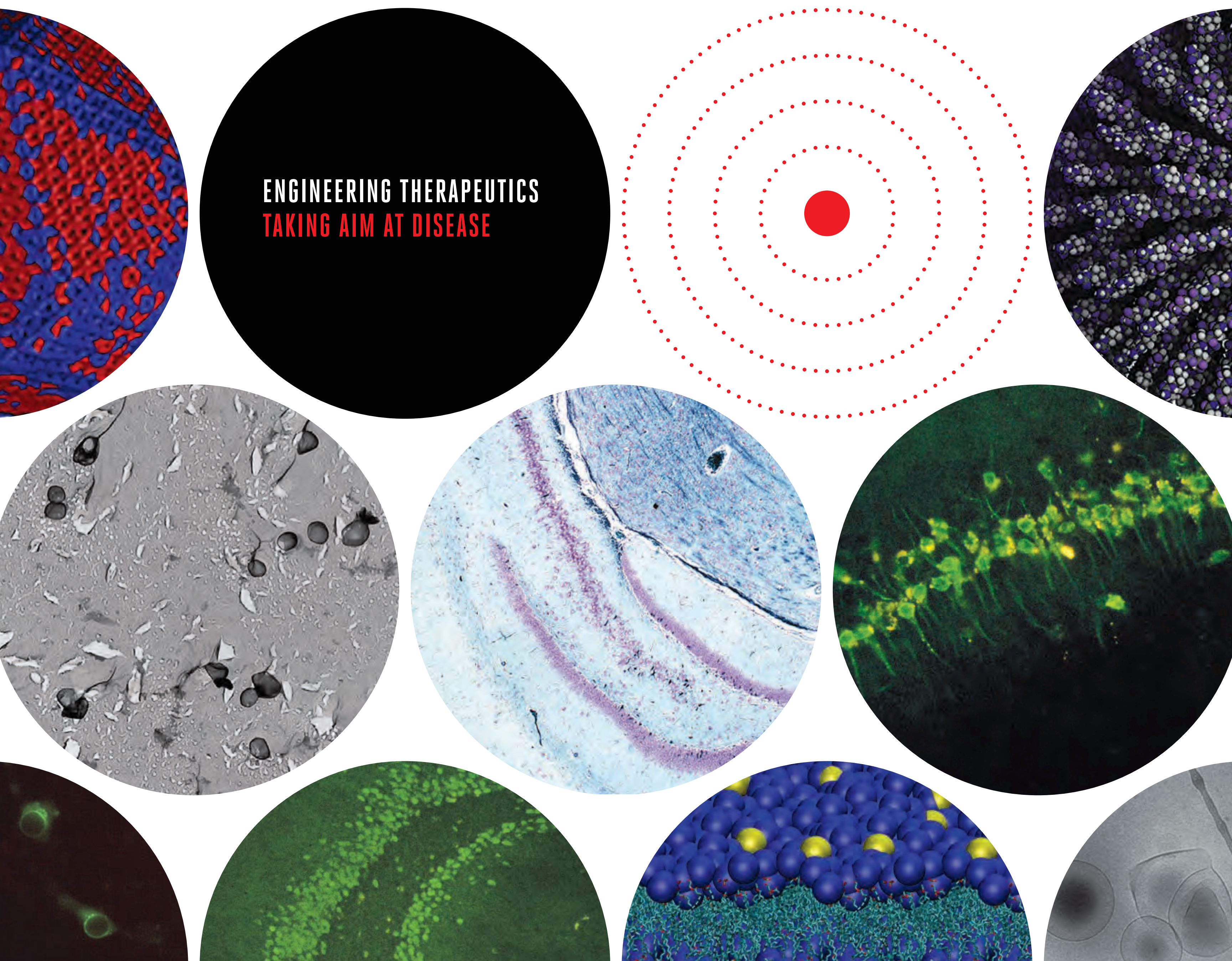
McCormick School of Engineering and Applied Science

NORTHWESTERN ENGINEERING

FALL 2014



LEADING WITH DESIGN

Last August, 70 students from 21 universities descended on Northwestern for the annual Design for America (DFA) Leadership Studio. Although their backgrounds and majors were different, the students united for a similar goal: to make social impact through human-centered design.

This year's event, which was the largest DFA workshop to date, focused on improving the lives of those affected by breast cancer. Six months after Billy (pictured on the right) married his wife, she was diagnosed with breast cancer. After interviewing Billy and an array of caregivers, survivors, and family members, DFA members put their education into action. They worked collaboratively to design and implement solutions, which included an apparel line to embrace the asymmetry of a woman's body after a mastectomy, enhanced communication channels for caregivers to find support, and a board game to help children understand the situation.

Photograph by Andrew Nelles

"Creativity has long been associated with the humanities and the arts, but the term is not used as frequently within science and engineering. The idea that engineering isn't creative is, of course, a myth.

JULIO M. OTTINO
DEAN OF THE MCCORMICK SCHOOL

GREETINGS FROM MCCORMICK

This fall, we launched a series of events called "Conversations at the Intersection" as a way to bring together thought leaders from different fields from across the University and Chicago to discuss subjects that cut across boundaries. Our series began with a focus on the nature of creativity. How do different fields—art, technology and science—incorporate new ideas? In what ways do these different areas intersect and enrich one another? It was a thought-provoking discussion that attracted university-wide participation.

Creativity was a deliberate choice; the theme fits McCormick well. Creativity has long been associated with the humanities and the arts, but less with science and engineering. The idea that engineering isn't creative is, of course, a myth. Creativity is essential to engineering thinking, as exemplified by the diverse content in this issue of our magazine. Engineers display creativity when charting new paths to deliver drugs to targets within the body, when finding solutions to end conflict in materials mining, or when defining new questions—the kinds of questions that have not been asked before—that guide our research. Creativity is also evident in how we evolve our curriculum, as highlighted in the Engineering First® program that we began planning 20 years ago.

Bringing diverse perspectives together is also critical. At McCormick, we have long believed in the power of intersections; that the best ideas and breakthroughs, in both research and education, are in new combinations and opportunities that come from the intersecting boundaries of different domains. Our Lab Notes section highlights the wide range of research we conduct at the intersection. Another especially interesting intersection—the best opportunities are the unexpected ones—is between Diego Klabjan, an analytics expert, and John McGinnis, a professor at the Northwestern Law School. They are working together to better understand what triggers patent litigation, an important issue of our time.

As you know, we are in the midst of an ambitious fundraising campaign: **We Will. The Campaign for Northwestern.** Generous donations from alumni and friends of McCormick have already impacted our ability to build research and education activities at the intersection, but there is much more that we will accomplish. Now, more than ever, engineering plays a central role in our world. We are encouraged that so many donors support our vision.

As always, I welcome your feedback.

Julio M. Ottino
Dean, McCormick School of Engineering and Applied Science

On the Cover

Enabled by advances in nanotechnology, molecular therapeutics, and computation, researchers at McCormick are exploring creative new ways to treat diseases.

Read more on page 14.

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McCormick
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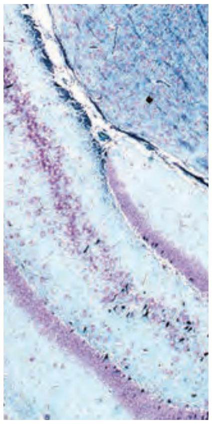
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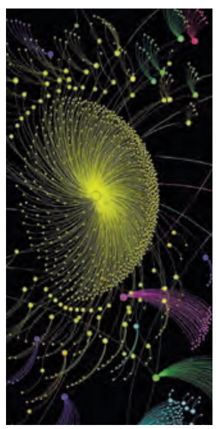
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NORTHWESTERN ENGINEERING
FALL 2014

NEWS

MARK HERSAM NAMED MACARTHUR FELLOW

Mark Hersam, a McCormick materials engineer who teaches the innovators of tomorrow and works across scientific boundaries to create new materials for use in electronics, solar cells, and batteries, has been named a 2014 MacArthur Fellow, an honor bestowed with a $625,000 "no conditions" award.

The MacArthur Foundation recognizes "talented individuals who have shown extraordinary originality and dedication in their creative pursuits and a marked capacity for self-direction."

A versatile and highly productive experimentalist, Hersam is developing novel nanomaterials for use in information technology, biotechnology, energy, and electronics, including solar cells, batteries, and personalized health monitors—the kind that can be integrated into clothing, not just strapped on your wrist.

Hersam views his principal job as that of an educator—a role in which he can have more impact on unsolved problems by harnessing the minds of hundreds of young scientists and engineers. "I love to teach in the classroom, but I also believe that scientific research is a vehicle for teaching," Hersam says. "Research exposes students to difficult unsolved problems, forcing them to be creative. I want them to come up with truly new ideas, not just regurgitate established concepts."

"THERE ARE VERY FEW AWARDS THAT PROVIDE UNRESTRICTED RESOURCES. THAT'S A GREAT OPPORTUNITY FOR A RESEARCHER—TO HAVE THAT LEVEL OF FREEDOM."

MARK HERSAM

ETOPiA PLAY EXPLORES COMMUTING TO WAR

Grounded, a one-woman play about an American fighter pilot reassigned to operate military drones, marked the seventh season of ETOPiA this fall. ETOPiA, the Engineering Transdisciplinary Outreach Project in the Arts, is an initiative that seeks to inspire cross-disciplinary dialogue about the role of science and technology in society.

Flying remote-controlled drones in the Middle East from a windowless trailer in the Nevada desert, the main character struggles through surreal 12-hour shifts far from the battlefield, hunting terrorists by day and being a wife and mother by night. Produced by Professor Matthew Grayson, each performance included a post-show discussion led by faculty and students.

Student Startup Targets Cancer

Northwestern startup Innoblative Designs has created a medical device that could potentially make breast cancer treatment more efficient and less expensive. Surgeons can use the device, a handheld radiofrequency ablation probe, to eliminate remaining cancer cells after a lumpectomy, reducing the need for radiation.

McCormick graduate students Brian Robillard and Curtis Wang are members of the Innoblative team. They have successfully tested the device and have received several honors, including first place at the Biomedical Engineering Innovation, Design, and Entrepreneurship Awards, the Global Champion title at the University of Texas Global Venture Labs Investment Competition, and an invitation to ring the NASDAQ stock market closing bell.

LEARNING THE BUSINESS OF SCIENCE

Twenty-four McCormick PhD students were selected to participate in the 2014 Management for Scientists and Engineers certificate program. Offered by the Kellogg School of Management and The Graduate School, the program is designed for post-candidacy doctoral students in science and engineering who want to gain management tools for running a future lab or working in the commercial sector.

DESIGNING MINDS WORKSHOP

This fall, McCormick hosted a daylong workshop about the past, present, and future of artificial intelligence. “Designing Minds” brought together researchers from Northwestern, Microsoft, IBM, Google, and elsewhere to discuss cognitive architecture used for work, education, and entertainment. Organized by Professor Ken Forbus, the workshop examined the prospects for, and impacts of, creating software systems that operate like human minds. “What we see here today is going to change everything,” said Dean Julio M. Ottino. “There are ideas in this room that someday will look like magic to people outside of the field.”

MSiA HOSTS FIRST HACKATHON

By analyzing data from 500,000 Amazon reviews, graduate students Peter Schmidt and Kyle Hundman found that a set of characteristics inherent in the review could predict whether or not readers determined it helpful. They discovered that the review’s length, keywords, and even punctuation served as predictive variables. The analysis received first place in McCormick’s Master of Science in Analytics program’s first-ever Hackathon. The daylong competition challenged students to apply Teradata Aster’s technology to provided data sets, including Amazon reviews, NFL or MLB statistics, State of the Union addresses, and airline flight data.

Programming Boot Camp

The ability to read and draw conclusions from massive amounts of digital data is becoming increasingly important as a way to make sense of the world. To give graduate students and postdocs a chance to build the skills required to analyze growing volumes of data, McCormick hosted its first Big Data Initiative: Programming Boot Camp this fall. Organized by Professor Luís Amaral, the event was attended by 100 Northwestern students, with nearly 20 percent of participants new to programming. After being introduced to the programming language Python, students worked on software development, object-oriented programming, and simple algorithms.

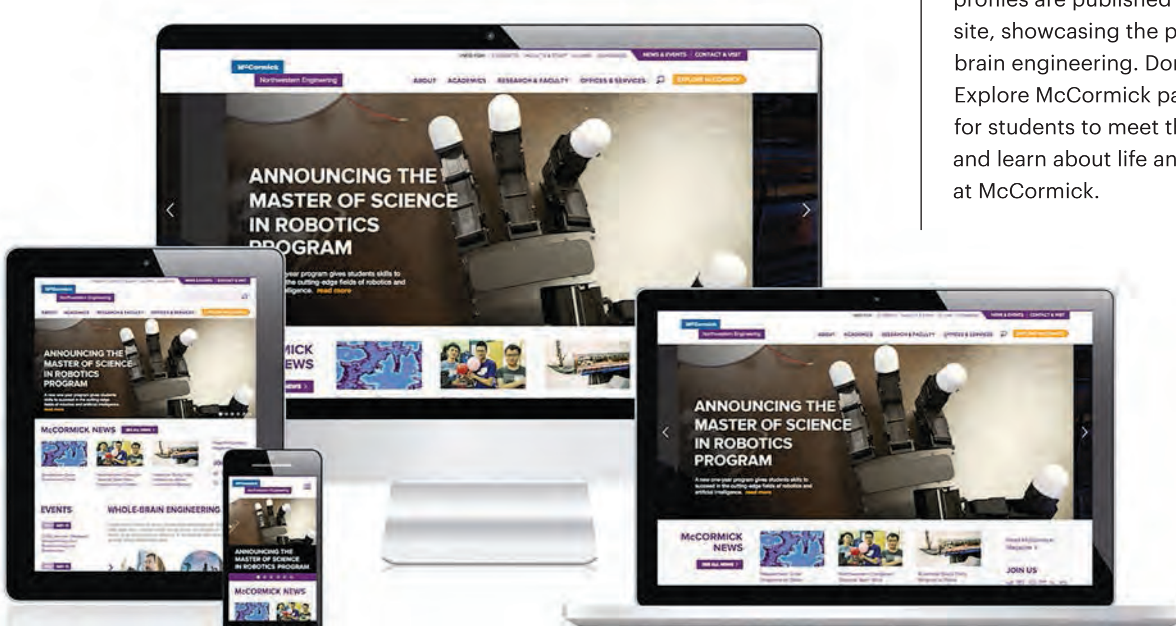
1

For the third consecutive year, IBM CEO, president, and chairman and McCormick alumna Ginni Rometty ('79) is the most powerful woman in the business world, according to *Fortune* magazine's annual ranking.

New Website Delivers Better User Experience

Now you can read about McCormick breakthroughs and accomplishments more easily on any device. This summer McCormick launched a new and improved website. Using responsive design, the new site is optimized for desktop, tablet, and mobile use. Information also has been reorganized and edited based on extensive user testing and analytics to help users find things more quickly and easily.

The new website features the research and activities that make McCormick unique. News stories and individual profiles are published throughout the site, showcasing the power of whole-brain engineering. Don’t miss the Explore McCormick page, a new place for students to meet their community and learn about life and opportunities at McCormick.



Two Alumnae Among Top Tech Leaders

From outer space to the other side of the world, McCormick alumni continue to thrive well after graduation. *Business Insider* magazine recently compiled a list of "22 Of The Most Powerful Women Engineers In The World," and McCormick alumnae took the top two spots.

Gwynne Shotwell, the president of Space Explorations Technology Corporation (SpaceX), was number one on the list. Carolyn Duran, the conflict minerals program manager and supply chain director at Intel, was number two.

Shotwell earned two degrees from McCormick—a bachelor's in mechanical engineering in 1986 and a master's in applied mathematics in 1988. After graduating, she spent more than a decade at Aerospace Corporation, where she quickly moved up the ladder. She joined SpaceX in 2002 as vice president of business development and became president in 2008.

Business Insider said Shotwell is powerful because she "is responsible for day-to-day operations for arguably one of the most exciting companies on the planet, and off it."

Having earned a PhD in materials science and engineering from McCormick in 1998, Duran has led Intel's efforts to stop using conflict minerals—electronics materials from mines run by warlords. The company now produces chips that are made with 100 percent conflict-free minerals.

The reason *Business Insider* said Duran is powerful: "Imagine personally ending slavery in some of the poorest, most violent places in the world. That's what Duran is doing with her job at Intel." (For more, see story on page 38.)

THE NORTHWESTERN UNIVERSITY CENTER FOR BIO-INSPIRED ENERGY SCIENCE WILL RECEIVE $12 MILLION OVER FOUR YEARS, AND THE ARGONNE-NORTHWESTERN SOLAR ENERGY RESEARCH CENTER WILL RECEIVE $15.2 MILLION OVER FOUR YEARS.

Millions Awarded for Energy Research

Two Energy Frontier Research Centers at Northwestern will continue to receive multimillion-dollar funding from the US Department of Energy for projects designed to accelerate the scientific breakthroughs needed to build a new 21st century energy economy. Northwestern's projects were competitively selected for funding from more than 200 proposals.

Directed by Professor Samuel Stupp, the Center for Bio-Inspired Energy Science will receive $12 million over four years. The center will use the funds to develop artificial materials inspired by biological systems that can change the way we convert and use energy.

The Argonne-Northwestern Solar Energy Research Center, directed by Professor Michael Wasielewski, will receive $15.2 million over four years. The center plans to revolutionize the understanding of molecules, materials, and physical phenomena necessary to create dramatically more efficient technologies for solar fuels and electricity production.

The centers will help lay the scientific groundwork for fundamental advances in solar energy, electrical energy storage, carbon capture and sequestration, materials and chemistry by design, biosciences, and extreme environments.

$1 MILLION

Amount McCormick startup Sinode Systems received from the Department of Energy to develop batteries that have double the energy density of standard batteries.

45,000

Participants in the 2014 Bank of America Chicago Marathon, where Professor Karen Smilowitz and her students used data analytics to help with preparedness and safety.

PROFESSORS TESTIFY BEFORE CONGRESS

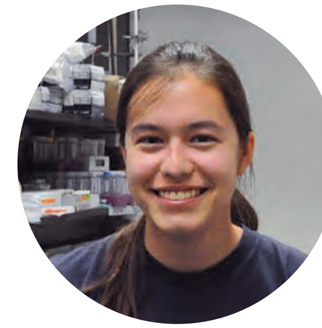
McCormick Professors Mark Hersam and Milan Mrksich testified before Congress in two separate hearings this summer, both pushing for more federal funding for nanotechnology research.

In his testimony before the US House Committee on Science, Space, and Technology's Subcommittee on Research and Technology, Hersam said that sustained support is particularly needed for fundamental research because of its potential for "unanticipated breakthroughs."

Mrksich testified before the US House Committee on Energy and Commerce's Subcommittee on Commerce, Manufacturing, and Trade. He discussed sustained investment in fundamental nanoscience research, the economic opportunities of nanotechnology, and the obstacles to realizing these benefits. These issues, he said, are critical to keeping the country scientifically competitive.

> "NANOTECHNOLOGY IS A BROAD-BASED FIELD THAT, UNLIKE TRADITIONAL DISCIPLINES, ENGAGES THE ENTIRE SCIENTIFIC AND ENGINEERING ENTERPRISE AND THAT PROMISES NEW TECHNOLOGIES ACROSS THESE FIELDS."

MILAN MRKSICH



MATERIALS SCIENCE UNDERGRADUATES WIN RESEARCH AWARDS

At the end of the 2013–14 school year, two materials science and engineering students received major awards to honor their research. Katie Jaycox, a senior in Professor Ramille Shah's laboratory, won the 2014 Harold B. Gotaas Undergraduate Research Award for creating 3-D printer inks that contain lunar and Martian dusts. The inks could be used to print tools on other planets.

Leanne Friedrich, a senior in Professor Derk Joester's laboratory, received the University-wide Fletcher Undergraduate Research Grant Award. Friedrich studies the chiton, a mollusk found in coastal tidal zones that has hundreds of tiny eyes covering its shell. She ran a number of experiments to better understand the calcium carbonate lenses that cover the chiton's eyes.

MOOC OFFERS LESSONS FOR JOB TRANSITIONING

According to William White, professor of industrial engineering and management sciences and veteran business manager, preparing for a new job helps new employees reach job efficiency and exceed workplace expectations at a much faster rate. This fall White offered a massive open online course (MOOC) called "Power Onboarding," which helped people start new jobs more effectively. Throughout the six-week course, participants learned how to create personalized onboarding plans and transition efficiently at any stage of their career.

YOUNG AFRICAN LEADERS GAIN ENTREPRENEURSHIP, LEADERSHIP SKILLS

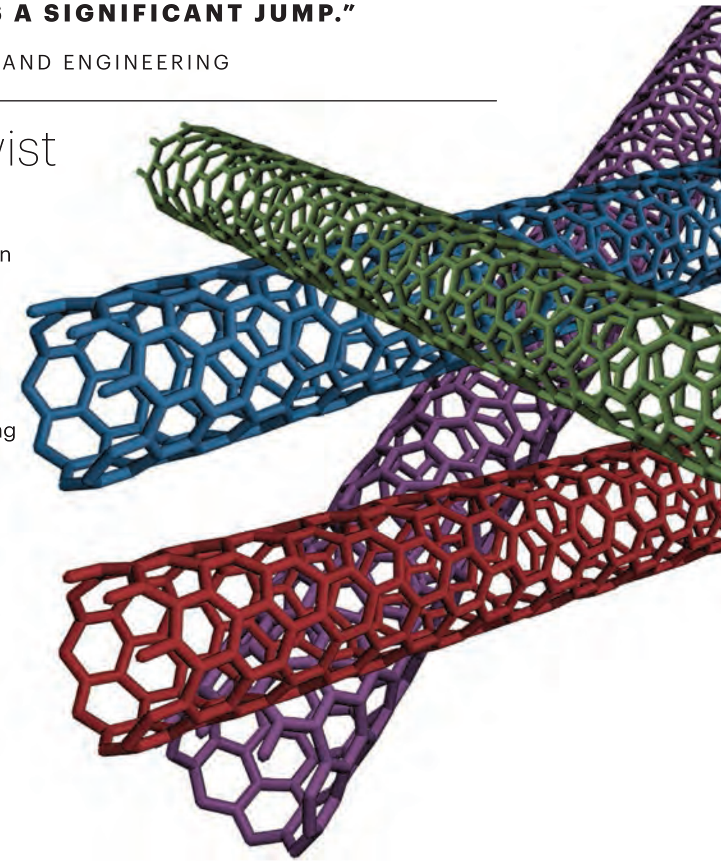
Twenty-five fellows from the Washington Fellowship of Young African Leaders Initiative (YALI) visited Northwestern this summer. The YALI program supports young African leaders, strengthens partnerships between the United States and Africa, and promotes democratic governance. McCormick's Farley Center for Entrepreneurship and Innovation and Center for Leadership and Northwestern's Program of African Studies hosted the cohort for six weeks. During their visit, the fellows exchanged ideas with representatives from the Chicago Cubs, IBM, Google, the Art Institute of Chicago, and other organizations.

"THE FIELD HAD BEEN HOVERING AROUND ONE PERCENT EFFICIENCY FOR ABOUT A DECADE; IT HAD REALLY PLATEAUED. BUT WE'VE BEEN ABLE TO INCREASE IT TO OVER THREE PERCENT. IT'S A SIGNIFICANT JUMP."

MARK HERSAM PROFESSOR OF MATERIALS SCIENCE AND ENGINEERING

Carbon Nanotubes with a Twist

Polychiral mixture makes more efficient solar cells



Lighter and cheaper than conventional solar cell materials, carbon nanotubes (CNTs) have long shown promise for photovoltaics. But research stalled when CNTs were unable to convert as much sunlight into power as other materials.

Now a team led by Mark Hersam, professor of materials science and engineering and the Bette and Neison Harris Chair of Teaching Excellence, has created a new type of CNT solar cell that is twice as efficient as its predecessors.

The secret lies in the CNTs' chirality, which is a combination of the tubes' diameter and twist. When a thin sheet of carbon is rolled into a nanotube, several hundred different chiralities are possible. In the past, researchers tended to choose one chirality to build an entire solar cell, which could only absorb a narrow range of optical wavelengths.

Hersam's team made a mixture of polychiral, or multiple chirality, semiconducting nanotubes. This maximized the amount of photocurrent produced by absorbing a broader range of solar spectrum wavelengths.

ILLUMINATING COOLER OBJECTS IN DEEP SPACE

Infrared waves are often used to probe the depths of space. With its long wavelength, infrared can penetrate dense regions of gas and dust to illuminate colder objects hidden from visible light. Although current infrared detectors work well with mid- and long-infrared waves, they do not perform well with very long infrared wavelengths.

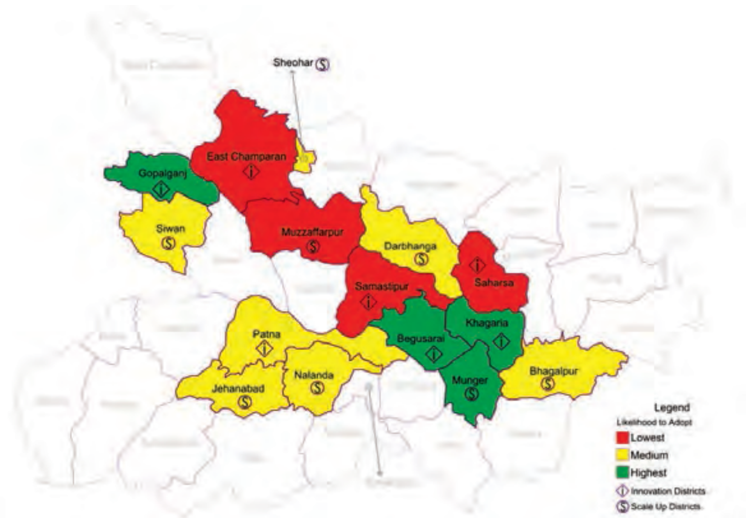
Professor Manijeh Razeghi has designed a novel superlattice material made of arsenide/indium arsenide antimonide. A detector created from the material shows a stable optical response to very long wavelength infrared light and can be used as an inexpensive alternative to current infrared technologies, making exploration of deep space more within our reach.

TOP TECH IN CHICAGO

If you care about Chicago tech, then you should know Michael Marasco, according to *Crain's Chicago Business*. Marasco, who serves as director of McCormick's Farley Center for Entrepreneurship and Innovation, was recently named one of *Crain's* "Tech 50 for 2014."

FACULTY STARTUP NARRATIVE SCIENCE FEATURED IN *BUSINESS INSIDER*

According to Professor Kristian Hammond, the days of the spreadsheet are numbered. Hammond spoke with *Business Insider* about his efforts to turn big data into short stories with his startup company Narrative Science. "We saw the beginnings of dissatisfaction with big data and we saw ourselves as the solution," he said. "You don't want spreadsheets, you want to be told."



USING SOCIAL MOTIVES TO INFLUENCE DECISIONS

Are you a person who needs to be liked? Or a person who needs to be right? The answer could help solve global public health crises. Professor Noshir Contractor is leading a survey of 14,000 family health workers in India to determine into which category each person falls. Based on that information, his team can identify the messages that will most likely influence the workers to use valuable public health information they might otherwise ignore.

Streaming Efficiency

Simply watching a DVD expends more energy than you might expect. First, energy is used to manufacture the disc and transport it. Consumers then must drive to and from local stores and rental locations. After all that, the DVD is inserted into an electricity-sapping player. Professor Eric Masanet and collaborators studied five different ways of viewing movies by using life cycle analysis to estimate energy used and carbon dioxide produced by each type of viewing. He found that video streaming reduced travel and the use of inefficient DVD players, making it the most Earth-friendly option.

"WE TREAT SEARCH ROBOTS LIKE THEY ARE BLIND. THEY OFTEN RUN BACK AND FORTH OVER AN AREA TO PASSIVELY RECORD FOOTAGE, AND THEN A PERSON HAS TO LOOK AT THE VIDEO TO JUDGE THE UTILITY OF THE INFORMATION."

TODD MURPHEY
ASSOCIATE PROFESSOR OF MECHANICAL ENGINEERING

DISPOSAL OR LANDFILL? PAPER OR PLASTIC?

How can you live green? Professor Eric Masanet has appeared on WBEZ Worldview's monthly EcoMyths segments to discuss trash versus disposals for food, and paper versus plastic bags for groceries. The answers? For food, disposals can leave a methane byproduct, while landfills have the ability to capture that methane. For bags, paper bags are energy-intensive to create, but "essentially whatever you choose is going to have an impact."

ROBOTIC SEARCHING GETS SMARTER

From shipwrecks to vanished people, the depths of water hold many secrets. A common way to search far below its surface is to deploy underwater robots to scour the seabed. But whether or not they find anything is up to humans to determine.

"We treat search robots like they are blind," said Professor Todd Murphey. "They often run back and forth over an area to passively record footage, and then a person has to look at the video to judge the utility of the information."

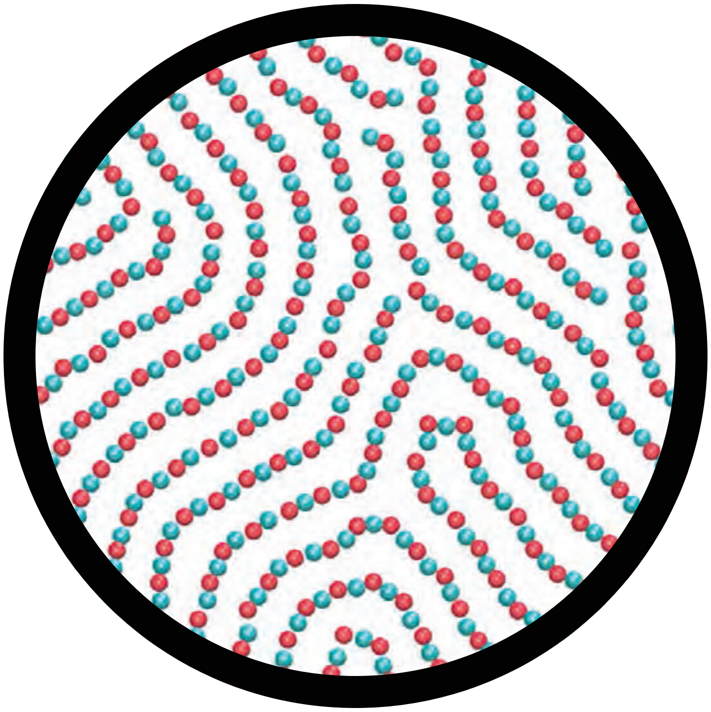
Murphey and his collaborators are developing computational algorithms that make search robots smarter and more autonomous, cutting out the human middleman. Using the algorithms, a robot can adapt its motion to new information and can be programmed to "know" what it is looking for. This could involve incorporating the characteristics of a submerged airplane, ship, or other object into its search criteria. Murphey's technology could make search and rescue missions more efficient and could be applied to mine detection and industrial flaw detection.

$25 MILLION

Amount recently raised by McCormick startup Naurex, which develops novel molecular therapeutics for depression.

1/3

In certain parts of the world, BitTorrent users are responsible for up to one-third of total Internet traffic, according to research by professors Luís Amaral and Fabian Bustamante.



UNDERSTANDING NON-EQUILIBRIUM FUNDAMENTALS

Although most processes tend to settle into equilibrium—a state of unchanging balance without potential or energy—it is within the realm of non-equilibrium conditions where new possibilities lie. Non-equilibrium systems experience constant changes in energy and phases, such as temperature fluctuations and movement. These conditions allow humans to regulate their body temperature, airplanes to fly, and the Earth to rumble with seismic activity.

But even though these conditions exist naturally and are required for the most basic life, they are rarely understood and are difficult to find in synthetic materials.

Professor Igal Szleifer and collaborators have developed a new technique for creating non-equilibrium systems, bringing scientists closer to understanding the fundamentals of the mysterious topic. Using models and simulations, the team gave energy to equilibrium systems using a mixture of pH-responsive particles. Varying pH levels flipped the electric charges of the particles, causing them to oscillate and assemble into non-equilibrium structures. This method could allow the creation of novel structures that are impossible to find in equilibrium conditions.

WHICH HAS A MORE EFFICIENT 'ENGINE': A TUNA OR A WHALE?

Which is the more efficient swimmer—a gray whale or a skipjack tuna? It historically has been difficult to compare propulsion efficiencies of differently sized animals. But now Professor Neelesh Patankar and his collaborators have developed a new metric to measure individual energy consumption efficiency and make such a comparison possible.

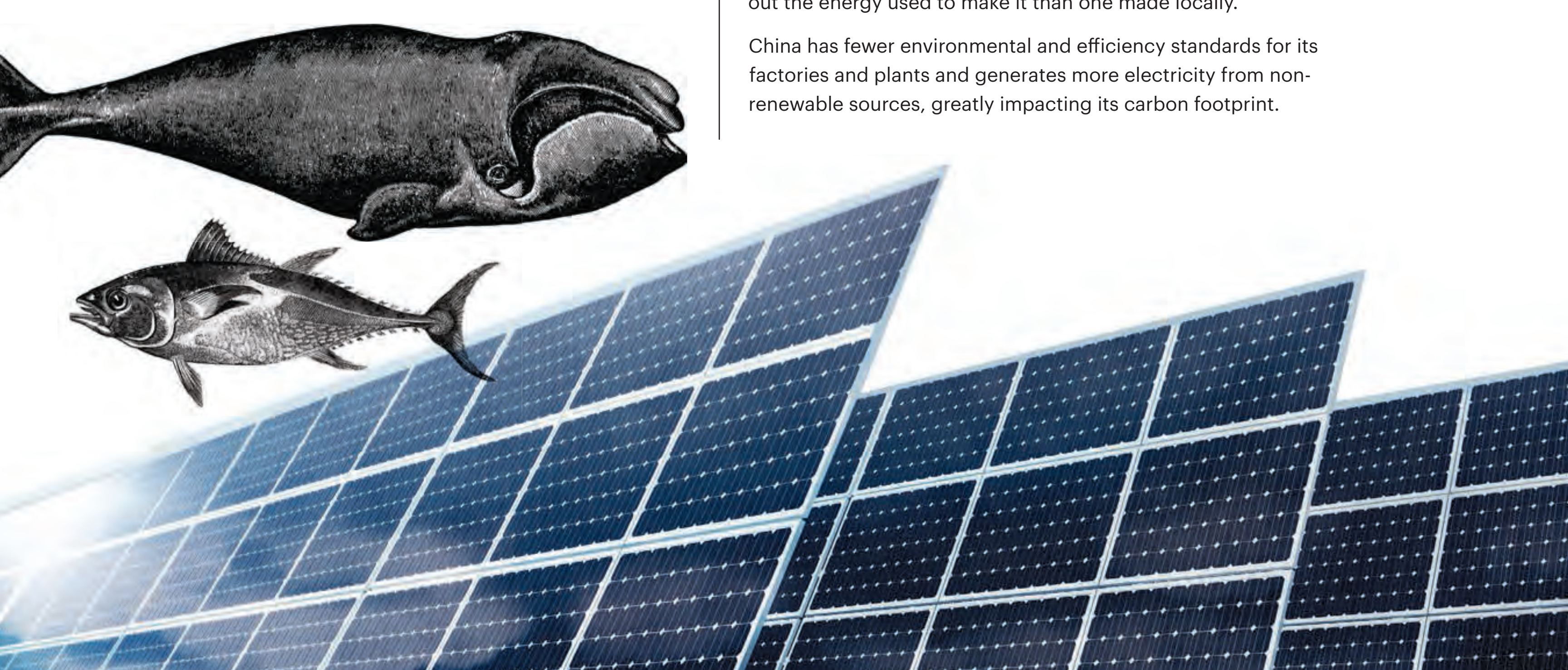
By taking into consideration metabolic rate, muscle mass, and physics, the team surprisingly found that the whale and the tuna are almost equally efficient. The new metric could be useful in designing underwater vehicles as agile and efficient as real fish.

THE CARBON FOOTPRINT OF SOLAR CELLS

Moving solar panel manufacturing from Europe to China might be healthy for the economy, but it's not healthy for the environment. Using lifecycle analysis, Professor Fengqi You found that the carbon footprint doubles when a solar panel is made in China and used in Europe, compared to those locally made and used.

The study compared energy and greenhouse gas emissions that go into the manufacturing of solar panels in Europe and China, including the energy to mine raw minerals, fuel to transport minerals and products, and electricity to power the processing factory. Installed in sunny southern Europe, a silicon solar panel made in China would take 20 to 30 percent longer to produce enough energy to cancel out the energy used to make it than one made locally.

China has fewer environmental and efficiency standards for its factories and plants and generates more electricity from non-renewable sources, greatly impacting its carbon footprint.



ROBOTICS LEADERS DESCEND ON CHICAGO

In September, nearly 2,000 robotics leaders from around the world attended the 2014 International Conference on Intelligent Robots in Chicago.

"Robotics is a hot field right now, with new technology and software enabling robotics researchers to design powerful and precise robots that can safely collaborate with humans," says Professor Kevin Lynch, chair of the Department of Mechanical Engineering and conference general chair.

Several McCormick projects were presented at the conference, including Lynch's work using electrical stimulation to reanimate paralyzed arms. Other McCormick researchers discussed their pioneering work to coordinate swarms of small robots, develop a robotic fish with bio-inspired sensing and motion capabilities, and translate robotics research into startup companies.

"Robotics is a hot field right now, with new technology and software enabling robotics researchers to design powerful and precise robots that can safely collaborate with humans." KEVIN LYNCH PROFESSOR OF MECHANICAL ENGINEERING

UNLEADED SOLAR CELLS

Researchers, including Professors Mercouri Kanatzidis and Robert P.H. Chang, were the first to develop a new, highly efficient solar cell that uses tin instead of lead perovskite as the harvester of light. The low-cost, environmentally friendly solar cell can be made easily using basic chemistry, without the need for expensive equipment or hazardous materials.

With the ability to absorb most of the visible light spectrum, the tin solar cell has an efficiency of just below six percent, a very good starting point. "There is no reason this new material can't reach an efficiency better than 15 percent, which is what the lead perovskite solar cell offers," Kanatzidis says. "Tin and lead are in the same group in the periodic table, so we expect similar results."

850,000

Square feet of classrooms, hallways, offices, and labs in the Technological Institute. Find your way with our new, improved room finder. bit.ly/techroomfinder

55,000

Number of downloads in two months of Pocket Lock, an app developed by McCormick student William Xiao that intelligently locks and unlocks your phone for you.

'Skin-Like' Device Monitors Health

A new wearable medical device can quickly alert a person if they are having cardiovascular trouble or if it's simply time to apply skin moisturizer. Co-developed by Professor Yonggang Huang, the small device can be placed directly on the skin and worn 24/7 for around-the-clock health monitoring.

The wireless technology uses thousands of tiny liquid crystals on a flexible substrate to sense heat, and measures the transient temperature of the skin's surface to determine blood flow rate, which is of direct relevance to cardiovascular health and skin hydration. When a crystal senses a temperature change, it changes color to let the wearer know something is awry. An algorithm translates the temperature data into an accurate health report, all in less than 30 seconds.

Co-developed by Huang's long-time collaborator John A. Rogers from the University of Illinois, the device twists and stretches with the skin, making it mechanically invisible and comfortable to wear.

A Phone that Senses Emotions

You need to download an important e-mail, but your smart phone is moving frustratingly slow. Your palms grow sweaty, and your pupils dilate in rage.

Professors Peter Dinda and Gokhan Memik are developing phones that will understand these biological signals and adjust their performance accordingly. Something as simple as an accelerated heartbeat could let your phone know it needs to speed up.

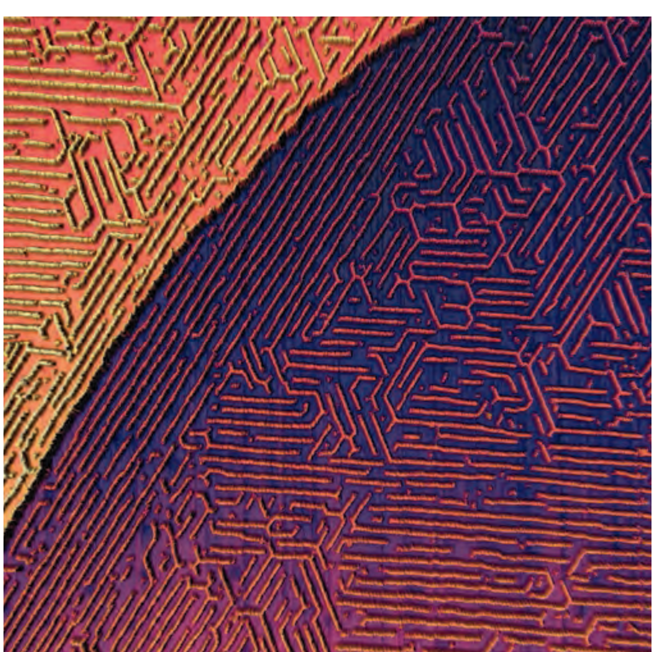
The team built a patented system with biometric input devices that monitor physiological traits such as eye movement, body temperature, and heart rate. They hooked up study participants to the system to record physiological reactions to factors like phone speed and screen brightness. The information is being used to create an emotion-sensing interface in the internal hardware that allows the phones to gauge user satisfaction. By sensing emotions, the phone can tailor itself specifically to each user without requiring outside input.

CAPTURING THE BEAUTY OF SCIENCE

Materials science and engineering graduate student Andrew Mannix won the 2014 Northwestern Scientific Images Contest "Capturing the Beauty of Science" with his image "Tryptophan Labyrinth."

In this image, molecules of L-Tryptophan (L-Trp), a biologically necessary amino acid, have self-assembled into rows on the surface of a copper single crystal. The orange section of the crystal is elevated higher than the purple section.

Thus far, Mannix and his colleagues in the laboratory of Mark Hersam and at Argonne National Laboratory have found that L-Trp is the only amino acid to form a maze-like structure. The ordered channels formed by the maze are potentially useful as a template to direct the motion and interaction of other molecules on the surface.

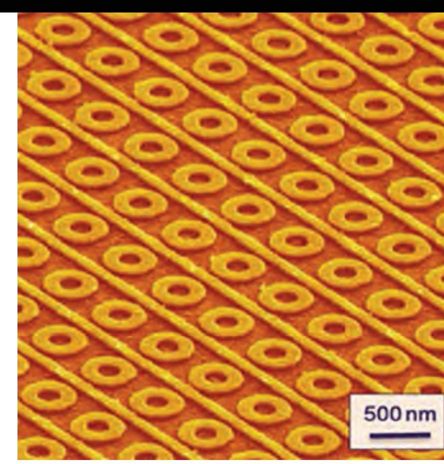


$150

Cost per month for broadband Internet access in Botswana, according to research by Professor Fabian Bustamante.

$20

Cost per month for broadband access in the United States. Bustamante studied broadband services worldwide to gain a clearer understanding of how broadband services are used, how much bandwidth people actually need, and how the market impacts usage.



BUILDING BETTER BIOSENSORS

Professor Koray Aydin has created an absorber that opens possibilities for more sensitive biosensors, which are able to sense subtle shifts in the environment. Typical absorber designs use two metal sheets with a non-metallic insulating material in between. Aydin's group found that removing the insulating layer caused the structure to absorb a much narrower band of light. Narrower bands of absorbed light mean a more sensitive biosensor.

NEW GLAUCOMA CULPRIT IS FOUND

In a unique study of human ocular cells, a research team led by Professor Mark Johnson found that endothelial cells in eyes from glaucoma patients are stiffer than cells in healthy eyes. This stiffness limits the cells' ability to deform and allow fluid to drain, which causes the elevated pressure associated with glaucoma.

Walter Herbst

Doug Downey

Jan Achenbach

L. Catherine Brinson

Giuseppe Buscarnera

Elmer Lewis

Isaac Daniel

Chad Mirkin

Samuel Stupp

Faculty Awards

Downey and Buscarnera Receive NSF CAREER Awards

Doug Downey, associate professor of electrical engineering and computer science, and Giuseppe Buscarnera, assistant professor of civil and environmental engineering, have received prestigious Faculty Early Career Development (CAREER) Awards from the National Science Foundation.

Chad Mirkin Named Faculty Fellow in Pentagon Program

For the second time, Chad A. Mirkin has been selected by the US Department of Defense as a fellow in the department's National Security Science and Engineering Faculty Fellowships program. Mirkin is the George B. Rathmann Professor of Chemistry, and a professor of medicine, chemical and biological engineering, biomedical engineering, and materials science and engineering.

Walter Herbst Wins Top Design Award

Walter Herbst, director of the Master of Product Design and Development Management program, received a Gold award in the Industrial Design: Computer and Entertainment category at the 2014 Edison Awards Gala for his design of the Logitech Case+ mobile accessories collection for iPhone5 and iPhone5s.

L. Catherine Brinson Awarded Nadai Medal

L. Catherine Brinson, Jerome B. Cohen Professor of Mechanical Engineering, was awarded the 2014 Nadai Medal of the American Society of Mechanical Engineers in recognition of significant contributions and outstanding achievements that broaden the field of materials engineering.

Isaac Daniel Receives C. E. Taylor Award

Isaac Daniel, professor of civil and environmental engineering and of mechanical engineering, received the C. E. Taylor Award from the Society for Experimental Mechanics at the Society's annual conference.

Jan Achenbach Receives Award from Scientific Research Society

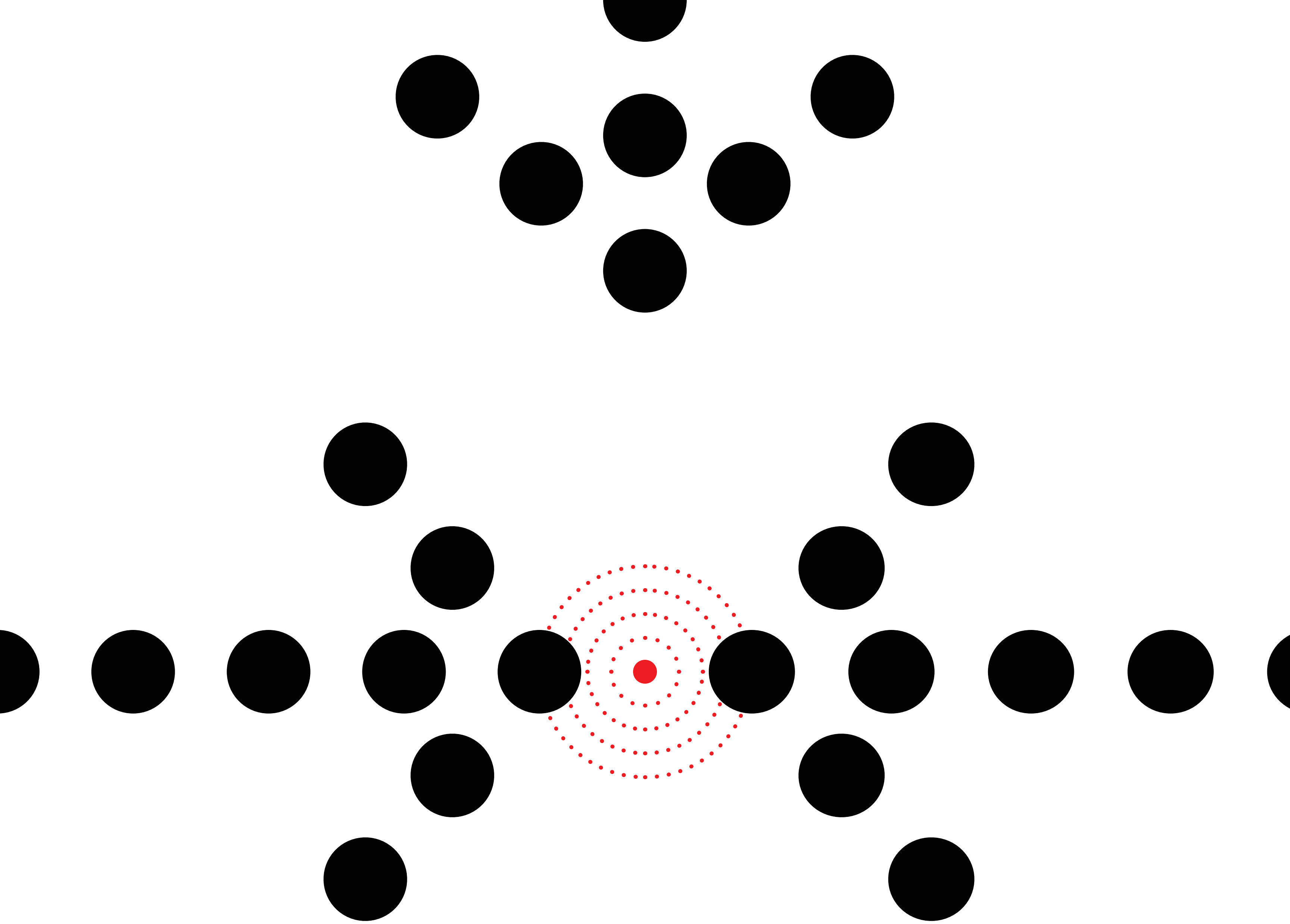
Jan Achenbach, Walter P. Murphy and Distinguished McCormick School Professor Emeritus of Civil and Environmental Engineering, Engineering Sciences and Applied Mathematics, and Mechanical Engineering, received the 2014 Monie A. Ferst Award from Sigma Xi, the Scientific Research Society.

Elmer Lewis Honored by American Nuclear Society

Elmer Lewis, professor emeritus of mechanical engineering, received the American Nuclear Society's 2014 Eugene P. Wigner Reactor Physicist Award for outstanding contributions to the advancement of the field of reactor physics.

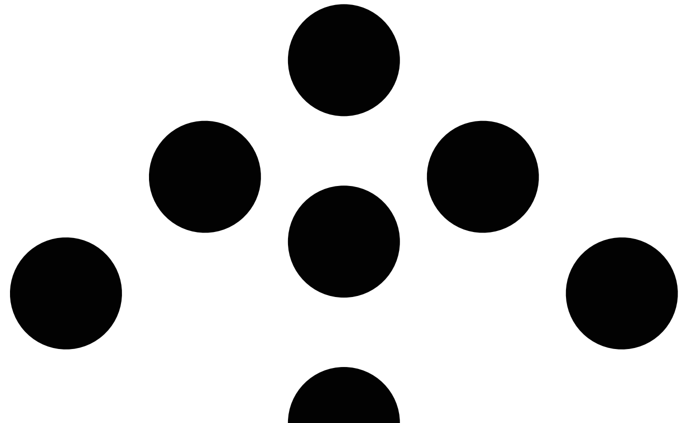
Samuel Stupp Receives International Award

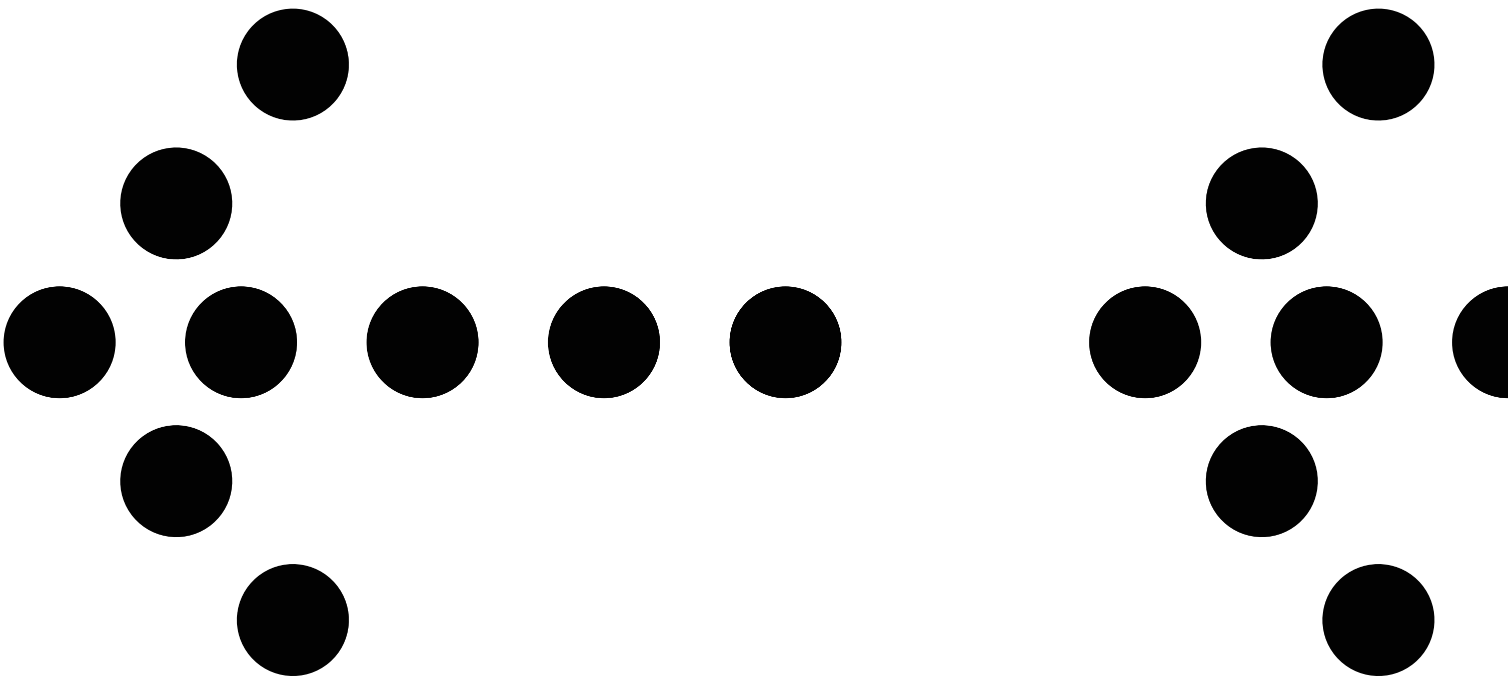
Samuel Stupp, Board of Trustees Professor of Materials Science and Engineering, Chemistry, Medicine and Biomedical Engineering, received the International Award from the Society of Polymer Science, Japan.



ENGINEERING THERAPEUTICS
TAKING AIM AT DISEASE

MCCORMICK RESEARCHERS FIND CREATIVE METHODOLOGIES FOR TARGETED THERAPIES





DISEASES LIKE CANCER AND HIV CONTINUE TO KILL MILLIONS OF PEOPLE EACH YEAR. Mental illnesses like depression and schizophrenia continue to shatter lives. Although therapies for such diseases have improved dramatically in recent years, they often fall short of ideal. In many cases, problems with efficacy lie not in the treatments, but in the targets.

For example, chemotherapy can effectively arrest cancer, but it attacks healthy cells as well as tumors, and still only cures the disease part of the time. Even when life is prolonged, the side effects of enduring a chemical onslaught can prove painful and debilitating. If such therapies could be contained and honed to target only mutated cells while sparing the healthy ones, treatment would be more bearable and, most likely, more successful.

Enabled by advances in nanotechnology, molecular therapeutics, genomics, and computation, as well as a better understanding of disease mechanisms, researchers at the McCormick School of Engineering are using design thinking to explore creative new ways to treat such diseases. Instead of developing new therapeutics, they're focused on finding better methods and new targets for delivering existing drug therapies.

PATRICK KISER

NEW DELIVERY TARGET: THE REPRODUCTIVE SYSTEM

In his desk drawer, Patrick Kiser keeps a box that he refers to as his "library of rings." They're the prototypes of various intravaginal rings, the focus of the past 10 years of his research as a biomedical engineer. In late 2013, Kiser's decade-long efforts culminated in the development of an intravaginal ring that delivers the antiretroviral drug for preventing HIV infection called tenofovir disoproxil fumarate (TDF).

Using tenofovir is not a new idea: three-and-a-half million HIV-infected people worldwide take an oral version of it. Kiser's breakthrough is a device that reaches a new target—the female reproductive system. Using a previously unexplored methodology, the TDF intravaginal ring delivers tenofovir directly to the site where transmission takes place, requiring a much lower dose than oral pills and eliminating potentially serious side effects, including reduced kidney function.

Within one year, Kiser invented the TDF intravaginal ring, tested it in non-human primates, where it demonstrated a 100 percent success rate, and then obtained approval from the FDA for clinical testing. The ring is currently undergoing its first test in women in a Phase I clinical trial in New York.

"This and other long-acting delivery systems could be an important tool in preventing rampant HIV transmission in many low-income countries," say Kiser, who is an associate professor of biomedical engineering.

EXPANDING THE SCOPE

Closer to Kiser's home in Chicago, the HIV pandemic looks much different than in developing countries. In Chicago, African-American gay men are the population at highest risk for HIV.

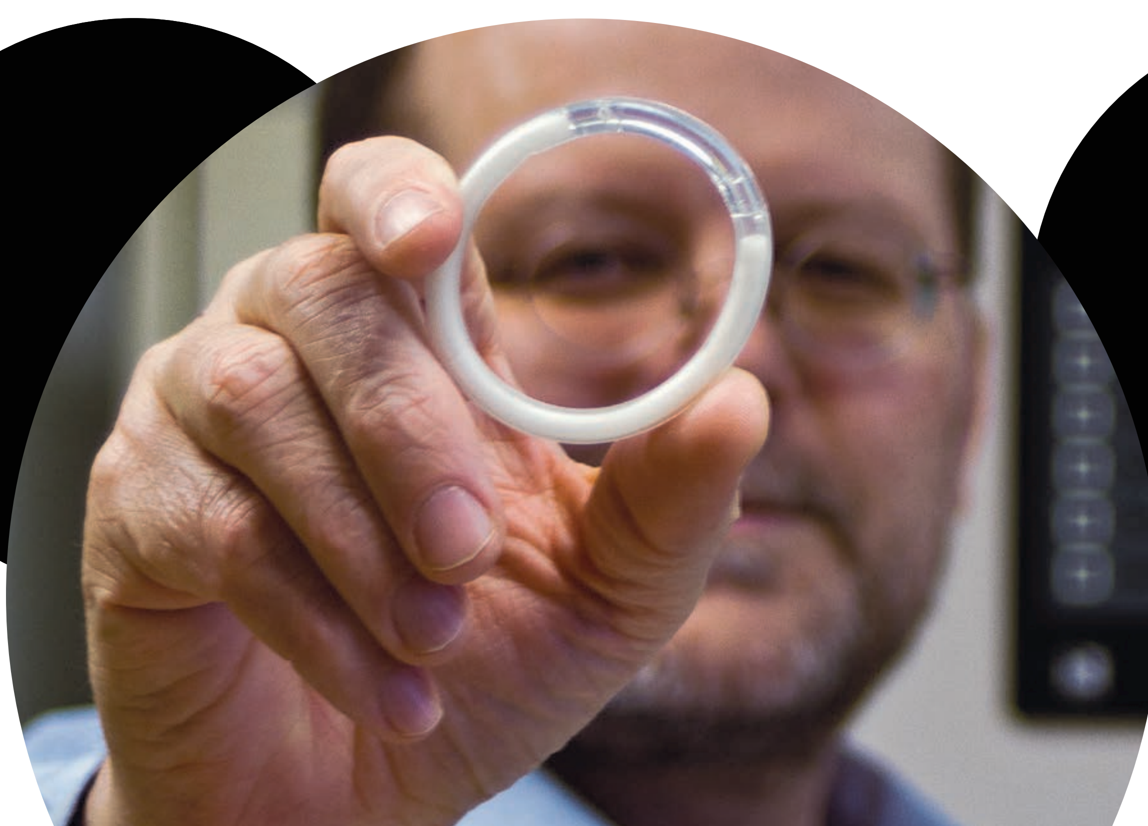
"The HIV contraction rate for that population is 40 percent by age 40," Kiser says. "We have an epidemic here in Chicago, and most large American cities have similar incidence. These numbers motivate me every day to keep working."

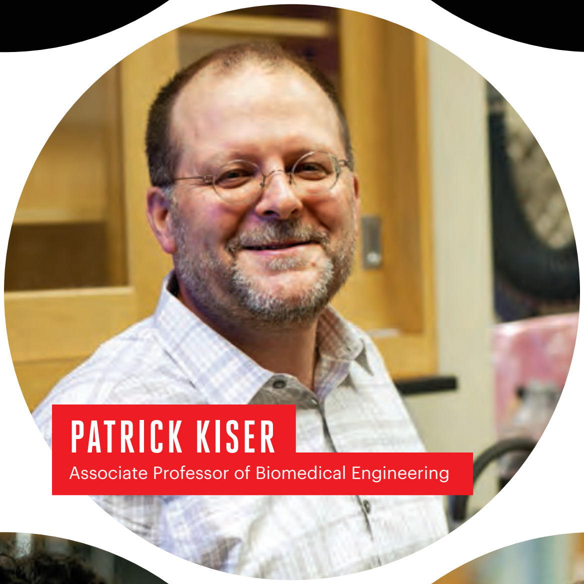
To reach a wider segment of the population, Kiser is working on long-acting implants that could be used by anyone susceptible to HIV. The implant is a small rod, no thicker than a matchstick, that when inserted beneath the skin in the arm could deliver antiretroviral drugs consistently for many months. The rod implant could be made from similar technology as the ring: an antiretroviral held in a medical-grade plastic shell that controls the drug's diffusion, so it is released in a controlled manner from the device and into the circulation.

EXPLORING NEW APPLICATIONS

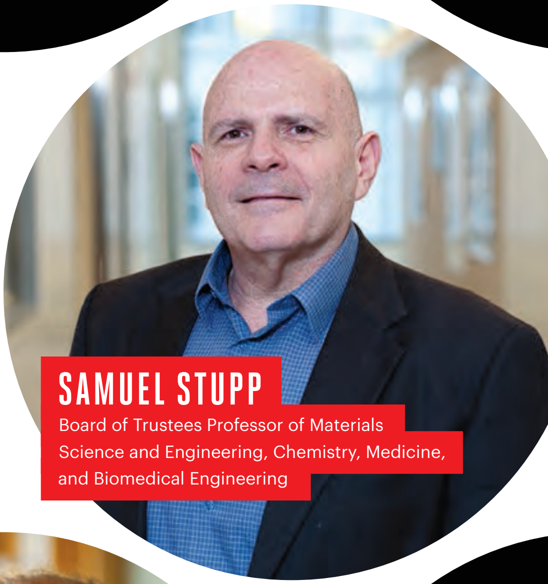
Kiser continues to find new uses for his intravaginal ring innovation. His lab was the first to invent a ring that can prevent HIV, herpes, and unwanted pregnancy by delivering tenofovir and the hormone levonorgestrel in combination. This ring, also soon to enter clinical trials, has reliably delivered both drugs for three months. Also under development by a company he started is Kiser's "Aquaring," which dispenses lubricant for women with vaginal dryness.

"What my lab brings to the table is the ability to do creative drug delivery work and help see that through the clinic," he says. "We've had five rings in the past two years tested in humans. That's a major feat for an academic lab."





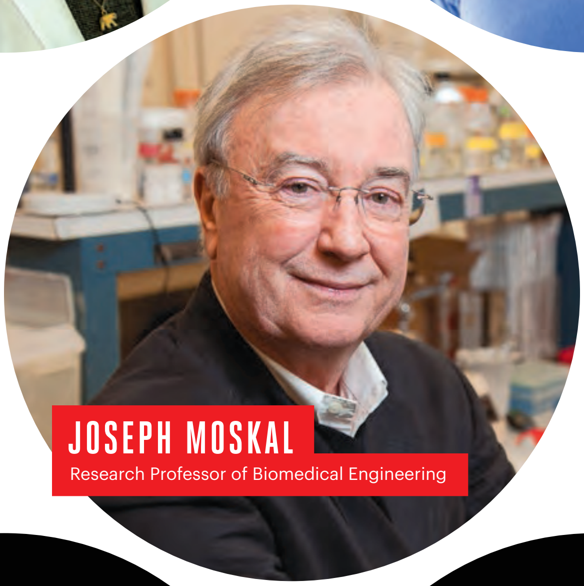
PATRICK KISER
Associate Professor of Biomedical Engineering



SAMUEL STUPP
Board of Trustees Professor of Materials Science and Engineering, Chemistry, Medicine, and Biomedical Engineering

MONICA OLVERA DE LA CRUZ
Lawyer Taylor Professor of Materials Science and Engineering

IGAL SZLEIFER
Christina Enroth-Cugell Chair of Biomedical Engineering



JOSEPH MOSKAL
Research Professor of Biomedical Engineering

IGAL SZLEIFER

NEW DELIVERY METHOD: LIPOSOMES

Igal Szleifer has been interested in modeling new systems for drug delivery for his entire 25-year career. He says his job is "to think about all the possibilities."

"We don't come up with the ultimate solution using theory and modeling," says Szleifer, the Christina Enroth-Cugell Chair of Biomedical Engineering at McCormick. "We narrow the variables in order to get an experiment to work, so others can concentrate on things that are doable in a relatively short time frame rather than having to test all the possibilities."

For many years, Szleifer has studied spherical vesicles composed of lipids, called liposomes, a group of naturally occurring molecules that includes fats and waxes. Tiny, bubble-like structures, liposomes are made from the same materials as cell membranes and can be filled with therapeutics, such as drugs or DNA.

"Liposomes make great drug delivery systems because they can be 100-percent biodegradable and biocompatible," he says. "Because the membrane is two molecules thick, the loading of the drug is very high and release can be triggered by disrupting subtle interactions in the bilayer. This is a beautiful example of how manipulating nanostructures can lead to important applications."

Recently, Szleifer's team has modified the surfaces of liposomes with pH-sensitive peptides. When the liposome enters a more acidic environment, the peptide senses the change and delivers the drug. This quality could prove particularly useful for cancer treatment.

"The environment of cancerous tumors is more acidic than normal tissue," Szleifer says. "We can tailor features of drug delivery systems to take advantage of that."

Szleifer's team is also modeling how different concentrations of cholesterol in the liposome can optimize drug delivery. Cholesterol makes the liposome's membrane tighter, slowing diffusion of the drug. The team discovered that cholesterol also affects the placement of the drug in the liposome; it changes the position of where the drug spends time before exiting the membrane. Knowing the drug's position helps researchers better understand its release profile.

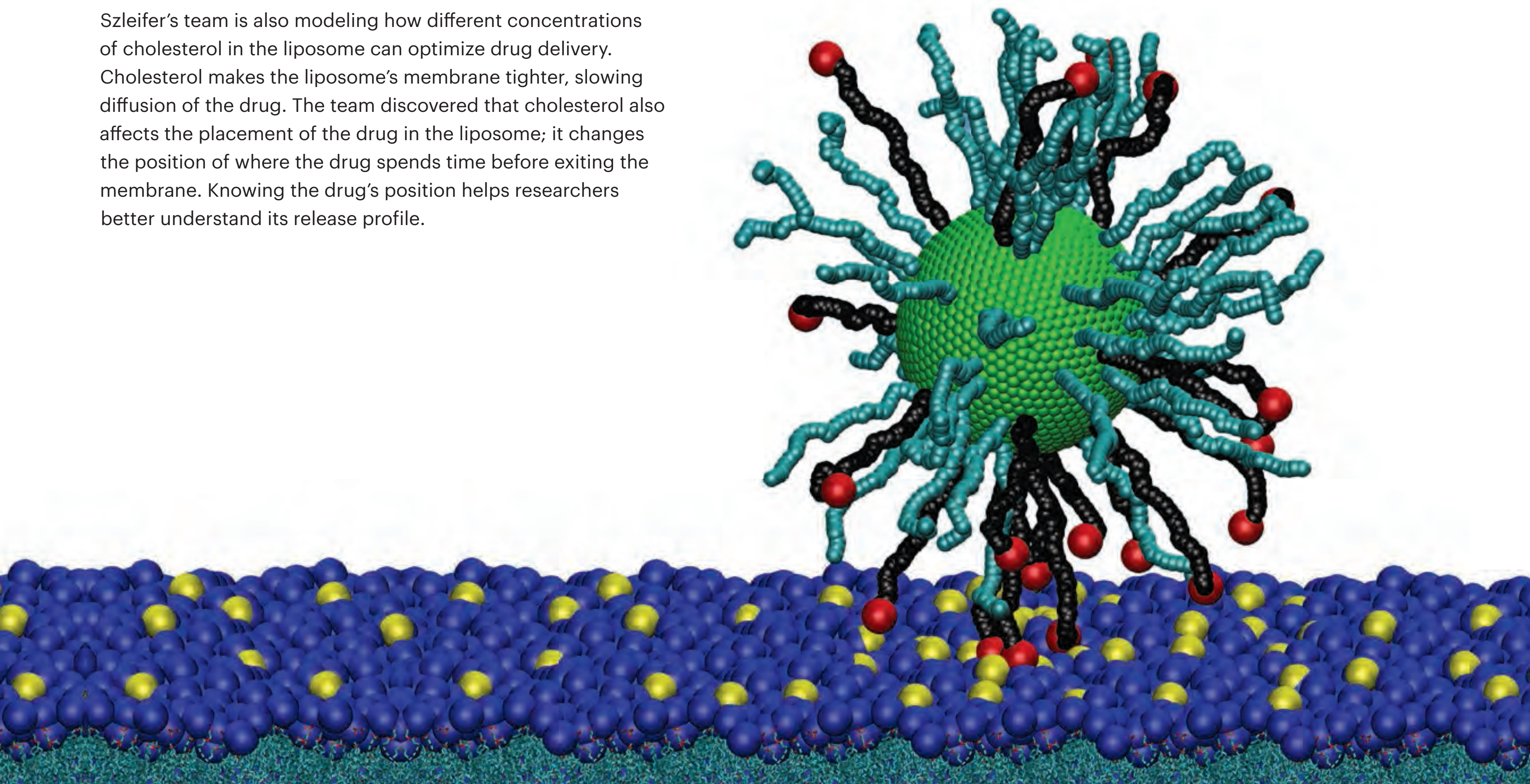
COLLABORATING ON TARGETED THERAPEUTIC DELIVERY

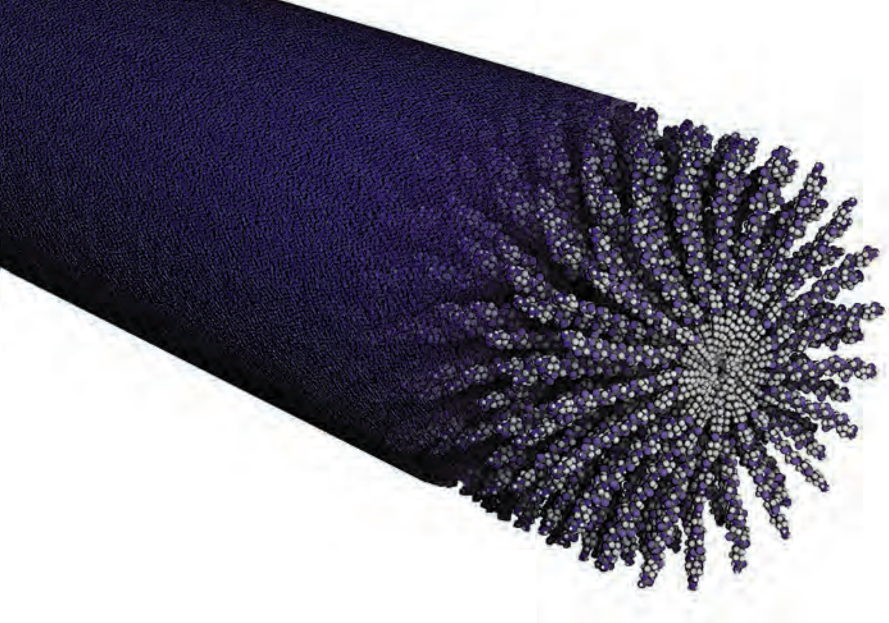
Szleifer is also creating models to help his fellow McCormick researcher, Patrick Kiser, understand the diffusion of drugs from Kiser's innovative intravaginal rings. For example, to be completely effective as a contraceptive, Kiser's tenofovir levonorgestrel combination ring should be left in place for the entire three months that it's active.

In clinical trials, however, researchers found that some women removed the ring for short periods of time for various reasons. How effective is it if the ring is removed and the drug concentration drops? For the answer, Kiser turned to Szleifer to build a theoretical model of the female reproductive system to understand the distribution and concentrations of the drugs in vaginal tissues.

Another member of the team, Thomas Hope, professor of cell and molecular biology at the Feinberg School of Medicine and a leading HIV virologist/immunologist, wants to know where the HIV goes in the body and how that overlaps with the drug as it disperses. Szleifer's model will help determine the best dosages and delivery format to intercept the virus.

"We want to not only discover what dose is needed to prevent infection by the virus, but we also want to know what the levels are in the cells that get infected and the probability of interaction with the virus," Szleifer says. "To stop this virus we need to quantitatively understand how the drug and target cells interact with the virus during the first steps of infection." A combined approach using engineering, virology, and modeling is required for the next breakthrough.





> "DURING EXPERIMENTS, WE REALIZED THESE FILAMENTS HAD A GREAT CAPACITY TO INTERACT WITH CELLS, AND THEY ARE BIOCOMPATIBLE. USING THEM TO DELIVER DRUGS WAS A NATURAL IDEA." **SAMUEL STUPP**

SAMUEL STUPP

NEW DELIVERY METHOD: CARGO COMPARTMENTS FOR DRUGS

Fifteen years ago, when Samuel Stupp first developed a cylindrical nanofilament structure that mimicked the collagen fibers present in bone materials, he knew the nanofilaments had great potential for applications in regenerative medicine.

Although Stupp, the Board of Trustees Professor of Materials Science and Engineering, Chemistry, Medicine, and Biomedical Engineering, never expected to apply this work to the area of drug delivery, he recently discovered that the nanofilaments showed promise in that area as well.

"You can't always predict what's going to happen," says Stupp. "During experiments, we realized these filaments had a great capacity to interact with cells, and they are biocompatible. Using them to deliver drugs was a natural idea."

FINDING THE RIGHT "ZIP CODE"

On further investigation, Stupp discovered that the nanofilaments could encapsulate drugs in their hydrophobic cores, and slowly release the drugs as they biodegrade. "Think of the core of the cylinder as a cargo compartment," he says.

Using the cylindrical nanofilaments to encapsulate chemotherapy drugs, Stupp's team found they were effective in reducing tumor size in an animal model of breast cancer, work that has been supported by Northwestern's Center of Cancer Nanotechnology Excellence. Stupp's team also incorporates targeting information on the surface of the cylinder, guiding it to a specific location in the body.

"It's almost like you provide information that allows the cylinder to find a ZIP code," he says. That "ZIP code" can take many forms; one of them is a structure that binds to common receptors in cancer cells. Another possibility is to rely on the fact that tumors express certain types of enzymes at a level that normal tissues do not. Thus, the ZIP code could be the substrate for those enzymes, and when the cylinders encounter a cancerous environment, they are more likely to break apart and release the drug they're carrying.

UNCOVERING NEW APPLICATIONS

Stupp says the nanofilaments can also perform double duty—carrying drugs not only inside their compartments, but also bonded to their surfaces. Because it's difficult to know how much of the drug a cylinder can hold in its core, bonding the drug to the surface increases its capacity so it can deliver a larger dosage.

"Then we could have the possibility of having a nanostructure that releases two drugs," Stupp adds. "Maybe the drugs need to be released at different rates, so one is held inside and one outside."

Most recently, Stupp's team has used the cylinders to store and deliver therapeutic gases, which have important biological effects but are typically unstable and difficult to corral and control. He has experimented with delivery of nitric oxide in collaboration with vascular surgeon Melina Kibbe in the Feinberg School of Medicine. This naturally produced gas can prevent the closing of blood vessels after stent placement.

"Stent placement, a very common procedure, saves many lives each year," Stupp says. "We put targeting information—the ZIP code—on the outside of the nanofilament, and that ZIP code delivered the cylinder to the place where the artery had been injured, and then it released the gas. It showed great success."

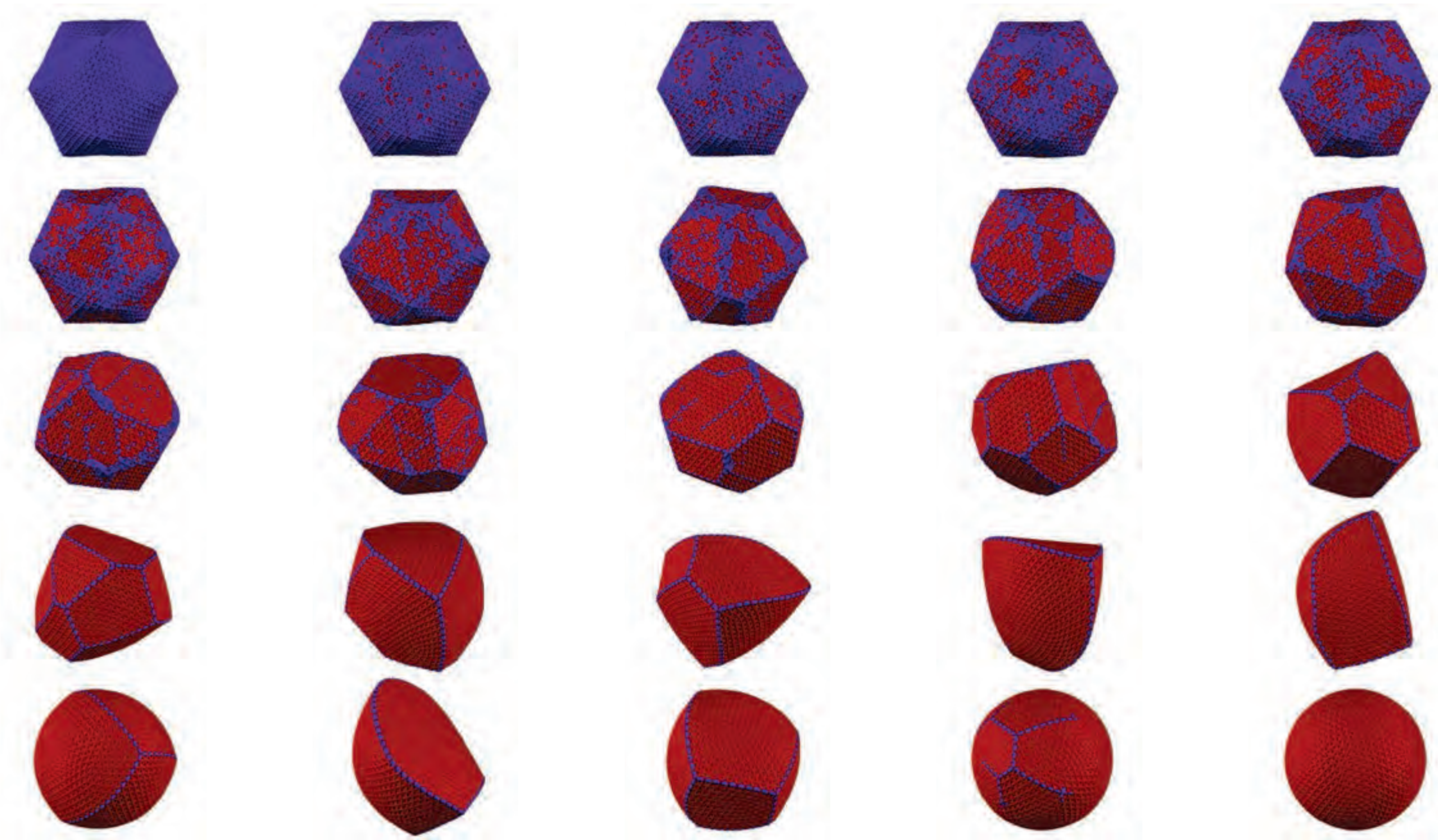


Image courtesy of Graziano Vernizzi, Siena College, Loudonville, NY.

MONICA OLVERA DE LA CRUZ

NEW DELIVERY METHOD: NANOCONTAINERS

For inspiration, Monica Olvera de la Cruz looks to the depths of the Dead Sea, where bacterial halophiles thrive under extreme conditions. From the Greek word for "salt-loving," halophiles live in water with exceptionally high salt concentrations, an environment where very few organisms can survive.

"The organisms are protected because their wall membranes are crystalline," says Olvera de la Cruz, the Lawyer Taylor Professor of Materials Science and Engineering. "This creates a very strong surface. Otherwise, the salt would kill them."

Using this principle drawn from nature, Olvera de la Cruz's team has designed liposome "nanocontainers," knowing that when liposomes crystallize, they become more stable and can withstand transportation into and through the human body.

To achieve this desired result, Olvera de la Cruz uses the electrostatics of chemical compounds that have heads and tails, called lipid amphiphiles. The heads are attracted to water; the tails are repelled by it. Her team computationally combined three amphiphiles with positive charges and one with a negative charge, which turned the liposomes into different shapes. They became multifaceted polyhedrons, with flat faces, straight edges, and sharp corners.

When broken symmetries occur, the liposomes have a "directional" reaction to stimuli, resulting in specific changes that induce other processes, such as the attraction to a preferred location in the body and release of the drug. "The less symmetry there is, the more function you have," says Olvera de la Cruz. "If everything were homogenous, then nothing would happen in nature."

Since changing the shape of liposomes at the nanolevel also changes their mechanics, researchers can design liposomes with specific shapes that can be recognized by receptors in the body to perform different functions. The surfaces can be patterned with components that are drawn toward a specific target, like a tumor, where the drug is released. The crystallized shell of the liposome not only helps the drug find its target, but also acts as a strong barrier that slowly breaks down for a timed release. This slow release is ideal because the therapeutic is delivered in a large, single dose that diffuses over time rather than in smaller doses that must be administered time and again.

JOSEPH MOSKAL

NEW DELIVERY TARGET: BRAIN RECEPTORS FOR LEARNING AND MEMORY

People suffering from treatment-resistant depression can go months or even years without any relief. Finally, for them, there may be a light at the end of the tunnel. A new antidepressant drug created by Joseph Moskal has been tested on adults who have not been helped by other antidepressant therapies, and it alleviated symptoms within hours.

"This addresses a population in great need of something that works," says Moskal, research professor of biomedical engineering at McCormick and founder of neuropharmaceutical company Naurex.

LOOKING FROM A DIFFERENT ANGLE

The road to Moskal's discovery began when he was a senior staff fellow at the National Institutes of Health, where he studied monoclonal antibodies to understand pathways of learning and memory. He realized this area of the brain could have potential for the treatment of neurological disease.

To create relief for difficult-to-treat depression, Moskal looked at the condition from a different angle. Instead of targeting serotonin receptors, as many antidepressants do, Moskal targeted brain receptors responsible for learning and memory—a very different approach from existing antidepressants.

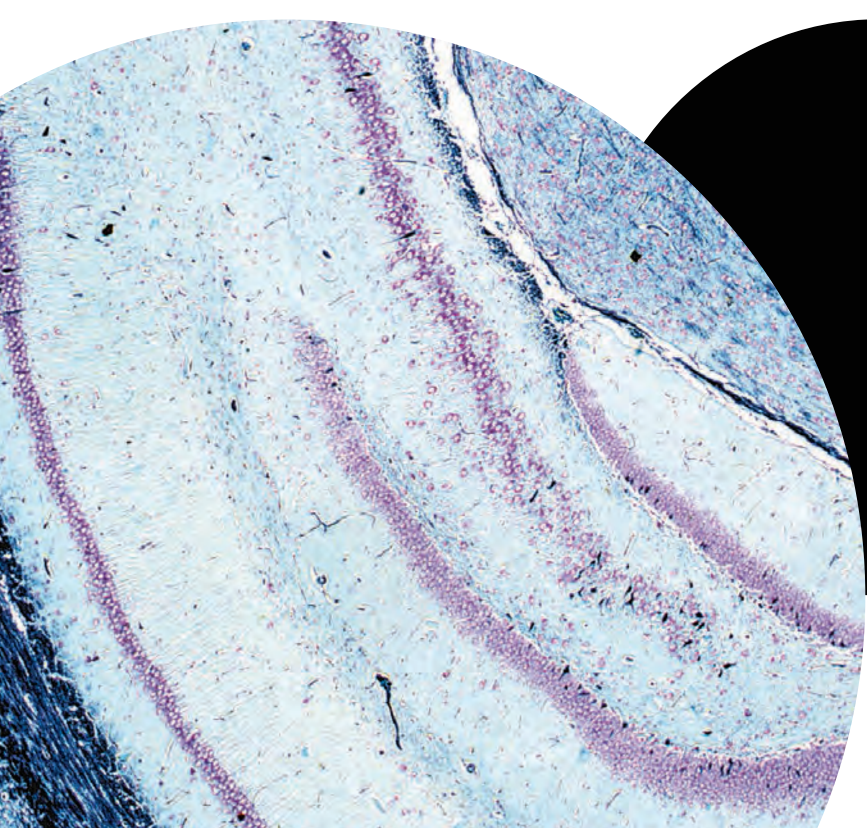
The resulting drug, GLYX-13, is a four amino acid peptide that modulates NMDA (N-Methyl-D-aspartate) receptors in the brain. NMDA receptors play a key role in regulating the quality of the connection between neurons—synaptic plasticity—and are important in regulating learning and memory functions.

In clinical trials administered at 12 sites nationwide, a single dose of GLYX-13 resulted in significant reductions in depression symptoms among subjects who had shown little improvement with previous drugs. The positive effects of GLYX-13 were evident within 24 hours and lasted an average of seven days. The effect size, a measure of the magnitude of the drug's antidepressant efficacy, at both these times after a single dose was nearly double the effect size seen with most other antidepressant drugs after four to six weeks of repeated dosing. In addition, GLYX-13 does not share the serious side effects, such as hallucinations and schizophrenia-like symptoms, of another drug on the market, ketamine, which also targets NMDA receptors.

While GLYX-13 is administered intravenously, Moskal is also working on an oral drug with similar properties and potential. The compound recently completed Phase IIb clinical trials and received a fast track designation from the Food and Drug Administration to expedite development.

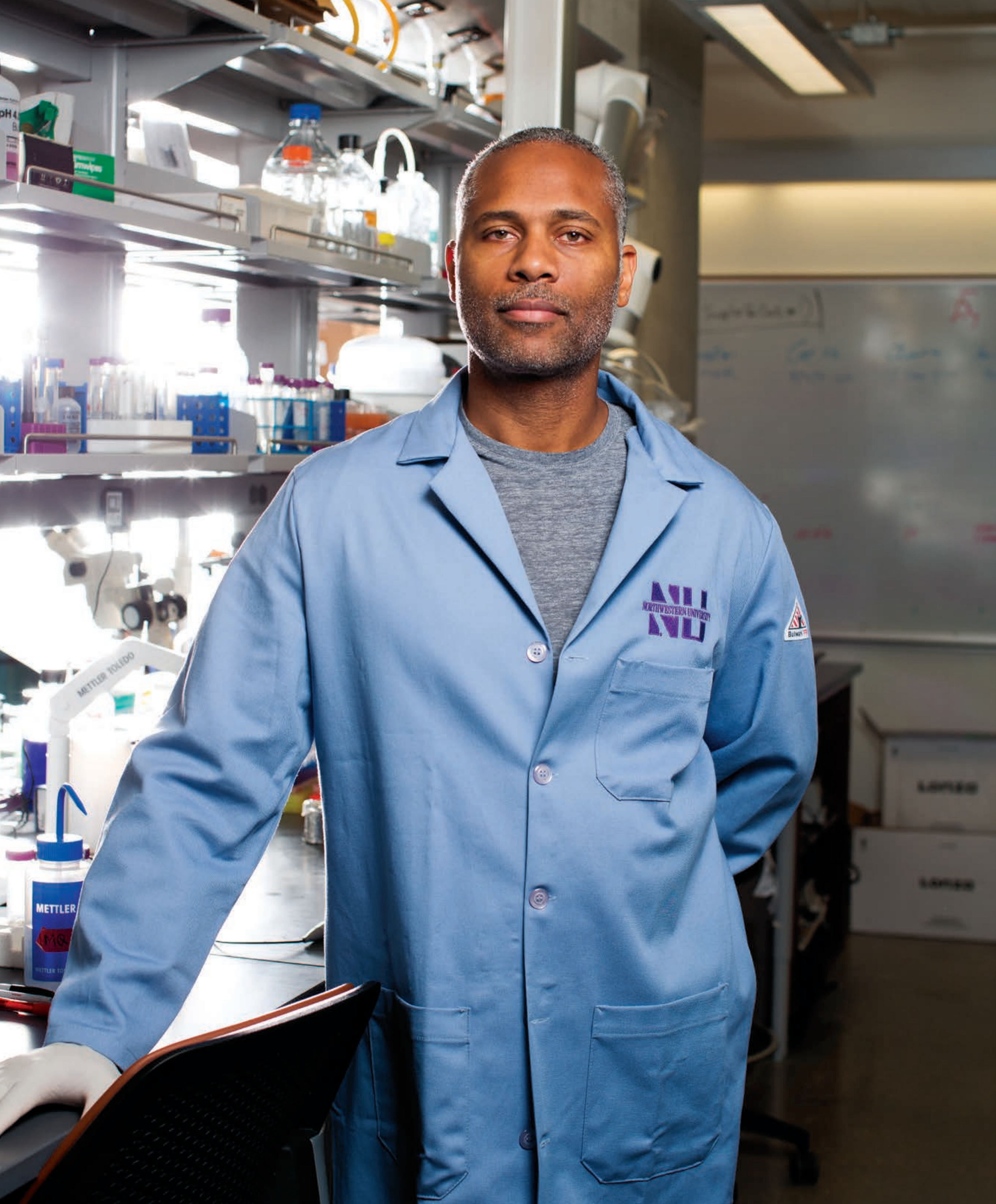
The new drug also could be helpful in treating other neurological conditions, including schizophrenia, bipolar disorder, anxiety, and Alzheimer's disease. Moskal says, "The drug has potential to address major issues that confront millions of patients worldwide."

AMANDA MORRIS



"THE DRUG HAS POTENTIAL TO ADDRESS MAJOR ISSUES THAT CONFRONT MILLIONS OF PATIENTS WORLDWIDE."

JOSEPH MOSKAL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THE OTHER SIDE OF O_2
NEW BIOMATERIAL PROMOTES SURGICAL HEALING

GUILLERMO AMEER'S INNOVATIVE ANTIOXIDANT BIOMATERIAL HELPS MITIGATE THE INFLAMMATORY RESPONSE TO IMPLANTS AND GRAFTS

Human beings in general think of oxygen as a good thing. We can't survive without it. But this life-sustaining molecule has a dark side, and Guillermo Ameer is out to stop it from wreaking havoc inside the human body.

"When surgeons place a medical device or implant inside the body, there's always an inflammatory response," says Ameer, professor of biomedical engineering in the McCormick School of Engineering and professor of surgery in the Feinberg School of Medicine. "In addition to that inflammatory response, with commonly used plastic materials, oxidation occurs."

A high concentration of oxygen in the body can cause oxidative reactions to fall out of balance, which modifies natural proteins, cells, and lipids, causing them to function abnormally. This oxidative stress is toxic and can contribute to chronic disease, chronic inflammation, and other complications that may cause surgical implants to fail.

STOPPING THE TOXIC DOMINO EFFECT IN ITS TRACKS

Ameer has created a biodegradable biomaterial that is inherently antioxidant. Biomedical engineers can use this material to create elastomers, liquids, gels, or solids for building devices that are more compatible with cells and tissues.

"Implants made from plastics can self-oxidize, creating free radicals as part of their degradation process," Ameer says. "The oxidation process can injure nearby cells and create a cascade effect that leads to chronic inflammation. Our material could significantly reduce the inflammatory response."

Ameer created the biomaterial, a polyester based on citric acid, by incorporating vitamin C into its building blocks. In preliminary experiments, his team coated vascular grafts with the antioxidant biomaterial. The grafts were then evaluated in animals by Ameer's long-time collaborator Melina Kibbe, professor of surgery, the Edward G. Elcock Professor of Surgical Research at Feinberg, and a vascular surgeon at Northwestern Memorial Hospital.

Typical of the foreign body response, grafts tend to inflame nearby cells and slowly cause tissue to scar over time, which eventually leads to failure. When the antioxidant-coated vascular graft was implanted, however, scarring was significantly reduced. Ameer's team, funded by a proof-of-concept grant from the Northwestern University Clinical and Translational Sciences Institute, also found that a water-soluble, thermoreversible version of the material sped up the healing of diabetic ulcers. Because the material is biodegradable, the body harmlessly absorbs it over time.

"In the past, others have added antioxidant vitamins to a polymer and blended it in," Ameer says. "That can affect the mechanical properties of the material and limit how much antioxidant you can add, so it doesn't work well. What we're doing is different. We're building a material that is already inherently, intrinsically antioxidant."

EXPLORING NEW USES

Ameer says the new biomaterial could be used to create scaffolds for tissue engineering, coat or build safer medical devices, promote healing in regenerative medicine, and protect cells, genes, and viruses during drug delivery. He adds that the new biomaterial is easy to make and inexpensive.

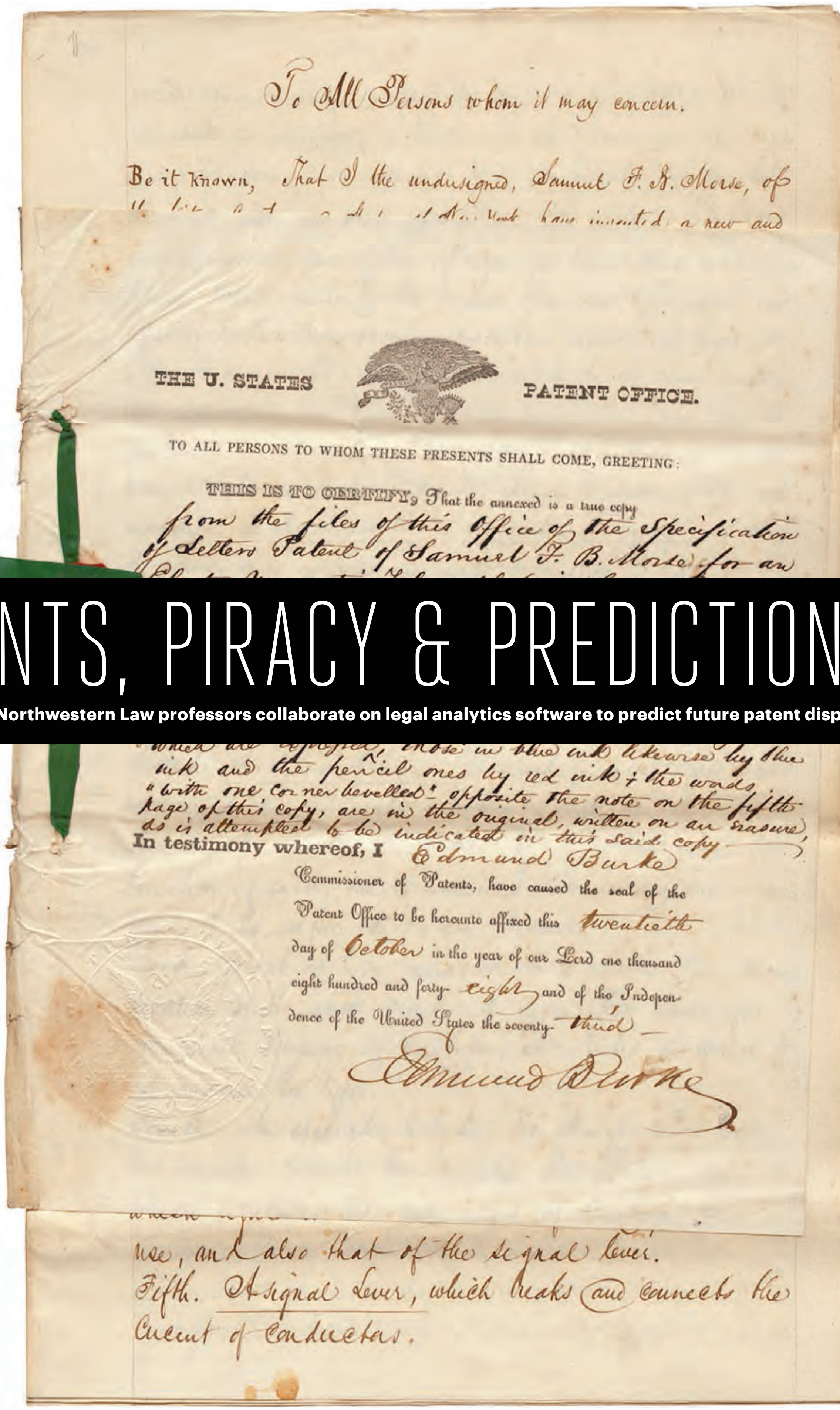
"Citric acid is affordable and in pretty much everything we come in contact with on a daily basis—food and beverages, skin and hair products, drugs, you name it," Ameer says. "It's a common, inexpensive raw material, and the human body can stabilize vitamin C, an antioxidant that we're all familiar with."

AMANDA MORRIS

Photograph by Chris Strong

PATENTS, PIRACY & PREDICTIONS

McCormick and Northwestern Law professors collaborate on legal analytics software to predict future patent disputes



To All Persons whom it may concern.

Be it known, That I the undersigned, Samuel F. B. Morse, of ... have invented a new and

THE U. STATES PATENT OFFICE.

TO ALL PERSONS TO WHOM THESE PRESENTS SHALL COME, GREETING:

THIS IS TO CERTIFY, That the annexed is a true copy from the files of this Office of the Specification of Letters Patent of Samuel F. B. Morse for an ...

... which are ..., those in blue ink likewise by blue ink and the pencil ones by red ink & the words "with one corner bevelled" opposite the note on the fifth page of this copy, are in the original, written on an erasure, as is attempted to be indicated in this said copy

In testimony whereof, I Edmund Burke Commissioner of Patents, have caused the seal of the Patent Office to be hereunto affixed this twentieth day of October in the year of our Lord one thousand eight hundred and forty-eight and of the Independence of the United States the seventy-third

Edmund Burke

... use, and also that of the signal lever.

Fifth. A signal lever, which breaks and connects the circuit of conductors.

Samuel Morse revolutionized global communication in 1838 when he patented the telegraph. Within a decade, more than 20,000 miles of telegraph wire spanned the continental United States. By 1866, a transatlantic line stretched all the way to Europe, introducing the world to near-instant messaging.

You might think Morse would have relaxed and basked in the glow of his success. Not so. He constantly watched over his shoulder for "patent pirates" and spent countless hours and a small fortune defending his patents in court.

"I have been so constantly under the necessity of watching the movements of the most unprincipled set of pirates I have ever known," Morse said in an 1848 letter to a friend, "that all my time has been occupied in defense..."

Telecommunications may have advanced exponentially in the intervening 166 years, but little has changed in the shady world of patent infringement. Inventors today spend millions on insurance to protect their intellectual property. A 2011 American Intellectual Property Law Association survey revealed that patent-related legal costs can range from $650,000 on the low end to a jaw-dropping $5 million.

PEERING INTO THE FUTURE AT NORTHWESTERN

What if inventors could see into the future and know whether or not their patents would be infringed? How much money could they save? How much more time would they have to innovate?

The answers may come sooner rather than later thanks to the collaborative effort of McCormick School of Engineering Professor Diego Klabjan and Northwestern School of Law Professor John O. McGinnis. Together with PhD student Papis Wongchaisuwat, they are developing a new model that not only identifies patents with a high probability of being litigated, but can also predict how many years into the future the dispute will occur.

"If you know a patent is more likely to be litigated, then you'll pay closer attention to possible infringements," said Klabjan, professor of industrial engineering and management sciences and director of McCormick's Master of Science in Analytics program. "A patent that is not likely to be litigated might be put aside. It really boils down to how you allocate your resources, like your budget for infringement detection."

AN IDEA COMES TO LIFE

Two years ago, McGinnis, professor of law, approached Klabjan for advice about developing a new legal analytics course. McGinnis has long been interested in data analytics and the growing role of machine intelligence in the legal profession. After several conversations, a research collaboration was sparked.

"Lawyers make predictions all the time," McGinnis said. "Will this be a good case? Will we win? Making the correct prediction is a central challenge for the legal practice. If we can make an analytic framework for prediction, then we can see the outcome before going through the costs of litigation."

The team started by examining publicly available data from the US Patent and Trademark Office. Then they retrieved litigation documents from Lex Machina, a company that tracks patent cases. They matched the data, focusing on the claims section of past patents and associated legal disputes. Klabjan and Wongchaisuwat used text analytics to pore over 100,000 patents to discover patterns and trends in those patents that were disputed and those that were not. They then extracted keywords and phrases that could indicate future litigation.

"We used historical patents to create our prediction model," Klabjan said. "Then we compared our predictions to what really happened. The actual prediction is for the future, but you don't know what will happen in the future, so you compare it against recent history."

After establishing an algorithm that makes an accurate prediction, Klabjan built software that automatically analyzes patent documents. So far, the model is able to correctly predict 64 percent of litigated patents. After filing for a patent, inventors can run the software to discover when it might be litigated.

"Our software might say it's likely to be litigated in three years," Klabjan said. "So for the first two years, they know they are fine. They don't have to do much. When they enter year three, they know they need to start monitoring for potential infringements."

REFINING THE MODEL

To further improve their prediction model, Klabjan and his team have started incorporating financial data from the US Securities and Exchange Commission (SEC). They are specifically reviewing revenue and profits from companies that own patents. According to Klabjan, large companies, such as Microsoft or Apple, are more likely to experience infringement cases because the amount of money involved is significant. SEC filings don't follow a standard format, so integrating financial information has been slower. The team had to write special, tailored codes to parse and analyze each format.

Klabjan and McGinnis plan to continue collaborating on other legal analytics projects. Right now, the field is ripe for exploration. Few researchers work within legal analytics because of difficulty accessing legal documents. Klabjan formed an academic partnership with Lex Machina and gained access to the company's materials. Otherwise, it could have cost tens of thousands of dollars.

"You can draw patterns from one document, but you cannot claim that the same patterns will occur in other documents," Klabjan said. "For that you need a large volume of documents, which is hard to obtain."

"We can use machine intelligence to forecast outcomes of patent litigation," McGinnis said. "This is the future of law."

AMANDA MORRIS

Photograph courtesy of National Archives and Records Administration

TRADING THE BEACH FOR THE RESEARCH LAB

MCCORMICK UNDERGRADUATE RESEARCHERS USE SUMMER BREAK TO BREAK NEW GROUND

At any given time during the regular academic year, you'll find about 150 McCormick undergraduates actively engaged in on-campus research. In the summer, that number often swells to 225.

For students who want to dive into their subject matter, summer provides the perfect atmosphere for a concentrated research experience. Without additional coursework to distract, students apply what they've learned in class to make new discoveries and advancements on their own.

For many students, these summer experiences can only be realized through funding sources like Northwestern's Office of Undergraduate Research and McCormick, which funds about one in six undergraduate applicants.

"These summer projects provide immersive and invaluable experiential learning," says Stephen Carr, associate dean for undergraduate engineering. "Students get a double benefit from their time in a research group—the pride of ownership that results from being published and the one-on-one engagement with our faculty."

AS TOLD TO SARA LANGEN

RESEARCH PROJECTS LIKE THIS CREATE **AN OPPORTUNITY TO GAIN EXPERTISE** YOU WON'T TYPICALLY GET FROM A QUARTER-LONG CLASS.

CONOR HETLAND '15 COMPUTER ENGINEERING

Before college I liked science and particularly math a lot. At some point, I naturally slipped into thinking I wanted to study engineering. I took an engineering design class on the Northwestern campus over the summer in high school, which helped solidify my interest.

McCormick is a really great fit for me. I found the parallelism project in Introduction to Computer Systems very interesting and put a lot of work into it. Professor Peter Dinda was really helpful, so when I decided I wanted to do an independent study related to parallelism, he was the first person I asked.

I'm still undecided on what I want to do after undergrad, so I wanted to get some significant research experience over the summer to see how much I enjoy it. I also wanted to continue to develop the subject matter expertise I had worked on during the year and during my independent study.

My project involves designing and implementing a nested data parallel programming language that compiles to the C programming language. We aim to create a language that eloquently describes and reveals structures of certain parallel problems. This will mean parallel programming will require less effort and allow programmers to take advantage of parallel hardware capabilities without forcing them to learn and use cruder existing parallel languages.

The project is partly based on NESL, a nested data parallel programming language developed in the mid-90s that contains a lot of the expressive power we'd like our language to have. By designing a new language with modern hardware in mind, we hope to find some new insights into the possible features and implementations of a similar language.

I'm a computer engineer, so I enjoy opportunities to program that require understanding of the underlying hardware. As a result, I was drawn to the relatively exotic and parallel architecture of graphics cards. I took Professor Robert Findler's excellent Interpreters and Compilers classes, which inspired my interest in languages. The idea of linking together what I'd learned about programming graphics cards for general purposes, language design, and compilers was incredibly interesting.

Currently, I've got the functionality of a tiny Turing-complete parallel language, a language that is data parallel, but not nested data parallel. I should have nested data parallel functionality quite soon. At that point, the language will have the core of the functionality I'm trying to provide. I'm getting a little excited thinking about it. Even though it isn't complete, it's a lot of fun to write a tiny program in the language I've made and see it work.

One of the things I've learned is how to better explain computer science and parallel problems. Some of that communications aspect filters through to the language itself, because ideally you want somebody who's looking at the program you've written to understand what you're trying to do. The language you design should communicate something. That's part of why having a parallel language like this is really cool.

Because of the quarter system, it's rare to stick with a project for more than 30 or so hours and to use the same language and tools two quarters in a row. Research projects like this create an opportunity to gain expertise you won't typically get from a quarter-long class.

Photograph by Chris Strong

DOING RESEARCH AND SEEING THINGS HAPPEN IN REAL TIME ARE **ENLIGHTENING AND INCREDIBLY EMPOWERING.**

SARAH RAPPAPORT '17
MATERIALS SCIENCE AND ENGINEERING AND MUSIC (FRENCH HORN)

Both my parents are engineers, so it's in my blood. I'm a dual major in materials science and engineering and French horn performance. What I really liked about McCormick is the whole-brain engineering idea, the fact that they want you not to just focus on your technical classes, but also on the creative side of engineering.

I really enjoy research because it's very different from course work. You're not handing in papers or reading a chapter; you're looking at work people are doing now. There isn't necessarily a clear answer—there are only a lot of things you can try. It's both concrete and abstract at the same time.

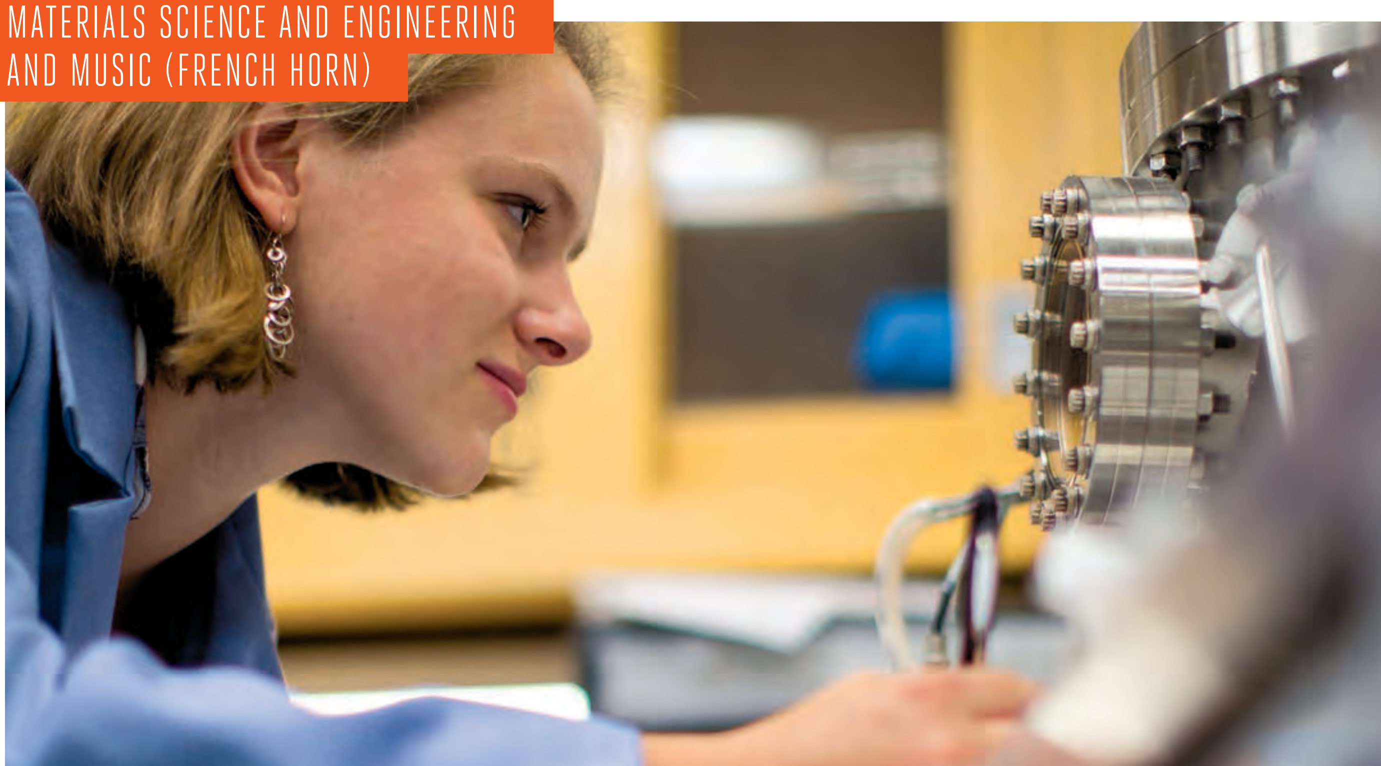
I've always found chemical reactions fascinating. I joined Professor Lincoln Lauhon's lab because some of the work he's doing lines up with my interest in creating a clean energy source. Finding a way to save the planet is my dream job, so being able to pursue that in this lab has been awesome. I like the idea of helping other people. Making progress in this area will benefit a lot of humanity.

My research focuses on preparing samples of MoS_2 [molybdenum disulfide, an inorganic compound] and analyzing them using a microscope that can produce a digital 3D reconstruction of the sample. Most of my work has been focusing on electro-catalysis; I'm looking at incorporating those thin samples of MoS_2 into an electrochemical cell—basically a fancy deconstructed battery—and running a bias through them to see if I can catalyze a reaction, specifically the electrolysis of water.

MoS_2 has promising applications in the catalysis field. I hope to analyze these samples under the atom probe and see where different impurity atoms are and then incorporate them into these cells to see how impurities might affect the catalytic process, or how much current is produced. It's absolutely going to take more than a summer; I'm just getting started. It all depends on the grants we get, but my ultimate goal is to keep working on it throughout the year.

As an undergraduate, you learn a lot of concepts in classes. It's very easy to just see them as abstract textbook concepts that don't really have any application. Doing research and seeing things happen in real time are enlightening and incredibly empowering. It's why you're an engineer in the first place. Having this opportunity as an undergrad also helps you decide if it's what you really want to do.

Both of my passions—engineering and music—require a lot of patience, especially research. There's no specific end to it; you go until you find something, and then you find something else. It's similar to practicing music where you work on specific pieces, but your work is really never done. All you can do is get better.



I'VE ALWAYS HAD A PASSION FOR INNOVATION.

ERIC YANG '15 BIOMEDICAL ENGINEERING

I've always had a passion for innovation. My dad's an engineering professor, and he encouraged me to try to understand how everything works.

McCormick was a pretty easy decision for me—I was drawn to the course work, which sparked my interest in diagnostics. Last year, Professor Hao Zhang gave me the opportunity to work in his lab on research that may lead to a non-invasive diagnostic for breast cancer that only requires a blood sample from the patient.

When you work on a research project during the regular school year, the time you have in the lab is limited. I wanted to make some real progress and that could only be done by conducting research during the summer. I was lucky to get a McCormick Summer Research Award, thanks to funding from Ben Slivka and Lisa Wissner-Slivka. That was the only way I was able to fund my stay here.

I actually worked on two projects this past summer, both having to do with breast cancer. The primary one is to develop a way to filter out circulating tumor cells in late-stage patients. Around Stage 4, the tumor cells metastasize and go to other parts of the body. That's why it's so devastating—you can't control where the cells go, and they can make tumors anywhere. Our idea is essentially to filter the tumor cells out of the blood.

We're developing a microfluidics chip through which we can push the blood after introducing it to a solution of nanoparticles that have functionalized mRNA strands specific to the type of cancer cells we're trying to filter out.

This chip sorts the cells by density as well as weight. When the cancer cells absorb the nanoparticles, those properties will change and it will be a lot easier for us to dissociate.

Our second project also deals with circulating tumor cells. A blood sample from a patient is mixed with our nanoparticles and incubated, allowing the nanoparticles to enter the cancer cells and produce a fluorophore when endogenous mRNA strands specific to cancer cells hybridize with the mRNA strands functionalized on the nanoparticle. Detection of the fluorescence is how we determine if the cancer is present or not.

Given the extremely low concentration of these tumor cells in the blood during early stages of cancer, the bulk of the effort has been to ensure that the sensitivity and specificity of our system and protocol are capable of reliable detection.

There's a chance this could be used to detect breast cancer early. The primary project could improve the prognosis of the disease by helping prevent the metastasis of the cancer. We hope both projects will be applied in clinical settings.

I've learned a lot this summer, but one of the biggest things is how to conduct research independently. I've had to figure things out myself and learn organization skills and time management. I've also gotten experience presenting my project to an audience that wouldn't necessarily understand the technical aspects.

It's really unique that as undergraduates, we can have experiences like this. Not only do we get to conduct independent research, we also get to help pioneer innovative technology and create new knowledge. You don't get an opportunity like that elsewhere.

Photographs by Chris Strong

WORLD'S LARGEST MATERIALS DATABASE NOW OPEN

MCCORMICK TEAM'S OPEN QUANTUM MATERIALS DATABASE OFFERS UNLIMITED ACCESS TO ANALYSES OF NEARLY 300,000 COMPOUNDS

A network graph—called a "minimum spanning tree"—showing the 7,410 predicted table compounds from the Open Quantum Materials Database. Since this image was completed, the number of compounds predicted has increased.

Christopher Wolverton was frustrated. His search for potential materials for new, stronger structural alloys and advanced battery electrodes was becoming far too time-consuming and difficult because most materials databases denied him access.

"I just wanted to download some data, but I couldn't," says Wolverton, McCormick professor of materials science and engineering. "So my students and I decided to build our own materials database."

Two years and several false starts later, Wolverton's group at McCormick has created the largest materials database in the world. The Open Quantum Materials Database (OQMD) launched in November 2013 and has been growing since. It is entirely open to the public and can be downloaded online.

TAKING GUESSWORK OUT OF NEW MATERIALS DESIGN

When researchers like Wolverton want to create better batteries, solar cells, and medical devices, they often look for answers in new materials. Materials with optimal properties can improve existing technologies and spark ideas for new ones. But finding materials that have just the right properties can take many years of trial and error.

"Suppose you want to find a material that would make a good solar cell, but you don't have a design strategy," Wolverton says. "You would have to explore in the dark."

The OQMD takes some of the guesswork out of designing new materials. Its purpose is to identify candidate materials for specific applications by screening them for various properties before they are tested in the lab. This dramatically accelerates the search, narrowing down candidates for possible materials to a mere handful that require further experimentation.

"The calculations are faster and easier with less cost than conducting experiments," Wolverton says. "And it's all on computers, so users can explore things—like toxic elements and radioactive elements—that they probably wouldn't want to do in their labs."

HOW IT WORKS

The OQMD allows users to search for materials by composition, create phase diagrams, determine ground state compositions, and visualize crystal structures. Wolverton says his group has also implemented machine-learning models, trained on the database, that can learn chemistry and predict the possible existence of new compounds that have not yet been synthesized.

"Using sophisticated data mining, we could turn materials science into a big data problem," he said. "We could use algorithms to make recommendations for materials the same way Netflix recommends movies you might like."

The team used Northwestern's high-performance computer cluster, Quest, to construct most of the database. So far, it contains analyses of 285,780 compounds and continues to grow.

"USING SOPHISTICATED DATA MINING, WE COULD TURN MATERIALS SCIENCE INTO A BIG DATA PROBLEM. WE COULD USE ALGORITHMS TO MAKE RECOMMENDATIONS FOR MATERIALS THE SAME WAY NETFLIX RECOMMENDS MOVIES YOU MIGHT LIKE."

CHRISTOPHER WOLVERTON
PROFESSOR OF MATERIALS SCIENCE AND ENGINEERING

KEEPING IT OPEN KEEPS ADDING VALUE

Since the OQMD launched, other institutions have started to make their databases public, but many remain closed. Wolverton says closed databases can only be used the way their creators intended. By keeping the OQMD open, more people can use it, adding their own compounds and growing its potential.

"People will use the database in ways that we couldn't possibly imagine right now," he said. "People will improve it, change it, and use it in different ways. They will search for applications of materials that my group isn't interested in, and that's great. They will get value out of it that we never would have."

Even though Wolverton cannot predict how others might use the database, one thing is certain: it will remain open to the public. "Our philosophy from the very beginning was that our database should be open," he says. "No one should have to repeat this work ever again."

AMANDA MORRIS

EVOLUTION AND INNOVATION BY DESIGN

AFTER NEARLY TWO DECADES, ENGINEERING FIRST® AND THE LEGACY OF DESIGN THINKING CONTINUE TO TRANSFORM THE MCCORMICK EXPERIENCE

TWO DECADES AGO, as the world entered an era of unprecedented technological advancement and rapid globalization, the standard approach to teaching first-year mathematics and engineering sciences was beginning to hold little appeal for students who longed for dynamic engineering experiences from day one.

Knowing that the time was right for a new entry point into the field, the faculty and administration at McCormick School of Engineering took on the ambitious task of creating an entirely new approach, one that would equip and inspire undergraduates to become the kind of engineering leaders that the 21st century would require.

They created Engineering First®, a visionary curriculum that combines engineering analysis with design and communication and engages students in engineering concepts from the start. This groundbreaking foray into design thinking created a unifying McCormick experience that continues to evolve today.

REINVENTING ENGINEERING EDUCATION

It was a conversation Stephen Carr has never forgotten. He remembers the weather (hot) and the building (silent) on that summer day about 20 years ago when then-dean Jerome Cohen drifted into Carr's office, put his feet up, and prepared to launch into one of the duo's usual philosophical discussions.

Only this conversation took a pointed turn, one that changed the future of McCormick and reshaped the entire concept of undergraduate engineering education. Carr, now senior associate dean, recalls, "We said to ourselves, we need something that will prepare our students for careers in the 21st century because it's going to be altogether different from anything seen over the last century.

"We knew that sooner rather than later, just simply getting an engineering degree where you learn about technologies would be disappointing and inadequate. It was going to be a brave new world. We needed to find a way to use the freshman year to make the education that our students get altogether different and much more relevant to the changing world."

Carr says Dean Cohen asked him to form a faculty committee in 1995 to collaborate on how to use the first year as a springboard to something big. "We knew we had to prepare our students to be leaders in engineering, not just practitioners," he notes. "It was also an empowerment of the faculty that if they had bright ideas for ambitious changes in the curriculum, we would stand behind them."

COMMUNICATION AS THE CORNERSTONE

The result was the Engineering First program. Envisioned as an ambitious two-part sequence of engineering analysis and design courses for first-year students, the plan introduced a new pedagogy for engineering education.

The Engineering Analysis (EA) program covered linear algebra, differential equations, Newtonian mechanics, computer proficiency, and engineering statics and dynamics in combination to show students how analysis serves as the foundation for thorough and accurate engineering. It became a new way to teach the basics of engineering and was typically a student's first experience with learning multiple subjects in an integrated fashion.

Charged with heading up a design component to complement the EA experience, J. Edward Colgate, the Allen K. and Johnnie Cordell Breed Senior Professor in Design, soon realized that incorporating faculty from the Writing Program at the Weinberg College of Arts and Sciences into the process was critical. "Experience with my students showed me that understanding one's work deeply is part and parcel of being able to communicate it well," he says.

Colgate put together a faculty team that included Professors David Kelso and Greg Olson on the engineering side and Professors Penny Hirsch and Barbara Shwom and Lecturer John Anderson on the writing side. The team decided to combine the design course with the first-year writing requirement to create an integrated, project-based, human-centered design and communication program.

"We thought of design as a creative problem-solving process and realized that the writing process is also creative problem-solving," Hirsch remembers. "The similarity could be used to help engineering students better understand communication."

Another key program innovation involved incorporating teamwork as a central component. Students would work in teams of four with courses team-taught by engineering and communication faculty and experts from the field. Pilot versions of the courses, known then as Engineering Design and Communication (EDC), were tested, refined, and fully integrated into the McCormick curriculum between 1997 and 2000.

Colgate says: "There was nothing out there that combined design and communication like this—certainly nothing that had the scope of what we were doing."

REAL PROJECTS, REAL CLIENTS, REAL SOLUTIONS

EDC put first-year students to work immediately on real design problems submitted by individuals, non-profits, entrepreneurs, and industry members. In the two-quarter course, teams of students interviewed clients, brainstormed ideas, and built, tested, and rebuilt prototypes until they got them right. They then presented their solutions to clients through written reports and a final presentation.

Thanks to partnerships with organizations such as the Rehabilitation Institute of Chicago, Shedd Aquarium, Kids in Danger, and Misericordia, the program's projects allowed students to design solutions that improved people's lives. Ultimately, the course introduced students to human-centered design: the ability to find the real problem behind the perceived problem.

"We've always believed the human side is very important," Colgate says. "You have to know for whom the solution is being created and what the client's needs are, so we embrace softer social skills to understand people better as part of this approach."

A LEGACY OF LEARNING

EDC proved that through real design projects, first-year engineering students can learn the skills of design thinking and develop the prerequisites for leadership. This new approach transformed the McCormick culture with the strong belief that leadership and design thinking can—and must—be developed from day one.

One of the greatest legacies to come out of EDC and the design education evolution it inspired is the six-story, 84,000-square-foot Ford Motor Company Engineering Design Center. Opened in 2005, the center houses faculty and student offices, classroom space, laboratories, research rooms, and a prototyping facility.

As word of McCormick's design curriculum spread, Ford Motor Company wanted to help create a space to foster innovation. The center provides students with a collaborative environment where the exchange of ideas and group work can flourish. It also inspired McCormick to expand design thinking beyond the first year.

"We thought that if we're going to have a whole building for design, we need to do more than one course," Colgate remembers.

INNOVATION OVER TIME.

DESIGN THINKING AT MCCORMICK.

SUMMER 1995
Faculty committee explores creating a new first-year program

WINTER 1995
Concept created that will become Engineering First®

1996
Resources gathered to support the program

1997
Engineering First launched

1997–2000
Engineering Design and Communication pilot programs tested, refined, and fully integrated into the McCormick curriculum

2001
The Ford Motor Company Engineering Design Center funded with a $10 million gift from the Ford Motor Company

In 2007, the Ford Center became home to the Segal Design Institute, which has as its mission to educate innovators and design thinkers while expanding the research frontiers of human-centered design. Crate and Barrel co-founders Gordon and Carole Segal endowed the institute and enabled McCormick to significantly expand its undergraduate design curriculum, develop new graduate degree programs, and fund additional design research.

Now, undergraduate students can take a variety of upper-level courses that tackle everything from industrial design to intellectual property—and, with enough courses, can achieve the Segal Design Certificate. Segal is home to several graduate programs in design and product development and also houses a PhD design cluster, which brings together faculty and graduate students from across Northwestern University to conduct design research.

THE FUTURE OF INNOVATION AT MCCORMICK

The cornerstone of design education, EDC, continued to evolve through expanding partnerships across the University. In 2012, the course was renamed Design Thinking and Communication (DTC) to reflect this growth.

One recent innovation, an entrepreneurial Design Thinking and Communication course called eDTC, is taught in conjunction with the Farley Center for Entrepreneurship and Innovation, also housed in the Ford Center. The course is designed for first-year students interested in moving products into markets. Projects in its first offering addressed technologies targeting a specific market as well as unmet needs seeking a solution. These included video eyewear for medical markets and enhanced battery capacity for wearable devices.

DTC has also partnered with the University's Center for Leadership to more fully integrate leadership assessments within teams. The Center worked closely with DTC faculty to develop software that helps DTC teams communicate more effectively and ultimately reach their goals. Early in the quarter, each team must develop a charter that lays out its mission, goals, and ground rules. At midterms, the team uses an online survey to assess its own work and that of its members. That way, any problems that may arise within the group can be solved in a timely manner. This communication-intensive teamwork approach has permeated the design curriculum, which is now open to students from across the University.

"Bringing in different points of view allows a team to be more balanced than any one individual ever could be," explains Bruce E. Ankenman, co-director of the Segal Design Institute. "We also have a class called Human-Centered Service Design. Students in journalism and psychology can imagine themselves designing a service and understand that it's the same design process."

Segal also brings diverse viewpoints together through Design for America (DFA). Founded at Northwestern in 2009 by undergraduate students and Liz Gerber, Breed Junior Chair in Design, DFA is an award-winning nationwide network of interdisciplinary student teams and community members who use design to create local and social impact.

DFA drives a lot of the new innovation at Segal, according to Ankenman. "It's also led to a lot of thinking about the pedagogy and whether it's better for students to learn on their own and be self-driven," he shares. "We now have PhD students and faculty members whose main research focus is the design process."

STANDING THE TEST OF TIME

Often imitated, never replicated, McCormick's Engineering First program created a legacy of design thinking and innovation that has stood the test of time. Carr notes, "To this day, 20 years or so later, most of the major engineering schools in the United States now have their version of DTC. But the magic sauce for why Design Thinking and Communication is very widely imitated but never copied successfully is that all projects have real clients with real needs, it is required of all engineering students, and it's truly 50 percent communication."

This design approach to education has diffused throughout the curricula over the past two decades, becoming the embodiment of McCormick's whole-brain engineering philosophy. "It's the idea that students don't just do the calculations," Ankenman says. "This balance between being able to understand the mechanics as well as the emotions of people and the way society works underpins our philosophy. Clearly, design is the one place this all comes together." SARA LANGEN

2003
Collaboration with the Rehabilitation Institute of Chicago begins, challenging students to improve lives through design thinking

2005
Ford Motor Company Engineering Design Center dedicated

2007
Institute for Design Engineering and Applications at Northwestern evolves into the Segal Design Institute

2008
Farley Center for Entrepreneurship and Innovation dedicated

2009
Design for America founded at Northwestern

FALL 2012
Engineering Design and Communication changes to Design Thinking and Communication

SPRING 2014
Entrepreneurial Design Thinking and Communication (eDTC) course debuts

Q&A

TAKING A STAND ON TRANSPORTATION

"WE SHOULD APPROACH SUCH NEW TRANSPORTATION IDEAS AS EXPERIMENTS. INSTEAD OF THROWING SMALL AMOUNTS OF MONEY AT HIGH-SPEED RAIL PROJECTS IN MANY STATES, WE SHOULD PICK A PROMISING MARKET, CONCENTRATE OUR RESOURCES THERE, AND TREAT THAT AS A NATIONAL EXPERIMENT."

JOSEPH SCHOFER PROFESSOR OF CIVIL AND ENVIRONMENTAL ENGINEERING

Joseph Schofer knows transportation systems. A professor of civil and environmental engineering and associate dean of faculty affairs at McCormick, he's more than an award-winning researcher and teacher. As an active member of the Transportation Research Board, he's helping to shape the future of the nation's transportation infrastructure. Frequently cited by the media as a transportation expert, he recently took time to share some ideas and insights in communication, funding, and the future of transportation.

WHAT MAJOR TRANSPORTATION CHALLENGES DOES THE UNITED STATES FACE?

The United States is really in a stranglehold in terms of public funding to fix infrastructure. It's a struggle that's been going on for years. As a country, we still haven't integrated into our thinking that infrastructure costs money, and we have to pay to use and keep it. What's invisible to people is how we fund these systems now, and that's a problem.

IS THERE A SOLUTION FOR THAT?

For starters, I'm interested in improving how we communicate the need for funding. We really haven't articulated our value proposition publicly—the connection between collecting revenue and taxes and creating value by assuring our infrastructure.

If I could, I'd like to personally hand every taxpayer a report that says, "Here's how we used your tax money this year to improve the infrastructure and how that makes your life better." We haven't done a good job of communicating that. Engineers know design and operations. We aren't always the best communicators. We need to communicate in terms of transactions.

People—citizens and their decision makers—tend to think in terms of stories. They like to use anecdotes, explanations that translate data, and analyses of what is important to their daily lives and their constituencies. Politicians learn to do this, although sometimes their stories stray from the facts. The challenge for technical professionals in my field is to learn to translate our studies and measurements to stories that have meaning for citizens.

RECENTLY, YOU ANALYZED DATA ON STOPLIGHT CAMERA TICKETS IN CHICAGO THAT ULTIMATELY LED TO A REVIEW OF 16,000 TICKETS. HOW DID YOU END UP IN SUCH A PUBLIC ROLE?

It started when David Kidwell, a *Chicago Tribune* reporter, showed me the data. It struck me immediately that the data were strange, that the automated ticketing system was not working as it should. To me, there's an ethical responsibility as a technical professional to do things right, to recognize errors and help address them. I have some knowledge of how these systems work, and when a reporter who is trying to communicate with the public about the issues contacts me, I feel an obligation to share that knowledge.

Of course, if I get quoted saying something that makes people angry, I'll hear from them quickly. You have to be prepared for that. If you want to be isolated and protected from that, don't speak out. But I see my responsibility as bringing truth to the process. I don't write the news stories, but I can offer important insights. I've been more effective with journalists when I have been able to suggest what questions they should ask rather than giving answers to questions.

IT SEEMS THAT MOST PEOPLE HAVE THEIR OWN IDEAS BASED ON THEIR EXPERIENCES ABOUT WHERE WE SHOULD INVEST OUR TRANSPORTATION RESOURCES. SOME FAVOR HIGH-SPEED RAIL. OTHERS SAY IT WILL AMOUNT TO A GOVERNMENT SUBSIDY. HOW DO WE RECONCILE THAT?

I never discuss transportation in social situations. It makes terrible cocktail party conversation because everyone is an authority.

High-speed rail is not a panacea for the United States. The answer to "Why can't we build high-speed rail like Europe, Japan, or China?" is that we are not like Europe, Japan, or China. If it's going to work in the United States, it has to make market and economic sense for us. That is still an open question.

We should approach such new transportation ideas as experiments. Instead of throwing small amounts of money at high-speed rail projects in many states, we should pick a promising market, concentrate our resources there, and treat that as a national experiment.

If the project succeeds, the idea will take hold. If not, we can say it was expensive, but we learned something from it. It makes more sense to do that than to spread limited resources over many places, get no meaningful product, and learn nothing to support future decisions. When resources are limited, we need to get smarter.

EMILY AYSHFORD

Carolyn Duran

An engineering solution to a humanitarian problem

When you answer your mobile phone, you most likely don't associate the device in your hand with civil war in the Democratic Republic of Congo (DRC). When you update Facebook or post a photo on Instagram, you probably don't pause to consider the source of the raw materials that went into manufacturing your laptop.

Carolyn Duran (PhD '98) does. The conflict minerals program manager and supply chain director at Intel Corporation ponders such questions every day, all the time. Why? Because nearly every piece of technology in use today contains four minerals—tantalum, tin, gold, and tungsten—all mined in the DRC, and Duran's job is to ensure that the materials that go into Intel's chips are not being produced by slave labor or funding warlords in the region.

"Even though those four metals are used in automobiles, aircraft, and appliances, the spotlight has been on cell phones recently because they're everywhere," she explains. "You certainly don't think the phone in your hand could be funding conflict half a world away."

Over the past five years, Duran and her team have applied engineering skills to solve a complicated supply chain problem. Thanks to their efforts, Intel is now manufacturing conflict-free microprocessors.

Love of science and a stubborn streak

"I was always a math and science person in school. My parents certainly weren't engineers or scientists. I broke the cycle and went into science. I'm kind of proud of that," she laughs.

Duran didn't have much support for her career decision from female mentors early on. When she announced in high school that she wanted to be an engineer, her guidance counselor suggested a more traditional women's field, like nursing. She says it was her stubborn streak that emboldened her to break through the barriers of other people's expectations.

After receiving her BS in materials science and engineering from Carnegie Mellon University, Duran went on to McCormick's PhD program.

"McCormick's materials science and engineering department was among the top in the country, but it was the program and the professors that got me excited most," she remembers. "I really enjoyed the program there, so much that now I sit on the school's academic advisory board for materials science."

An engineering approach to problem solving

Duran says she loves the straightforward nature of engineering. "Two plus two always equals four—there's no subjectivity there," she says. "With conflict minerals, it's totally different. It's more difficult to know if you're right or you're wrong. And that's another reason I like engineering—you can apply it to solve a problem and get to the answer."

Duran refers to the difficulty of actually knowing the source of the minerals that go into Intel's products. By taking an engineering approach, her team identified the point in the supply chain where they could definitively verify the source of the materials.

CONFLICT MATERIALS

World attention has increasingly focused on "conflict minerals" from mining operations in the Democratic Republic of the Congo (DRC) and nearby countries. It is widely believed that those engaged in mining operations in this region commit serious human rights abuses against workers and use the profits from the minerals they produce to finance armed conflicts in the region. Many industry, government, and social advocacy groups are raising awareness and working for change. The US Congress and the Securities and Exchange Commission have established reporting requirements regarding conflict minerals. For more information on the issue, visit intel.com/conflictfree.

"We realized that the smelter is the pinch point," she explains. "If you test for the source of the raw material at the smelter site, you have your answer, and it doesn't matter where the minerals go afterward."

Getting the smelters to cooperate in the testing presented another problem. Duran says she had to muster all the creative thinking and communication skills she learned at McCormick to solve it. The team set up a program to certify smelters through audits that prove the materials they use are not sourced from militia-controlled mines.

The first audit occurred late in 2010. Today, more than 90 smelters in 21 countries have gone through the program, with many more now in the certification process. "Considering there are only a few hundred smelters in the world for these four metals, it's beginning to make a difference," Duran says. "And that includes an impact on the miners, who receive more money supplying to certified smelters than they did to the militias."

Results that change peoples' lives

Knowing her team's efforts have paved the way for the global Conflict-Free Sourcing Initiative is gratifying to Duran. "There are reports of a 55 percent reduction of funds to the warlords in that region, because no one will buy minerals that haven't gone through the certification process," she says. "That's really what it comes down to—making a change on the ground. We basically applied engineering problem-solving skills to a humanitarian problem."

During her 16 years with Intel, Duran has helped solve many other problems as well. She started out in R&D and rose through the ranks to become director of supply chain ramp and regulations. Recently, Duran was named one of *Business Insider*'s "22 Most Powerful Women Engineers in the World."

"I would never have thought when I joined Intel that I'd be working on something that would have such a global impact," she says. "You'll never be bored if you have the strong backbone that comes from the McCormick experience."

SARA LANGEN

Images courtesy of ©Intel Corporation

CLASS NOTES

1950s

Stanley Polcyn ('54, MBA '58), a US Navy veteran, was presented with four military service medals last November by US Rep. Elizabeth Esty. Polcyn was a flight engineer and captain of a PBM seaplane patrol bomber during the Korean War.

Thomas E. Reimer ('59, '86) completed his novel, *San Patricios* (Virtualbookworm.com, 2013), the third book in his "Wild Onion Saga." The story continues the tale of mid-19th century immigrants Axel Konrad and Seamus O'Shea.

1960s

Michael Moffitt ('62) wrote *Granddad's Dictionary* (WestBow Press, 2014), a collection of reflections on the history and values that have made America exceptional.

1970s

Joseph Martinich ('72, PhD '80) was appointed Founders Professor of Operations Management at the University of Missouri–St. Louis.

Ray Drasga ('73) retired in 2012 after practicing oncology for 30 years in Northwest Indiana. Last January, Drasga and a colleague from Indiana University published "Why Oncologists Should Support Single-Payer National Health Insurance" in the *Journal of Oncology Practice*.

Steven Gross ('76), a neuro-ophthalmologist for more than 20 years, was appointed associate medical director of the neuroscience group of Pharmaceutical Product Development, an international contract research organization.

Virginia M. Rometty ('79), chief executive officer, president, and chairman of IBM, received an honorary degree from Rensselaer Polytechnic Institute after delivering the Institute's commencement address last May.

1980s

David Dohnalek (MS '82), senior vice president and treasurer of The Boeing Co., was named chairman of Boeing Capital Corp.

Michael S. Zedalis (MS '82, PhD '85) was named chief operating officer of Tingley Rubber Corporation.

Jay A. Alexander ('86), former vice president and general manager for the oscilloscope and protocol division at Agilent Technologies, was promoted to chief technology officer of Agilent's spinoff company, Keysight Technologies.

Kirk D. Bowman ('87), a partner at Accel Partners, joined the board of Couchbase, Inc.

Rita D. Brogley ('87) was named CEO and president of MyBuys, an online marketing firm.

Daniel Lipinski ('88) received the Champion of Science Award from The Science Coalition. He was honored for his strong commitment to funding the basic research that keeps the United States and the state of Illinois at the forefront of scientific discovery and technological innovation. Lipinski, who joined Congress in 2004, has been a leading voice in support of federal investments in innovation and scientific research at universities, national labs, and other entities in Illinois and around the country.

1990s

Barry Charles Fougere (MEM '92; KSM '92) joined Atlantic Tele-Network, Inc. as senior vice president of business operations.

Mario Greco ('93) was inducted into the Fellowship of Realty Professionals, an honorary society for agents who have sold at least $500 million worth of property in their careers.

Joe Hetz ('93), a patent attorney, was elected to the board of directors of his law firm, Brinks Gilson & Lione. He was also elected to the boards of directors of CARPLS, a legal aid organization, and Rock for Kids, an organization that provides music education to underprivileged children in Chicago.

Jeanne VanBriesen (MS '93, PhD '98) was named the Duquesne Light Company Professor in Civil and Environmental Engineering at Carnegie Mellon University.

Smita Shah ('94), president and chief executive officer of Spaan Tech, was appointed to the Chicago Plan Commission by Mayor Rahm Emanuel (MA '85) and confirmed by the Chicago City Council in February. Shah serves as vice chair of the commission.

Daniel Oerther ('95), the John A. and Susan Mathes Chair of Environmental Engineering at Missouri University of Science and Technology, is serving as a Jefferson Science Fellow at the US State Department.

Aaron Adam Wilson ('95; KSM '08) was appointed chief executive officer at Trifacta, a data transformation platform provider.

Michael J. Anguiano ('96) was promoted from managing director to senior managing director at the Kiser Group.

Tassos Gianakakos (MS '96) was appointed to chief executive officer of MyoKardia Inc. The company focuses on developing innovative therapeutics to treat genetic heart disease.

Todd Sermersheim ('97) was named to the *Indianapolis Business Journal*'s "Forty Under 40" in 2014. Sermersheim is a sports agent and does off-the-field marketing for professional athletes.

Ignacio Aguerrevere (MEM '99; KSM '99) was appointed vice president of global product management and marketing at CTP Transportation Products.

Marcus Elliott ('99) joined Perteet as senior project manager after building a transit-focused consulting practice that served the city of Seattle and King County Metro Transit.

Daniel P. Merz ('99), director of the clinical affairs program at St. Jude Medical, was appointed vice president of healthcare affairs at Uroplasty, Inc., headquartered in Minneapolis, Minnesota.

2000s

Melissa Anyetei ('02), a registered patent attorney, was named a partner at Mayer Brown. Her practice focuses on patent litigation, patent portfolio strategy, and intellectual property licensing.

Joseph W. Barber ('02), a business litigation attorney at Howard & Howard, was named to the *Illinois Super Lawyers* "Rising Stars" list for 2014.

Rachel R. Bishop (PhD '02) joined TreeHouse in 2014 as senior vice president and chief strategy officer. Previously, Bishop was at the Walgreen Company, where she most recently served as group vice president, retail strategy.

Joshua Cohen ('03, MS '11) joined the staff at the Texas Heart Institute in Houston as a cardiovascular anesthesiologist.

Amir Khan (MS '04) teaches undergraduate technical courses at the DeVry University campuses in Anaheim and Long Beach, California. He is also a technical lead and production support principal in information technology for Kaiser Permanente's sales systems in Pasadena.

Aamir Jariwala ('05) and **Akshat Ghiya** (WCAS '05) formed Karma Recycling, a startup with a mission to extend the life of electronics and promote electronics reuse. One of the first ventures of its kind authorized by the government of India, Karma started operations in February 2013 in response to the overwhelming growth of mobile devices and related e-waste in that country.

Chris Campbell (PhD '07) won the 3M™ corporate-level award for the "Circle of Technical Excellence and Innovation" for his 2013 accomplishments. His excellence in leading a global cross-functional team in the rapid development and launch of 3M Liquid Optically Clear Adhesive resulted in innovative solutions that enabled tremendous yield, cost, and cycle time savings for end user customers.

Glenn Allison (MS '08) became director of global networks for the Kellogg Co., located in Battle Creek, Michigan. He was previously director of service operations for W.W. Grainger.

Can Bayram (PhD '11), assistant professor of electrical and computer engineering at the University of Illinois Urbana-Champaign, received the IEEE Electron Devices Society Early Career award.

Send us your news!
magazine@mccormick.northwestern.edu

IN MEMORIAM

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Mr. Michael F. Wieczorek '39
Mr. Robert J. Lee '42
Mr. Stephen P. Ronzheimer '42
Mr. William A. Wrase '43
Mr. Howard A. Clunn '45
Mr. Edward L. Barnett, Jr. '46
Mr. James Hap M. Murphey, Jr. '46
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Mr. Andrew Gadzinski '05

A HEADY MARKETING MIX

TAPHANDLES FOUNDER **PAUL FICHTER** (BS '94 MMM '97) MIXES BEER WITH BRANDING, ARTISTRY, AND ENGINEERING.

It may not have been the best idea, but it was the best one he had.

In 1999, fresh from an unsatisfying two-year consulting stint, Paul Fichter ventured to Home Depot, purchased a table saw and drill press, belt sander and band saw, and from his Seattle balcony began crafting artful wooden tap handles for homebrewers.

The idea, Fichter confesses, "went nowhere" with his target audience.

On the other hand, commercial brewers took notice of Taphandles, Fichter's upstart enterprise. Orders streamed in for his detailed, ambitious designs. In 2001, Taphandles created an elaborate handle for the Alaskan Brewing Company—an orca whale leaping from the sea. When Alaskan's beer sales surged, the brewery hustled to place additional orders.

"This is when I knew I was onto something. I wasn't just selling tap handles; I was selling marketing and branding. By creating something functional, beautiful, and stongly branded, we could help brewers sell more beer," Fichter says.

Today, Taphandles dominates North America's beer handle market. Mixing wood, plastic, and metal, Fichter's team uses intricate shapes and whimsical imagery to capture a given beer's "essence" and bar patrons' attention. In the process, they have revolutionized a once-stodgy, mass-produced product with artistry and spirit.

"You'd be hard-pressed to walk into a bar in North America and not see one of our handles," says Fichter, whose firm boasts annual sales of $25 million and employs about 500 people at its operations in Seattle, Chicago, and Portland in the United States as well as in China.

Though Fichter says he remains "an engineer at heart," particularly evident when he orchestrated the manufacturing flow of Taphandles' overseas production hub, he has strategically positioned his 15-year-old company as a marketing and branding firm. "I flowed with the response to my idea and allowed it to morph," Fichter says. "That flexibility really made the company."

So, too, did Fichter's ability to analyze situations and seek novel solutions, a mindset developed at McCormick and, specifically, his time with former engineering and management faculty member Wally Hopp.

"When you're constantly challenged as you are at Northwestern, then you're constantly working to find answers, to innovate," Fichter says.

And with that, Fichter adds, "Marginal entrepreneurial ideas develop into successful business ventures.

"Nothing good comes from standing still," he says.

DANIEL P. SMITH

"INDUSTRIAL ENGINEERING, IN PARTICULAR, IS ALL ABOUT EFFICIENCY. THIS IS HOW I WAS TRAINED, SO IT'S INGRAINED IN HOW I OPERATE TODAY … AND IS PROVING CRITICAL IN A BUSINESS WHERE WE NEED TO BE BETTER AND QUICKER."

Nimble in Healthcare

IN AN EVER-SHIFTING HEALTHCARE LANDSCAPE, **CINDY KENT** ('91) LEANS ON HER MCCORMICK EXPERIENCE TO BRING INNOVATIVE PHARMACEUTICAL SOLUTIONS TO MARKET

Healthcare today is not the same industry Cindy Kent entered 23 years ago.

Then a stable industry characterized by high-margin blockbusters, today the healthcare marketplace changes constantly amid an intense focus on outcomes and costs, new technologies, and developing global markets.

"Increased access, better quality of care, and improved clinical results all at lower costs—that's the game today," says Kent, president and general manager of 3M Drug Delivery Systems, a leading contract drug development and manufacturing organization that specializes in inhalation, transdermal, and conventional dosage forms.

Fortunately, Kent possesses the wherewithal to tackle the ever-shifting healthcare landscape. "Nothing develops your analytical and critical thinking skills quite like engineering," she says.

At 3M, Kent is the business head for the drug delivery division that has five manufacturing plants worldwide and a cross-functional team of approximately 1,200, including senior-level leaders across manufacturing, engineering, research and development, sales, and marketing. She determines the division's strategic priorities, decides which projects the business will tackle and how much it will invest, and manages day-to-day business operations.

Kent knows quick, purposeful action is imperative in today's marketplace, which is why she's revamping her division's business model. She understands that to be competitive, her unit must implement lean practices at every point in the value chain and align its core capabilities with customer needs. She even created Drug Delivery Systems vision cards to remind her team of its "True North," including top priorities and how they drive value creation.

Kent's reorganization of her divison is on point, evidenced by its recently earning a first-to-file patent application status on a key product line. "That's a marker we're making the strides we need to," she says.

It's a transformation Kent says she would not be able to lead without her experience at McCormick, where she learned how to extract the best from people and gained the foundational knowledge to thrive in highly technical business environments and turn the complex into simple, sellable value propositions.

"Industrial engineering, in particular, is all about efficiency," she says. "This is how I was trained, so it's ingrained in how I operate today … and is proving critical in a business where we need to be better and quicker."

DANIEL P. SMITH

ROUND TRIP MCCORMICK AND BACK

BOB PESKIN (MS '75, PHD '77) PLANS TO DONATE HIS BOOK COLLECTION TO THE TRANSPORTATION LIBRARY

Robert Peskin's enormous collection of transportation-themed books all started with one hardcover: *Chicago Surface Lines* by Alan R. Lind. A fellow graduate student gave it to him during Peskin's days in civil engineering at McCormick.

"It documents the history of Chicago's railway street system and is considered a classic in the field," says Peskin. "Little did I know it would evolve into a huge collection."

Now Peskin's compendium includes 1,750 books about public transportation systems, transit and railroad architecture, vintage posters, and graphic design. He plans to donate them all to Northwestern's Transportation Library, one of the world's largest transportation information centers.

A life-long journey

Peskin's interest in transportation was sparked when he was a small child, watching the engineers of Pennsylvania Railroad GG-1 electric locomotives from the platform of Washington's Union Station. His time at McCormick, however, solidified his love for transportation and secured a long career in the field.

"In my first year of grad school, we took a field trip to tour most of the Chicago Transit Authority rail system," Peskin says. "I was amazed to watch the transformation of urban landscape right before my eyes. That really fired me up."

Of the items in his collection, Peskin identifies a few as having special significance. One, Philip Ashforth Coppola's self-published, multi-volume series, *Silver Connections: A Fresh Perspective on the New York Area Subway System*, took the author three decades to complete. Coppola considers the hand-illustrated volumes describing the interior décors of the New York subway stations his life's work.

Peskin also plans to donate *Regional Rapid Transit: A Report to the San Francisco Bay Area Rapid Transit Commission*, a rare, oversized four-color document presented to Bay Area stakeholders in the 1950s. The document outlines the vision for "space-age" rapid transit as a solution for the then-growing, post-war traffic congestion facing the region.

"This limited edition volume was formerly part of the MIT Transportation Library," Peskin says. "It somehow found its way to a rare book seller in Cleveland, where I purchased it."

Coming home to Northwestern

When looking for a new home for his collection, Peskin immediately settled on Northwestern. "My interest in transportation books started here, and in a sense, my career has always centered around Northwestern," he says. "Encouraging intellectual discovery is at the heart of the library's mission. I have learned so much from these books and hope that future students of public transportation will, as well."

Peskin's life intertwined with Northwestern many times before and after he attended McCormick. The connections were so plentiful that Peskin felt "pre-ordained" to come to McCormick. Two of his undergraduate professors at the University of Maryland earned PhDs from McCormick's civil engineering department. And after Peskin earned his PhD, he joined the transportation consulting practice of Peat Marwick Mitchell & Co., where three partners were McCormick alumni. AECOM acquired the practice in 2000 and, over the years, has hired dozens of Northwestern transportation graduates.

Having been with the same practice for 37 years, Peskin currently serves as a senior consulting manager to transportation systems in North America. Although he lives in Bethesda, Maryland, he stays strongly connected to his alma mater.

Peskin has served as a member of the McCormick Advisory Council since 2003 and co-director of the Washington, DC-area Northwestern University Alumni Admission Council since 1987. As co-director, he manages more than 300 alumni volunteers to provide outreach to applicants and their families on academic programs, campus life, and financial aid. The council conducts alumni interviews, which Peskin prefers to call "conversations," with DC-area high school applicants.

"The best interviews are fluid and two-sided," Peskin says. "We both ask each other questions and work together to see if Northwestern is the right fit. Having a meaningful role in this process is motivating. It's rare for alumni to be able to support a line function of the University."

AMANDA MORRIS

TAKING FLIGHT FIVE ALUMNI SOAR AS AERIAL VEHICLE STARTUP IS BOUGHT BY GOOGLE

After graduation, five McCormick engineers (Stephen Benson '13, Dan Cornew '11, Kyle Liske '10, Matthew Nubbe '11, and Nick Renold '11) took the skills they learned during their time on McCormick's Formula SAE and solar car teams and went to work for Titan Aerospace, a start-up that designs and builds solar-powered, unmanned aerial vehicles. In April, the company was purchased by Google. The group took time to tell us about that transition, their favorite memories of McCormick, and how they keep in touch.

How did you get involved with Titan Aerospace? Dan was visiting some friends in San Francisco, and he showed us a video of the work that Titan was doing. I was fascinated by the concept of an aircraft that could fly indefinitely, and the challenge to do something new with this technology. I asked if I could come help, and I moved out to start work the next month. *Nick Renold*

What is the coolest part about your job? We get paid to build something new! The Titan technology is pushing new boundaries, and it's exhilarating to see the aircraft come together. *Dan Cornew*

What is your favorite memory from your time at McCormick? The 2011 Design Competition. In a competition where the objective was to move target cakes to one side of the field, we had the only robot that propelled them across instead of carrying them. Between the other teams' surprise and the audience's reaction, it was great to see it working mostly as intended. *Matthew Nubbe*

How did your work with the car teams at McCormick help you in your current role? Experience with the car teams has helped in many ways. The intensity of the work required as a senior member of a car team really conditioned me for an exciting, evolving job. It provided experiences that no other students at Northwestern had. It caused me to think outside the box. The limits of "What can we get?" were replaced with "What can we design and make?" During my time with the Formula SAE team, we did things that pushed boundaries constantly. We were always pushing materials and designs to the limit to be as lightweight as possible. Nothing has changed making the jump to Titan. We're just playing in a different league now. *Stephen Benson*

How do you stay in touch with McCormick? I stay in touch by visiting the Northwestern vehicle teams when I am in Chicago. It is fun to come back down to the machine shop in Ford, see what they are working on, and talk to them about the projects. *Nick Renold*

Keeping It Green in the Peace Corps

After graduation, Natalie Lake ('12) sought hands-on experience applying the green technologies she studied at McCormick. Armed with a passion for sustainability and an enthusiasm to help others, she joined the Peace Corps, and is helping educate communities in Peru about renewable energy through interactive environmental projects.

How would you describe your experience as a Peace Corps volunteer? My experience in the Peace Corps has been the weirdest, most challenging, and most rewarding of my life. For the past two years, I've been working as an environmental volunteer in Peru focusing on resource management, waste management, and environmental education.

I've helped build and install two biodigesters, a photovoltaic solar panel system, and a wind turbine. I've also implemented microturbines and pico solar units in five schools to use in climate change education, built a small native tree nursery in my town, and helped my community start a recycling program.

Please share your favorite memory from your time at McCormick. I actually really miss the crazy all-nighters I used to pull in Tech—getting a room with fellow engineers, using three different types of caffeine to try to stay up, eating a million different snacks, and taking power naps underneath tables. It all brings back great memories.

What lessons from McCormick have helped you most in your Peace Corps work? Problem solving. I find that I approach problems in a different way than my community partners do, and this has proven to be an incredibly useful skill in the Peace Corps where Murphy's law rules—anything that can go wrong, will go wrong! ALEX GERAGE

IN MEMORIAM

TED BELYTSCHKO

RENOWNED RESEARCHER, SCHOLAR, AND MENTOR PASSES AWAY

Mechanical engineering professor revolutionized virtual prototyping

Ted Belytschko, Robert R. McCormick Institute Professor and Walter P. Murphy Professor Emeritus of Mechanical Engineering and Civil and Environmental Engineering, passed away September 15, 2014. A member of Northwestern's faculty since 1977, Belytschko was a central figure in the McCormick community and an internationally renowned researcher who made major contributions to the field of computational structural mechanics.

One of the most cited researchers in engineering science, Belytschko developed explicit finite element methods widely used in the automotive industry for crashworthiness analysis and virtual prototyping. His numerous honors include membership in the US National Academy of Engineering, US National Academy of Science, and the American Academy of Arts and Sciences.

"Ted exuded technical excellence," said McCormick Dean Julio M. Ottino. "His work shaped an entire industry and legions of students."

After receiving his PhD in mechanics from the Illinois Institute of Technology in 1968, Belytschko joined the University of Illinois at Chicago, where he was a favorite among students. At Northwestern, Belytschko was named a McCormick Distinguished Professor in 2003 and served as chair of the mechanical engineering department from 1997 to 2002. Students and colleagues enjoyed his sense of humor and admired his ability to explain complex problems in an easy-to-understand manner.

"Ted was my department chair when I arrived at Northwestern and my model for a successful academic," said Kevin Lynch, chair of the Department of Mechanical Engineering. "He was a great mentor, colleague, and friend. His passing is a deep loss for our department."

DUDLEY CHILDRESS

REHABILITATION ENGINEERING PIONEER PASSES AWAY

Biomedical engineering professor developed numerous assistive devices for people with disabilities

Dudley Childress, one of the first graduates of the biomedical engineering PhD program at the McCormick School of Engineering and an important contributor to the advancement of the field of rehabilitation engineering, passed away August 6, 2014.

During his career, Childress served as professor of biomedical engineering at McCormick, professor of physical and rehabilitation medicine at the Feinberg School of Medicine and the Rehabilitation Institute of Chicago, director of the Prosthetics Research Laboratory and the Rehabilitation Engineering Research program, and senior rehabilitation research scientist at the VA Chicago Health Care System.

"Dudley was one of a handful of people from Northwestern elected to the Institute of Medicine, the pinnacle of his profession," said Julio M. Ottino, dean of McCormick. "In addition to his innovative work, he was one of the most gracious professors I have had the pleasure of knowing."

Childress received his PhD from McCormick in 1967 and became the first biomedical engineer appointed to a joint faculty position in the medical and engineering schools at Northwestern. He developed numerous assistive devices for people with limb disabilities, including the first myoelectric system that allowed a prosthetic user to control the speed and grip force of the device's fingers in 1968, a sip-and-puff wheelchair in 1972, and a state-of-the-art motion analysis system in 1998.

Childress became a professor emeritus in 2004 and was known for his benevolence as a scholar, teacher, and mentor.

"He was one of our department's first PhD program graduates and became one of its brightest stars," said John Troy, chair of the Department of Biomedical Engineering.

left The classroom named in honor of the Krebs family
right James and Margie Krebs

WE WILL.

THE CAMPAIGN FOR NORTHWESTERN

Northwestern University's multi-year campaign is well underway. To learn more about We Will and the campaign priorities, visit wewill.northwestern.edu.

DONOR HIGHLIGHT: JIM KREBS ('45)

When McCormick needed help funding a state-of-the-art classroom in the new McCormick Education Center (located within a new multi-use structure on north campus), it found a champion in **James N. Krebs** ('45). A career-long jet engine designer and executive at General Electric, Krebs has been a major supporter of McCormick since 1989, when he and his late wife Margie (SESP '46) endowed the James N. and Margie M. Krebs Professorship. In 1995, Krebs established a fund to support McCormick master's programs. The objectives were to dramatically increase the number of McCormick MS graduates and to encourage students to achieve the MS in four years (12 quarters). There are now 80 to 90 McCormick BS/MS students in matriculation at all times, some graduating in just 12 quarters, and nearly 1,000 MS students.

The success of the master's programs generated the need for more dedicated MS classroom space, and the James and Margie Krebs Master's Fund helped launch construction of the McCormick Education Center. In recognition of their generous friendship over many decades, McCormick is proud to name a new 70-person classroom in the center in their honor.

A second classroom in the center has been donated by **Richard Padula** ('84, '15 P) and **Susan Padula** (WCAS '86, '15 P). Their significant donation built the 40-person classroom, now known as the Padula Family Classroom, and also supported undergraduate initiatives.

MCCORMICK GIVING REPORT

Charitable donations are essential to McCormick's teaching and research success. We are grateful of the support of alumni and friends who help make our school great.

Faculty, alumni, and friends have contributed more than $600,000 to create an endowed graduate fellowship fund in honor of Johannes and Julia Weertman, emeriti faculty in materials science and engineering.

Bob Shaw ('70, MBA '81) and **Charlene Shaw** (WCAS '70) have made a major commitment to support the development of new undergraduate courses as part of the Power of Computer Science, one of McCormick's three campaign priorities.

Barbara and **Bob Feldmann** ('76) have made a major gift to the Dean's Fund, which will contribute to the renovation of Cohen Commons, the event space in the Technological Institute.

Milton Morris ('92, MBA '04), a new member of the McCormick Advisory Council, has made a major gift in support of the Power of Computer Science, which will support the MAC Visiting Professor in Computer Science.

The Wissner-Slivka Foundation, established by **Ben Slivka** ('82, MS '85, '12 P) and **Lisa Wissner-Slivka** (WCAS '85, '12 P), donated $100,000 to endow a summer undergraduate research fellowship in engineering biology.

Laura and **Tim Stelly** ('70, MS '72) endowed a new scholarship for an undergraduate McCormick student.

MCCORMICK.
MORE THAN A MATTER OF DEGREES.

STAY CONNECTED WITH THESE OPPORTUNITIES FOR LIFELONG LEARNING

FOR THE TRULY WHOLE-BRAINED, GRADUATION OFTEN MARKS ONLY THE OFFICIAL BEGINNING OF A LIFETIME OF ADVANCED LEARNING. THE MCCORMICK SCHOOL OF ENGINEERING AND APPLIED SCIENCE CAN HELP SATISFY THAT UNQUENCHABLE THIRST FOR NEW KNOWLEDGE WITH EXECUTIVE EDUCATION PROGRAMS, GRADUATE DEGREES, AND MASSIVE OPEN ONLINE COURSES (MOOCS) TAILORED TO EACH KIND OF LIFELONG LEARNER.

EXECUTIVE EDUCATION: INNOVATION AND MANAGEMENT

In spring 2015, the Master of Product Design and Development Management program will offer a three-day certificate course in innovation and management. This intensive course addresses skills and issues related to managing creativity and design, customer-focused innovation, gap analysis in the design process, strategy in design, industrial design essentials, human factors, and intellectual property. Leading faculty from McCormick and the Kellogg School of Management and industry experts will use case studies and group workshops to illustrate and illuminate concepts. The program is designed for product design and development professionals with either technical or marketing backgrounds.

Next session: March 22–25, 2015

For more information, visit segal.northwestern.edu/programs/graduate/mpd2/executive-education

PROFESSIONAL MASTER'S DEGREE PROGRAMS

These part- and full-time graduate programs help young and mid-career engineering professionals take the next career step or pivot into a new field:

- MS in Analytics
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- MS in Engineering Design and Innovation
- MS in Information Technology
- MS in Product Design and Development Management
- MS in Project Management
- MS in Robotics
- Master of Engineering Management
- MMM program (combined MS in Design Innovation and MBA)

For more information, visit mccormick.northwestern.edu/graduates

MCCORMICK MASSIVE ONLINE OPEN COURSE (MOOC)

Not a Chicago resident? Can't travel to attend courses? Study remotely by enrolling in a MOOC. Upcoming MOOCs taught by McCormick faculty members include:

Power Onboarding, taught by William White, professor of industrial engineering and management sciences. Research shows that actively preparing for a new job helps employees reach job efficiency and exceed workplace expectations at a much faster rate. In a six-session format, Power Onboarding provides practical tools for individuals who are transitioning into new jobs. Throughout the course, participants will learn how to create their own personalized onboarding plans. The course applies to people at all stages in their careers and can also be helpful for those accepting promotions, making lateral transfers, changing companies, and for those who are happy in their current jobs but want to be prepared for future moves.

The course is free and began October 12.

To discover more MOOCs, visit coursera.org

BIG IDEA

Using infrared technology, researchers uncovered three human-like figures hidden beneath the painted layers of Monet's *The Beach at Sainte-Adresse*.

VIEWING PAINTINGS WITH "X-RAY GOGGLES"

When Art Institute of Chicago researchers used infrared and x-ray technologies to peer through the painted layers of Claude Monet's *The Beach at Sainte-Adresse*, they discovered three ghost-like figures emerging from beneath the artist's impressionistic brush-strokes. Monet deliberately revised the painting by covering the figures, which appear to be well-dressed tourists.

A Northwestern team is now working to allow art enthusiasts to unveil hidden images in paintings such as Monet's, without needing specialized skills or access to high-tech equipment.

Starting with *The Beach at Sainte-Adresse*, Oliver Cossairt, assistant professor of electrical engineering and computer science, and Marc Walton, senior scientist of the Northwestern University–Art Institute of Chicago Center for Scientific Studies in the Arts (NU–ACCESS), are connecting images of the painting's layers to an application for Google Glass. By tilting their heads in different directions, Google Glass wearers will be able to uncover different layers beneath the painting's surface. "They will act as x-ray goggles," Cossairt says. "Viewers will be able to enter the orbit of the painting to receive a more immersive experience."

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A MATERIAL THAT HEALS

Created in the laboratory of Professor Guillermo Ameer, this polymer is based on vitamin C-rich citric acid, making it inherently antioxidant. Building a medical device or surgical implant out of this new material could potentially prevent oxidative stress, a common issue that leads to chronic disease, inflammation, and the ultimate failure of implants. See story on page 22.

Photograph by Chris Strong