: the course NUvention: Medical Innovation, in which students from across Northwestern create and market medical devices.) The patch, which looks like plastic wrap and is made of Parylene, attaches directly to the heart and can release anti-inflammatory, antiscarring, and anti-arrhythmia agents and pain medication for defined periods of time. When Ho and his group first developed the film employed in the patch, they brought it to McCarthy and asked him a series of questions: How thick do you want it? Would this be easy to handle in the operating room? How difficult would it be to affix to the heart?

"It's great to work with someone who is so involved in the medicine-engineering interface," Ho says. "Having a surgeon standing right there really helped accelerate the development of the technology."

Ho also recently started a project with Charles Clevenger, professor of pathology, to use nanodiamonds to deliver emerging therapeutics for breast cancer. Nanodiamonds have a carbon structure similar to the diamonds found in jewelry but are much smaller: hundreds of thousands of these nanodiamonds could fit on the head of a pin. Ho has used nanodiamonds for other cancer treatments such as chemotherapy. They are ideal for carrying chemotherapy through the body because they shield the drug from normal cells and don't cause inflammation. Ho hopes the nanodiamonds will help stabilize the new therapeutics and make them last longer. "The diamond keeps the drug in the tumor longer," he says. "We're pretty excited."

In a field like Ho's, connections like these are critical. "It's important to have a proactive dialogue between the engineer and the end user, the clinician," he says. "Interacting with Feinberg professors gives us key details on how to improve the design. Ultimately it's what is needed to push translational medicine forward."

Feinberg connections with McCormick extend to education in biomedical engineering as well. For the past several years undergraduates have worked with John Vozenilek, associate professor of emergency medicine and director of the Center for Simulation Technology and Immersive Learning, to create lifelike simulation models for health care education. Vozenilek has worked with students in several senior design courses to create models for the developing world. Their projects have included a wireless EMG sensor and a placenta model. (See related story on page 8.)

"Engineering students have consistently created devices for developing countries that don't exist in the market," he says. "This gives us an opportunity to think creatively about what we can do that is inexpensive and durable. And frankly, we're having a lot of fun doing it. The students are really engaged and excited. They provide new perspectives, which I really appreciate."

Vozenilek is so appreciative, in fact, that he has hired several biomedical engineering graduates to work in his lab. Vikram Nandhan (biomedical engineering '11) joined the lab after working with Vozenilek on a senior design project—two experiences that share some parallels: "Working in the lab is a lot like working on a design project," says Nandhan, who hopes to go to medical school. "When you begin, you don't know much about it, but you talk to your client, do background research, and at the end you become an expert."

Jenny Haag (biomedical engineering '12), a summer intern in the lab who also hopes to go to medical school, says engineers provide a different view in the lab. "With engineering you learn a lot of critical thinking, a lot of problem solving. We learn

Carla Pugh and Chang Liu

to look at things in a different way. We're interested in how different things come together or how to improve processes. I think those are important skills that you don't necessarily learn with other majors that lead to careers in medicine."

MEDICAL EDUCATION AND ELECTRICAL ENGINEERING

To create simulation models for education and testing, McCormick and Feinberg have also looked to other disciplines. Take the collaboration between Carla Pugh and Chang Liu. Pugh, an associate professor of surgery, knows models: as director of the Center for Advanced Surgical Education, she has made more than 20 simulation models over the past 15 years that have been used to teach medical students how to do everything from pelvic exams to laparoscopic surgery. "I build anything I see a need for," she says.

Pugh knew that the direct-force sensors she used in her models were no longer satisfactory. If she had better sensors, she could get much better data on how well doctors are performing diagnostic exams that require touch. Enter Chang Liu, professor of electrical engineering and computer science and of mechanical engineering. He knows sensors: using micro- and nanofabrication technology, Liu creates innovative artificial hair cells that can sense force from several directions.

Now the two have teamed up to create a state-of-the-art model that will test how well physicians perform breast exams. "It could change the way we define competency for hands-on clinical performance," Pugh says. "To be able to quantify something like touch is a worldwide goal."

Palpation tests like breast exams involve many fingers that do complex maneuvering, so Liu and his graduate students began building a sensor plate that could measure multidirectional and sliding forces from five different fingers. "It's an open field," Liu says. "We're in no man's land. That is where raw creativity and scientific discipline come in."

Pugh and Liu have begun building an array of sensors that can sense sliding and complex motions for a single finger, and they are working to expand the capability to several fingers. "For five fingers we need something fresh," Liu says. "We're trying multiple approaches."

When the model is finished, Pugh will take it for testing at medical conventions. There she can gather data on how doctors usually move their fingers during exams. She hopes to expand the technology to other tests, and Liu hopes his new approach to sensors could be used outside the medical field. Either way, their collaboration is sure to push the state of the art.

"Collaborating should be the norm," Pugh says. "I think that's the wave of the future. We can no longer work in academic silos. Innovation comes from bridging two disciplines together. This is where it happens."

COLLABORATING FOR REHABILITATION

McCormick-Feinberg collaborations have had a host of successes in physical rehabilitation as well. A few years ago, Ed Colgate, professor of mechanical engineering and the Allen K. and Johnnie Cordell Breed Senior Professor of Design, and Michael Peshkin, professor of mechanical engineering, teamed up with Todd Kuiken, professor of physical medicine and rehabilitation at Feinberg, to create a prosthetic arm that reads nerve impulses and provides the user with touch feedback.

Using an innovative procedure called targeted reinnervation surgery, Kuiken grafted the nerve endings that once went into an amputee's limb onto the amputee's pectoral muscle. Once the nerve endings grew into their new location, Kuiken and his team could use sensors to read the impulses of the nerve to move a prosthetic limb. Unexpectedly, these nerve endings were also able to receive input, meaning that new prosthetic devices could actually provide touch sensation to the user as a real limb would. Colgate and Peshkin used their research in haptics—tactile feedback technology that uses touch as an interface—to give the arm "touch feedback" capabilities.

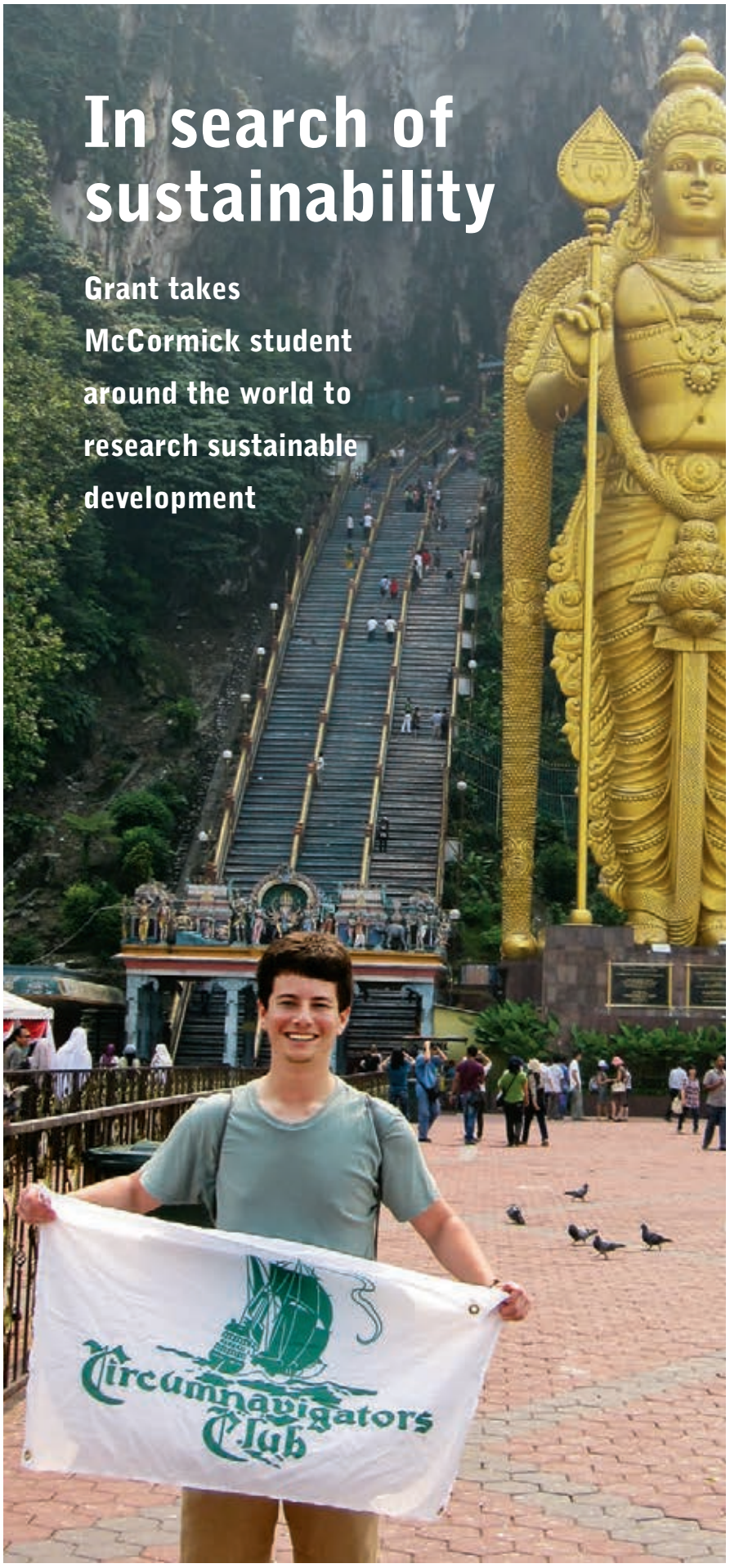
The connection between biomedical engineering and physical rehabilitation has also helped biomedical engineering associate professor Eric Perreault and assistant professors Wendy Murray and Matthew Tresch—all of whom have joint appointments in physical medicine and rehabilitation. Murray, for example, uses computer simulation techniques and experimental methods to investigate how humans move and control their arms and hands. Tresch used a model of the muscles in a frog's hind leg to perform a computational analysis showing that researchers could control the limb using muscles groups just about as well as by controlling individual muscles.

With all these successes, there is still room for growth. Minisabbaticals are allowing more McCormick professors to spend a quarter conducting research at Feinberg, and Feinberg professors have come up to the Evanston campus to give seminars. This past spring Nathaniel Soper, the Loyal and Edith Davis Professor and chair of surgery at Feinberg, visited with McCormick professors and students and discussed how to encourage more medicine-engineering connections. Professors from both schools were eager to build on the expertise of others and pave more roads between the disciplines.

"We need to figure out how to make this work between us," Soper said. "We were meant to take care of humans, and we can do it better if we work together." M Emily Ayshford

In search of sustainability

Grant takes McCormick student around the world to research sustainable development



Ben Shorofsky's passion for sustainability began with, of all things, shoes.

Shorofsky was introduced to sustainable practices as a high school student in Baltimore, when a service club he was involved with started collecting shoes for a nongovernmental organization (NGO) in the West African nation of Ghana. The shoes would be sold to fund the installation of "miracle pumps"—stationary bicycles-turned-water pumps that allow farmers to drip-irrigate their crops, replacing the age-old and inefficient process of sloshing buckets one by one to plants.

Recently Shorofsky got to see these pumps with his own eyes. Shorofsky, an honors BS/MS environmental engineering major now in his final year at McCormick, spent last summer circling the globe to visit sustainable development projects in both developed and developing countries: Ecuador, Malaysia, the United Arab Emirates, Ghana, Denmark, Sweden, and the United Kingdom. The project was funded by a grant from the Circumnavigators Club of Chicago, an organization comprising people who have made a trip around the world. The club selects one Northwestern student each year to take his or her own around-the-world voyage. For Shorofsky, it was an opportunity not to be missed—especially since he had been considering taking a year off after graduation to do a similar trip on his own.

"At some point in my life I want to work in a job that is nonprofit or NGO related," Shorofsky says. "I felt like I couldn't do that without having seen the different models, the different work being done."

> "Sustainability projects are great, but if they're not really getting through to people, then they're never going to work."
>
> BEN SHOROFSKY

After being selected and spending six months booking plane tickets and arranging for hostels and other low-budget accommodations, Shorofsky embarked on a sustainability adventure that would bounce him for the next three months between the developed and developing worlds. He saw Masdar City in Abu Dhabi, a high-tech, 2.3-square-mile planned development in which state-of-the-art "personal rapid transit" systems skitter people to their destinations. He visited Samso, a Danish island of 4,000 people that, since winning a government competition in 1997, has transformed itself to run completely on wind energy. He spent 11 days with a Malaysian NGO teaching composting and recycling techniques to schoolchildren in Kuala Lumpur.

And in Ghana, Shorofsky came face-to-face with that miracle pump, the instrument that sparked his budding career. He also saw some of the new endeavors of that NGO, such as teaching chicken-rearing strategies to farmers who, for centuries, have free-ranged their flocks, losing out on valuable nutrition and money from eggs.

As an engineering student, Shorofsky has always been impressed by chic designs and forward-thinking technologies. But as he worked his way around the globe, he became increasingly interested in the human element of sustainability—how even the greatest advances in the world can fail without a behavioral switch, a change in a people's thinking about the world and their place in it. Over the course of dozens of videotaped interviews with residents, NGO workers, facilities managers, professors, and interns, Shorofsky noticed a trend: The most successful projects were ones borne by the people themselves, or, in the case of developing nations, those in which stakeholders made a careful effort to understand the needs and desires of the populations they were serving. Projects in which sustainability efforts were forced on residents seemed to stall.

"I really learned the importance of effective communication at the community level," Shorofsky says, "I saw the troubles that NGOs, governments, and companies have in communicating things to people on the ground level. It can be difficult to get people to understand that this sustainability stuff doesn't have to change your life, that it can be worked into everyday behaviors. That education is extremely important. These sustainability projects are great, but if they're not really getting through to people, then they're never going to work."

In each of Shorofsky's 40 interviews, he made it a point to ask the same question: What does sustainable development mean to you? He learned that no two people viewed sustainability the same way; while much of their research focused on environmental work, many NGOs practicing what they called "sustainability" were focused on promoting economic growth, teaching business practices, or helping communities branch into the tourism industry. There's sustaining the planet, Shorofsky learned, and then there's sustaining people. Ideally, the two go hand-in-hand.

In his final site visit before returning to the United States, Shorofsky was introduced to an idea that continues to plague him. If every human being on the planet consumed as many resources as a person living in the United Kingdom, we would need three planets to sustain us; if everyone consumed as many resources as a person living in the United States, we would need six.

"Six planets!" Shorofsky later remarked in his travel blog. "Just think about how much of an impact we are having in our daily lives and the damage that we'll do in the long run. We can change this path, however, and with this research I hope to help."

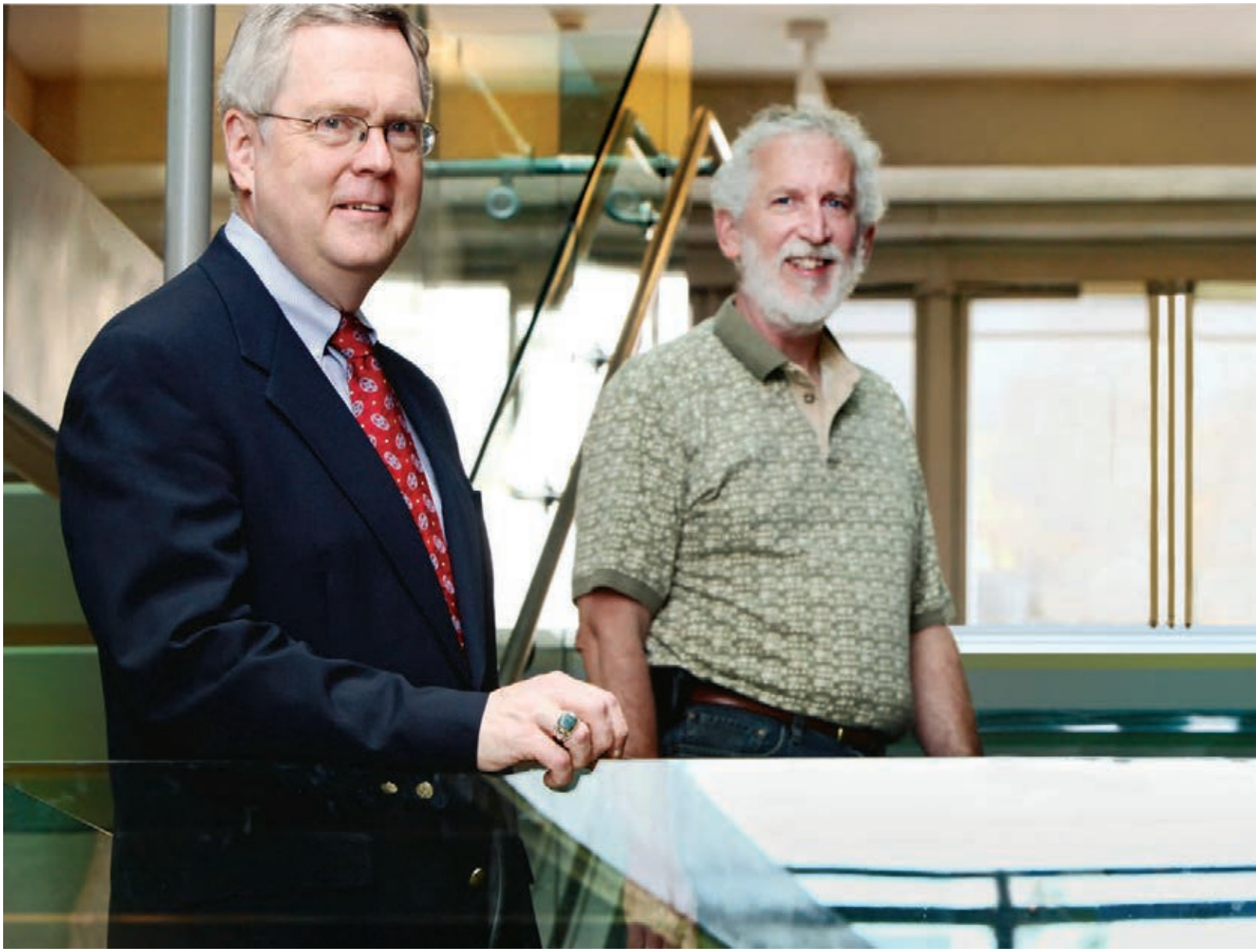
Now back in Evanston in his off-campus home—a "college-kid" apartment, by his own description—Shorofsky is distracted by the wastefulness of his leaky windows. He's extra diligent about shutting off the lights when leaving a room and washing his clothes in cold water instead of warm, and he is starting in a limited way to grow his own food: For his birthday he bought himself a dwarf lime tree.

Shorofsky will spend much of this year analyzing the data he brought back from his trip; he is required to submit a 50-page report to the Circumnavigators Club and plans to use his trip as the basis for his McCormick honors thesis. He is also working toward a certificate, McCormick's Certificate in Global and Ecological Health Engineering, which will likely send him on more international adventures.

For now, though, Shorofsky is eager to start enacting changes on the local level—where the real work needs to be done. "It's great to go abroad and do all these things and help people who need it," he said. "But when it comes to sustainability, we're the culprits." M Sarah Ostman

Read Shorofsky's travel blog at http://blog.undergradresearch.northwestern.edu/ben.

Pictures from Ben Shorofsky's travels (clockwise from left): visiting the Batu Caves in Malaysia; helping turn compost in Kuala Lumpur, Malaysia; an organic farming project coordinator in Kuala Lumpur; a group of villagers in Estero del Platano, Ecuador.



THE INTERSECTION OF

Above, from left: Medill professors Owen Youngman and Richard Gordon and McCormick professors Kristian Hammond and Larry Birnbaum. Together they manage the Knight News Innovation Lab.

The tightest of deadlines, zero chance of getting a byline, a readership of perhaps only a handful of people—even with jobs in journalism becoming increasingly scarce, such conditions might tempt reporters to surrender their press passes. Yet just across the Chicago River from Tribune Tower, a reporter hums away without complaint, crafting a lively and accurate article about a sports event that ended one second ago. The article even cites your Little Leaguer for making the winning play.

"We want to make the information that comes to you more interesting," says Larry Birnbaum, associate professor of electrical engineering and computer science at McCormick and chief scientific adviser for Narrative Science, a media startup with the slogan "We turn data into stories."

TECHNOLOGY AND JOURNALISM

"People like stories," says Kris Hammond, professor of electrical engineering and computer science at McCormick and chief technical officer at Narrative Science. "Readers want insights. We use technology to turn the numbers into stories with a narrative arc and a point of view."

Narrative Science, cofounded by Hammond and Birnbaum with chief executive officer Stuart Frankel, commercializes technology developed in a partnership between McCormick and Northwestern's Medill School of Journalism, Media, Integrated Marketing Communications. The McCormick-Medill efforts have included courses, research, and ongoing projects in the Knight News Innovation Laboratory. "With a top engineering school and a top journalism school," says Birnbaum, "Northwestern was one of the few places where this could have been possible."

From 'toon newscasters to articles that write themselves

The partnership came together after John Lavine, the dean of Medill, learned about a project of Hammond's called News at Seven. With support from the National Science Foundation, Hammond and graduate students in Northwestern's Intelligent Information Laboratory created a system that collects information and generates a virtual newscast anchored by avatars. Refinements to the system allowed the talking 'toons to banter with one another and swap opinions about films. Lavine saw the possibility for a promising exchange between McCormick and Medill. Those joint efforts now take place under the umbrella of the Medill McCormick Center for Innovation in Technology, Media, and Journalism.

The two schools first worked together on a spring 2009 course called Innovation in Technology and Journalism, taught by Hammond and Birnbaum alongside Medill faculty members Jeremy Gilbert and Rich Gordon. The goal was for computer science students and journalism students to learn from one another in order to create new media systems. The course is now

> "People like stories. Readers want insights. We use technology to turn the numbers into stories with a narrative arc and a point of view."
>
> KRIS HAMMOND

being offered twice a year. "The experiment has been exceedingly successful," says Hammond.

As the journalists learned what was technologically feasible, the computer scientists studied news stories and narrative arcs. Hammond, whose primary area of research is artificial intelligence, had some media experience, having worked as a science and technology correspondent for WTTW, Chicago's public television station. The journalists brought the computer scientists up to speed on the day-to-day issues they face as well as developments in the industry.

The cross-disciplinary teams tapped the power of the Internet, Twitter, and the iPhone to create five new programs and tools intended for journalists and news consumers. Attracting the most media attention was a system that analyzed box scores and play-by-play data from a sports event, such as a college baseball game, and spit out a story that captured the highlights of the game.

After the course ended, the students continued to work on the project along with Birnbaum and Hammond in the InfoLab. By fall 2009 the system had a catchy name, StatsMonkey. Unlike the proverbial typing monkeys that ultimately produce a Shakespearean manuscript, StatsMonkey was instantaneous: data in, article out.

Media reviewers of StatsMonkey, anticipating fill-in-the-blanks journalism, were pleasantly surprised by how human the stories sounded. In the *New York Times* David Carr wrote, "The weird thing about StatsMonkey is how not-that-terrible the stories are." Cathal Kelly, sportswriter for the *Toronto Star,* made a tongue-in-cheek comparison of two articles written about the same game in an American League Division series, one by a baseball writer at the Associated Press and one by "the icy transistors of StatsMonkey." Kelly admitted that StatsMonkey's chronological description of what happened was pretty good. Perhaps his most telling comparison was this observation about the "robo-copy": "No discernible errors of fact or grammar. Real writers make dozens, possibly hundreds, of mistakes. Stats Monkey, the heartless synthetic ghoul, is intent on putting all copy editors on the bread lines."

Will "robo-copy" replace reporters?

Perhaps error-prone copy editors deserve to be on the bread lines, but what about hard-working reporters? Putting reporters out of work was never the intent of the team behind StatsMonkey—which was created, after all, by journalists working with computer scientists. Neither is the management of Narrative Science plotting to diminish the job market for journalists.

"The sweet spot for us is what isn't being covered," says Nate Nichols, lead architect at Narrative Science, who earned a PhD under Kris Hammond. "Without our technology," says Birnbaum, "these are stories that would not have been written. The readers would have missed out on something."

Narrative Science produces some 15,000 stories a week for its roster of clients. Among them is GameChanger, a statistics management website for youth, high school, and college baseball and softball. One popular GameChanger app texts updates about Little League games to parents. "It used to be just the box score," says Nichols. "By using our technology, [GameChanger] can send a complete write-up. If you're the kid's grandma, you'll want to print it out and put it up on the fridge."

If grandma speaks only Polish, Narrative Science can generate the article directly in Polish, says Hammond. What if her grandchild's team loses? The article can be written from the losing team's point of view, spotlighting an individual player's moves.

Two sample Narrative Science headlines/tweets and ledes for a November 2010 men's basketball game between the University of Wisconsin Badgers and the Prairie View A&M University Panthers, in which the Badgers were victorious, demonstrate the difference.

> **Badger fans read:** ***Jon Leuer scores 24 and Josh Gasser adds 21 as Wisconsin crushes Prairie View A&M 99-55*** Jon Leuer scored 24 points and Josh Gasser added 21 points as they teamed up to lead the Badgers to a 99-55 victory over Prairie View A&M on Sunday at Kohl Center in Madison. …
>
> **Panther fans read:** ***Simpson scores 14 but Prairie View A&M can't contain Wisconsin in 99-55 loss*** The Panthers couldn't find a way to contain the Badgers' potent offense as the Panthers fell 99-55 on Sunday at Kohl Center in Madison. …

How does a computer know if a baseball game is a rout? "It looks at the data, whether the score is lopsided or if there's a lot of back and forth, with the lead changing hands," answers Hammond. "The system pulls in the data and asks, What's the angle? If it's not in the data, we won't see it, but we're pulling in more data all the time."

Hammond says that Narrative Science can spin out a story in any area that is driven by data. The company's clients include not only sports-related enterprises but also financial and real estate publishers in need of earnings reports, stock analyses, or specialized market reports (see sidebar). "We have different narrative arcs for different areas," explains Hammond. "Our journalists look at what a story is about." On staff at Narrative Science are Medill graduates John Templon and Nick Allen, both veterans of that first joint McCormick-Medill class. Two more Medill graduates, Andrew Paley and Dan Platt, recently joined the company. Rather than putting journalists out of work, Narrative Science is hiring them.

Sending you the news you can use

Generating a story about a Little League game for a Polish grandmother is one small example of the big push to personalize information. "We realized you don't want 100 search results or even 10," Birnbaum says about ongoing research in computer science. "You want one result, something that synthesizes the information you need right now. We want to make artificial intelligence more contextually aware. Instead of your searching, the system pushes the information directly to you, in a form you can use."

In the Knight News Innovation Laboratory, researchers at Northwestern are pursuing several media projects that do just that, using technology developed in the associated InfoLab. A joint McCormick-Medill initiative, the Knight Lab is the first of its kind in the country. It was created in February 2011 with support from the

University and a four-year $4.2 million grant from the John S. and James L. Knight Foundation, which supports journalism and media innovation. Veteran newspaper and television journalist Michael Silver heads the lab, where researchers work to develop new technologies for reporting, analyzing, and disseminating news.

The first thing that greets a visitor to the Knight Lab—on the second floor of the Ford Motor Company Engineering Design Center—is an installation of four flashing screens underlined by news crawls, the work of computer science graduate student Patrick McNally. Dubbed Patchwork Tweet, McNally's project is a mash-up of current topics of interest on Google and up-to-the-second Twitter commentary. McNally explains that the hyperkinetic display is actually a way to slow down and focus online information. "The Twitter stream is too fast," says McNally. "By the time you've aggregated it, the world's changed. Patchwork Tweet feeds you the most interesting topics right now."

In a nearby room computer science graduate student Lisa Gandy fine-tunes Congressional Closeup, a system she created to monitor votes in the US Senate. "We look at anomalous votes," says Gandy. "Why did a senator depart from the expected position on a particular vote?" Using data categorized by political scientists, Congressional Closeup checks to see if political factors—employment in the district or the influence of political backers—might explain the anomaly.

Working at a computer next to Gandy, graduate student Shawn O'Banion is helping the *Chicago Tribune,* which is working with researchers in the Knight Lab, to determine how to target information to consumers. "How can the *Tribune* find out what interests you?" asks O'Banion. His solution, Twitter Profiling, monitors a person's Twitter feed to build a personal profile and generate a personalized news page.

"There's more and more data all the time," says Birnbaum. "It's easy to collect it, but the question is how to make it actionable. We want to present people with information targeted to their interests, in a way that's useful to them."

M Leanne Star

Same data, two different stories

To demonstrate how its technology can generate stories with very different tones, Narrative Science supplied two earnings reports based on the same data. The tone of the first is straightforward, just-the-facts-ma'am:

Cooper Tire & Rubber Misses Estimates

Cooper Tire & Rubber Co. (NASDAQ:CTB) reported a lower net income in the second quarter compared with a year earlier, falling below analysts' estimates.

Net income fell 40% to $11.5 million or 18 cents per share, short of the mean analyst estimate of 26 cents. A year ago, the company reported net income before extraordinary items of $19 million or 30 cents per share.

Revenue rose 14.7% to $922.2 million from the year earlier quarter against an estimate of $979.9 million in revenue.

Gross margin fell four percentage points to 7.9% from the year earlier quarter. Over the last five quarters, margins have contracted on average 3.4 percentage points per quarter on a year-over-year basis.

In the second example the Narrative Science reporter cuts loose, becoming as irreverent as a human reporter getting slaphappy as a deadline approaches:

Cooper Falls Short on Revenue and EPS

Cooper Tire & Rubber Co. (NASDAQ:CTB) came up a day late and a few million dollars short of expectations in both revenue and income.

The company booked revenue of $922.2 million, an increase of 14.7% over the same quarter in the prior year, but well short of The Street's prediction of $979.9 million. On top of that, EPS of 18 cents per share was not even within shouting distance of the estimated 26 cents per share.

So how does a company see revenue rise, but come up short on the bottom line? Here's a little lesson in a thing called shrinking margins: Revenue may have risen, but when your cost of sales figure climbs more (19.9% from the year earlier), that results in gross margin shrinking by four percentage points and the bottom line taking a 40% hit.

And after this AWESOME quarter, I'm sure the CEO will clear things up for us: Roy Armes, Chief Executive Officer, commented, "The industry is currently being challenged by two forces: the drop in consumer demand and high raw material prices. These challenges are not new to the tire industry, and we have historically found ways to successfully address the issues. While these forces may continue to put pressure on the industry in the short term, we are optimistic about our ability to successfully compete. We are well positioned to take advantage of opportunities to grow profitably."

And from the possibly useful information department: Last quarter marked the fifth straight quarter that the company saw shrinking gross margins as gross margin fell four percentage points to 7.9% from the year earlier quarter. Over that time, margins have contracted on average 3.4 percentage points per quarter on a year-over-year basis.

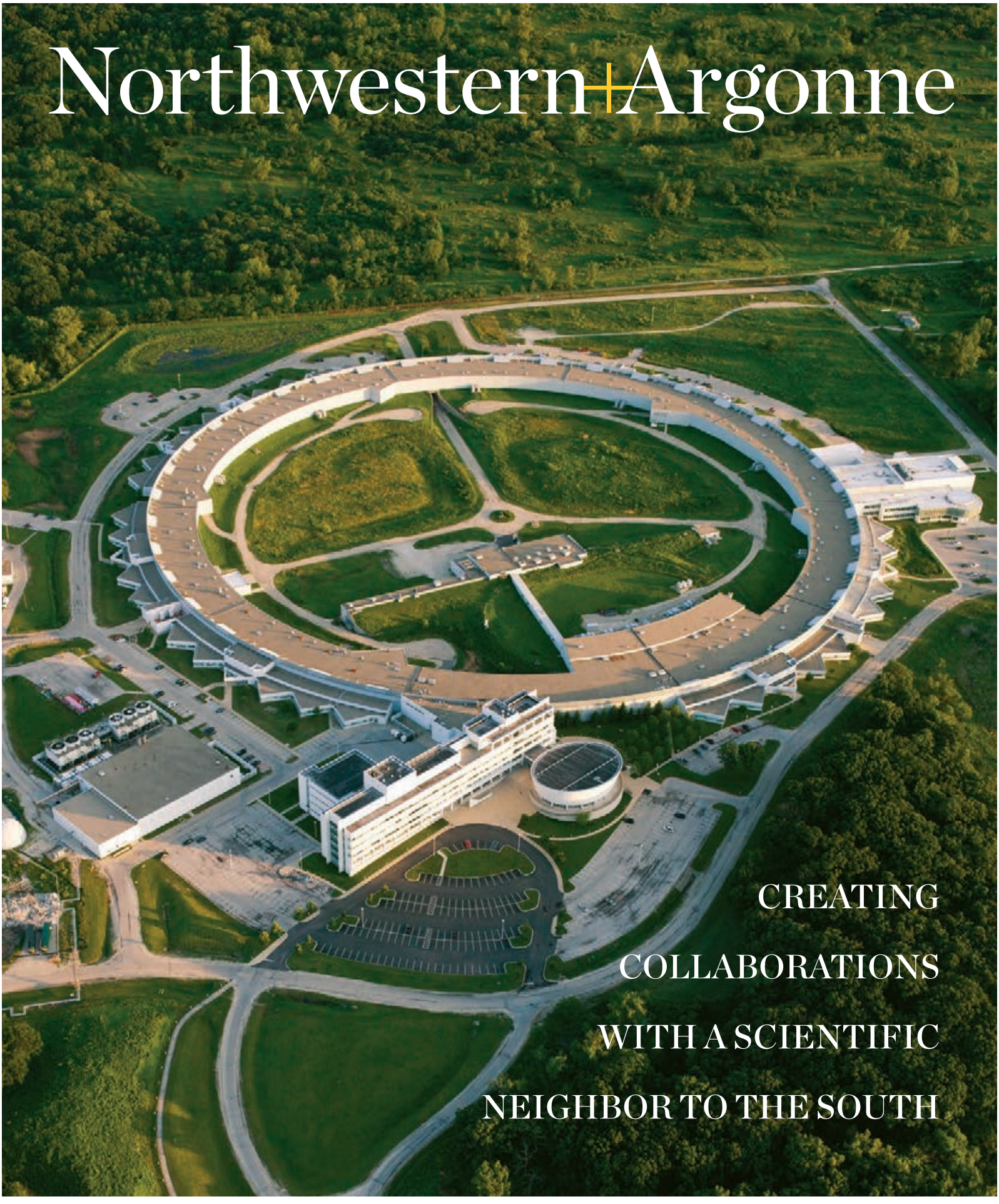
On the bright side, over the last five quarters revenue has increased 18.2% on average year over year. The biggest increase came in the second quarter of the last fiscal year, when revenue rose 27.3% from the year earlier quarter.

NEW LOOK FOR SCIENCE AND ENGINEERING LIBRARY

The Seeley G. Mudd Library, home to the University's science and engineering collections, underwent a major renovation this summer. The renovated library—which enjoys views of Lake Michigan and is filled with natural light—is the premier study space at the north end of the Evanston campus. The renovation of the main floor includes six new group study rooms controlled by an online reservation system, new desks and casual seating, more power sources for laptops, improved wireless access, student project storage, and digital signage.


EXIT

Northwestern+Argonne



CREATING COLLABORATIONS WITH A SCIENTIFIC NEIGHBOR TO THE SOUTH

Each day around 8 a.m., a small group of Northwestern graduate students piles into two cars. They make their way south from campus and drive along the highway, talking about their research, before turning west on Interstate 55. After an hour's drive they pass by the Waterfall Glen Forest Preserve and enter an area that's very different from Northwestern's campus: Argonne National Laboratory, a 1,500-acre complex that houses some of the most high-tech facilities in the world and is one of the nation's oldest and largest science research centers. The students drive across grounds filled with steam pipelines, brick buildings, and the occasional white deer to join their professors—including the more than 40 McCormick faculty members affiliated with Argonne—to conduct research in nearly every engineering area, from civil engineering to materials science.

Earlier this year the two institutions created the Northwestern-Argonne Institute for Science and Engineering, which will expand opportunities for Northwestern students and faculty to perform research at Argonne. The institute will allow for scientist exchanges, joint research projects, and easier access to facilities.

"This institute formalizes a partnership that has been successful for many years," says Julio M. Ottino, dean of McCormick. "It will allow us to bring collaboration to a new level. Strengthening the ties between Argonne and Northwestern will contribute to Chicago's reputation as a leader in science and technology."

The institute builds on current collaborations in fields ranging from solar cell development to high-performance computing. In 2009 the Argonne-Northwestern Solar Energy Research (ANSER) Center was formed to revolutionize conversion of sunlight into electricity and fuels. That center was funded by the US Department of Energy as an Energy Frontier Research Center. McCormick and Argonne have been involved in two other such centers, the Institute for Atom-Efficient Chemical Transformations and the Center for Electrical Energy Storage. In addition, the two institutions already share researchers (they offer a yearly Early Career Investigator Award to promising researchers at Northwestern and Argonne) and frequently hold symposiums where joint researchers present their work. Now they hope to make even more connections.

"One of the great strengths of the national laboratory systems is our ability to develop thoughtful collaborations with our colleagues in academia," says Eric Isaacs, director of Argonne. "This joint initiative will create some great new opportunities for Argonne's scientists and engineers to cross disciplinary lines, join forces with Northwestern researchers, and do the kinds of groundbreaking research that can fuel American innovation and technological competitiveness in this global economy."

The brightest X-ray beam around

Michael Bedzyk was an early beneficiary of the Northwestern–Argonne relationship: when he arrived at the University in 1991 he received a joint appointment with the two institutions. Why did the professor (and now chair) of materials science and engineering want to split his time between opposite ends of Chicago?

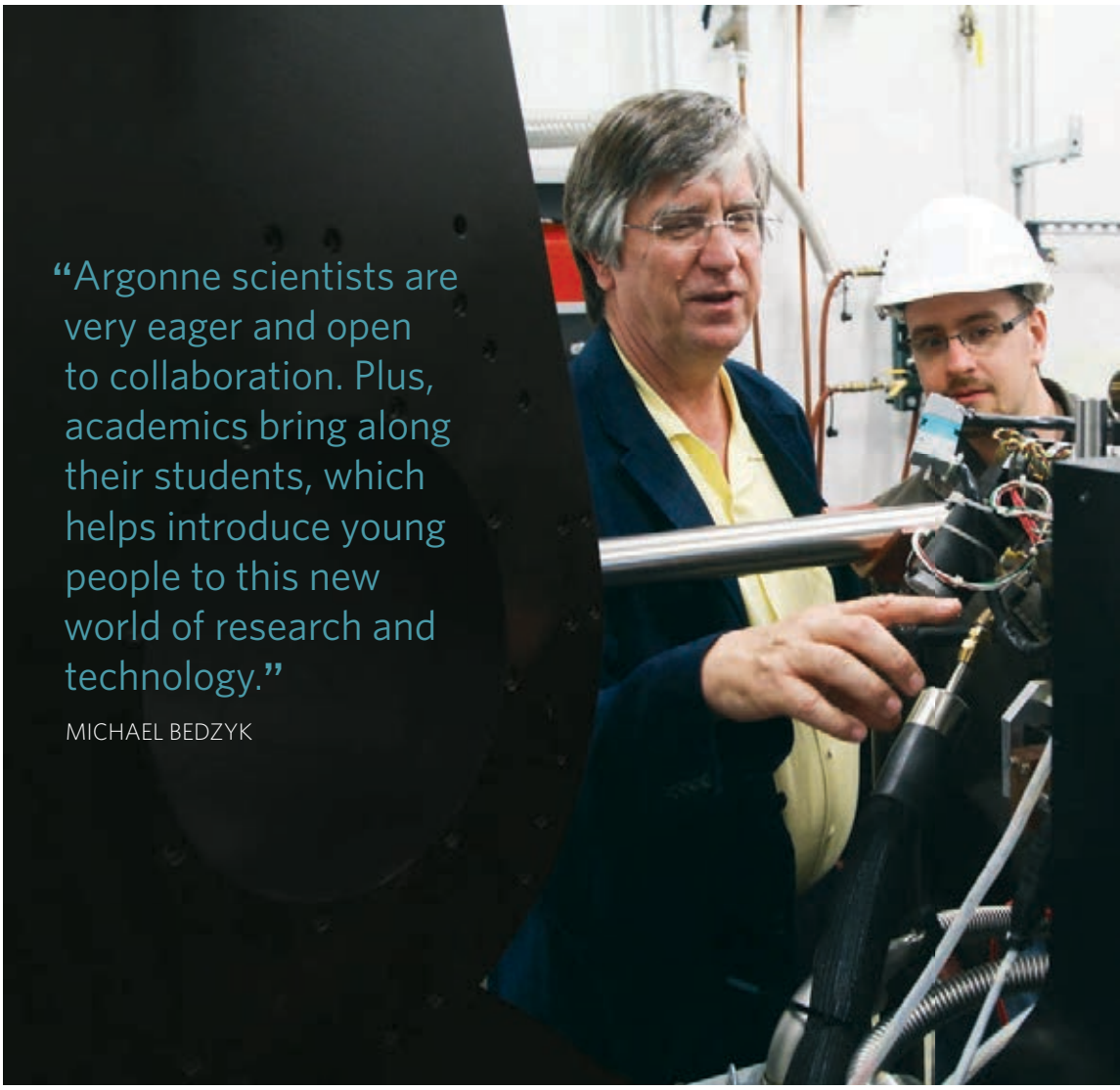
"The Advanced Photon Source," Bedzyk says.

That, for many researchers, is Argonne's main attraction. The APS is the brightest X-ray beam in this hemisphere. It accelerates electron bunches around a one-kilometer ring at close to the speed of light. The electron bunches pass through undulating magnetic fields that produce intense X-ray beams. Scientists and engineers harness those beams to conduct research at the atomic scale. "We are very fortunate at Northwestern to be situated near the highest-intensity X-ray sources available in this hemisphere," Bedzyk says.

When the APS was built, Northwestern joined with DuPont and Dow Chemical Company to build a research facility there that could access a beamline from the source. That beamline has produced a wealth of research for Bedzyk. His first experiment used X-ray reflectivity and standing waves to locate ions at the interfaces between water and mineral surfaces. That research, which Bedzyk still pursues, has implications in understanding how contaminants are transported in groundwater. Bedzyk has also used the beamline to examine ultrathin films and study atomic-scale reactions on their surfaces under different chemical conditions.

"These X-rays have a very high penetration power," Bedzyk says. "They can be used to look at surfaces that are buried underwater and at gas-solid interfaces. There is no other way to look at those buried surfaces under chemical reaction conditions with atomic-scale resolution."

Bedzyk has worked with collaborators to study films that are multiferroic (meaning their properties can be changed by applying an electric current or magnetic field) and could have implications in the electronics industry. He also works with McCormick professors Mark Hersam, Harold Kung, and Chris Wolverton within the Center for Electrical Energy Storage to investigate new anode materials for lithium batteries.



Anodes are the electrodes that collect positive lithium ions and are usually made of graphite. Replacing the graphite with other materials can improve the quality of the battery. Bedzyk's group X-rays the solid-electrolyte interface to understand just how the interactions work. "Argonne has been an extremely valuable resource to our research," he says.

Bedzyk travels to Argonne about once a week and enjoys collaborating within a community outside the University. He and other Northwestern faculty members and graduate students often participate in Argonne's workshops and conferences. "It's a focal point for bringing people together," he says. "Argonne scientists are very talented and open to collaboration. Plus, academics bring along their students, which helps introduce young people to this new world of research and technology."

For Bedzyk's graduate student Martin McBriarty, the APS offered access to specialized equipment for experiments that can be performed at only a few other places in the world. "During the first week of orientation it became very clear that Argonne was an extremely important and unique resource for research at Northwestern," he says. "I chose to work with Professor Bedzyk largely because I wanted to make use of the APS in my own research. Our experiments give us insight into the structure of surfaces and interfaces at the atomic scale, which is increasingly important in fields like catalysis, battery technology, and next-generation electronics. I'm fascinated by this unique view of interesting materials systems in action."

Research, with teaching

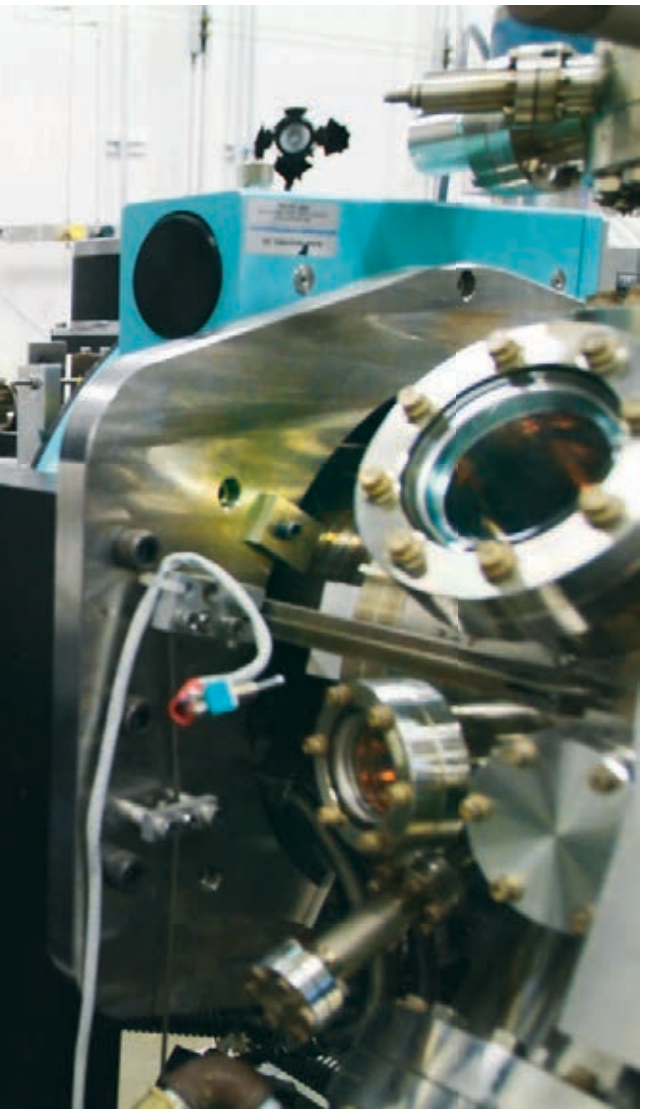
Access to students like McBriarty is what lured Amanda Petford-Long to her joint Northwestern-Argonne appointment. The professor of materials science and engineering arrived at Argonne from the University of Oxford in 2005 and wanted to continue teaching along with research. "I love teaching," she says. "I enjoyed being responsible for students at Oxford, and I didn't want to give up that opportunity."

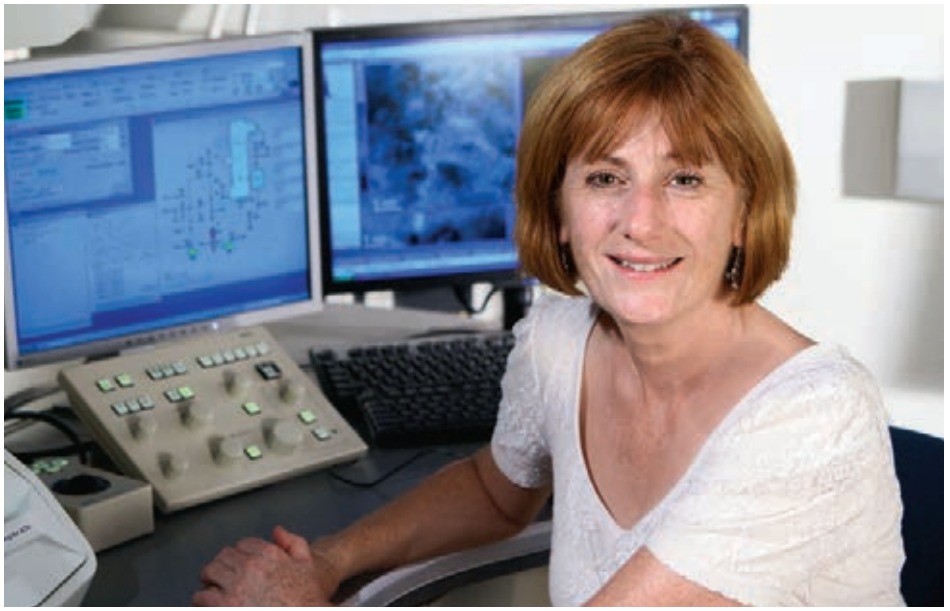
She was an adjunct faculty member at Northwestern before becoming a full professor in 2008. Now she teaches at the University every other year and has a cohort of Northwestern graduate students. "I think it's beneficial for the students because they get access to my research and my group," she says.

Petford-Long directs Argonne's Center for Nanoscale Materials and uses electron microscopy—which illuminates materials at the nanoscale with an electron—to study the behavior of multiferroic films; she applies heat and cold and (like Bedzyk) magnetic and electric fields to see how the materials react. "The kind of research we're doing is very fundamental," she says. "These materials could ultimately be used for computer memory or information storage, but we need to understand how the material behaves."

Petford-Long has had several collaborations with faculty from Northwestern's Department of Materials Science and Engineering, including David Seidman, Walter P. Murphy Professor, and Lincoln Lauhon, associate professor. She is also involved in a collaborative project that uses electron microscopy to examine what happens when glass is heated to create crystallines. After this process is completed, images can be stored in the glass, which, with its high resolution and dynamic range, could be useful in mammogram image plating.

"I really welcome the collaboration," she says. "Argonne has very good scientists and a lot of capabilities and expertise that aren't available at Northwestern. But the collaboration also benefits Argonne enormously. Having high-quality





universities around means we can attract high-quality collaborations and have access to professors and their research capabilities and interests."

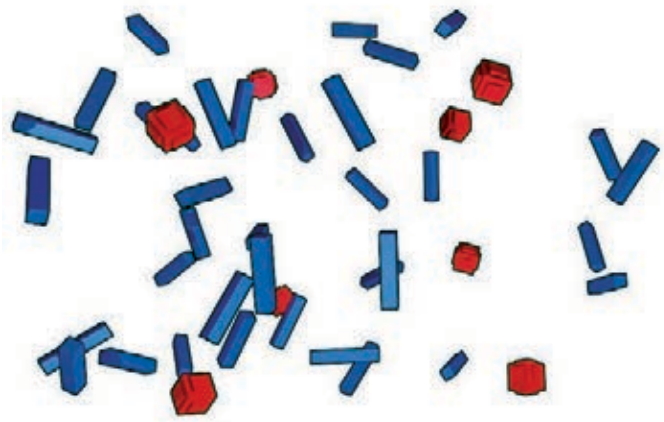
Increasing the quality of collaboration

That neatly sums up the goal of the Northwestern-Argonne Institute for Science and Engineering. The partnership's first order of business is identifying liaisons from the two institutions who can help make connections. Then, if all goes as planned, this winter the institute will begin offering minisabbaticals that will allow McCormick professors to take a quarter off from teaching to conduct research and create new relationships at Argonne. (McCormick offers a similar sabbatical program with the University's Feinberg School of Medicine that has borne several new collaborations.) The two institutions also hope to organize more joint conferences and cofund graduate students, an arrangement that would offer more opportunities to Northwestern students while giving Argonne researchers access to young talent.

"Argonne is already connected with the University of Chicago, which manages the laboratory," Ottino says. "With this agreement, we hope to create an axis of cutting-edge research in the Chicago area that includes our strengths in engineering. It will make connections easier and more effective, and everyone will benefit."

M Emily Ayshford

Left: Michael Bedzyk and graduate student Martin McBriarty at Argonne's Advanced Photon Source
Top: The Advanced Photon Source
Above: Amanda Petford-Long



A WINNING FORMULA

Weekends of brainstorming for competitions pay off for graduate student Chris Wilmer

Above: Chris Wilmer and drawings of a metal-organic framework self-assembling from his work in the lab of Randy Snurr. The blue shapes represent organic molecules, and the red cubes represent metal-containing molecules.

"I have no discernible schedule," says chemical and biological engineering PhD candidate Chris Wilmer. "When I was working on a project to estimate the distribution of electrons in crystals, I slept in the office for 10 days straight and showered at the gym. I didn't want to lose time commuting." Commuting would have meant a trip to an apartment a few blocks away.

Since marrying last summer Wilmer spends more time at home, but he continues to manage his time vigilantly—especially when it comes to entering science and engineering competitions. "We never spend more than a sleepless weekend or two on a competition entry," says Wilmer, who typically collaborates for the competitions with researchers from other disciplines (see sidebar).

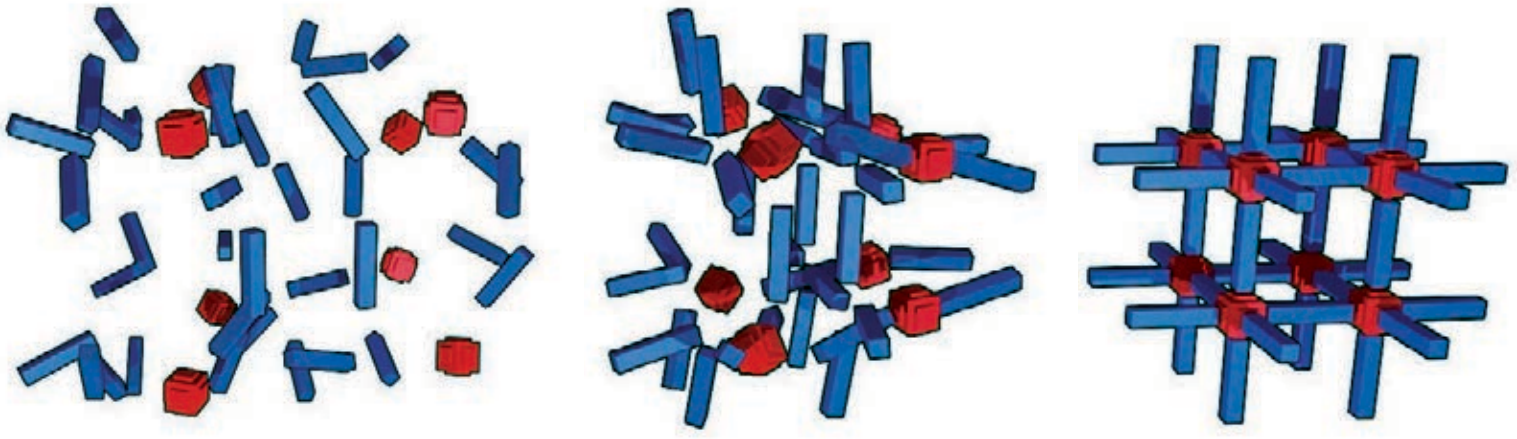
Wilmer's small investment of time has yielded big rewards. Between fall 2009 and spring 2011 Wilmer and his teammates collected more than $60,000 in prize money from competition organizers such as InnoCentive, which describes itself as "the world's largest problem-solving marketplace." An even bigger payoff, says Wilmer, is "to learn about a real problem that needs solving and to know that your solution will be relevant." Competition winners may see their ideas implemented quickly—a literal change of pace from the years of research and testing that shape the schedules of graduate students like Wilmer, who enrolled in McCormick in 2007.

Working in the lab of Randy Snurr, professor of chemical and biological engineering, Wilmer designs materials capable of absorbing greenhouse gases or storing natural gas. "Gases are usually highly dispersed, but they like to stick on surfaces. Crystals are porous with lots of surface area and holes, like sponges that can soak up the gases," says Wilmer. The team creates the ultra-absorbent crystals via self-assembly of molecular building blocks.

Knocking off a quick competition entry related to Wilmer's ongoing research might sound like a no-brainer, but Wilmer says the projects for the competitions he enters are "tangents not directly related to my research." Even so, he says he learns something from each entry, win or lose. *Competition rule #1: Winning isn't everything; learning is.*

Even with his impressive number of victories, Wilmer wins only about 50 percent of the competitions he enters. He takes losses in stride and may recycle the entries for another competition. "Sometimes a project loses one competition but wins another," Wilmer says. *Competition rule #2: If at first you don't succeed, try again.*

The real key to Wilmer's success, he says, is simply participation. "We're entering an era of



crowd-sourcing. You can't be afraid to go beyond what you know; you have to be open to learning from others," says Wilmer, who often collaborates online with colleagues throughout the world. *Competition rule #3: Multiple brains are better than one.*

The breadth of topics Wilmer tosses around with teammates demonstrates his fearlessness as well as his openness to new ideas. In the past two years he has weighed in on microfinance, toothpaste, and water treatment in developing countries (see sidebar).

"Science is in my bones," says Wilmer, who grew up in a suburb of Toronto, the son of a mathematician and a psychologist, both Polish émigrés who were visiting Canada when Poland went under martial law in 1981. In high school Wilmer lapped up books like Ray Kurzweil's *The Age of Spiritual Machines* and K. Eric Drexler's *Engines of Creation.* At the University of Toronto, Wilmer studied engineering and met his wife, a historian.

Wilmer's winning streak is not confined to science competitions. He took first place at McCormick's art fair last year for a sculpture of an alien that he created using Blender, a free software program he's been playing with since high school. On the Shapeways website, Wilmer turned the computer-generated image into a sculpture via 3-D printing. He used the same process to craft silver wedding rings that he and his wife designed together: a circle of stylized letters that spell out "Chris loves Emily loves Chris loves Emily."

Sounds like another winning collaboration for Wilmer. **M** Leanne Star

WILMER'S WINNERS

Overcoming the cultural barrier: leveraging microfinance networks for local community-based distribution of folic acid and other micronutrients
Collaborators: Toan Vu Phan, international macroeconomics; Simeon Bogdanov, electrical engineering and computer science; Eneda Hoxha, medical genetics and molecular biology—all Northwestern PhD students

Winnings: $10,000 third prize from InnoCentive: Scientists Without Borders Global Malnutrition Challenge; $5,000 Dow Sustainability Innovation Student Challenge Award

"Getting folic acid into foods is easy, but people weren't going for the fortified foods. We suggested highlighting the profitability of folic acid enrichment and encouraging local food sellers to promote the foods."

Clean drinking water in developing countries via solar disinfection: an inexpensive quality-control mechanism
Collaborator: Ron Appel, CalTech electrical engineering PhD student

Winnings: $10,000 first-prize Perkins Coie Innovative Minds Award; $50 first prize at the Northwestern Public Health Innovations Conference; $250 InNUvation Applied Research Day ISEN Award

"It's been exciting to see this idea implemented. CORR TECH is manufacturing the device, which measures sunlight exposure to determine how much UV disinfection is needed. It's being field tested by the Albert Schweitzer Hospital medical research unit in Gabon, Africa."

Oral care for the poor: waste-free refillable toothpaste system
Collaborator: Toan Vu Phan

Winnings: $1,000 second-prize Perkins Coie Innovative Minds Award

"Toan was in Vietnam; I was in Kansas. We spent New Year's Eve collaborating over the Internet."

Synthetic DNA management system
Collaborators: Wilmer went solo, but "my dad advised me on this one, and that was part of my motivation."

Winnings: $31,500 first prize from InnoCentive private sponsor

"The challenge was to create a communication system to organize large quantities of information about synthetic DNA produced by private and government labs, like creating a mini-Amazon.com for scientists. The solution was a software database. Two weekends of work."

Absence of "profit drive" incentive to employ water treatment technology in rural populations of developing nations
Collaborators: Toan Vu Phan, Simeon Bogdanov

Winnings: $4,000 first prize from InnoCentive: Nature.com

"The kernel of the idea came out of an interdisciplinary grad student discussion group I run called Let's Connect the Dots. We've talked about everything from gun control to health care."

SUPERFAST STARTUPS

NUvention: Web helps students create software companies in record time

At the end of their first quarter of NUvention: Web—a sequence of two courses in which students develop and launch software companies—a team of students stood before the course's advisory board and pitched their idea. It's an iPhone app, the students explained, that scans your music library and organizes your playlist according to your moods or activities. It seemed like a good idea to the students, but the board thought otherwise.

"We got ripped apart," recalls Neal Ehardt (computer science '12). "We were advised to stay away from music, and we were told that the idea was not enough for a business."

But by the end of spring quarter the group came back with a new idea—an iPad music magazine for the 21st century—and the reaction was enthusiastic. By the end of the summer the team had raised $150,000 and was gearing up for a launch.

That kind of speedy success story is the hallmark of NUvention: Web, one of a suite of experiential learning courses offered by Northwestern's Farley Center for Entrepreneurship and Innovation. The course takes students from schools across the University, puts them into multidisciplinary teams, and charges them with creating software companies that address current or future needs. Coached by faculty members, successful alumni, and web entrepreneurs, teams explore a suggested area (smartphones or tablets, for example) and are given two quarters to turn an idea into a company. Over those two quarters they hear lectures from top Northwestern professors and alumni who have launched successful software businesses and products, and at the end of each quarter they present their ideas to an advisory board that includes successful entrepreneurs, venture capitalists, and executives.

The course is chaired by Todd Warren, who spent 21 years at Microsoft serving as corporate vice president from 2004 to 2008 and developing the technical product strategy for Microsoft's Windows Mobile operating system and related products. After retiring in 2008, Warren—who serves on Northwestern's Board of Trustees and the McCormick Advisory Council—came back to McCormick to teach a software engineering course. He spoke with Farley Center director Michael Marasco about NUvention: Medical Innovation—which focuses on creating medical devices—and the two began to create a similar course using Warren's experience.

Several successful apps came out of the first NUvention: Web course in 2010, including a navigation app for the Lincoln Park Zoo (see spring '11 *McCormick* magazine) and a company called Adaptly, a service that allows businesses to buy ads on multiple social network ad platforms simultaneously. Adaptly, cofounded by Nikhil Sethi (electrical engineering '10) and Garrett Ullom, a computer science junior who put his studies on hold to start the company, has gone from two guys working out of Sethi's studio apartment to 25 employees working in a Manhattan office. The move was made possible by a round of fundraising that garnered the company $2 million. Adaptly's clients now include Pepsi, General Electric, Arby's, and News Corp., among others.

"We're continuing to expand our business and chug away," Sethi says. "But we still have all of our old desks in my living room. It's kind of weird that I haven't replaced them with a sofa and television yet."

Sethi, who founded another company his sophomore year in college and was recently named an "All-Star Student Entrepreneur" by *Forbes* magazine, says he feels comfortable in a business setting, while his engineering background gives him the ability to understand the technical aspects of the field. He still gets advice from professors and alumni affiliated with the Farley Center, however. "Those advisers and investors have supported our every decision," he says. "Without that program we wouldn't be where we are."

Success stories like Adaptly have made the NUvention: Web one of the hottest courses on campus. "We could probably do two sections and still have people who couldn't get into it," Marasco says. "Through this course you can actually create an app and launch it across multiple platforms in less than six months."

This year Marasco and Warren reengineered the class to make way for

tablet computing (which wasn't as pervasive a year ago) and to create more opportunities for smartphone apps. They tried to get students to focus more on customer needs and embraced a concept called the "lean start-up," which focuses on creating shorter business models rather than long business plans. "It helped our non-Kellogg students get a better grasp on business concepts," Marasco says.

Then they let the students run with their ideas.

VIRTUAL SAVINGS

Picking an idea that sticks is the first challenge for many student teams in NUvention: Web. The members of one team knew they wanted to do something local, something that would appeal to the Northwestern student base. Perhaps a smartphone shopping app, they thought, or a dating app. "We had 30 or 40 ideas on a list," says Austin Asamoa-Tutu, a student in Kellogg School of Management. "We just kept at it, going back and forth."

"One day we just picked one," says Kalan Kircher (biomedical engineering '11). The team would create an app that would benefit local businesses. But what did those businesses need? The team walked around downtown Evanston and talked to shop owners: What problems did they face? What sort of technology could help them?

Eventually the team approached Downtown Evanston, the local merchants' association, which had recently begun selling a gift card/coupon package called "Passport to Evanston." That could be an excellent starting point for an app, the team realized. Downtown Evanston agreed, and the team got to work on creating virtual coupons. Within six months they had launched SweetPerk, a smartphone shopping app available on the Android and iPhone platforms that helps residents and visitors discover great perks at more than 75 participating businesses in downtown Evanston. The app also includes a business listing complete with maps, store and restaurant information, and phone numbers.

"We want to make hyperlocal shopping more digital," Asamoa-Tutu says. "Bigger companies don't offer that. We saw the need and wanted to bring the benefit of prevalent technology to local businesses in a simple and effective way."

The app launched May 26 with more than 450 downloads in its first 12 days, and the team expects to surpass 10 times that in Evanston by the end of the year. "The team launched Android and iPhone versions of their app before the course was over," Marasco says. "That has never happened before in NUvention: Web and really shows the nature and potential of the app business."

The SweetPerk team: Mili Jain, Kalan Kircher, Austin Asamoa-Tutu, Phil Dziedzic, and Matt Gilk; not pictured: Christopher Nish

The Groovebug team: Jere McAllister, Neal Ehardt, Jeremiah Seraphine, and Brad Awodu

Getting the app to the marketplace took two quarters of hard work: team member Christopher Francis, a computer science graduate student, spent several hours learning how to program an Android app, and the group spent much of its time brainstorming ways to track redemptions of Evanston's virtual coupons. Members eventually settled on specially designed quick response, or QR, codes, which smartphone users can scan to gain access to information created by a business. Each business would have its own QR code at its register, and a customer using the app would just scan the code, and the program would keep track of usage.

The idea proved a little rougher in practice. For example, some stores have several cashiers and each would have to be trained to use the system. But ultimately the idea worked. The app—with interface design by Phil Dziedzic, a graduate student in engineering design and innovation—gives users a list of businesses in different categories (shopping, restaurants, etc.). When a user chooses a business, he or she receives a page with the business's name, a description, a map, the phone number, and a "redeem" button that activates the code scanner. Over the summer the group added more features, including benefits for loyal customers, and worked to expand their idea to other parts of Evanston and shopping malls. Team members are currently looking for funding to help them expand their idea.

"It's fun," says Kircher, who deferred a job offer for a year to keep working on SweetPerk. "You're personally invested in every single move your company makes. The decisions you make each day affect whether you succeed or fail. I found there were times when I knew I should be doing my homework, but I really just wanted to work on the business. It's great to be excited about something like that."

"It's fast paced and exciting," Dziedzic says. "That's great for me, because I get bored easily."

Asamoa-Tutu, who worked for eight years as a software manager before enrolling in Kellogg, says his professors have stressed the idea that entrepreneurs have the opportunity and responsibility to create new businesses and jobs in tough economic times. "That merged really well with why I came to school," he says. "Especially in a recession, being part of creating jobs has so much meaning for me."

The group has big plans for SweetPerk, but for now it is proud of coming up with an idea and putting it into practice within two short quarters. "It was a monumental effort," Asamoa-Tutu says. "I think we all buy into the same vision. It's really exciting."

A MUSIC MAGAZINE FOR THE 21ST CENTURY

After the NUvention advisory board ripped apart their iPhone music app idea, members of that team knew they had to change their concept—but they ignored the board's advice about the music industry. Sure, the old guard

"Through this course you can actually create an app and launch it across multiple platforms in less than six months."

MICHAEL MARASCO

wasn't making any money off of record sales, but there was still money to be made. "Music services are actually doing really well," says Jeremiah Seraphine, a graduate student in integrated marketing communications at the Medill School. And music was where the team's passion lay: Neal plays the drums, while Jeremiah is a coowner of the record label Revolutionary Music.

So they concentrated on creating an iPad app and came up with an idea that ultimately impressed the board: a personalized music magazine called Groovebug that scans your music library to offer artist information, news, videos, concert dates, and recommendations for similar music. It's the type of magazine that couldn't have existed 10 years ago but now seems like an inevitable and necessary realization of both music and information technology trends.

"The concept of developing a music magazine that synchronizes with your own music collection and gives you up-to-date content on what's going on with that band hasn't been done before," Marasco says.

The app works by pulling content from websites including EchoNest, YouTube, Last.fm, and Google custom search. Those sites pull news from thousands of other websites and blogs and build recommendations using specialized software. "All of this content is out there for free," Ehardt says. "We figured it would be nice to have this all pulled together for you on your iPad."

The team surveyed potential users about their needs and priorities, then designed an interface that pulls together the content into a stylized magazine experience. "With most music magazines, you are limited to what they curate for you," Seraphine says. "Groovebug gives you the content you want and replaces the experience of looking through a record album. With mp3s, you don't have anything to look at. This is what a record cover should look like in the 21st century, merged with the concept of a magazine."

The group used its music knowledge to choose news sources (including more than 2,000 blogs) and spent hours testing the results to make sure that a search for "Prince" brought up the musician and not an heir to the British throne. Members then released the app to a group of beta testers and tweaked the concept based on user demand.

At the end of the second quarter of NUvention: Web, the team returned to the site of its earlier dressing-down and received its reward: the board was so impressed with Groovebug that they told team members their business was worth more than the team had stated; one board member even offered to be the first investor.

The group spent the following summer in the Farley Center's incubator space in downtown Evanston, refining the app and raising $150,000 in seed money, much of it from alumni. It launched the app September 8.

The Groovebug group hopes to make money through affiliate relationships with mp3 and ticket sellers and eventually hopes to provide artists with a platform to promote their music on the app. But before that happens, the team must convince users that Groovebug is the music magazine of the future. "Right now it's all about the ultimate customer experience and making our customers happy," Seraphine says.

Groovebug was just one of several NUvention: Web teams in the Farley Incubator space in downtown Evanston last summer. The office space is available free for up to a year to NUvention teams and other students who apply; it offers both a physical address and a chance for teams to network with other Northwestern startups. This past summer the incubator housed businesses that ranged from creators of apps that allow users to review restaurant menus or find taxis to a developer of diagnostic devices for women's reproductive health.

Marasco says the space has been key in helping make teams successful. "They've had a place to go, with support from us, after the course has ended," Marasco says. "There's been a lot of excitement, and we hope that will continue to grow." **M** Emily Ayshford

Q&A

NUvention: Web, a two-quarter interdisciplinary course sequence designed to expose students to the entire product and business development life cycle for a software company, has quickly become a popular class for students across Northwestern. McCormick *magazine spoke to* ***Todd Warren,*** *cocreator of the course, and* ***Bob Plaschke,*** *a course adviser, on their experiences with NUvention, the students, and the resulting companies.*

McCormick: Todd, why were you interested in helping to create NUvention: Web?

Warren: I had the opportunity to teach at McCormick while on a leave from Microsoft in 2001, and when I left Microsoft in 2009 I came back and taught a software engineering course. Dean Julio M. Ottino connected me with Mike Marasco, and he described what he had done around NUvention: Medical Innovation—combining students from different disciplines and looking at entrepreneurship holistically. That really excited me. In my career I have gone back and forth between the technical side and the business side, and one of the things I thought Northwestern could do well was look at the multidisciplinary approach that goes into making a software product and give students the experience to learn project management techniques and methods and collaborate with business students.

McCormick: Bob, how did you become involved?

Plaschke: I met Mike Marasco at a dinner four or five years ago out here in California, and we were talking about ways that I could contribute to the University. I said I'd love to be able to help more folks to come out here and get jobs. I'd love to be a gateway to Silicon Valley. I said I could also come and talk about what I did and some of the experiences that I've had out here in the valley.

Mike and Todd then came out and asked if I would help as a NUvention: Web adviser. It's a wonderful program—it really does show the best of what Northwestern and its students can do. It's been a positive experience—positive for me and my company. I've gotten more out of this than I've given.

McCormick: What do you think makes NUvention so successful?

Warren: We have this amazing ingredient that is the Northwestern students. We also push students to work together and to have something tangible at the end of the course. That gives students the experience of failing forward but also the opportunity to see they can have impact beyond what they thought they could at the beginning of the course.

Plaschke: I think the combination of Todd and Mike as leaders and as facilitators is what makes the course unique. I've seen these kinds of efforts elsewhere, and they are successful, but they don't have the same passion and enthusiasm that Mike and Todd provide. And Todd's particular background adds both credibility and realism.

Warren: I would add the advisory board. I think it's this combination of multidisciplinary students, real-world results, and a real-world advisory board that makes it different.

McCormick: You've both had successful careers in computer and mobile technology. Why take the time to help teach the course and coach students?

Warren: I think there's an opportunity to see what's happening in the market through the students' eyes. That benefits me. Seeing how students look at markets and how they behave gives me a window on coming web trends. Plus, there is great satisfaction in helping students explore more deeply and become much better prepared for whatever they do—start a company, go to graduate school, or go into a medium- or large-sized company.

Plaschke: My wife and I both attended Northwestern, but living in California we can't as easily get back, so it was a way to stay connected and give back. It's grown to be much more. I've learned a hell of a lot from the students. They are far more connected to trends than I am. I look forward to it as a two-day tune-up and training course on current trends on the Internet.

What has been unexpected is my ability to retain, attract, and pull in really bright students. This has been, from my company's perspective, the biggest success. We now have four interns from Northwestern over the summer. We had two interns last summer. We have two full-time Northwestern students. All of these folks have been affiliated with NUvention: Web. It's been a fantastic source of human capital for us. Each of our employees has demonstrated their capabilities in front of me and has been recommended by faculty. It's my little secret.

McCormick: What have been some of your defining moments in teaching and coaching in this course?

Warren: For me, an unexpected thing was recruiting the advisory board. I thought it would be great to have some alums from industry give feedback to our students at the end of each quarter. That group has really become an important source of advice for the class and a good set of industry contacts for me. Getting to know other alumni I didn't know and understanding how successful many of our alumni have been in high tech—that's been a great moment.

The second thing has been seeing how students change and grow during the course. Take Groovebug, for example. At the end of the first quarter the advisory board didn't like their concept very much. The day after they met

with the board, the team really wanted to meet with me to figure out how to regroup and work better. Seeing how the teams respond so resiliently—that's been a defining moment.

The unexpected thing is having alums come back after a year and seeing how students hang on every word of someone like Nikhil Sethi (electrical engineering '10), who is having success with his startup. That's been an amazing experience.

Plaschke: I think the defining moment for me was seeing the Groovebug group come back at the end of the sequence. I don't think any of us had any sense of how they would take our feedback and what would pop out. I remember sitting and looking at my fellow advisers. We said, "Wow, not only is this presentation incredibly well done, this is a real company." It's a real company created in an academic course. You typically don't see such high quality. And suddenly people were saying, "I'll actually fund that." They've really cracked the code on that.

McCormick: You both graduated with computer science degrees in the 1980s. What would a NUvention computer science course have looked like back then?

Warren: One of the reasons I ended up teaching software project management is that I experienced a two-quarter software project management course when I was at Northwestern. There was a week of lectures, and they cut six of us loose on a project. We learned by doing, but we didn't have a lot of guidance. I know when I originally talked to folks on faculty about coming back to teach 10 years ago, I said, "Gosh, that course helped me, but it could have been so much more helpful."

I don't think you could have done a course like this before the Internet. One advantage we have is it is pretty fast to get something up and running on the web. Students can get the full-cycle experience in a much shorter time. That's the big change from 25 years ago.

Plaschke: When I was at Northwestern, you got your degree, you found a place to go that would then give you the skills to apply what you had learned, and you would expect that process would be three to five years. After that, you could go off and do what you wanted to do. And therefore, all my course work was incredibly theoretical. And for good reason: that was the way it worked.

What's breathtaking is the pace in this course. Not only is there some good theory laid down, but students immediately get to apply it. It's just like a startup. It's a wonderful laboratory. This program is wonderful for all of the classic skills around building a company and thinking through value propositions and what customers want and shaping the product and failing and rethinking it, but an equal number of lessons are learned on the interpersonal side—what it means to work on a team and make the team work.

Warren: As teachers, we sell a course on software entrepreneurship, but a lot of what the students get is learning about collaboration across disciplines. I think it gives them quite an advantage to have had that experience in a safe, academic setting.

McCormick: What does the future hold for NUvention: Web?

Warren: We're going into our third year. We will continue to recruit a great set of students. The demand for the class doubled from the first to second year, and it will be a high-demand course again this year. Mike has done a great job of thinking through all the things we can do to extend what's happening in the course.

I think NUvention alumni will continue to play a larger and larger role in the evolution of the course. What I'd like to think is, in 10 years there will be a set of NUvention: Web alumni who get together and will be some of the titans of the Internet business at that point. Just like how there is a purple mafia in Los Angeles [in the entertainment industry], there will be a purple mafia in Silicon Valley and in Chicago that are driving the industry forward.

Plaschke: I think this is only going to build on itself. I think the quality will continue to improve because better and better students will apply, and Mike and Todd will be able to put together even more compelling teams. At some point the secret will have gotten out, and there will be more venture capitalists from Silicon Valley showing up.

This experience is authentic. For me, having to deal with everyone out here, it's very nice to have some authentic, hardworking students who actually want to learn. I hope that as the course becomes more successful it doesn't lose its Midwestern orientation.

Todd Warren (computer science '87) spent 21 years at Microsoft in management and product development roles. He served as corporate vice president from 2004 to 2008 and was responsible for the development and technical product strategy for Microsoft's Windows Mobile operating system and related products. After retiring in early 2009, Warren, who also serves as a Northwestern trustee and on the McCormick Advisory Council, came back to the school to teach a software engineering course at McCormick. He then worked with Mike Marasco, director of the Farley Center for Entrepreneurship and Innovation, to create NUvention: Web.

Bob Plaschke (computer engineering '85) is the president and chief executive officer of Sonim Technologies, pioneer of the world's toughest GSM phone, the Xtreme Performance 1. He has served as entrepreneur-in-residence at Sutter Hill Ventures, where he focused on wireless investments, and was senior vice president of worldwide client services at Infospace. He also served as chief financial officer and vice president for business development at Prio and an associate at McKinsey & Company.

TAKING DESIGN TO THE NATION

DESIGN *for* AMERICA, the Northwestern University student initiative that creates local and social impact through interdisciplinary design, has expanded to eight more universities and colleges across the country, including Barnard, Brown, Columbia, Cornell, Dartmouth, Oregon, Stanford, and the University of California, Los Angeles.

More than 20 students from those colleges descended on Northwestern in August for the first-ever Design for America Leadership Studio, which launched the expansion. Students spent a weekend learning Design for America's values and processes and ways to effect change in their own communities. They spent Friday on a one-day design project: how to improve the lives of people with asthma. The students interviewed a mother and her five-year-old son and tried to frame and reframe potential problems. They then used Play-Doh, foam core, markers, and Post-it notes to brainstorm possible solutions.

Students spent Saturday reflecting on their experiences with organizations and learning the core values of Design for America: to look locally, act fearlessly, and create fervently. They talked about working in teams and heard from coaches on how to best work with different types of communities. They heard from design sage Bruce Mau, designer and distinguished fellow of the Segal Design Institute at Northwestern, who shared his story and his design manifesto. Students then spent Sunday learning how to run a DFA studio and how to scope out projects: Are they daring, feasible, and applicable? Are they interdisciplinary? Do they make you excited?

Design for America was conceived at McCormick in 2008. DFA organizers aim to make the Leadership Studio an annual event and hope to expand the organization to more than 50 universities over the next five years.


SegalDesignInstitute

Alumni profile: **Deepak Ahuja**

The chief financial officer for Tesla Motors leverages his engineering background to succeed in business

"Change is good," says Deepak Ahuja, chief financial officer for Tesla Motors, the automotive company that has buyers salivating over high-end electric vehicles that go from 0 to 60 in 3.7 seconds—with zero emissions. "Change forces you to push your limits and discover your potential."

Ahuja is clearly comfortable with change. He has lived on three continents and worked in fields as dissimilar as ceramic engineering and finance. Above all, he has been flexible about what to do next, learning along the way what gives him the most satisfaction in work and life.

Growing up in Mumbai, Ahuja originally planned to go into the family business. His parents were serial entrepreneurs who had established several successful businesses, primarily in the garment industry, manufacturing jeans and lingerie. After Ahuja earned a bachelor's degree in ceramic engineering from Banaras Hindu University, his father invited him to become a business partner in a factory that would manufacture ceramic insulators for the electric grid. The plan was that Ahuja would study in the United States to learn more about ceramic technology, then he would return to India.

The initial part of the plan worked well: in fall 1985, at age 22, Ahuja enrolled in McCormick as a PhD student in materials science, his first time in the United States. Two years later he had earned a master's degree and made a couple of alterations to his life plan: he would not return to India right away, and he would not complete a PhD. "A PhD would have taken me too deeply into pure science," explains Ahuja, who discovered he was more interested in applied technology.

While at Northwestern, Ahuja maximized his experience both on and off campus. At McCormick he was strongly influenced by professors Morris Fine, R. P. H. Chang, and Thomas Mason. But before Ahuja could learn from them, he had to adjust to the American educational system. "In my first class, Professor Fine made an assignment and said it had to be typed," remembers Ahuja. "I told him that in India I had done programming on mainframes, but I had never used a PC. He said that was unacceptable." Ahuja found an IBM desktop in the department but had no idea how to turn it on, and his repeated inquiries to someone working there went unheeded. "I had a heavy accent and couldn't make myself understood," he says.

A fast learner, Ahuja went on to immerse himself in his studies, becoming a teaching and research assistant—"a wonderful experience," he says. He also took full advantage of his new surroundings. He joined the sailing club and learned to captain a small boat. When he was offered the use of a car to drive to Argonne National Laboratory to do research, he practiced driving in Chicago—"very different from India." He became president of Northwestern's Indian student association and organized social activities for the group. While at Northwestern he met his wife, a physical therapist who was also from India. "I have an emotional soft spot for the Chicago area," says Ahuja.

> "When I moved into the business world, I wanted to leverage my engineering background."
>
> DEEPAK AHUJA

But Ahuja's fondness for Northwestern and Chicago did not tie him down. He and his wife soon moved to the Pittsburgh area, where for almost six years Ahuja worked as an engineer for Kennametal, developing ceramic composites for use in the aerospace and automotive industries. While there, he racked up four patents for new ceramic materials. As successful as he was, Ahuja did not see room to grow in his job. He decided to make another transition, this time to the business world. "I wanted to help drive strategic decision making," says Ahuja, who earned an MBA from nearby Carnegie Mellon University while working at Kennametal.

"When I moved into the business world, I wanted to leverage my engineering background. I wanted to work in an environment with a manufacturing core; joining a bank would have been out of the question for me," says Ahuja, who put his business skills to work for Ford in 1993, relocating his family to Michigan. "My engineering background made me a much better finance person."

Ahuja began his financial training at Ford's Woodhaven stamping plant, where he worked as a production line supervisor for a few months. "I had been in manufacturing plants with my parents from a young age," says Ahuja, "but manufacturing in the United States is a very different experience. You're part of a massive enterprise. It gave me a back-to-basics understanding of how manufacturing and the auto industry work."

At Ford, Ahuja gained diverse business experience dealing with financial aspects of manufacturing, product development, marketing and sales, currency hedging, and acquisitions. "Then Ford offered me the opportunity to grow from manager to leader," says Ahuja, who became CFO for a joint venture between Ford and Mazda and later served as CFO for Ford of Southern Africa. "South Africa opened the eyes of my children and helped them develop empathy for others," he says. The Ahujas' two daughters are now 17 and 19.

Back in Michigan, Ford asked Ahuja to join the leadership team directed to bring fuel-efficient automobiles to the North American market—a segue that foreshadowed his current work at Tesla. Coming back from South Africa also made Ahuja realize that he enjoyed smaller organizations, so when Elon Musk, the charismatic chair and cofounder of Tesla, approached Ahuja in 2008 about joining the company, Ahuja found the offer hard to resist.

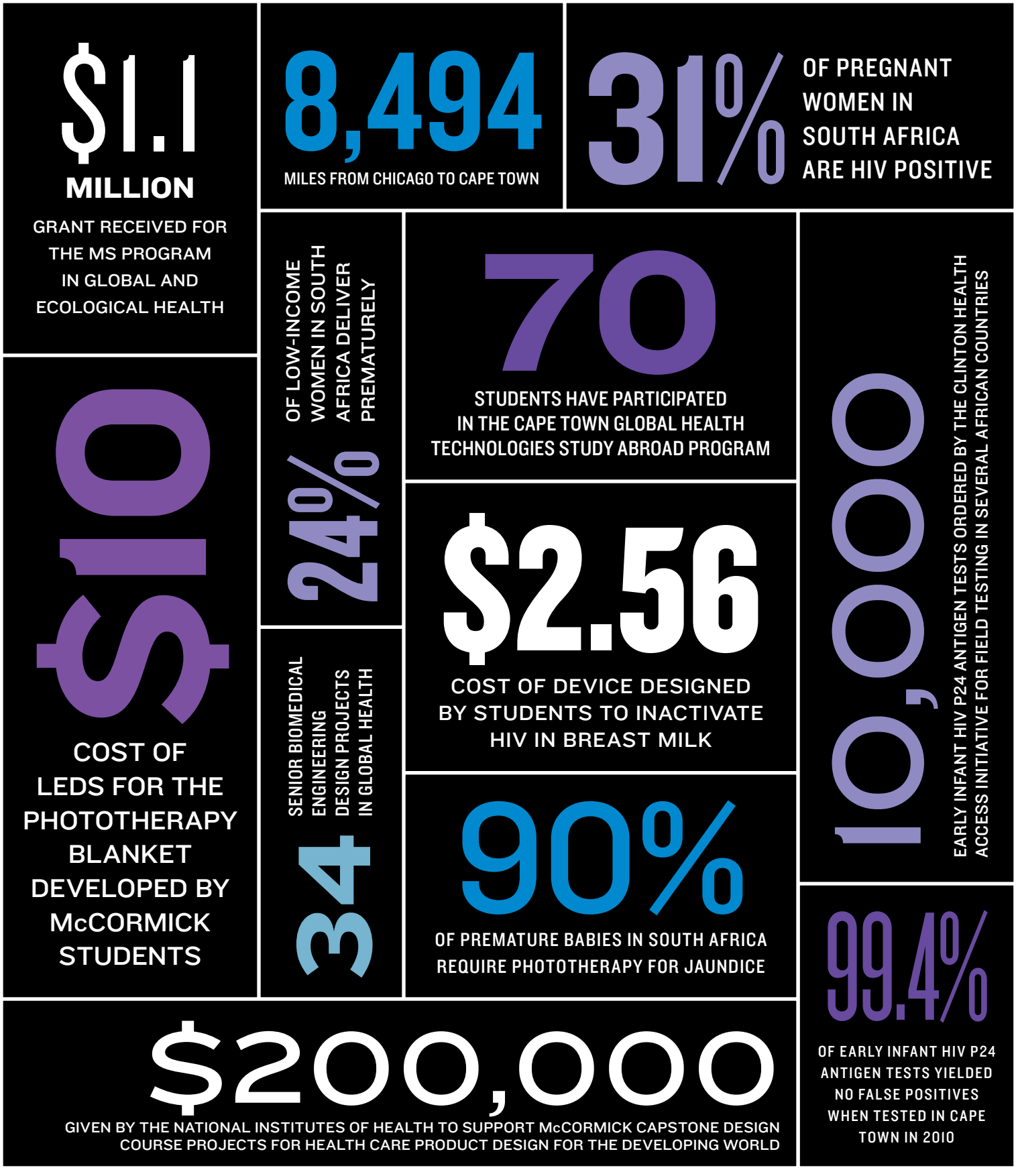
"Elon is a dynamic person with a vision to

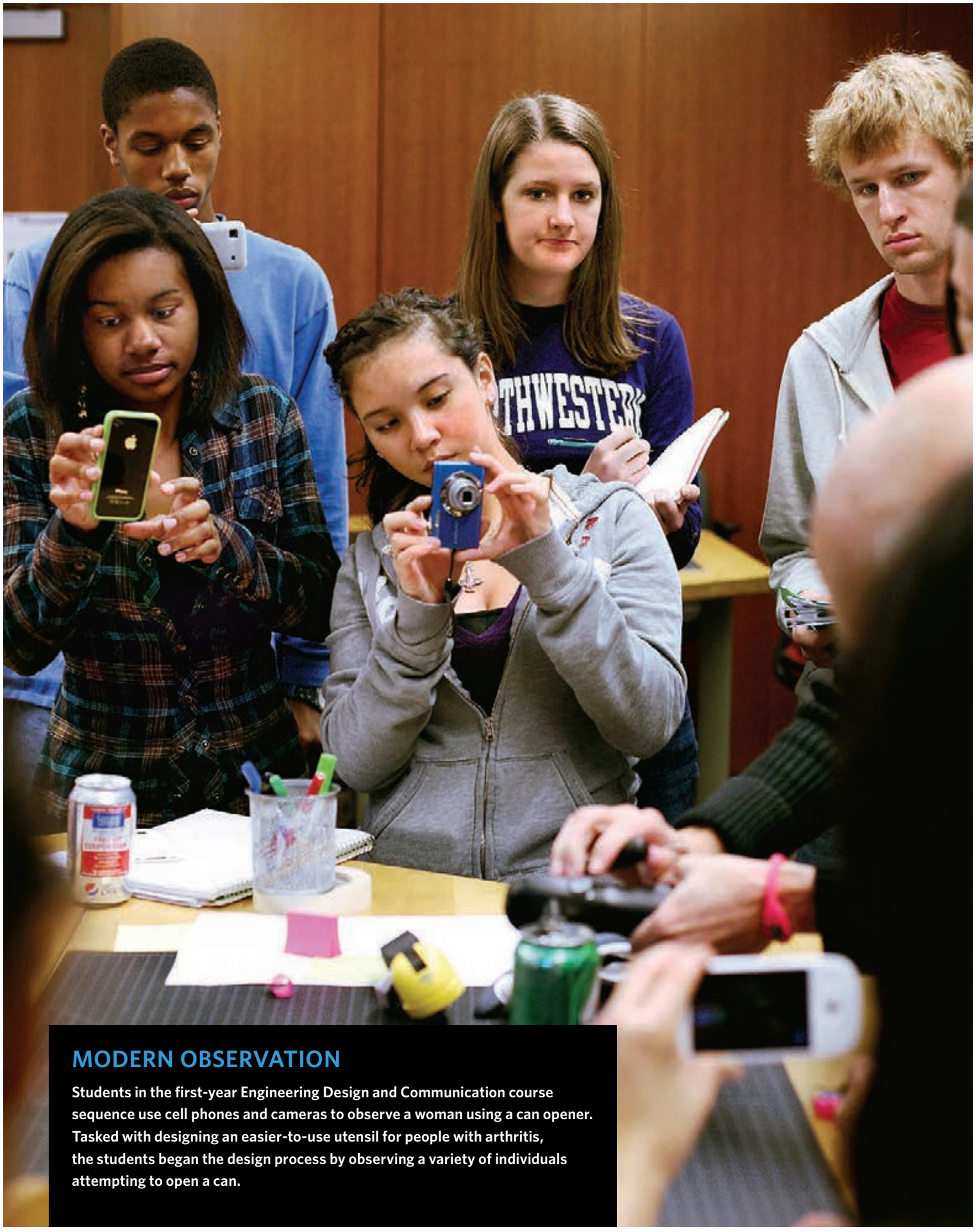
make all-electric cars for the 21st century," says Ahuja. "He took me for a ride in a Tesla Roadster and then let me test-drive one. It blew my mind." Another attraction for Ahuja was Tesla's unique business model. The company owns all its stores and sells its cars at a fixed price—$110,000 being the base price for the sculpted, hand-built, all-electric Roadster model.

Persuading his family to relocate to Palo Alto, California, was easy—"After South Africa, they were used to moving"—and the lifestyle agrees with them. Ahuja logs about 50 miles of road biking on weekends and fits in hikes when he can. When the mood strikes he may whip up a Sindhi curry, blending lentils with special spices for a taste of home. He travels to India to visit his parents, but he has not complied with his original plan to return there to work. "It is quite unlikely, but one can never say never," says Ahuja. "One thing may lead to another." M Leanne Star

Top: The headquarters of Tesla in Palo Alto, California
Bottom: The Tesla Roadster

Global health *by the numbers*





MODERN OBSERVATION

Students in the first-year Engineering Design and Communication course sequence use cell phones and cameras to observe a woman using a can opener. Tasked with designing an easier-to-use utensil for people with arthritis, the students began the design process by observing a variety of individuals attempting to open a can.

CLASS NOTES

1960s

John S. Newman ('60), professor of chemical engineering at the University of California, Berkeley, joined RTI International as a distinguished fellow and the chief engineer for the Research Triangle Solar Fuels Institute.

John F. Carney III (MS '64, PhD '66) stepped down as chancellor of the Missouri University of Science and Technology in August.

Phillip L. Gould (MS '66), a senior professor at Washington University in St. Louis, was named a distinguished member of the American Society of Civil Engineers.

Howard J. Sumka (MS '68) was appointed CEO of OneVoice, an initiative of the PeaceWorks Foundation, which seeks to help Israeli and Palestinian moderates achieve a two-state solution.

Fang-Chen Luo (MS '69, PhD '73), the chief intellectual property officer of AU Optronics Corp., received the Jun-ichi Nishizawa Medal from the Institute of Electrical and Electronics Engineers for contributions to his industry.

1970s

Dennis L. Christiansen ('70), agency director of the Texas Transportation Institute, was appointed to the board of directors of the Intelligent Transportation Society of America.

Michael O'Rourke (MS '70, PhD '72), a faculty member in the department of civil and environmental engineering at Rensselaer Polytechnic Institute, received the 2011 Walter P. Moore Award from the American Society of Civil Engineers.

Allen Taflove ('71, MS '72, PhD '75), professor of electrical engineering and computer science at McCormick, was inducted into *CQ Amateur Radio* magazine's 2011 hall of fame.

Richard W. Gochnauer ('72), who was director and CEO of United Stationers until his retirement in May, was elected to the UGI Corporation board of directors.

Dean O. Knudson (PhD '72), an associate professor of computer science at North Dakota State University, received one of the university's highest honors, the Peltier Award for Teaching Innovation.

Jonathan I. Hattis ('73, Kellogg '75) was promoted to president of American Asset Management Services Corp. in Skokie, Illinois.

Matthew V. Tirrell III ('73) was appointed founding Pritzker Director of the University of Chicago's Institute for Molecular Engineering.

Charlotte S. Yeh ('73, Feinberg '75) is chief medical officer of AARP Services Inc. in Washington, DC. She received the American Hospital Association's 2011 Board of Trustees Award in April.

Peter J. Barris ('74), managing general partner of New Enterprise Associates, was eighth on *Forbes* magazine's 2011 Midas List, a ranking of 100 top venture capitalists.

Promod Haque (MS '74, PhD '76, Kellogg '83), managing partner with Norwest Venture Partners, received a 2011 Visionary Award from the Silicon Valley nonprofit group SDForum in recognition of his outstanding achievements and contributions to the technology industry.

Donald P. Monaco ('74, MS '74), principal owner of Monaco Air Duluth, joined the board of directors of Next 1 Interactive.

Paul J. Wotowic ('74), immediate past chief of staff for the San Ramon Regional Medical Center, was named to the hospital's governing board for 2011–12.

Joshua J. Jacobs ('77), an orthopaedic surgeon at Rush Medical Center in Chicago, was named second vice president of the American Academy of Orthopaedic Surgeons.

Enrique R. Venta (MS '77, PhD '80), dean of the Lamar University College of Business, was appointed to the Texas Emerging Technology Fund Advisory Committee by Governor Rick Perry.

Thomas J. Riordan ('78), most recently president and chief operating officer of Terex Corporation, was named president and CEO of Neenah Enterprises Inc.

David L. Porges ('79), president and CEO of EQT Corporation, was named chairman of the company's board of directors.

Virginia M. Rometty ('79) was named president and CEO of IBM, effective January 1, 2012.

1980s

Frederick R. Ferrin (MS '80) was named vice president of TranSystems, an engineering and consulting firm. He was formerly CEO of the Jacksonville, Florida, Port Authority.

George Ribarchik ('82) was promoted to vice president of research and new technology acquisition for Peaceful Greasy Feeling Inc. His company is a leading supplier of lubricants, solvents, and waxes, which are utilized by the automotive and aerospace industries. In addition, he took third place at the "Men's National Dance-Off" competition, recently held in Butte, Montana.

Helen S. Kim ('85), chief business officer of NGM Biopharmaceuticals, was appointed to the board of directors of ImmunoCellular Therapeutics.

Kristin Asleson McDonnell ('85), most recently CEO and cofounder of LimeLife, was appointed to the advisory board of aisle411, a mobile retail navigation service.

James N. White ('85) of Sutter Hill Ventures was 32nd on the 2011 *Forbes* magazine Midas List, a ranking of 100 top venture capitalists.

Gregory B. Morrison (MS '87), senior vice president and chief information officer of Cox Enterprises, was named to the board of directors of Gwinnett Technical College.

June E. Taylor ('87, Kellogg '93), president and CEO of MWV Pinnacle Advisory Services, was appointed to a four-year term on the Ohio Casino Control Commission.

Mason B. Reay ('89) was named president of Nuun & Co. He was formerly head of marketing.

1990s

Michael P. Maley ('90) was named president and CEO of Hydro Green Energy.

David L. Nichols ('91, Kellogg '00) was appointed Americas CIO services leader for the advisory practice of the law firm Ernst & Young, based in its Chicago office.

Vinod Kumar Dasari (MEM '92, Kellogg '92) was promoted to managing director-designate of Indian automobile manufacturer Ashok Leyland in April.

Sheila K. Gujrathi ('92, Feinberg '96) was named chief medical officer of biopharmaceutical company Receptos Inc.

William James Krueger (MEM '92, Kellogg '92), most recently a senior vice president at Nissan Americas, assumed the new role of vice chairman.

Kathleen A. Maskarinec (PhD '92), director of Western Illinois University's School of Computer Sciences, was named interim associate provost of the university.

Matthew Birkelund McCall (MEM '92, Kellogg '91, '92) is a partner at New World Ventures. He was named to the newly formed board of advisers for the Chicago Innovation Awards program.

Alex Vaillancourt ('92) was promoted to vice president and chief information officer of the Christ Hospital in Cincinnati.

Matthew L. Goska ('93) joined Grand Rapids, Michigan, law firm Warner Norcross & Judd as senior counsel.

Hugh Bradley Ekberg (MEM '94, Kellogg '94) was appointed executive vice president of the Kitchen & Bath Americas division of Kohler Co.

Gaurav Chaturvedi ('95) was hired as medical director for hospital medicine at Northwestern Lake Forest Hospital. He was previously an instructor in the division of hospital medicine at Northwestern's Feinberg School of Medicine.

Aaron Ross Feigelson (MS '95, PhD '98) is moving from associate to member at law firm Leydig Voit & Mayer in Chicago.

Yixin Shao (PhD '95), associate professor of civil engineering and applied mechanics at McGill University in Montreal, was named a fellow of the American Concrete Institute.

Ashish S. Vazirani (MEM '95, Kellogg '95) returned to the management consulting firm ZS Associates as a principal and leader of its high-tech practice after having worked at the company during the 1990s. He is based in the firm's San Mateo, California, office.

Mark R. Ruh (MEM '96, Kellogg '96) was appointed executive vice president and chief financial officer of Mission Community Bancorp and its subsidiary, Mission Community Bank, operating out of San Luis Obispo, California.

Chelsea R. Stoner ('96) was promoted from vice president to principal at Battery Ventures and is based in its Menlo Park, California, office.

Valerie Ann Fuller (MEM '97, Kellogg '97) was promoted to chief operating officer of FordDirect, where she was previously executive vice president of operations.

Kathleen Anne Issen (MS '97, PhD '00), an associate professor of mechanical and aeronautical engineering at Clarkson University, received the school's distinguished teaching award.

Brian H. James (MEM '97, Kellogg '97) was named senior vice president of corporate marketing for OpTier, an IT management software company.

Shekhar Purohit ('97), previously a principal and global compensation consulting leader at Hewitt Associates, was appointed managing director and head of the Northern California office of Pearl Meyer & Partners, an executive compensation consulting firm.

Cecelia M. Wigal (PhD '98), assistant dean in the College of Engineering and Computer Science at the University of Tennessee at Chattanooga, won the 2011 Supernova Award presented by the Young Women's Leadership Academy Foundation.

Noha S. Ekdawi ('99) is a pediatric ophthalmologist. She recently joined the pediatric practice at Wheaton Eye Clinic.

Gregory A. Terri ('99) is area manager covering the St. Louis region for geotechnical contractor Hayward Baker, where he has been employed since 2005.

2000s

Melissa L. Hefferin ('01) was named assistant director for the National Center for Foreign Animal and Zoonotic Disease Defense at Texas A&M University.

H. Casey Logan (MEM '01, Kellogg '01) joined the senior management team at pharmaceutical company Anaphore Inc., headquartered in La Jolla, California.

Christopher A. Schuh (PhD '01) was named head of MIT's department of materials science and engineering.

Bruce P. Lee (MS '02, PhD '05) was appointed to the biomedical engineering faculty at Michigan Technological University.

Todd Kelly (MIT '04) was named vice president of sales engineering for CradlePoint, a provider of network router solutions. He was previously vice president of technology development at MobileForce Communications.

Christopher Ellison (PhD '05), an assistant professor of chemical engineering at the University of Texas at Austin, received a Faculty Early Career Development Award from the National Science Foundation.

Yuk-Ki Lam (MS '05) was named a practice manager for the mid-Atlantic region of Healthcare Administrative Partners.

Changhong Ke (PhD '06), a faculty member in the mechanical engineering department at Binghamton University in New York, was selected to join the Air Force's Young Investigator Research Program.

Prateek Panigrahi ('09, MS '11) joined AbselonTaylor in Chicago as a research associate.

2010s

Nikhil Rakesh Sethi ('10) is the founder of Adaptly, which helps companies manage advertising on social media sites. A *Forbes* magazine story described his success as a student entrepreneur, taking an idea developed at Northwestern and turning it into a successful business.

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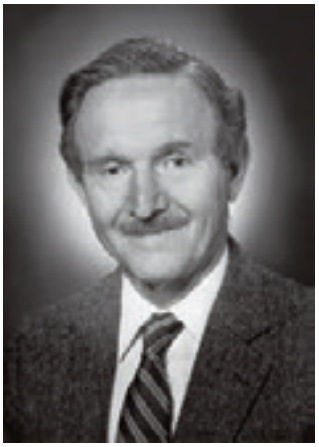
In memoriam

Allan K. Alsaker ’36
Edward A. Fredholm ’36
James W. Algeo ’37
Warren M. Rohsenow, PhD ’41
Louis R. Wernecke Jr. ’41
William Raymond Powell ’42
Dag R. Bruun ’43
John Flaherty ’44
James A. Klotz ’44
Paul A. Felix ’45
George William Fruth ’45
William L. Anson ’46
Blaine J. Manker ’46
Ralph H. Mertz Jr. ’46
Jay Burns III ’47
Arthur G. Janis ’47
Fredrik K. Jacobsen ’48
Frederick T. Johnson ’48
Alfred W. Lutter Jr. ’48
George F. Jahn ’49
Ralph E. Sieben ’49
Edward P. Sullivan ’49
Theodore R. Wedell ’49
James H. Wilkinson ’49
James R. Coldren ’50
John C. Conway ’50
Peter P. Hostert Jr. ’50
Robert T. Kelton ’50
Mrs. Gerald D. Slusser ’50

S. George Bankoff, professor emeritus of chemical engineering, died in July. He was 89. Bankoff, whose research into the fundamentals of heat transfer and two-phase



flow won him recognition in chemical and nuclear engineering, had a long career at Northwestern that began in 1959 and lasted until long after he became professor emeritus in 1992. He was a member of the National Academy of Engineering and won numerous awards, including the Ernest W. Thiele, Robert E. Wilson, Donald Q. Kern, and Heat Transfer and Energy Division Awards from the American Institute of Chemical Engineers.

Bankoff’s work covered a wide variety of topics in multiphase heat transfer and fluid mechanics, many of which are connected with nuclear reactor safety, including bubble nucleation and growth in boiling, heat conduction and diffusion with phase changes, vapor explosions, and stability of thin liquid films under heating. He published more than 200 papers and served as thesis adviser to more than 70 graduate students.

Edward Campbell, a former president and chief executive officer for J. I. Case Co. and a life member of the McCormick Advisory Council, died in October 2010. He was 82. Campbell had a long, successful career in manufacturing after he received both his BS in mechanical engineering in 1952 and his MBA in 1959 from Northwestern. He worked for American Brake Shoe Company, Whirlpool Corp., and Joy Manufacturing Company before joining Case in 1968. He rose to become executive vice president in 1976. He left Case in 1978 for Newport News Shipbuilding until he returned to become president and CEO at Case in 1992. He retired in 1994. He is survived by his children Gary, Kevin, and Diane.

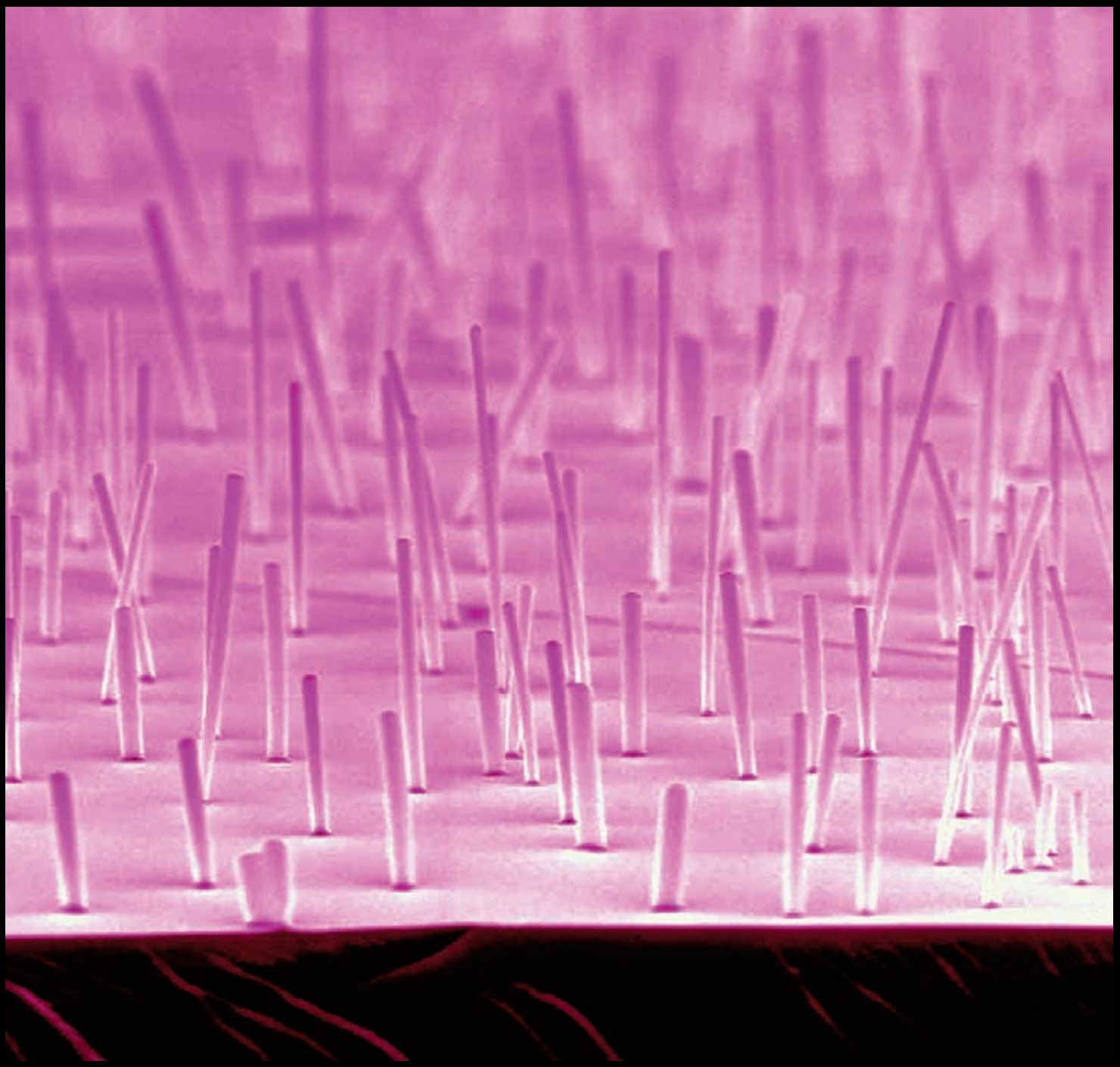
Richard C. Halpern, a leader and innovator in the construction industry and member of the McCormick Advisory Council, died in July. He was 78. During his 50-year career, Halpern served as chief operating officer and chief executive officer for two global construction groups, including the Chicago-based Schal

Associates (which he cofounded with Harold Schiff). Most recently he was cofounder and chairman of the board of RISE International, a program management consulting company. One of the leading builders of the modern era, Halpern was executive-in-charge of the construction of the Sears (now Willis) Tower, the tallest building in the world at the time of its opening in 1974. His other notable Chicago projects included Navy Pier, McCormick Place, and the Harold Washington Library.

In addition to his service on the McCormick Advisory Council, he established the Richard C. Halpern/RISE International Distinguished Architect in Residence at McCormick in 2008 and was integral in developing the school’s Architectural Engineering and Design Program. “I’ve worked with architects my whole life, and I feel that Chicago certainly is a mecca for fine architecture in America,” he said at the time. “The city needs a program that is managed by and housed in one of the top universities in the country. I think this architecture program will enable students at Northwestern to add to the quality of engineering and architecture throughout the United States and the world.”

Halpern is survived by his wife, Madeline; his daughters, Susan Halpern Winstead and Rebecca Halpern; and his son, Daniel Halpern.

Zenonas V. Rekasius, emeritus professor of electrical engineering, died in February at the age of 83. He earned his BS in electrical engineering from Wayne State University in 1954 and a PhD from Purdue University in 1960. Before arriving at Northwestern, he was an assistant professor at the Detroit Institute of Technology and at Purdue. He specialized in the field of automatic control and nonlinear systems and was published in the *Transactions of the IEEE Professional Group on Automatic Control.* He retired from Northwestern in 1997.



the art of engineering

Research at McCormick pushes frontiers and crosses disciplines—and along the way it may produce images of significant aesthetic value. These images may suggest new questions, generate or reveal new information, convey new meaning, and generate new connections. Many—like the one shown here—can be considered pieces of art in their own right.

Researchers in the lab of Jiaxing Huang, the Morris E. Fine Junior Professor in Materials and Manufacturing, are interested in the chemical synthesis, structure characterization and identification, and chemical properties of organic nanocrystals. This image, taken with a scanning electron microscope, shows vertical arrays of organic nanowires prepared in Huang's lab that could be used for optical sensing and nanophotonics.

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Design for America leaders from across the country gather at Northwestern's Leadership Studio in August. For more information and photos, see the story on page 40.