Northwestern University

McCormick by Design

Robert R. McCormick School of Engineering and Applied Science

Spring 2006

The art of engineering

CONTENTS

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

ON THE COVER: **Georges-Pierre Seurat, French. *A Sunday on La Grande Jatte — 1884,* 1884–86, painted border 1888/89. Oil on canvas. The Art Institute of Chicago: Helen Birch Bartlett Memorial Collection, 1926.224.**

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Artwork images courtesy of the Art Institute of Chicago.

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Greetings from McCormick

In recent months science and engineering have moved to the forefront of public discussion. Much attention has been given to the role of engineering innovation in the future success of our country, and academics and politicians have sounded the alarm — America's technological leadership may be at risk. They point to the growing number of engineers graduating in Asia, the changing economics of our increasingly "flat" world, and alarming trends in the American educational system.

The numbers certainly merit concern, but many seem to be missing a key part of the message. The problem isn't about the quantity, but rather the quality of the engineers that we produce. Change brings challenges, and challenges bring opportunity. The ability to identify and anticipate these opportunities is critical to our future prosperity — and it is at the core of the McCormick education.

In this issue of *By Design* you'll find a sampling of McCormick's broad, interdisciplinary, and innovative approaches to research and education. In our cover story we examine an exciting partnership between the Art Institute of Chicago, Argonne National Laboratories, and Northwestern. These exciting projects allow our faculty and students to explore interdisciplinary research projects that exemplify the relevance of engineering principles to many facets of our society.

The importance of engineering was also made abundantly clear as the United States responded to Hurricanes Katrina and Rita. McCormick joined the rest of the country in offering its help to those affected by the storm, and our faculty played an important role in contributing to the public discussion on recovery from the storm.

In this issue we introduce a new feature, "Career Paths," highlighting the growing number of McCormick alumni working in consulting, law, finance, and other service industries. We profile three alumni — Dennis Chookaszian, Sam Sperry, and Bob Puette — who credit much of their success to their experiences at McCormick.

We also highlight NUcorp, a new student organization that provides students with the opportunity to gain experience running a business during their undergraduate years at McCormick. This successful program, funded by the Walter P. Murphy Society, provides a much-needed outlet for the entrepreneurial spirit often found at McCormick.

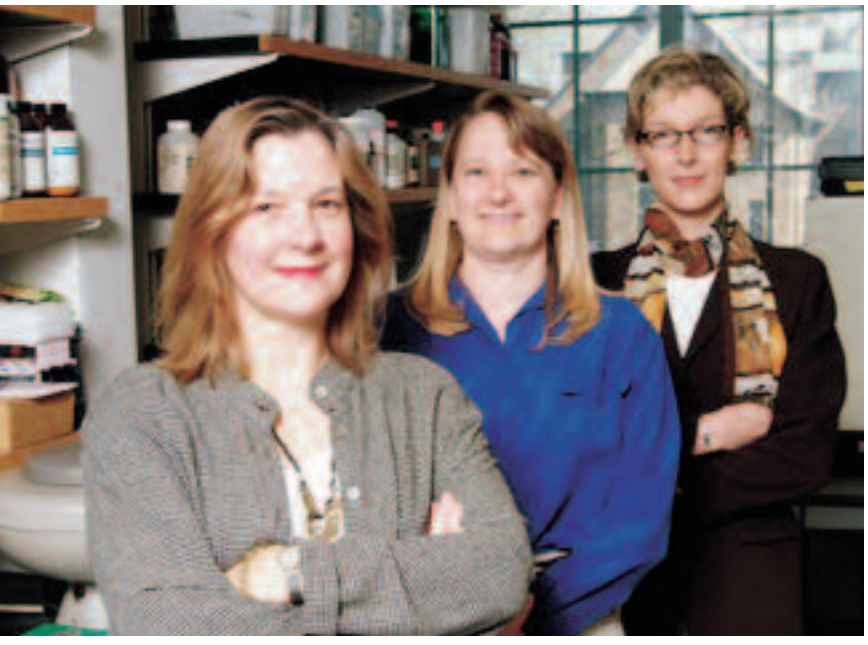
McCormick faculty continue to be leaders in innovative interdisciplinary research. This issue features Fabián Bustamante, Karen Smilowitz, and Tito Homem-de-Mello and their unique application for distributed systems and optimization. We also highlight the work of Bartosz Grzybowski, a young faculty member who has received wide-ranging recognition for his work in dynamic self-assembly.

In a time when the world is becoming keenly aware of the importance of engineering and technology to the prosperity of the country, we realize our enormous responsibility. We must continue to innovate, to educate the public about our changing world, and to ensure that our faculty and students are focused on the future.

Julio M. Ottino, Dean | April 2006

The art of engineering

The Art Institute of Chicago and McCormick unravel the mysteries of art



Kimberly Gray, Deanna Hurum, and Francesca Casadio

Hanging in the galleries of the Art Institute of Chicago is a mystery — actually, thousands of them. Curators, conservators, and scientists at the Art Institute of Chicago spend countless hours trying to understand each piece of art — when and where it was made, how it was used, how it reflects the historical period, and whether it has changed over time. Their research provides more than an understanding of a specific painting or sculpture; it provides insight into the cultural heritage of a society. Now the Art Institute has a new set of research tools to unlock these mysteries — the faculty expertise and cutting-edge equipment of McCormick.

The driving forces behind the ongoing collaboration between the two institutions have been Francesca Casadio, Andrew W. Mellon Conservation Scientist at the Art Institute, and Katherine Faber, professor of materials science and engineering at McCormick. With a doctorate in analytical chemistry, Casadio brings a unique background to the Art Institute. When hired in 2003, the Art Institute purchased much of the high-tech equipment she needed, but quickly found that it would be impossible to finance the amount of desired equipment. Casadio connected with Faber and quickly realized that there was significant crossover between their areas of study and mutual interest in collaboration.

"Francesca can't reasonably equip her lab with all of the instruments she needs, but there is no need to because of proximity to Northwestern and the shared interests that we are developing," Faber says.

But the relationship between McCormick and the Art Institute goes far beyond shared equipment. "The infusion of science in the museum and stimulation by art of some of the nation's top scientific thinkers should help to develop innovative ways of looking at art and lead to new discoveries," Casadio says.

The collaboration has been strengthened by a recent grant of $500,000 from the Andrew W. Mellon Foundation — the first multi-year collaboration in conservation science in the nation to involve an art museum and a university. In addition to the Art Institute and Northwestern, the grant funds related efforts at Argonne National Laboratory, a U.S. Department of Energy laboratory located just outside of Chicago.

"The infusion of science in the museum and stimulation by art of some of the nation's top scientific thinkers should help to develop innovative ways of looking at art and lead to new discoveries."

A unique aspect of the funding is a seminar series that brings experts from academia, museums, and private practice to discuss new techniques in conservation science. During last year's inaugural series, there were three seminars that drew participants from museums across the region, as well as from national institutions such as the Metropolitan Museum of Art.

"The seminar series is really meant to be a cross-fertilization program," says Faber. "It's absolutely essential to making things go well."

And things are going well, as several exciting projects between the Art Institute of Chicago and McCormick demonstrate.

Georges-Pierre Seurat, French. *A Sunday on La Grande Jatte — 1884,* 1884–86, painted border 1888/89. Oil on canvas. The Art Institute of Chicago: Helen Birch Bartlett Memorial Collection, 1926.224.

Finding Seurat's light

Within years of the completion of Georges Seurat's famous *A Sunday on La Grande Jatte,* the yellow pigment used in the painting began to change. "The yellow, all of the flecks of light in the painting, became very dark and were no longer luminous," explains Kimberly Gray, associate professor of civil and environmental engineering and of materials science and engineering. "It's been a question for over a hundred years — what was it about those pigments that caused them to so rapidly change?"

To explore this question, Francesca Casadio sought a suitable light source to determine if the pigments were particularly sensitive to a specific type of light, causing them to change rapidly. The Art Institute didn't have the proper equipment for the experiment, but Gray, whose research interests include photochemistry, did.

Deanna Hurum, a research scientist working in Gray's research lab, worked with Casadio to test pigment changes on a palette of zinc chromate yellow subjected to a xenon arc lamp in order to accelerate the effects that light may have had on the painting.

After analysis of the palette, Casadio determined that the light alone didn't provide cause for the dramatic pigment change seen on Seurat's masterpiece. But, as does often happen in research, the experiment is leading to a series of new, expanded tests.

Nirav Shah, an environmental science major in the Judd A. and Marjorie Weinberg College of Arts of Sciences, is working with Gray and Casadio to build an environmental chamber that will allow the pigment to be tested under different conditions. "We'll try to simulate varying moisture content, acidity, and light and see if some combination of those factors could account for the rapid deterioration of the pigment," Gray says. "We've expanded the experimental design in order to look systematically at the effects of numerous factors and the interaction of those factors that could account for changes in the painting."

The environmental chamber is funded by the Office of Industry Relations, an example of support for the collaboration with the Art Institute extending beyond the Mellon Foundation funding.

To Gray, the collaboration provides an exciting application for the scientific principles used in her research. "It provides interesting opportunities for our students. It brings examples to show how our research and our capabilities can be beneficial for society," she explains. "If you can answer the very basic question, you may find that it has surprising applications. It may have relevance to understanding why a painting faded a hundred years ago or to developing new materials for the future."

Anonymous, Chinese, Kneeling Figure, Shang Dynasty, (c. 1600–c. 1045 BCE) 13th–11th century BCE. Chlorite, 19.5 x 8.8 cm. The Art Insitute of Chicago: Edward and Louise B. Sonnenschein Collection (AIC 1950.671). The kneeling figure is being prepared for environmental scanning electron microscopy.

Analyzing ancient colors

One of the prize pieces in the Art Institute's collection of Chinese jades is an ancient sculpture of a kneeling figure with its hands bound behind dating back to the Shang Dynasty (1600–1045 BCE). The piece had no known counterpart when it was bequeathed to the Art Institute in 1950 as part of the Edward and Louise B. Sonnenschein Collection, but since 2001 at least 11 stylistically identical pieces have been unearthed in China. Those newly discovered pieces, however, are yellowish gray or dark green in color — unlike the very dark, almost black sculpture at the Art Institute.

"What is of interest was how this piece came to be black," Faber says. "Was the stone actually black? Was this some sort of painting or coating? Or had the object undergone some sort of a burning process to change its color? We decided that once we found what the mineral was, we could address some of these questions."

Faber and Casadio worked with Ariel Knowles (materials science and engineering '05), who used the project for her senior thesis. "As an undergraduate project, it was absolutely terrific," Faber says. "It got her outside of the university and allowed her to use the techniques she's learned in materials science for a project that has to do with cultural heritage, which is certainly an expansion beyond what we normally do in this department."

The research group performed tests at the Art Institute and at Northwestern in order to determine the mineral used in the piece. Casadio performed Raman micro-spectroscopy at the Art Institute, allowing the researchers to gain some insight into the composition of the material, as well as micro-Fourier Transform Infrared spectroscopy (FTIR) to identify any organics that might be on the surface of the piece.

Prior to bringing the piece to Northwestern for the next round of tests, it was of key importance to ensure the careful handling of the sculpture in the laboratory. In order to properly adjust the instrumentation, Knowles built a plaster model of the piece. The model allowed the group to design a fixture to ensure the security of the piece during testing. The team brought the piece to Northwestern for two days of analysis, including x-ray diffraction to determine the composition and structure of the material and electron microscopy to perform topological studies and chemical analysis of the piece.

The research group was able to determine the composition of the piece from the first round of testing. They were also able to determine that there was no paint on the piece, eliminating one possible cause of the distinctive color.

After acquiring samples of similar minerals, Knowles subjected each sample to a series of heating studies to determine if heat would induce a similar color change. Art historians and Chinese archaeologists provide two theories about why the stone may have been heated: artists may have heated stones to soften them prior to carving, or stones may have been burned as part of ritual ceremonies.

In addition to heating the samples, the research group polished and treated each one with Japan wax, residues of which were found on the surface of the kneeling figure. Waxing is a common treatment

Ariel Knowles and Katherine Faber

Students Amy Gooch and Ankit Mohan with professor Jack Tumblin

used by collectors of Chinese jades and other hard stones to enhance an item's appearance. Both treatments were representative of changes to the artifact that may have been caused by collectors after the creation of the piece.

Comparing the color changes, the research presented some likely factors that contributed to the current appearance of the piece. "At the end, we feel reasonably comfortable saying that the piece could have gone through some heating, because we know that we can get color changes to very dark colors, and that in a flame, like a burial flame, the temperatures are sufficiently high to get this color change. Also, some collector along the line might have used Japan wax to make the piece darker and shinier," Faber explains. "These two reasons are the most likely, but I don't think we'll ever be able to differentiate between them without further testing."

The end result addresses the unique challenge facing conservation science. Until recently, the care and handling of pieces have rarely been documented, making it difficult to discern the aspects of a piece bestowed by the original artist from changes resulting from collectors and environmental factors. Though it is impossible to provide a decisive answer for a piece such as the jade studied in this project, the scientific analysis, coupled with comparable archaeological data, provides additional insight into the context and provenance of the piece.

Revealing an artist's revisions

Jack Tumblin has turned a digital camera, laptop computer, and a disco light into a powerful tool for analyzing art.

Tumblin, assistant professor of electrical engineering and computer science, attended one of the seminars sponsored by the Art Institute and Northwestern, where he met Francesca Casadio, Stephanie D'Alessandro, associate curator of modern painting and sculpture at the Art Institute, and Kristin Lister, paintings conservator. The group discussed challenges facing an upcoming project (set for an exhibition in 2009), which started Tumblin thinking about how his work might be able to complement the Art Institute's research.

The project involved pentimenti (Italian for regrets or repentances), or changes made by an artist while creating a piece of art. In paintings these changes can often be seen through careful analysis of the surface texture of the object. If an artist changes a brushstroke's direction and paints over a part of the painting, the variations in the surface of the paint can often reveal the artist's earlier thought.

One technique often used to analyze surface detail is raking-angle light, where a light is cast at a low angle, resulting in increased visibility of subtle variations in texture. The problem with raking-angle light is that the variations in texture change based on the position of both the light and the viewer. At different positions, some changes in the texture are highlighted, while others are hidden from view.

Traditional photography catches only one angle of one view, often hiding some of the details within the texture. Using a computer-controlled camera and light (which comes in the form of an off-the-shelf disco light), Tumblin and his students are able to create a digital file that combines the various angles from which a piece can be viewed or lit. The result is an abstract data type that can be relit, giving the user the ability to see a level of detail that would be lost in a typical film-based photograph. This new tool allows users to capture the type of data that is processed by a human eye.

"This is a new way of measuring very subtle surface variations of a painting that's independent of the painting color," Tumblin explains. "We're able to combine this data with infrared imaging and X-rays to get a very rich data set, so we can pull out features people couldn't see before."

Tumblin's device was used on Picasso's *Untitled (Man with Moustache, Buttoned Vest, and Pipe)*, and has initially found surprising results. "The device made it very vivid and clear in the raw data that originally the man was wearing a bowler hat," Tumblin explains. "You can see where Picasso changed his mind."

Tumblin's device and related work may have far-reaching implications for museum science. He recently received National Science Foundation funding to work on the application of the device with

Pablo Picasso, Spanish. *Untitled (Man with Moustache, Buttoned Vest, and Pipe),* 1915. Oil on canvas. The Art Institute of Chicago: Gift of Mrs. Leigh B. Block in memory of Albert D. Lasker, 1952.1116.

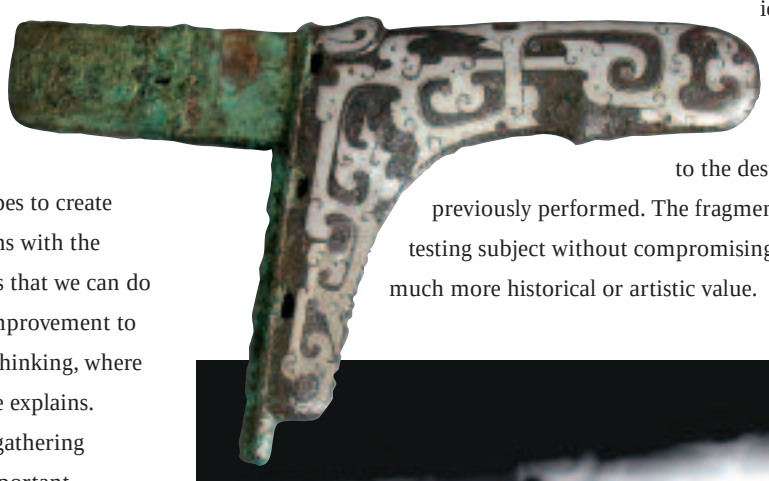
the Field Museum. In the long term, Tumblin hopes to create a better way for museums to share their collections with the general public. "I think that one of the best things that we can do as computer graphics people is to make a great improvement to photography, to get away from film and filmlike thinking, where we're just recording the focal plane intensities," he explains. "Instead we can say this is a computational data-gathering device. We want to compute all of the visually important information with our cameras."

Conquering the challenges of corrosion

David Dunand, professor of materials science and engineering, worked with Casadio and colleagues of the Art Institute of Chicago to analyze several bronze pieces from the museum's Asian art collection. For Dunand, the project seemed to be a perfect mesh of his current interests and family history. "I'm a metallurgist, and my grandfather was also a metallurgist with a wide range of interests, including archaeological materials. My father was a curator of a small museum in Geneva that specializes in Asian art," he explains. "I've always been very close to Asian art. Even though I am a scientist, the other part of my brain is active. For me, art is a very important part of life. It makes us human in our highly technological society — discovery drives the scientist in me, but art allows for emotional expression."

Dunand and graduate student Marcus Young began the research by studying a 3,000-year-old fragment from an ancient bronze vessel. The original vessel had been acquired as a whole object in the 1940s but was damaged during transport to the West, leading to the discovery that it was indeed a pastiche of soldered fragments (some ancient and others modern and made of pure copper) camouflaged with the application of a green stucco to simulate missing decoration and corrosion products. Once the forgery was discovered, the original fragments were donated to the then–Art Institute curator Charles Fabens Kelley to be used as study pieces.

The research project focused on one of the authentic pieces as an initial test to see if nondestructive experiments using updated analytical methods could determine similar information to the destructive tests previously performed. The fragments provided a testing subject without compromising a piece with much more historical or artistic value.



Above: Anonymous, Chinese Dagger-axe (Ge), Eastern Zhou dynasty, Warring States period (480–221 BCE), 3rd/2nd century BCE. Bronze inlaid with silver; 20 x 13 cm. The Art Institute of Chicago: Gift of Russell Tyson (AIC1950.1627). Right: Traditional laboratory X-ray radiography of the dagger-axe, taken at the Art Institute. The image shows the presence of silver inlays under the green corrosion layer but does not allow conservators to see if there is a blade concealed within the sheath.

David Dunand and Marcus Young

The team traveled to Argonne National Laboratory to use synchrotron X-rays to examine the thick, bronze pieces and determine their composition and microstructure. Together with Argonne scientists, they worked to determine if the corrosion was natural or forged and if there was any uncorroded bronze core under the corrosion layer in the piece. The team determined that, indeed, there was uncorroded metal in the original fragment, but the real result, according to Dunand, was much more important. "We could show that we could nondestructively probe ancient bronze artifacts not just close to their surface, but in their bulk thanks to the very penetrating X-rays available at Argonne. That allows us to probe other museum-quality objects, which, of course, you would never test destructively." Dunand says.

The group then used the same X-ray techniques to a very valuable piece from the Art Institute collection, a bronze dagger-axe from the Eastern Zhou Dynasty (3rd/2nd century BCE) with beautiful silver inlays. The art-historical question was whether the axe consists of a functional bronze sheath containing a corroded bronze blade (which cannot currently be removed without damage) or whether the whole object was cast as a single bronze piece to resemble a sheathed blade. Using the same synchrotron X-ray diffraction and imaging, the group was able to determine that the piece was, indeed, cast as a single object without blade, likely for ceremonial use.

Dunand and Joseph Lambert, Claire Hamilton Professor of Chemistry in Weinberg College, expect to continue their research on ancient Chinese bronzes, as well as to expand into modern bronze pieces from the 20th century, with the goal of identifying the alloy and patina used in each piece. "We'd like to know if an artist systematically used a certain type of bronze, maybe because of the resulting patina," Dunand explains.

As the research continues, perhaps the biggest challenge is choosing a direction. "There is a huge quantity of objects that could be studied in this way," Dunand says. "The challenge is to pick the right questions and the right objects, because there's a backlog of thousands of years of research."

Pinpointing pigments

The collaboration between the Art Institute and Northwestern also extends beyond McCormick and into the Weinberg College of Arts and Sciences. Richard Van Duyne, Charles E. and Emma H. Morrison Professor of Chemistry, and graduate student Alyson Whitney are working to determine new methods to identify the pigments used in particular pieces of art. This determination is important: The attributes of a particular pigment affect the conditions needed to preserve a piece, give insight into the artist's methods, and provide another method to verify a piece's authenticity.

Whitney approached Casadio with a desire to combine her chemistry background with her appreciation of art. The two discovered a shared interest in Raman spectroscopy, a method that has proved particularly useful in the study of pigments. This nondestructive method provides a wealth of useful information for inorganic

Jean Hey (the Master of Moulins), *The Annunciation,* c. 1500. Oil on panel. The Art Institute of Chicago: Mr. and Mrs. Martin A. Ryerson Collection.

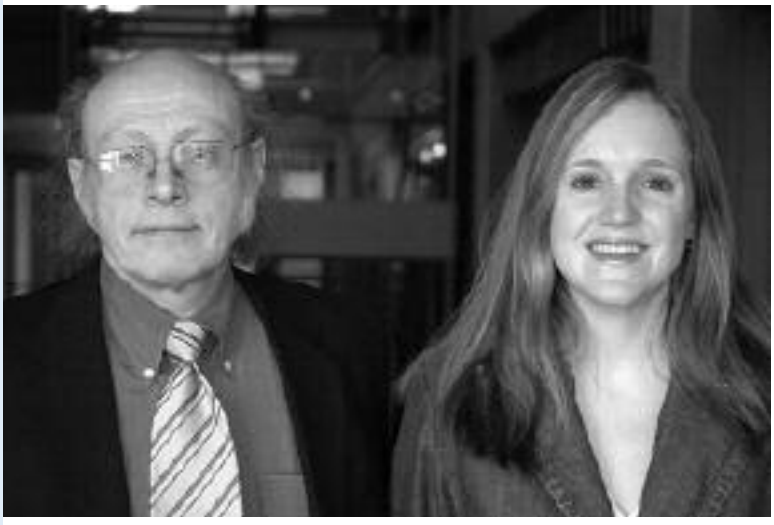
McCormick Corporate Partners Undergraduate Research Grants

These $5,000 research grants are funded by members of McCormick's Corporate Partners Program and are coordinated by the Office of Industry Relations. Two of this year's grant recipients will use the funds to work on projects with the Art Institute of Chicago:

- **Chi Yen Cheung** and adviser **Jack Tumblin:** "Shedding new light on historical paintings using raking-angle photography"
- **Nirav Shah** and adviser **Kimberly Gray:** "Deterioration of the Zn yellow pigments in Georges Seurat's *Sunday on La Grande Jatte:* Chamber studies to simulate and accelerate aging"

Other recipients of Corporate Partners Undergraduate Research Grants are

- **Gregory Bok** and adviser **Russ Joseph:** "Fine grain phase characterization and prediction for power management"
- **Constantin Chikando** and adviser **Annelise Barron:** "Protein polymers for tissue engineering: Hydrogels and gene delivery"
- **Dorothea Koh** and advisers **SonBinh Nguyen** and **Suzanne Olds:** "Enhancing DNA detection: Small molecule DNA hybrids"
- **Mackenzie Nicholson** and adviser **Joseph Schofer:** "All-red, pedestrian crossing: Impact of pedestrians on signalized intersections capacity and delay"



Richard Van Duyne and Alyson Whitney

continued from page 7

pigments but has significant limitations with organic pigments. When undergoing testing, organic molecules fluoresce, making it impossible to read the Raman scattering used to determine the makeup of a molecule.

Using surface-enhanced Raman spectroscopy (SERS), however, the group has been able to uncover a wealth of new information about these organic pigments. SERS was discovered by Van Duyne in 1977 and is now widely recognized as the most sensitive form of spectroscopy capable of identifying molecules. "If you coat a substrate with a very thin nanometer layer of silver, you will get a beautiful Raman spectrum of the pigment," Van Duyne explains. "The overlayer of silver does two things — it quenches the fluorescence and it amplifies the Raman scattering."

This new application of SERS allows researchers to rapidly determine the molecular "fingerprint" of pigments that haven't yet been studied. The group started with an analysis of red lakes (pigments obtained by precipitating an organic dyestuff onto an inorganic substrate), which are particularly hard to study. "No one has done this before, so we've been developing a library focusing on red pigments," Whitney explains. "We're determining what these red pigments look like with a silver film on them, so then other conservators can use the information."

The development provides many new opportunities to reexamine previously studied pigments. "Because they've basically been impossible to study before, you don't know what kind of dating and authentication information is contained in these organic materials," Van Duyne explains. "We may find new signatures that are characteristic for a particular artist or time period."

Bartosz Grzybowski sees dynamic possibilities on a very small scale

Bartosz Grzybowski, Kyle Bishop, and Yuriy Chege

At first glance, Bartosz Grzybowski's research group may not appear to belong in the Department of Chemical and Biological Engineering. His postdoctoral fellows span a wide spectrum of the sciences — mathematics, physics, chemistry, and biology — and that's just what Grzybowski intended.

Grzybowski's research focuses on self-assembly, predominantly on the micro- and nanoscales. It's a cutting-edge field that provides a new level of control to recent developments in forming small structures and functional devices.

Researchers focusing on nanotechnology have been able to form a wide variety of static structures — mostly through meticulous top-down fabrication procedures under equilibrium conditions. In contrast, Grzybowski's research focuses on using non-equilibrium processes and phenomena to create systems that build themselves dynamically. This approach is inspired by biology, where components interact and organize only when powered by externally delivered energy, such as food.

"We're interested in pieces that self-organize but not just into static structures," Grzybowski explains. "We want to build things that can change and have the potential to adapt. A good example is the dynamic nanoparticle crystals we have recently synthesized. Depending on the wavelength of light that they are exposed to, the components of these unusual structures come together or fall apart. This behavior is a primitive form of adaptability at the nanoscale and is the first step towards 'intelligent' nanostructures. We are now extending this system to crystals that can be reconfigured from one form to another and thus change their optical or electrical properties."

The crystals and other structures Grzybowski's group is making can, in turn, be used as building blocks for higher-order architectures. "For example, we have used nanoscopic objects to build composite spheres and then to make microscopic crystals from those spheres," says Kyle Bishop, a chemical and biological engineering graduate student in Grzybowski's research group. "Through this bottom-up approach we were able to build materials that were 99 percent composed of metal but behaved like a flexible plastic."

Tackling the fundamental questions in this emerging area of research has presented its own challenges. "The theory and the practice behind self-organization have been limited to static structures," Grzybowski says. "There is no theory as to how and why the dynamic assemblies should form and work. Coupled with the lack of theory is a lack of experiments. Experiments are normally built on theory, but we had neither when we started."

The lack of documented knowledge explains the diverse expertise represented by the members of the research group Grzybowski recruited from all over the world. Their varied backgrounds equip the team to handle everything from creating molecules and analyzing their interactions to rationalizing the physics behind a structure's composition.

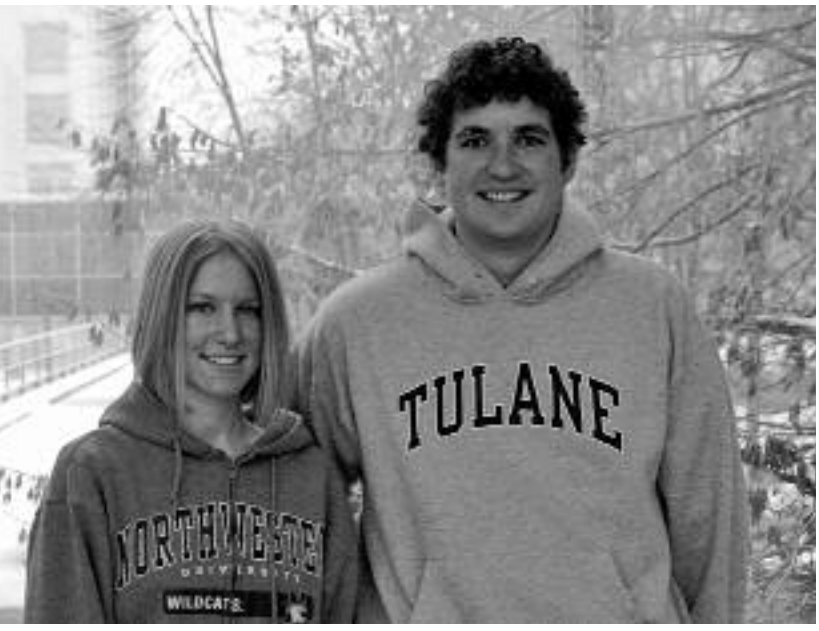
"When we first started, we had to be sure that each person understood what the other was saying," Grzybowski says. "Interdisciplinary research requires certain skills, especially in terms of communication."

"It's definitely a unique environment," says Bishop. "We feel uniquely situated to attack almost any type of problem."

The group has certainly succeeded in attracting attention. Last year alone it published more than 20 articles, and its research was featured on the cover of six leading scientific journals. In February their work on nanocrystals was published in *Science*. Grzybowski was recently awarded a National Science Foundation CAREER Award and the 3M Nontenured Faculty Award, and his group has secured support from a wide variety of sources, including the NSF, the National Institutes of Health, and several high-tech companies.

Despite the challenges associated with working in this type of emerging field and with such a diverse team, Grzybowski wouldn't change his approach. "Our motto is that we never do anything better, because we never do anything that anyone else has done," he says. "Life is too short to optimize someone else's work."

Hurricanes Katrina and Rita
McCormick responds



Tulane students Kristen Fadely and David Welch at Northwestern

"Hurricane Katrina was a seminal event," explains Joseph Schofer, associate dean for faculty affairs and professor of civil and environmental engineering at McCormick. "It was unique in terms of size and scope but also in the way that it affected us here at McCormick."

McCormick joined the rest of the country last September searching for ways to help in the aftermath of Katrina. "We had people who volunteered, and we made a home for students and allowed them to continue their education. We also used Katrina as an opportunity to study, analyze, learn, and contribute to the public," says Schofer. "I'm pleased with the various ways McCormick was able to contribute. It gave us all an opportunity to learn to do a better job in the future."

Making a new home for students

Hurricane Katrina forced many Gulf Coast universities to close their doors for fall semester, leaving many students without an academic home. Universities across the country answered the call to help — and Northwestern was no exception. The University enrolled a total of 64 students for fall quarter. McCormick welcomed four of those students, including David Welch, a junior studying biomedical engineering at Tulane University.

McCormick appealed to Welch because it was one of the ABET-accredited biomedical engineering programs closest to his home in Kansas. It was important to Welch, a junior, to stay on track with his major — something that wasn't a problem at McCormick.

"Registration was the easiest part," he says. "They had staff available in the computer lab to help us get into whatever classes we needed."

Welch moved into the Public Affairs Residential College, where many other Tulane students — affectionately nicknamed "Stormies" — were housed. "It was like being a freshman again," he says. "The rest of our building was mostly freshman, and about half of my floor was from Tulane."

As Welch headed back to finish his degree at Tulane, he took with him fond memories of his temporary home. "It was a very good experience," he says. "I made connections I hope to keep for the rest of my life."

Charlie Srivilasa

Lending a helping hand

After seeing the impact of Hurricanes Katrina and Rita last September, Charlie Srivilasa (biomedical engineering '07) felt compelled to help. Thanks to his training as an emergency medical technician (EMT), Srivilasa was able to be a significant contributor in the disaster area.

Flexible arrangements with the McCormick School allowed him to spend two weeks helping those affected by the hurricanes. Working with Joe Holtgreive, assistant dean for undergraduate engineering; Matt Glucksberg, professor and chair of biomedical engineering; and his other professors, Srivilasa was able to rearrange his class schedule. He called several volunteer organizations before finally connecting with Remote Area Medical, a group that typically provides free health care to impoverished areas in Tennessee and West Virginia. Then he flew into Gulfport, Mississippi — one of the only open airports in the region.

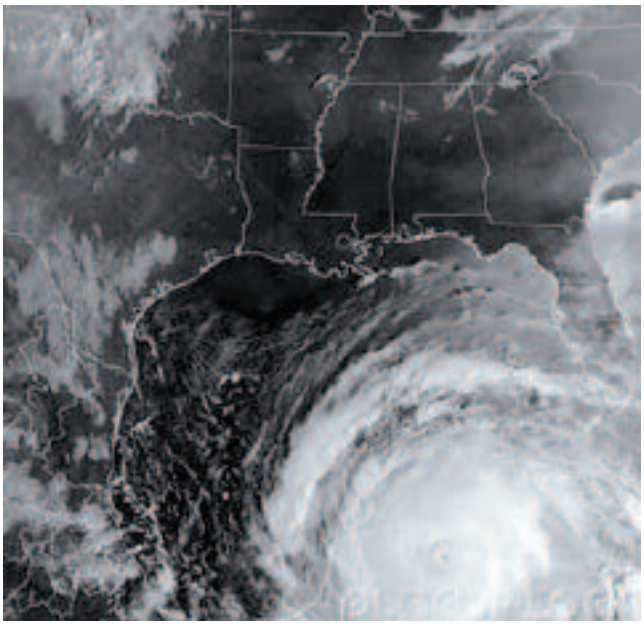
For the next two weeks Srivilasa served with a doctor and two nurses on the staff of a traveling clinic. They set up in any available space, utilizing any methods available to advertise their services. They sent radio messages offering medical services and even went door to

door, seeking those who might not be able to travel to the clinic. They treated serious injuries, immunized those who needed protection from disease, and cared for common maladies. "A lot of people had high blood pressure or were suffering from depression, but had no medication left," he explains. They treated as many people as possible each day, seeing up to 1,000 patients each week.

Srivilasa's experience in New Orleans will serve him well in the future — one that includes plans for medical school. "We were practicing the stripped-down basics of health care," he says. "It was one on one with the patients, no bureaucracy. This confirmed that I really do want to pursue a career in health care. I want to continue to give back to others."

Faculty experts speak out

In the weeks immediately following the hurricanes, many faculty members at McCormick were sought out by the media to provide expertise on the science and technology behind the tragedies. Members of the Department of Civil and Environmental Engineering and the Infrastructure Technology Institute were cited more than 30 times, providing insight on everything from coastal protection to hurricane recovery. Quoted in such sources as the *New York Times, USA Today,* and ABC News, McCormick faculty helped the nation and the world understand the role of engineering in preparing for — and recovering from — a natural disaster.



Hoping to provide a forum for discussion of the problems facing the Gulf Coast — and to demonstrate the relevance of an engineering education to the needs of society — McCormick organized the symposium "Hurricane Katrina: Preparation, Response, and Rebuilding" in October. Moderated by Joseph Schofer, a panel of six faculty members from across the University presented their perspectives on the lessons of Hurricanes Katrina and Rita to a packed room of students, faculty, and alumni.

Charles Dowding, professor of civil and environmental engineering, discussed problems leading up to the disaster, including the geophysical inevitability of natural disasters and the shift of population into areas facing a high risk of natural disasters.

Kimberly Gray, associate professor of civil and environmental engineering and of chemical and biological engineering, proposed that Katrina spotlighted a "chronic condition" — the containment of natural processes that cause cascading intentional and unintentional outcomes. The rerouting of the Mississippi River to facilitate barge traffic, for example, leaves areas in the Mississippi Delta without the natural land-building effect of sedimentation.

Henry Binford, associate professor of history in Weinberg College, highlighted similar disasters in the 1927 Mississippi River Flood and Hurricane Betsy in 1965. Binford noted that as early as 1840 engineers recognized the unique problems of New Orleans's location.

Anne Johnsos, adjunct lecturer in the Medill School of Journalism, discussed the intensely emotional qualities that pervaded press coverage of Katrina's aftermath. She explained that reporters were dependent on local agencies and people for their well-being, possibly resulting in a skewed perspective.

Donald Haider, professor and director of the Center for Nonprofit Management at the J. L. Kellogg School of Management, discussed the problems facing the Federal Emergency Management Agency, arguing that due to the agency's wide range of accountability and responsibilities, it was nearly impossible to prepare effectively for disasters such as Katrina.

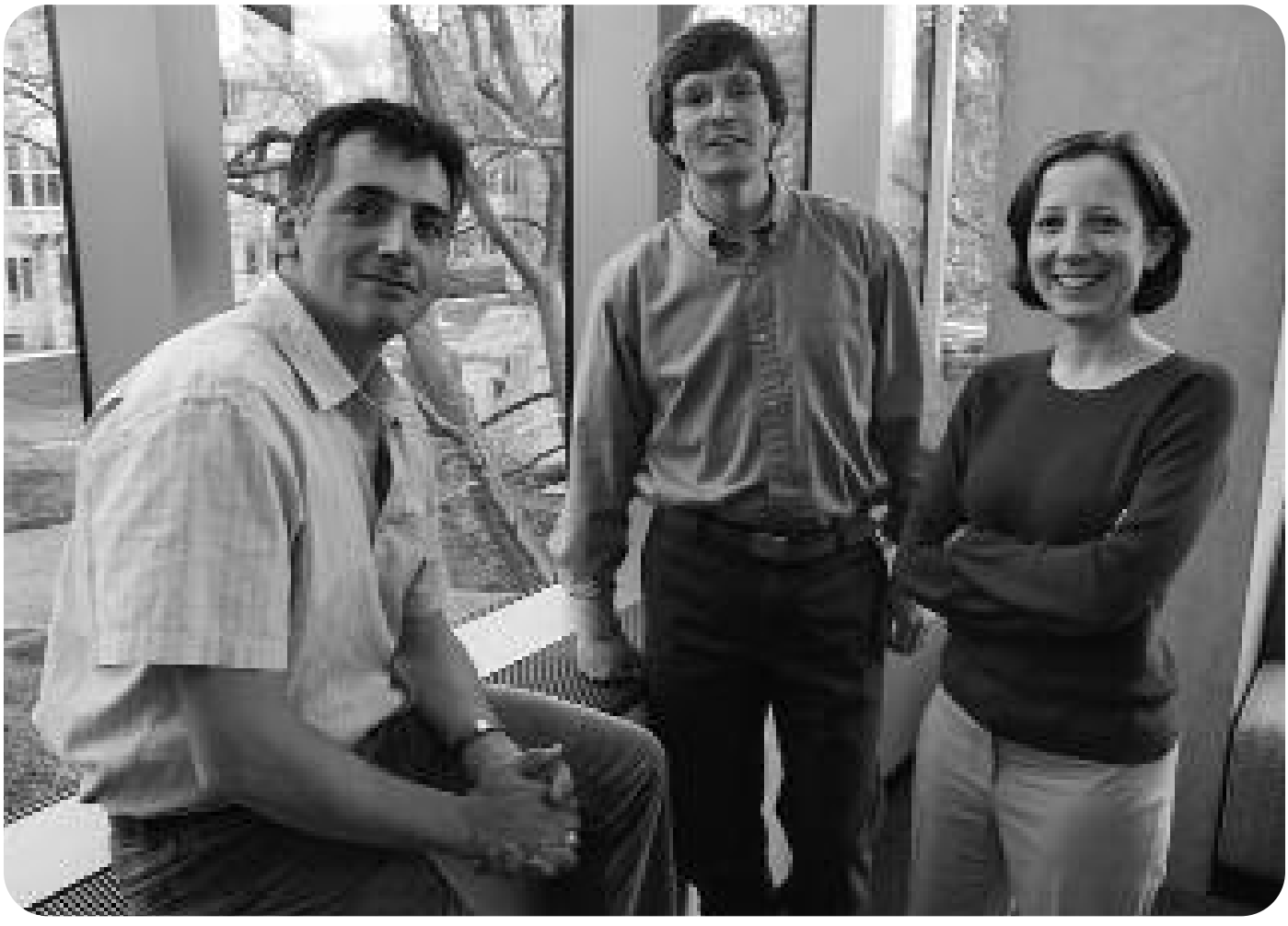
David Schulz, director of Northwestern's Infrastructure Technology Institute, suggested that raising the grade of New Orleans to prevent flooding — similar to work done in Chicago in the 1850s and in Galveston, Texas, in 1913 — was worth investigating. He also stressed the importance of fixing the relationships between local, state, and federal governments before any specific engineering, architecture, or planning solutions could be effective.

A recurring theme throughout the presentations was the overarching problem of a population shift to areas that are highly susceptible to natural disasters. Whether referring to hurricanes in New Orleans or Miami or to earthquakes in Los Angeles or San Francisco, faculty experts warned of the inevitability of future disasters.

In addition to McCormick's Katrina seminar, Northwestern's Transportation Center brought representatives from a variety of private transportation companies together to discuss Katrina's impact on the industry. "It's important to use these national events as a learning opportunity," says Schofer, "and then to use our faculty as intellectual bridges to share what they've learned with our students and the general public."

C3: Car-to-car cooperation

Three young faculty members take aim at traffic



Fabián E. Bustamante, Tito Homem-de-Mello, and Karen Smilowitz

Drivers in major urban areas are used to the headaches caused by traffic congestion and delays. But what if transportation is your business?

Traffic delays are more than an inconvenience to the transportation industry — they're a financial disaster. The Chicago area is the busiest transportation hub in the country, with $572 billion in freight moving through annually. Traffic delays and congestion in the area cost $4 billion each year.

A new project at McCormick joins faculty from across disciplines to try to reduce that problem. Karen Smilowitz, assistant professor of industrial engineering and management science; Tito Homem-de-Mello, associate professor of industrial engineering and management science; and Fabián E. Bustamante, assistant professor of electrical engineering and computer science, are combining their knowledge of transportation management, optimization, and distributed systems to create "car-to-car cooperation" — or C3.

"It started because the three of us are friends outside of our research," Smilowitz says. "On some level we knew what each of us was doing, but we were looking for ways to collaborate."

Each member of the team brings a unique perspective and background — Bustamante in distributed systems, Homem-de-Mello in optimization under uncertainty, and Smilowitz in routing models for freight operations — but all three say they have enjoyed learning more about the other disciplines. "When Fabián talks about networks,

it's completely different from what I think about networks," Smilowitz says. "Some of the methodology we use is the same, so you can start to see where the problems are similar across disciplines."

In the beginning stages of the project, understanding each other's disciplines proved to be a challenge. Terms like drayage (the movement of containers by truck) and MANET (model ad-hoc network) required explanation. "We had to go through a whole phase of translation," Bustamante says. "We had to develop a common language, but for us it was easier because we are friends."

Simulating traffic behavior

The C3 project explores distributed systems issues in large-scale intervehicle networks and addresses a critical problem in the transportation industry: the lack of effective ways to determine routes and forecast traffic conditions based on real-time information. Traffic information is currently gathered with sensors on major thoroughfares, requiring significant investment in infrastructure equipment. Once that information is gathered, it is sent to a centralized system for analysis. While this data helps detect congestion on major routes, it isn't an effective method to predict future traffic patterns or monitor other routes such as city streets or small highways.

The C3 project is trying to leverage the computation and networking capabilities increasingly common in new vehicles to track real-time conditions, communicate with other vehicles, and then predict optimal routes. The result would be a traffic advisory system with up-to-date, no-cost information on traffic conditions, as well as better information and increased flexibility for transportation dispatchers. And because the data is not fed into one centralized source, the system could be scaled to a large number of vehicles and still be fairly reliable.

It isn't feasible to start with a large-scale implementation of a project of this scope, so Bustamante and graduate student Dave Choffnes began with the development of an integrated network and traffic simulator. They found that existing tools were good at either simulating computer networks or traffic but not both.

"I work in large-scale distributed systems," Bustamante explains, "so the idea of distributed applications built on large numbers of instrumented cars seemed to be a novel one." He adds that Smilowitz and Homem-de-Mello "know what's happening when it comes to network optimization."

Using the simulator, the group can explore traffic behavior based on many changing factors. That data is used to develop the optimization models needed to predict ideal routes. Eventually, cars with computerized instrumentation will provide information for the simulator. "The idea is that the simulator receives these measurements and calibrates itself so that it becomes more and more accurate, and we can be sure that we have good solutions," says Homem-de-Mello.

Exploring other applications

The project is more feasible given the recent surge of computerized components in cars. Navigation systems are available in a wide variety of vehicles, but the majority of these systems work using static maps, not real-time conditions. Even high-end models that alert drivers to congestion are limited to reports from major routes. Nonetheless, this trend of outfitting vehicles with computerized systems is promising for the C3 project. "We will start to see this technology trickling down to lower-end cars so that all cars will have it," Bustamante says. "We want to leverage that technology."

After the initial simulation was up and running, undergraduate students at McCormick worked to create the test nodes needed for vehicles to collect data. Moving forward, more nodes will be used to gather data. The City of Chicago has agreed to equip their fleet of vehicles for the project, providing an ideal group of vehicles to gather information from around the city.

Consumers are sure to be interested in any product that may save travel time, but the project provides many potential opportunities for transportation managers. "One of the long-term possibilities is being able to swap loads based on traffic conditions," Smilowitz says. "It would allow the possibility to swap information about loads and tasks and provide more information for the dispatchers."

For Bustamante, the benefits of a car-to-car network go far beyond transportation management. The system would create a large-scale backbone for communications unlike today's Internet or traditional wireless models. "People are increasingly concerned with the stability of the Internet," he says. "This creates a wireless environment that is completely free of infrastructure. It's more resilient, dynamic, and scalable but also more complex than current approaches."

Such a system could also provide another means for distributing information in times of crisis. "If you have some disruption, this system could be an alternative way of sending messages throughout a city," Homem-de-Mello explains.

The team is seeking funding to expand on their research, but they're not waiting on it to move ahead. "We're very excited about this project and have decided that we will work on this. People will realize how interesting the problem is, and that it makes sense to invest in the idea given its enormous potential impact," Bustamante says.

Conference honors pioneer in aircraft safety methods

Jan D. Achenbach

In honor of Jan D. Achenbach receiving the National Medal of Technology last year, Northwestern University held a two-day symposium, "The Quest for New Aerostructural Materials and Designs," in October.

President Bush presented Achenbach, Walter P. Murphy Professor and McCormick School Professor of Civil and Environmental Engineering and of Mechanical Engineering, with the nation's highest honor for technological innovation March 14, 2005, in a White House ceremony.

Experts from industry, academia, and government agencies attended the symposium to engage in discussions on the next generation of materials and designs for commercial and military aircraft. The symposium included five lecture sessions and three panel discussions; the speakers explored future trends and needs as well as significant opportunities and obstacles facing aircraft manufacturers, material suppliers, the academic community, the Air Force, and the Federal Aviation Administration (FAA). The shift from aluminum alloys to composites and hybrid materials, already in progress with the Airbus 380 and the Boeing 787, received special attention.

R. John Hansman, professor of aeronautics and astronautics, Massachusetts Institute of Technology, delivered the keynote address, "Air Transportation and Technological Change."

Other speakers at the conference included Achenbach; Thomas A. Cruse, U.S. Air Force Research Laboratory; Gail Hahn, Boeing PhantomWorks; Larry Ilcewicz, the FAA; John Liu, Alcoa; Oliver Masefield, Eclipse Aviation; Gregory B. Olson, Wilson-Cook Professor of Engineering Design at McCormick; Henrik Roesner, Airbus; Brian W. Smith, the Boeing Company; Terry Weisshaar, Defense Advanced Research Projects Agency; and James C. Williams, the Ohio State University. The symposium was supported in part by the FAA.

"This symposium was successful because it reflected an impetus to the development of new materials and designs by the expected expansion of air travel as well as by the international competition between the major aircraft manufacturers — Boeing and Airbus," remarked Achenbach.

Achenbach received the National Medal of Technology for his seminal contributions to engineering research and education and for pioneering ultrasonic methods for the detection of cracks and corrosion in aircraft, leading to improved safety for aircraft structures.

MEM helps engineers broaden their perspective

Rebecca Carriveau began researching graduate school options assuming she would pursue an MBA. After working several years as a manufacturing engineer and operations manager, Carriveau — who graduated with a degree in industrial engineering from the University of Wisconsin–Madison and is director of DBS (Danaher Business System) for KaVo Dental Corporation — found herself gaining more responsibility and wanted to increase her understanding of the business as a whole. While researching programs at Northwestern, she discovered McCormick's Master of Engineering Management Program. "Given my background and what I wanted to do in my career, the combination of managerial and technical disciplines was ideal," she says.

The MEM program is designed for engineers who find themselves at this stage in their careers — needing to build their managerial skills but wishing to remain connected to the technical side of the business. "We make you both a better engineer and a better manager," says Barry Nelson, professor of industrial engineering and management sciences and director of the program. "We provide engineering tools that can be used for making management decisions as well as an enhanced understanding of the role of each function in a company."

This approach allowed Carriveau to learn more about the other divisions in her corporation. "It gives you enough of an understanding to be able to speak the language," she explains. "I have no experience as an accountant, but now I can converse with our accounting department. As you deal with more parts of the corporation, it helps to understand where they're coming from and to know the lingo."

As a trained engineer, Carriveau appreciated the experience and technical focus of her classmates. "The program assumes a level of technical knowledge," she says, contrasting it with MBA programs. In fact, MEM students must have at least three years of experience in industry to be eligible for the program. "You don't have to spend time on technical issues in class, which means you can concentrate on strategic issues and cover more subjects."

As Carriveau progressed through the MEM program, she found many of her classes were helping her along the way. At one point she started a new position job in procurement while taking a class on negotiations — one that she found very helpful when dealing with contracts.

"The things that we teach are immediately useful," Nelson explains. "A common experience for our faculty is that someone wants to come in early for class to talk about something they discussed and how they can apply that concept to their company. Our classes are very practice oriented."

Carriveau held three different positions at Danaher (KaVo's parent company) and even got married while she was completing the program — experiences that helped her appreciate the program's flexibility. Students are free to take time off or adjust their class load. Carriveau took two quarters off but was able to double up on classes during other quarters. All told, it will have taken her three years to complete the program when she graduates in June. "For a working professional, I can't imagine an easier program in terms of staff support, flexibility, and schedule," she says.

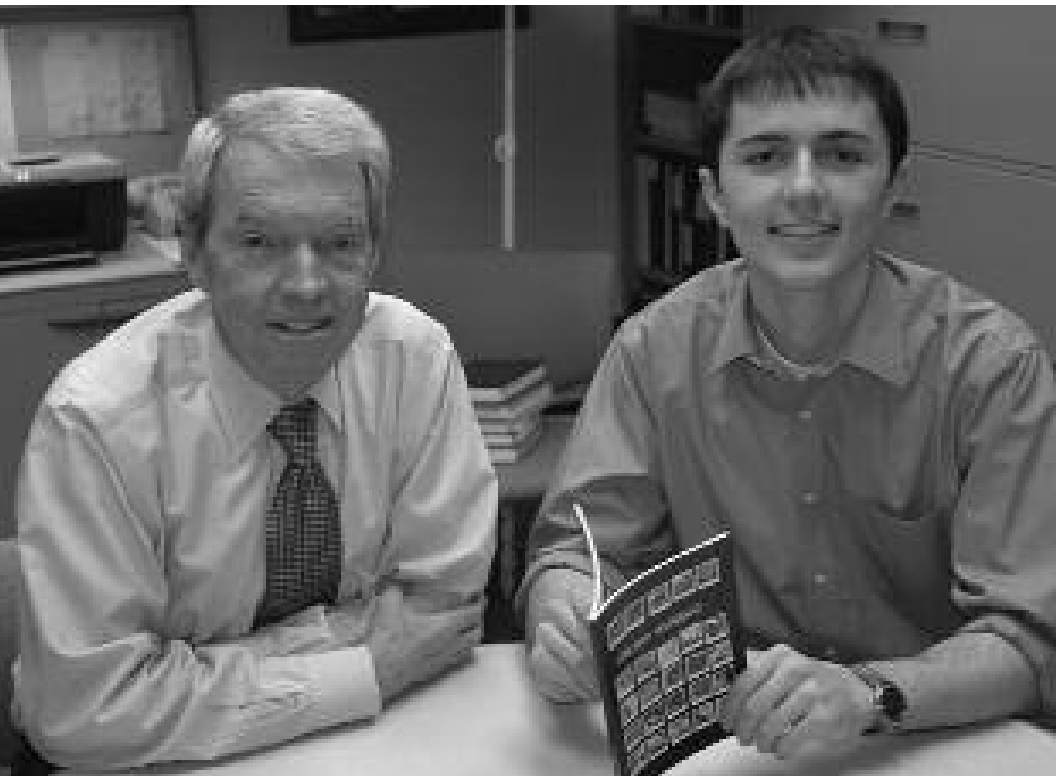
Rebecca Carriveau and Barry Nelson

Adding to the convenience of the program for the many students living and working in the western suburbs is the option to take some classes in Schaumburg. Anywhere from one- to two-thirds of the curriculum can be taken there. For Carriveau, that option saved an hour from her commute.

As Carriveau finishes the program, she says she wouldn't change a thing. Recalling one of her favorite classes, Donald McNeely's strategic management course, she sums up the larger benefit of the degree: "As an engineer, you're very technical, very project oriented. As you get higher in management, there's a shift from tactical to strategic. I liked [McNeely's] class because that's the direction I'm going in my career, and that's what I wanted to hear — big picture issues."

Fostering entrepreneurship at McCormick

NUcorp provides student with real business experience



William White and Liridon Rrushaj

As a sophomore, Liridon Rrushaj (industrial engineering and economics '08) boasts a pretty impressive résumé. After all, how many students can list CEO as work experience?

Rrushaj is the CEO of NUcorp, Northwestern's new collection of student-run enterprises. The organization takes entrepreneurship beyond the classroom and into the real world. "I've always been interested in learning the process of starting a business," he says. "It's not a skill you can learn by reading a textbook — you have to experience it."

William White, former CEO of Bell & Howell and professor of industrial engineering and management science, has found that McCormick is full of students with an interest in entrepreneurship. Six years ago, White and his colleagues developed a new entrepreneurship course for McCormick in response to student requests. The course was a success, and Engineering Entrepreneurship has been offered ever since. But White found that students wanted even more.

"They said that it would be nice to be able to practice some of these things while they were still in school," White says. "I had a friend who was an entrepreneur who came to speak to the class, and I found out that he had been working with students at Columbia who had been running their own businesses."

Intrigued by the idea, White applied for a grant from the Walter P. Murphy Society — McCormick's donor group, which funds a variety of academic projects each year — to see whether this would be a good fit for McCormick. Response from a student survey was positive, leading White to apply for additional Murphy Society funding to get NUcorp — originally known as the Center for Undergraduate Entrepreneurship — off the ground.

Before Rrushaj took over as CEO, White worked with Majid Bourejerdi (materials science and engineering '04), NUcorp's first CEO. Using the Murphy Society grant as working capital, NUcorp recruited student leaders to head several student-run businesses, ranging from an advertising agency to a tutoring business. Bourejerdi helped the president of each company get organized, and now serves on the organization's advisory board. Before graduating he worked with White to identify Rrushaj as NUcorp's new leader.

In addition to continuing its highly successful initial businesses, NUcorp evaluates new proposals and has established several criteria to evaluate in business plans, Rrushaj explains. "We want a business that students can run and that will be profitable. The business has to provide the opportunity to manage, to gain experience, and to get insight into entrepreneurship."

One of Rrushaj's major responsibilities as CEO is to work with the NUcorp advisory board, composed of business executives, faculty members, students, and alumni from McCormick and the J. L. Kellogg School of Management, and members of the University administration. The board is chaired by Jeff Coney, director of the Illinois Technology Enterprise Center (ITEC)-Evanston, which also provides guidance,

recommendations, and meeting space for NUcorp activities. The partnership has proved to be very beneficial for the students.

"ITEC lives in this area of entrepreneurship and start-ups, and they want to link with undergraduates," White says. "The staff at ITEC has been great with showing the students some of the shortcuts but making sure that they dot their *i*'s and cross their *t*'s."

For Rrushaj, those details have been the biggest challenge. "There are many uncertainties with entrepreneurship, and there's a lot of work that goes into the essential details before launching," he says. "So much preparation has to be done before you can get an idea out into the marketplace."

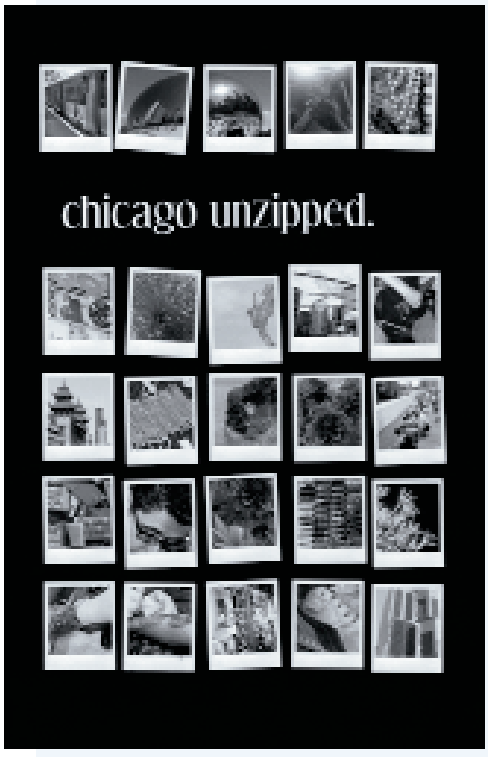
With its original businesses proven successes, NUcorp can now utilize Murphy Society grants to become completely self-sufficient. As the companies continue to grow, profits are redirected back into NUcorp as working capital for other business opportunities. But the real success of the project isn't measured financially but rather in terms of the experience it provides its participants.

"Just because you have a novel idea does not ensure your success," Rrushaj says. "There's a lot that goes into starting a business. Sometimes the details that would-be entrepreneurs overlook ultimately lead to their failure. I look forward to utilizing the knowledge gained from my experiential learning with NUcorp in the future."

A case study for success

One of the most successful NUcorp businesses has been *Chicago Unzipped,* a guide to Chicago written and produced entirely by Northwestern students. Readers travel through Chicago neighborhood by neighborhood, from Evanston to the Loop, via short profiles of trendy restaurants, shops, and attractions.

The first edition of *Chicago Unzipped* was led by Ben Levy (materials science and engineering '05). After taking the Engineering Entrepreneurship course, Levy applied for NUcorp and was hired as the president of the guidebook. He assembled a core team of seven students to research the book and develop business strategies. That group also came up with the title. "We liked it because it was short, sweet, and catchy, but it talks about uncovering Chicago and revealing it to readers," Levy explains.



To write and design the book, the group enlisted a team of more than 30. Many of the writers were students in the Medill School of Journalism, enticed by the opportunity to add published writing to their portfolios.

One of the biggest challenges facing *Chicago Unzipped* was securing sales before the book was completed. "I spent a lot of hours on the phone and on e-mail trying to get the book sold, even though we didn't yet have a product," Levy says.

Levy's hard work paid off when *Chicago Unzipped* landed its first big sale — months before the book was actually published in fall 2005; Loyola University agreed to buy 2,000 copies for its incoming freshman class. "I gave them a five-page example, and they agreed to sign a contract for the books," Levy explains. "Without that kind of guarantee, I don't know if we would have had the same product that we ended up with. It gave us hope."

To date, the book has sold more than 5,000 copies and is in its second printing, wildly exceeding Levy's expectations. "In the beginning, my idea of success was selling one book," he explains. "If we could finish one book on time and to our standards, then I knew we would be able to turn a profit in the future. We could have lost money in the first year, but instead we were able to create a great product that sold enough to turn a profit."

A new team of Northwestern students is working on the second edition of *Chicago Unzipped,* building on the lessons learned during the first edition. *Chicago Unzipped* is available at the Norris bookstore and on Amazon.com.

Ford Motor Company Engineering Design Center achieves "green" status

Photo by Neil Alexander/Neilphoto.com, courtesy of Davis Brody Bond.

THE NEW FORD MOTOR COMPANY ENGINEERING DESIGN CENTER recently received silver-level certification from the Leadership in Energy and Environmental Design (LEED) Green Building Rating System®. The building is the first at Northwestern specifically built to obtain certification in environmental sustainability, and Northwestern has adopted a policy targeting LEED certification for all future buildings.

Just south of the Technological Institute, the six-story, 84,000-square-foot building is the focal point for McCormick's initiatives in design education — including the Engineering Design and Communication (EDC) program for first-year undergraduates.

To keep energy costs down, the building's design provides natural daylight to more than 75 percent of the interior spaces, even though two of the six floors are below ground. In addition, an automated solar tracking system closes window shades in the face of direct sunlight and opens shades in areas facing away from the sun. An innovative raised-floor system provides more precise temperature control for the building's occupants, resulting in more efficient heating and cooling of interior spaces.

Many of the materials used to construct the building — such as steel, glass, concrete, carpeting, and ceiling-tile materials — have recycled content. Additionally, the building's design incorporates effective collection, storage, and management of recyclable materials.

The building's exterior features a number of measures that minimize its impact on the surrounding environment:

• A light-reflective roof reduces the "heat island" effect of the building on the site.

• Exterior lighting illuminates the ground but not the surrounding sky, reducing urban light pollution near the University's historic Dearborn Observatory.

• A specially integrated retention basin, located beneath the building, captures groundwater that is used to irrigate the surrounding landscape and the historic Shakespeare Garden to the east. Any excess is returned directly to groundwater rather than to the city sewer system.

The University engaged a team of experts in environmentally sustainable building design from the Rocky Mountain Institute in Snowmass, Colorado, to review design constraints and recommend ways to achieve certification from LEED, part of the U.S. Green Building Council. In addition, the building committee worked closely with the Garden Club of Evanston, whose members are the caretakers of the Shakespeare Garden.

In addition to EDC, the McCormick programs now housed in the center include the Institute for Design Engineering and Applications, the Walter P. Murphy Cooperative Engineering Education Program, a portion of the electrical engineering and computer science department, the civil and environmental engineering department's Infrastructure Technology Institute, and three professional master's degree programs: the Computational Biology and Bioinformatics Program, the Master of Product Development Program, and the Master of Management and Manufacturing Program. (The latter is run jointly by McCormick and the J. L. Kellogg School of Management.)

Ford Motor Company donated $10 million toward the new building. Other corporate donors include ITW, Deere & Company, 3M, and Steelcase. The building was designed by the architectural firm of Davis Brody Bond of New York, and Turner Construction Company was the general contractor.

Finding balance

McCormick provides role models for women in engineering

Katherine Faber (left) and Cate Brinson (above)

Engineering has long been a male dominated field, but two McCormick professors have taken part in projects aimed at balancing that gender gap. Cate Brinson, Jerome B. Cohen Professor in Engineering, associate chair of the department of mechanical engineering, and professor of materials science and engineering, and Katherine Faber, professor of materials science and engineering, were included in recent books as role models for women considering careers in science and engineering.

Juggling a career and a family life is tough for any working professional, but women in science face a unique set of challenges. From dealing with inflexible research timelines to the demands of publication, funding, teaching, and advising, Brinson and three colleagues offer advice from their experiences in a chapter for the recently published book *Success Strategies for Women in Science: A Portable Mentor* (Academic Press). "People ask for advice," she says, "and this chapter was our attempt to put together some strategies that can work."

For Brinson, work-life balance is a topic she knows well. During her 13 years at Northwestern, Brinson has been an active researcher, teacher, and adviser while raising four children. "It's really been a juggling act," she says.

Brinson and her coauthors have each taken different approaches to making their personal and professional lives work together. "One of the things that we came together on is that you have to find your own path," Brinson says. "There is no one way to do this, and you may have to try a number of things."

While some choose to work part-time or take time off from their scientific pursuits, Brinson has chosen to take one day at a time to balance her life. "My solution has been to just make it work, to make time for things when you need to make time for them. I try not to overplan."

There are times, Brinson admits, when she has to compromise to balance the many aspects of her life. In *Success Strategies* she writes, "While it is very easy to say, 'Set priorities and accept the compromises,' it can be very difficult to carry that out. However, it is OK for this to be difficult. It is acceptable to have regrets. You are not alone, it is not debilitating, and you will continue to move forward anyway."

All of the contributors in the chapter note a shift in attitudes that is gradually creating a more supportive environment for women in science. These changes are likely to affect current and future generations of scientists as they seek a balance between their personal and professional lives, and that's important because, as Brinson writes, "being happy in your career depends on being happy in your entire life, and vice versa."

As part of another recent project designed to encourage girls to choose a career in engineering, Katherine Faber was featured in the book *Women Engineers: Extraordinary Stories of How They Changed Our World.* The book was published by the Extraordinary Women Engineers Project, an outreach program chaired by First Lady Laura Bush.

More than 100 extraordinary women engineers are profiled in the book, which highlights the wide array of opportunities available to someone with an engineering background. Faber's profile illustrates the variations within a typical day in academia. From teaching to advising student groups to leading university collaborations (see page 2), Faber serves as an inspiration for young women considering an academic career in engineering.

"The effort to educate potential women engineers is very important to me," says Faber. "Giving young girls the opportunity to see engineering as a people-oriented profession with countless avenues of specialization helps to overcome stereotypes and develop a strong engineering community."

Stephanie Dandt, Melvyn Stewart, and Richard Schreck at Industry Day 2005

Students and alumni connect at SWE's Industry Day

More than 700 students hoped to find the right connection to their dream job or internship at the Society of Women Engineer's annual Industry Day last October. A McCormick tradition for more than 30 years, Industry Day connects students with representatives from 60 companies, including many Northwestern and McCormick alumni.

Industry Day is the largest student-run career fair on campus, rivaling Northwestern's all-campus career fair as one of the largest recruiting events of the year. More than 50 members of SWE organize all aspects of the event, including inviting and organizing the attending corporations and promoting the event on campus. SWE even designates a student host to assist the companies as they set up and tear down their booths. Representatives from companies join SWE members for dinner before the event, giving students high-quality time with prospective employers.

The high turnout can be attributed to the months of work that SWE puts into planning the event, making it one of SWE's biggest activities. "We start sending out letters in June, and by the start of school we're going full throttle," says Nina Bhatti, program director for SWE. "We wanted to include students outside of McCormick, so we targeted a wide variety of students this year."

From an employer's perspective, SWE does a good job of running the show. "It's smooth and professional and doesn't require a lot of extra time from us," says Richard Schreck, General Motors' liaison to Northwestern. "It gives us an opportunity to see a large number and variety of students. I had three representatives there who talked to students for three straight hours."

In addition to the actual event, the Society of Hispanic Professional Engineers and the National Society of Black Engineers have joined forces in recent years to increase the amount of programming surrounding Industry Day. Their groups cosponsor Industry Week, composed of events that prepare students to make the most of Industry Day. This year's events included seminars on résumé preparation and financial planning.

"In recent years Industry Week has been a good example of McCormick's student groups coming together to offer something to the student population," says Ellen Worsdall, assistant dean for undergraduate education. "It's a great way for students to kick-start their job search and get experience in front of recruiters."

One thing is certain — when it comes to finding qualified engineers, companies look to McCormick. Priya Alexander, a former SWE member who attended the event to recruit for Eaton Corporation's leadership development program, says that the company appreciates McCormick students "because Northwestern is an engineering school that focuses on teams and people, involving other people in every aspect of a project."

KaNeeTa Kimble, a McCormick graduate working for Procter & Gamble, agrees. "P & G decides what schools produce the best engineers. They've come to the conclusion that Northwestern is one of those schools, not just in terms of book smarts and technical knowledge but well-rounded students."

For nearly 50 alumni like Schreck, Alexander, and Kimble, Industry Day was also a chance to reconnect with their alma mater as recruiters. "You get to see what things are the same with McCormick but also how things are changing," Kimble says. "It's fun to see how the school is evolving."

Lights, camera — engineering!

McCormick graduate students make their reality TV debut

Mechanical engineering graduate students Kellan O'Connor and Tony Swanson are no strangers to creating devices in the lab, but now the two bring their engineering skills to Animal Planet's new reality TV show *Chasing Nature*. The program draws some of the top engineering students from across the country with the challenge of simulating one of nature's wonders through modern technology.

O'Connor and Swanson responded to a request for applicants from the producers of the show. After reviewing the students' résumés, the producers invited O'Connor and Swanson to an on-camera interview during a visit to campus. Weeks later, both students received word that they had been selected for the show.

Produced by Beyond International, *Chasing Nature* is filmed in Australia. Swanson and O'Connor were flown from Chicago to Sydney for separate five-day filming sessions. Before they arrived they had not been given any information regarding their challenge or even the concept of the show. Once they arrived they were given the task of replicating a distinctive animal characteristic through mechanics. After the teams built a device, they had to test it on a larger, human scale.

Swanson's team was asked to replicate the unique talent of the archerfish, which spits a stream of water to knock its prey off of branches and into the water. The team had to create a cannon that would knock human "prey" off a platform from a distance of 30 feet. To succeed, they had to be accurate on at least 40 percent of the attempts.

The group succeeded in building the cannon but had difficulty testing the device without harming their teammates on the platform. Unlike the archerfish, they were interested in the safety of their prey.

Working with the special-effects team, who helped coordinate the stunts, was a highlight for Swanson. "The special-effects guys were amazing," he says. "They could do anything. Their knowledge and ability to create functional devices quickly was amazing. In terms of prototyping, they're the best."

O'Connor's team worked to replicate a dolphin's ability to jump impressive distances above water. They used a barge with a specially design rig to launch team members out of the water while pulling them forward. The group then devised ways to improve the distance their colleagues could be flung. By modifying a wetsuit using silicone and neoprene, O'Connor and a teammate created a suit that resembled the tail of a dolphin and improved buoyancy and limited drag in the water.

Tony Swanson and Kellan O'Connor

As if these engineering challenges were not enough, capturing it all on camera added further complications. "There are a lot of interruptions, and sometimes you have to shoot things multiple times," Swanson says. "It was tough to get a lot of work done." Adds O'Connor: "It was hard to get into the TV frame of mind because we had never done it before. All of the interviews on the show take 15 minutes to do, even though they air as five-second segments. There's a ton of editing."

Since their teammates were selected from some of the top engineering schools in the country, including MIT, Stanford, and Cornell, O'Connor and Swanson found working with their graduate student counterparts a highlight. "Our team was great, and I'm still in touch with them," O'Connor says. "Not everybody lucks out to end up with a team that's so close."

Editor's note: Swanson's episode aired in January, but at press time the show was on hiatus and O'Connor's episode had not been scheduled.

Seamless transition

Motorola center at Northwestern gets new name, focus

Bruce Wessels, professor and chair of electrical engineering and computer science, with Ken Zdunek and Aggelos Katsaggelos

In a dedication ceremony in November, the Motorola Center for Communications at Northwestern University was renamed the Motorola Center for Seamless Communications. The change reflects the center's focus on technical innovations involving seamless communications and Motorola's "Seamless Mobility" initiatives, which aim to enable multiple devices to serve up multiple media across multiple access networks and technologies from multiple vendors. In addition, Motorola announced a $600,000 grant to the center.

The Motorola center was established in 1998 as a collaborative effort between researchers in the McCormick School and Motorola to address a wide variety of issues in the telecommunications industry. The Motorola Center for Seamless Communications funds research in technologies needed to accomplish seamless connectivity and access to content and services across multiple access networks and end-user devices.

"We'd like to thank Motorola for its continued support and partnership in establishing the new Motorola Center for Seamless Communications," said center codirector Aggelos Katsaggelos, who is also professor of electrical engineering and computer science at McCormick. "The faculty and students at Northwestern are excited for the opportunity to collaborate with industry leaders at Motorola in researching technological solutions that will ultimately advance the state of seamless communications."

Each year Motorola provides funding to the center and works with Northwestern faculty to select up to 10 innovative research projects that address key issues in wireless and wireline communications and applications. Under the leadership of professors from the Department of Electrical Engineering and Computer Science, faculty members and graduate students work together on these projects to develop new inventions that are relevant to solving outstanding technical and customer problems.

Once projects are completed, Northwestern professors work together with Motorola to transfer project results and inventions into intellectual property for Motorola. In recent years these efforts have resulted in the development of innovative technology solutions, such as wireless ad-hoc routing protocols and image coding technology. The collaboration also has resulted in internships and permanent jobs for Northwestern students at both Motorola and Motorola Labs.

"As technology continues to evolve at a rapid pace, there is an ever-growing need to create solutions that will enable Seamless Mobility for users," said Ken Zdunek, vice president, networks research, Motorola Labs, and codirector of the Motorola Center for Seamless Communications. "This year's funding and renaming of the center recognizes the mutually beneficial and ongoing partnership between Motorola and Northwestern and celebrates the combined efforts to pioneer the future direction of mobile technology."

—Megan Fellman

Northwestern researchers build world's smallest universal material testing system

THE DESIGN, DEVELOPMENT, AND MANUFACTURING of revolutionary products such as the automobile, the airplane, and the computer owe a great deal of their success to the large-scale material testing systems that have provided engineers and designers with a fundamental understanding of the mechanical behavior of various materials and structures.

In the world of nanotechnology, however, where the mechanical characterization of materials and structures takes place on the scale of atoms and molecules, existing material testing systems are useless. The development of a universal nanoscale material testing system (n-MTS), which could fit in existing electron microscopes (instruments that can magnify images approximately 1 million times) and possess the resolution and accuracy needed to mechanically test nanoscale objects, has been a major challenge within the scientific community.

Now researchers at Northwestern have designed and built the first complete micromachine that makes possible the investigation of nanomechanics phenomena in real time. The findings were published last fall in *PNAS (Proceedings of the National Academy of Sciences of the United States of America)*. The machine, which can fit in tiny spaces as required by in situ transmission electron microscopy, successfully characterized the mechanical properties of nanowires and carbon nanotubes.

The n-MTS developed by Horacio D. Espinosa, professor of mechanical engineering, and his colleagues consists of an actuator and a load sensor fabricated by means of microtechnology, a derivative of the computer industry. The load sensor is based on differential capacitive sensing, which provides a load resolution of about 10 nanonewtons. This is the first n-MTS that provides continuous observation of specimen deformation and failure with subnanometer resolution while simultaneously measuring electronically the applied forces with nanonewton resolution. The integration of electro- and thermomechanical components at the microscale made the achievement possible.

One of the challenges overcome by the researchers was the integration of micro-electro-mechanical systems (MEMS) and circuits for measurement of electronic signals. They solved this problem by using a double-chip architecture consisting of a MEMS chip and a microelectronic sensing chip. Another challenge was the mounting of individual nanostructures on the testing device. Using

Horacio D. Espinosa

a nanomanipulator inside a dual-beam scanning electron microscope and focused ion beam apparatus (a new tool available to nanoscientists), the researchers picked up nanostructures, cut them to the desired length, and nanowelded the structures onto the n-MTS using electron-beam–induced deposition of platinum.

As reported in the *PNAS* paper, the system capabilities were demonstrated by in situ electron microscopy testing of free-standing polysilicon films, metallic nanowires, and carbon nanotubes. Espinosa's team achieved the first real-time instrumented in situ transmission electron microscopy observation of carbon nanotube failure under tensile loading.

In 1959 Nobel laureate Richard Feynman delivered a talk at the California Institute of Technology titled "There is Plenty of Room at the Bottom," in which he envisioned the possibility of making very small machines. "Our MEMS-based nanoscale material testing system represents another milestone along the path of miniaturization anticipated by Feynman," said Espinosa. "We expect it will have a similar impact and produce the same level of opportunities as the development of the universal testing machine had in the last century."

The n-MTS can potentially be applied to characterize the mechanical, thermal, and electromechanical properties not only of nanowires and nanotubes but also of a large number of organic materials, including DNA, proteins, and nanofibers.

Espinosa's coauthor on the *PNAS* paper was graduate student Yong Zhu. Their research was supported by the National Science Foundation.

—Megan Fellman

In analyzing his success, Dennis Chookaszian credits his engineering background

Strong analytical skills and proactive career planning propelled Dennis Chookaszian to his position as chairman and chief executive officer of CNA Insurance Companies. Though his career took him far away from his major in chemical engineering, he credits much of his success to the engineering background he received at McCormick.

Chookaszian was born and raised in Chicago and graduated from McCormick in 1965. After graduation, he earned an MBA at the University of Chicago and a master's in economics at the London School of Economics. In his 25-year career at CNA, Chookaszian served as chief financial officer, president and chief operating officer, chairman and chief executive officer, and chairman of the executive committee. He retired from CNA in 1999 and now divides his time among a variety of business ventures and philanthropic activities.

Chookaszian serves on the boards of five public companies and a number of private ventures. He also serves on the boards of seven not-for-profit organizations — including Northwestern University. He is involved in several entrepreneurial ventures, and he and his son work on a variety of real estate development projects. He also serves as an arbitrator and has handled some high-profile cases between companies, including a settlement related to the September 11 attacks.

Chookaszian spends as much time as possible at the Annabelle Inn, a bed and breakfast in Aspen, Colorado, that he designed and built — and named after his mother.

Your career falls outside of the traditional engineering path. What aspects of your engineering education have helped you to succeed?

Several elements of the engineering education were invaluable to me. First was the extension of my analytic abilities, which gave me the confidence to know that there wasn't anything that you couldn't do. No business problem seemed complicated to me after studying engineering.

Second was problem solving. Not only did you develop the skills to be able to handle complicated questions, you gained the ability to solve problems. A course in creative thinking stands out in my mind. We were given a different problem every week and had to experiment with solutions. We learned new ways of thinking about problems and how to develop alternate solutions.

Third was a course titled Enterprise and Entrepreneurship. This course had a very profound impact on me — to this day I remember a lot of the specifics. The course brought in great speakers, including Ray Kroc from McDonald's just as McDonald's was going public. Another speaker who made a significant impact was Jay Pritzker, the CEO of Hyatt. His presentation focused on different approaches an individual could employ to build a career.

Finally, there was socialization. It was important to learn how to work effectively with others in a complex project environment.

How did you end up in the insurance business?

When I went into consulting, I had no insurance background. I worked on projects for clients in the insurance business and found that it appealed to me and involved what I was good at — finance, accounting, and computer systems. Those are the core competencies needed to be successful in insurance.

Do you have any advice for current students preparing for their careers?

The main principle is to plan your career. If you do some planning, you can have a materially different effect on where you will end up — but you have to make appropriate choices with an eye on the long term.

I teach a course on career planning, and I tell people that your life is composed of three things: your work, your family, and your personal activities. Everything you do falls into one of those three categories. My advice is to choose two, because you can't do all three well. If you have a demanding career, you will have to choose between family and personal activities since you will not have time to do both. Making that choice correctly and understanding what type of lifestyle you want will determine how successful your life will be. Successful career planning also requires making decisions based on long-term, not short-term characteristics of your jobs.

Alternate routes to success: McCormick paves the way

The McCormick School prides itself on equipping graduates with the necessary skills to lead productive, fulfilling careers. Those careers, however, don't always follow traditional engineering paths. Two McCormick alumni, Sam Sperry ('65) and Bob Puette ('64), have enjoyed very successful careers in service professions — Sperry in law, and Puette in business — and both demonstrate a strong commitment to giving of their time and resources to McCormick.

Puette, president of Puette Capital Management in Corral de Tierra, California, and Sperry, a municipal bond attorney with Orrick, Herrington & Sutcliffe in San Francisco, have enjoyed careers made possible by the McCormick School's commitment to comprehensive problem-solving principles and effective communication. And both have applied those principles in the leadership roles they have chosen at McCormick — Sperry as past chair of the Murphy Society Annual Fund and Puette as past chair of the McCormick Advisory Council.

Whether they pursue careers in engineering, law, or business, McCormick graduates frequently express profound gratitude for the analytical tools gleaned during their time at Northwestern.

Problem solving and the law

Outstanding engineering faculty at the McCormick School taught Sam Sperry a great deal about problem solving. In addition, they trained him to seek out solutions even when problems are not apparent — an invaluable skill in his area of legal expertise.

"There isn't always a problem to be solved in my business," says Sperry. "Sometimes it's simply a matter of making things work better than they did before. My professors at Northwestern did an amazing job of teaching me to cherish the common thread between problem solving and task performance."

Sam Sperry

The class that taught Sperry most about task performance was appropriately titled Creativity and Problem Solving, and he estimates that it was "probably the closest precursor to the design classes that we have now."

As a municipal bond attorney for large-scale projects throughout the state of California, Sperry has to think creatively about making the best use of land and building developments. "Dean Ben Gotaas used to say that gifted engineers can't just be concerned about making money. They have a responsibility to society," says Sperry, whose senior class designed a pipeline that relieved periodic flooding of the Fox Lakes. "That was grounded in my thinking very firmly at McCormick."

After attending Stanford Law School, Sperry was able to leverage a powerful one-two punch of engineering and law to thrive in the field of public finance. "It has just been tremendous to use the intellectual tools and hands-on experience that I got from McCormick in the field of law," says Sperry.

He continues to invest time and philanthropy to support McCormick's growth as a premier institution of higher learning. Sperry was chair of the Murphy Society Annual Fund for four years, and his law firm recently hosted a group of Northwestern alumni who interviewed 120 area high school seniors who have applied to the University. This pattern of involvement really began in 1975 when he met then-dean of admissions and financial aid Bill Ihlanfeldt.

"Bill started a network called the Alumni Admissions Council," says Sperry. "He initiated the idea of building up the awareness of alumni and giving them a significant role to play in the admissions process. And he made California a prime target." San Francisco was a key city for Ihlanfeldt's work, so Sperry found himself in a great position to help the McCormick School and the University.

"Bill had the right perception," he says. "If you can give alums a task to perform that makes them feel good about what they're doing for the institution, then you've got a meaningful partnership."

Over time Sperry's role as a McCormick alumnus has evolved from focusing on admissions to assisting in development. "It's always rewarding to talk to future Northwestern students, but I'm really interested right now in motivating other alumni to give back," he says. "For me, I don't feel obligated; I feel motivated to give back to the place that gave me so much."

The essence of management

Like Sperry, Bob Puette employs the engineering acumen that he cultivated at McCormick to succeed in an alternative career — actually, several alternative careers. In addition to serving as president of Puette Capital Management, he sits on the boards of six notable companies — in technology, real estate, and electrical contracting — and has a wide range of technical expertise from more than 20 years at Hewlett-Packard. He is also the former president of Apple Computer and was on the board of Cisco Systems for nine years.

The scope of Puette's virtuosity should not surprise anyone, considering the fact that he successfully juggled Division 1 football — playing on the 1962 team that was ranked No. 1 in the nation — and grueling engineering classes.

"In addition to learning some outstanding analytical tools while at McCormick, I found out early on that there's nothing like having a very disciplined schedule," says Puette. "Studying engineering and playing football left no free time, so I really learned to structure my schedule and to prioritize. There was no better place than Northwestern for that kind of training."

In addition, Puette lauds McCormick's commitment to simple, efficient thinking that removes extraneous impediments. "No matter what field you're in, you really need the analytical skills to make complex things simple," he says. "I always tell people that they'll get a big raise if they take complex things and make them simple. If they want to get a smaller raise — or no raise at all — then they can go around keeping complex things complex."

When preparing for an engineering final, Puette would often crystallize a semester's worth of notes into two pages. "That's

Bob Puette

the only thing I would do to prepare for the final," he says. "I'd work everything down to its very essence, and then I'd know it cold. I've continued this practice throughout my career, and it has been a very valuable tool."

In 1991 Puette gave the commencement address to McCormick graduates shortly after joining the McCormick Advisory Council. In addition, he was instrumental in the early expansion of the Murphy Society after former dean and personal friend Jerome Cohen tabbed him to lend his expertise to both entities. For several years Puette chaired the McCormick Advisory Council. "When Jerry asked me to help influence the curriculum and direction of McCormick, I jumped at the chance," he says.

Similarly, Puette is enthusiastic about helping Dean Julio Ottino wrestle with issues that will shape the future of McCormick, equipping the next generation of leaders. "I really understand the challenges that the deans face and how long it takes to accomplish certain goals based on my own personal experience as a manager," he says. "Every dean or manager has limited time to accomplish major objectives and, therefore, must be very effective in his or her role."

Puette is more than optimistic about what's on the horizon for McCormick, which is why he continues to actively support the University. "I really enjoy working with Julio," he says. "He has an exciting energy, and I think he's going to effect some real positive change at McCormick and for the engineering profession."

—Alex Runner

For more information about how you can support the McCormick School of Engineering and Applied Science, contact Roger Williams, Development Director, at r-williams7@northwestern.edu

Faculty honors

Annelise Barron, associate professor of chemical and biological engineering and of biomedical engineering, gave the Thiele Lecture in chemical engineering at the University of Notre Dame. She was also appointed to the committee on biomolecular materials and processes for the Nuclear Regulatory Commission.

Cate Brinson, Jerome B. Cohen Professor in Engineering, associate chair of the department of mechanical engineering, and professor of materials science and engineering, is serving on the National Academies' panel on benchmarking the research competitiveness of the United States in mechanical engineering.

Linda Broadbelt, associate professor of chemical and biological engineering, was appointed to the committee of visitors for the National Science Foundation (NSF).

Wei Chen, associate professor of mechanical engineering, received the Intelligent Optimal Design Prize at the 18th International Conference on Structural Mechanics in Reactor Technology.

Alok Choudhary, professor of electrical engineering and computer science, gave the keynote talk at the 2005 International Conference on Computers and Communications.

Pablo Durango-Cohen, assistant professor of civil and environmental engineering, received an NSF CAREER Award.

Bartosz Grzybowski, assistant professor of chemical and biological engineering, received an NSF CAREER Award and a 3M Nontenured Faculty Grant.

Kristian Hammond, professor of electrical engineering and computer science, and Intellext Inc. were honored with a 2005 Chicago Innovations Award for their Watson software.

Gordon Hazen, professor of industrial engineering and management sciences, received the 2004 Meritorious Service Award from the Institute for Operations Research and the Management Sciences (INFORMS).

Herbst LaZar Bell, the firm founded by **Walter Herbst,** adjunct professor of mechanical engineering, received six 2005 Good Design Awards from the Chicago Athenaeum.

Tito Homem-de-Mello, associate professor of industrial engineering and management sciences, received the 2004 Meritorious Service Award from INFORMS.

Wallace Hopp, Breed University Professor of Industrial Engineering and Management Sciences, was named a fellow of both the Manufacturing and Service Operations Management Society and the Production and Operations Management Society. He also won the Society of Manufacturing Engineers Education Award for 2006.

William Kath, professor of engineering sciences and applied mathematics, was named codirector of the Northwestern Institute on Complex Systems.

Raymond Krizek, Stanley F. Pepper Professor of Civil and Environmental Engineering, was selected the 2006 Karl Terzaghi Lecturer.

Harold Kung, professor of chemical and biological engineering, presented a plenary lecture on "Nanotechnology and Heterogeneous Catalysis" at the 13th Brazilian Congress on Catalysis. He was also elected a fellow of the American Association for the Advancement of Science.

Wing Kam Liu, Walter P. Murphy Professor of Mechanical Engineering and professor of civil engineering, is serving as chair of the executive committee of the American Society of Mechanical Engineers' applied mechanics division.

Seda Ogrenci Memik

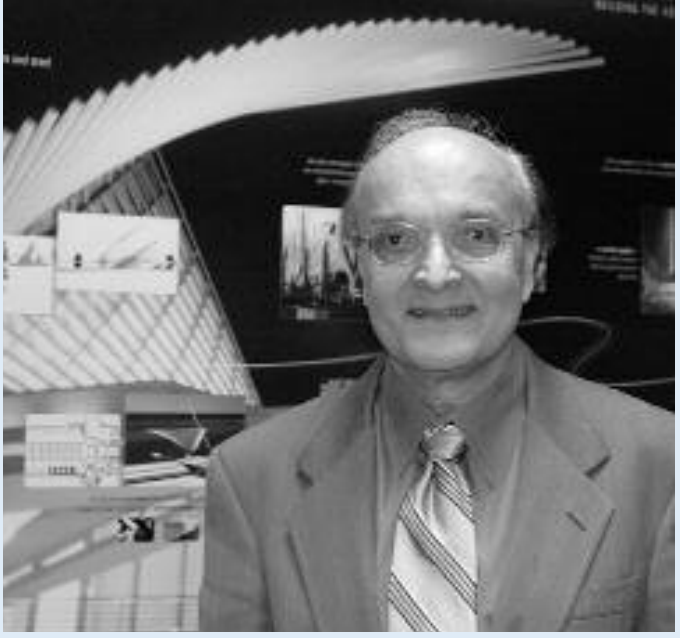
Sanjay Mehrotra, professor of industrial engineering and management sciences, was appointed director of the Optimization Technology Center, operated by Argonne National Laboratory and Northwestern University. He was elected vice president of INFORMS and vice chair of the INFORMS Optimization Society and received the INFORMS 2005 Moving Spirit Award.

Gokhan Memik, assistant professor of electrical engineering and computer science, received the 2005 Department of Energy Early Career Award in Mathematical, Informational, and Computational Sciences.

Seda Ogrenci Memik, assistant professor of electrical engineering and computer science, received an NSF CAREER Award.

Phillip Messersmith, associate professor of biomedical engineering and of materials science and engineering, was elected a fellow of the American Institute for Medical and Biological Engineering.

William Miller, professor of chemical and biological engineering, joined the newly established Scientific Advisory Board of the Stem Cell Network of Canada and was elected a fellow of the American Association for the Advancement of Science.



Shah elected to National Academy of Engineering

Surendra P. Shah, Walter P. Murphy Professor of Civil and Environmental Engineering and a noted expert in the fields of concrete materials and nondestructive testing, has been elected to the National Academy of Engineering, one of the highest honors that can be accorded an engineer.

Academy membership honors those who have made "outstanding contributions to engineering research, practice, or education, including, where appropriate, significant contributions to the engineering literature." Membership also rewards accomplishment in "the pioneering of new and developing fields of technology, making major advancements in traditional fields of engineering, or developing/implementing innovative approaches to engineering education."

Shah was cited for his work on advanced cement-based materials and for promoting interdisciplinary research and education on concrete materials. He has done pioneering research in fiber-reinforced concrete, high-performance concrete, and fracture mechanics of quasi-brittle materials. Shah's research involves connecting microscopic behavior to the structural response of concrete. Such bridging of scales is important in developing improved materials that are tougher, greener, and more durable. In addition, he has developed innovative nondestructive tools, such as Electronic Laser Speckle Interferometry and Digital Image Correlation, to detect fractures in concrete materials.

Shah's current research projects include hybrid fiber-reinforced cement-based composites; the interaction between microcracking and transport properties; monitoring in-situ properties of concrete at an early age using ultrasonic methods; computational models for fatigue fracture; utilization of waste material; and early-age cracking of high-performance concrete, self-compacting concrete, and extruded composites.

In addition to being director of the Center for Advanced Cement-Based Materials, Shah is affiliated with the University's Infrastructure Technology Institute, where his work has focused on nondestructive testing and evaluation of various properties of concrete, including ultrasonic testing of concrete strength.

Shah joined the Northwestern faculty in 1981. He has authored more than 400 publications and is coauthor of three books. A fellow of the American Concrete Institute, Shah is a member of the editorial boards of numerous journals and is currently editor in chief of the journal *Concrete Science and Engineering.*

Barry Nelson, professor of industrial engineering and management sciences, was named editor in chief of *Naval Research Logistics* and was elected a fellow of INFORMS.

Don Norman, professor of electrical engineering and computer science, received an honorary doctorate in industrial engineering from the rector of the Technical University of Delft in the Netherlands.

Julio Ottino, dean, Walter P. Murphy Professor of Chemical and Biological Engineering, and McCormick School Professor, is serving on the National Academies' panel on benchmarking the research competitiveness of the Unites States in chemical engineering. He delivered the Reilly Lectureship in Chemical and Biomolecular Engineering at the University of Notre Dame.

Thrasos Pappas, associate professor of electrical engineering and computer science, was elected a fellow of the Institute of Electrical and Electronics Engineers.

Mary Phillips, associate professor of electrical engineering and computer science, was selected McCormick Teacher of the Year by students and faculty.

Rodney Ruoff, professor of mechanical engineering, was named distinguished chair visiting professor at the SAINT-Sung Kyun Kwan University in Seoul, South Korea.

Samuel Stupp, Board of Trustees Professor of Materials Science, Chemistry, and Medicine, has been named to the "*Scientific American* 50," the magazine's annual list of leaders in science and technology.

Jay Walsh, senior associate dean and professor of biomedical engineering, was named Adviser of the Year by McCormick students and faculty.

William White, professor of industrial engineering and applied sciences, is the author of a new book, *From Day One: CEO Advice to Launch an Extraordinary Career,* geared to those seeking their first job or who want to manage their career for outstanding results.

1940s

Lester Crown ('46) is chairman of Henry Crown & Co. and a life trustee of Northwestern. His son A. Steven Crown is general partner of the company and is a charter trustee of the University.

1950s

Charles R. McBride ('55) of Wichita, Kansas, and his wife, Nancy, celebrated their 50th wedding anniversary in March with a surprise reception hosted by their four children and their spouses and 15 grandchildren. McBride retired from IBM in 1987 after 32 years in marketing.
Jonah Z. Lavi (MS '57) of Ramat Gan, Israel, is a manager at Computer Based Systems Engineering Associates and cowrote *Systems Modeling and Requirements Specification Using ECSAM: An Analysis Method for Embedded and Computer-based Systems* (Dorset House Publishing, 2005). He is lead developer of the embedded computer systems analysis and modeling method and consults and teaches industrial and university courses.
Robert M. Handy (MS '58, PhD '62) of Gilbert, Arizona, retired from Motorola in 1998 and found a new vocation as a church organist. He also works as a patent attorney. He and his wife, Niecie, spent a year as service missionaries, teaching English at Qingdao University in China's Shandong Province.

What's happening in your life?

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

1960s

Ralph E. Beedle ('61), a retired Navy captain, is among five Granite City (Illinois) High School alumni who were inducted into the school's Wall of Fame.
Donn Armstrong ('62), a scientist formerly with Argonne National Laboratory, is a cofounder of Lockport, Illinois–based International Titanium Powder Inc. He was featured in an article in *Crain's Chicago Business* about the start-up's seeking capital funding to build a pilot production plant.
John A. "Jack" Blaeser ('64), former CEO of Concord Communications, has joined the board of directors of Qovia Inc., an enterprise IP telephone management company.
Stephen P. Fox ('64) retired in October 2005 from his position as vice president and deputy general counsel for intellectual property at Hewlett-Packard.
Lee A. Dayton Sr. ('65) was named a director of software company Open-Xchange.
Leonard "Len" Elliott Jr. ('65) of Auburn, Washington, competed in the 28th Annual American Crossword Puzzle Tournament in Stamford, Connecticut, in March 2005. He placed third in his skill division, fourth in his age group, and 38th overall among the 456 competitors. His wife, Linda Beia Elliott (Music '65), retired in June after teaching elementary school music for 30 years.
Lawrence E. Stanfel (MS '65, PhD '66) was named vice president of VoIP technology and operations at New Global Telecom, based in Golden, Colorado.
Phillip L. Gould (MS '66), a civil engineering professor at Washington University in St. Louis, was appointed by Missouri Governor Matt Blunt to the state's Seismic Safety Commission.
Joseph B. Adeyeri (MS '69) of Akungba-Akoko, Ondo State, Nigeria, established an engineering program at Adekunle Ajasin University, where he is a professor.

1970s

Justin Zivin (MS '70) is a professor of neuroscience at the University of California, San Diego. He was featured in a *Wall Street Journal* article in which he commented on the new study of neuro-intensive care to heal the brains of stroke patients.
Fred Krumberger ('72) launched Performance Sciences LLC, a strategic management consulting company based in Ashwaubenon, Wisconsin.
Promod Haque (MS '74, PhD '76), managing partner of Norwest Venture Partners, was featured in an article in the *Wall Street Journal* about the burgeoning technology industry in India.
Mark R. Norman (MS '75), director of the technical activities division of the Transportation Research Board, has been elected to the board of directors of the Institute of Transportation Engineering International.
Maureen Grzelakowski ('76, MS '79, Kellogg '88) was appointed director of Broadcom Corporation.
Michael Corcoran ('78, MS '02) of Schaumburg, Illinois, became vice president of operations at Worknet Inc. in Naperville in September 2004. The firm provides managed information technology and network consulting services.
Thomas J. Riordan ('78), became executive vice president and chief operating officer of SPX Corporation in December 2004.
Anibal Taboas (MS '78), a senior executive in the U.S. Department of Energy, was named a 2004–05 fellow by the American Society of Mechanical Engineers.
Naras Eechambadi (MS '79) is CEO of the marketing and technology services company Quaero.

1980s

Michael T. McCormick ('82) has joined law firm Dorsey & Whitney LLP as a partner in the corporate group, focusing on corporate transactions and counseling for U.S. and foreign-owned companies.
Ben Slivka ('82, '82, MS '85) and his wife, Lisa (Weinberg '85), were featured in an article about members of Social Venture Partners, a group that involves people in the high-tech industry in philanthropy.
William P. Schonberg (MS '83) of Rolla, Missouri, is professor and chair of the department of civil, architectural, and environmental engineering at the University of Missouri–Rolla. He was named a fellow of the American Society of Mechanical Engineers in April 2005. His research contributed to the development of kinetic energy weapons, insensitive munitions, aging aircraft, and space orbital debris protection systems. He also received the Charles Sharpe Beecher Prize from the United Kingdom's Institution of Mechanical Engineers in 2000.
Edward H. Belanger Jr. ('84) of Dallas became managing principal at American Appraisal Associates in December 2004. He heads the firm's business-valuation practice for the Southwest region.
Lawrence Rusinko ('84, Kellogg '89) was hired by Rubio's Restaurants Inc. as vice president of marketing.

Julia Weertman ('78, DDS '82) has been an integral part of Illinois Vest-a-Dog, a nonprofit group that provides bullet- and stab-resistant vests for police dogs. Thanks to the efforts of the group, all 55 Chicago Police Department dogs are now protected with bulletproof vests. Pictured are Chicago Police Department Superintendent Philip Cline, Dr. Weertman, Officer Lee Boivin, and Bullet, the fourth dog vested by Dr. Weertman.

James N. White ('85), managing partner of Sutter Hill Ventures, joined the board of Right Hemisphere, a product graphics management software company.
Joe Girardi ('86) is the manager of the Florida Marlins major league baseball team.
Jeffrey J. Vaitekunas ('88) is the chief biophysicist at Omnisonics Medical Technologies Inc. in Massachusetts and was recently appointed to the company's senior management team.
Randolph "Randy" Hood ('89), married Julie Kathleen Huff on October 1, 2005.

1990s

Daniel Bredy ('90) recently married Freda Washington.
John J. Frieders ('90) of New York City married Kimberly Fairfield in May 2004. He was promoted to business development manager at Turner Logistics in July 2004.
Matthew B. McCall (Kellogg '91, MEM, Kellogg '92), managing director of early-stage venture capital firm Draper Fisher Jurveston Portage in Northfield, Illinois, was featured in an article about the promise of technology investments in the Chicago area. McCall backed **Jamie Crouthamel**'s (MEM, Kellogg '92) business, Performics, and is currently an investor in Feedburner, a local startup that builds RSS (Real Simple Syndication) technology tools.
Ravindra Gettu (PhD '92) of Chennai, India, is professor of civil engineering at the Indian Institute of Technology Madras in Chennai.
Robert Nowakowski ('92) of Carlsbad, California, is a staff engineer at QUALCOMM Inc. A lieutenant commander in the U.S. Naval Reserve, he was promoted to executive officer of the Military Sealift Command Expeditionary Port Unit in Point Loma.
James Brailean (PhD '93) is the CEO of PacketVideo, which is providing technology for Verizon Wireless's V CAST Music Service.
Gupreet Singh ('93, MS '94, Kellogg '03) was named partner in global management consulting firm DiamondCluster International's financial services practice.
Mark W. Anderson (MEM, Kellogg '94) was appointed president and chief operating officer of Pro Mach Inc., a packing company.
Rita Smith Beckford ('94) of Aurora, Ohio, is a board-certified family doctor. She produced the fitness and wellness video *Home with Dr. B* and is a certified group fitness instructor and personal trainer. Beckford conducts exercise programs at medical clinics, community centers, and churches.
Monique McRipley Ollie (MS '94, PhD '99) of Newark, New Jersey, is a managing consultant in the business consulting services group at IBM. She specializes in life sciences.
David Thomsen ('94) of Palo Alto, California, is a product designer at IDEO Product Development. He earned a master's degree in product design engineering at Stanford University in June 2004. In summer 2004 he worked at NBC Sports in Athens, creating online coverage of the Summer Olympic Games.
Richard Chino (MEM, Kellogg '95) was named chief revenue officer of global operations at Smarter.com, based in Monrovia, California.
Patrick S. Jensen ('95, PhD '97) was appointed executive vice president of engineering at Integrated Healthcare Systems Inc., a pharmacy technology company based in Seattle.
Anindya Bakrie ('96), head of Bakrie Telecom and the Indonesian national television network ANTV — both divisions of his family's Bakrie Group — has been included in an article about Indonesian companies' challenges with corruption.
Daryl R. Morey ('96) is the Boston Celtics' senior vice president for operations and information and is teaching the first course on sports management at the Massachusetts Institute of Technology.
Sailesh K. Patel ('96) was elected partner in the intellectual property group at Chicago law firm Schiff Hardin LLP.
Duane Hong ('97) of Chicago became vice president of Wi-Tronix in Bolingbrook, where he is responsible for key projects such as embedded systems deployment and implementation of advanced data acquisition technologies.
Michael Montero ('97) of Oakland, California, an independent consultant, is working on a book based on his doctoral research. He earned his doctorate in mechanical engineering at the University of California, Berkeley, in 2004. He enjoys writing, art, snowboarding, and traveling.
Stephane Bordas (MS '99, PhD '04) of Chavannes-pres-Renens, Switzerland, is a research associate with the Swiss Federal Institute of Technology in Lausanne, where he works on research and development of computational mechanics code. He and his wife, Laurelle, have a baby daughter, Iphigenie.

Eric M. Falker ('99) of Houghton Lake, Michigan, married Katja Schwarz in May 2003.

John Nix and **Larry Spear** (both MEM, Kellogg '99), cofounders of technology company Go2Call.com, received a Best Bosses award from Winning Workplaces and *Fortune Small Business* magazine.

Patrick R. O'Hern ('99, Kellogg '04) married Karen A. Bartlett (Communication '02) of Winnetka, Illinois, in July 2004.

Daniel M. Relles ('99) married Dina Rachelle Lucas in July 2005.

2000s

Douglas Williams ('00) of Stanford, California, attends Stanford Graduate School of Business.

Debra Hand (MS '01) of Flossmoor, Illinois, is an award-winning artist who creates paintings, sculptures, stringed instruments, and vessels. The Smithsonian Anacostia Museum and Center for African American History and Culture selected her *Mello Cello* for its permanent collection in February 2005. In 2002 she received a Black Excellence Award from the African American Arts Alliance of Chicago.

Richard "Rick" Armbrust ('03), product manager of ISMP for MSN Information Services, was included in an article about Microsoft's efforts to recruit new young employees and reinvent its corporate image.

Jay Goyal ('03) has declared his candidacy for the Ohio House of Representatives. He is the first Democrat to enter the race for a seat that will be vacated at the end of 2006.

Jeffrey Albert ('04) married **Erin Kupres** ('04) in July 2005. He is a second year medical student at Vanderbilt University School of Medicine. She is a clinical research coordinator at Nashville Medical Research Institute.

Ori Sivan (MS '05) was featured in the *Chicago Tribune* as co-owner of Greenmaker, a Chicago building supply company that sells environmentally friendly materials.

Xiadong Xu (PhD '05), a quantitative research analyst, works in Deutsche Management Quantitative Strategies Group's Research Center in New York.

In memoriam

Melvin E. Remus, '33
Bruce Warren, '33, MS '34
George Pagels Jr., '34
John L. Dahlquist, '36
Earl R. Klinge, '38
Michael N. Salgo, '38
Curzio Paesani, '44
Jack A. Bono, '46
Richard C. Brown, '46
Richard C. Herchenrider, '46
John R. Long, '47
Wendell L. Perkins, '47
Jack A. Selsemeyer, '48
Thomas E. Smith, '48
James H. Bankey, '49
William N. Dunlap Jr., '49
Charles S. Houha, '49
John W. Padgitt, '49
Paul J. Bodine Jr., '50
James T. Evans, '51
Richard W. Walker '52
George C. Cox, '53
Robert K. White, '53
Marvin Glaser, '54
Kenneth L. Guenther, '56
Earl E. Waller, '56
Arthur Marion Schulz, '59
Donald A. Mnichowicz, '62
John W. Kolet, '64
Everett C. Carter, '69
Moon Jung Chung, '81

The 2006 Career Day for Girls committee: (top row, from left) Shannon Binder; Ellen Worsdall, assistant dean for undergraduate education; Sharla Rent; Liz Abrahamson; Sara Salahi; (bottom row, from left) Annalee Embry, Kelly Luckasevic, Liz Hohl, and Jennifer Breger

Electrical engineering major **John Velez** ('06) wrestles with a busy but exciting schedule

Why did you choose Northwestern?
Northwestern was the most intriguing school that I applied to. I wanted to wrestle and study engineering and be close to a big city. I met with Professor [Allen] Taflove, and he inspired me to be a great engineer, and I met with my coach, and he inspired me to be a great wrestler. Everyone I met gave me the feeling that I would have the ability to grow a lot here.

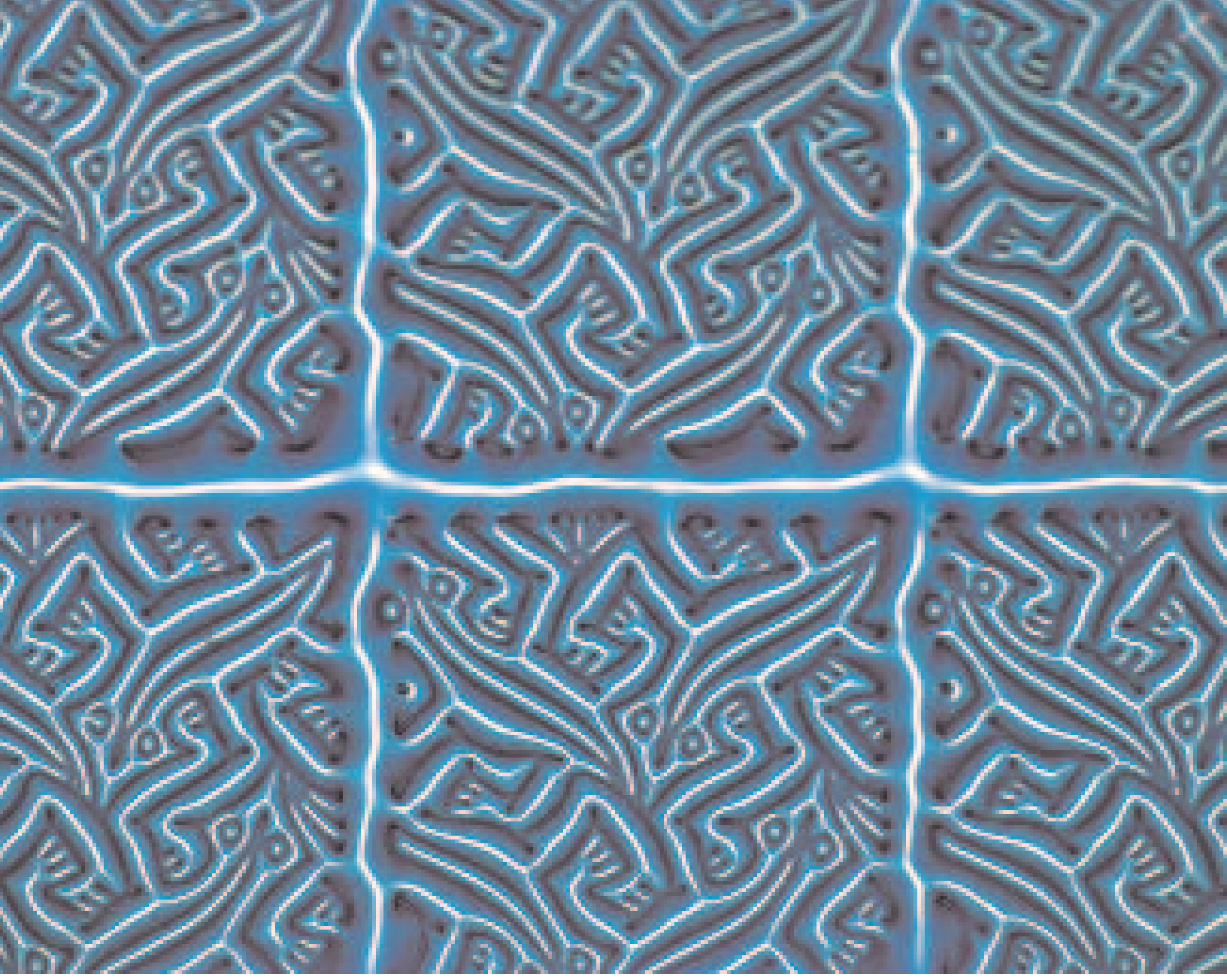
You're a nationally ranked wrestler for Northwestern. How do you balance your academic requirements with training and competitions?
Some days I just had to hold on, other days I tried to get ahead. I had a really hard freshman year, but each year got a little bit easier for me. It's not easy, but if you have the desire, it's certainly achievable. It's something I really wanted to do. I could have given up engineering or I could have given up wrestling, but they were both important to me.

You served as president of the Society of Hispanic Professional Engineers (SHPE). What was the highlight of your involvement with the group?
The real highlight of SHPE is that you get to meet a lot of people on an in-depth level. I have relationships where I may not see people for a month or two, but then I run into them and we're able to go right into a conversation about what they're doing with their lives. The group unifies different engineering students with varying backgrounds and provides a sense of community.

You had a great internship abroad. How did that happen?
I went to Puerto Rico and worked at Cordis, a medical device company owned by Johnson & Johnson. It was a great experience. It's interesting because the work is done in English, but the workers all speak Spanish to one another. There are a lot of communication barriers — sometimes what they think they're saying in Spanish or English gets a little blurred. I found that all the different cultures brought different ideas to the brainstorming sessions. The best part about it was that it was a great avenue for me to learn a lot about my culture.

What research projects have you worked on?
After my freshman year I did a project with the Materials Research Center working on solid oxide fuel cells. More recently I worked on a project through a GM grant that involves cars using wireless technology to predict traffic conditions. Basically, we tried to create mobile nodes that would communicate with each other, so one car could relay traffic conditions to another 10 miles behind it.

You've been very busy at Northwestern. What was the benefit?
I think you should try to go out and do a lot of things. It would be easy to focus on just your academics, but you learn so much more from getting involved. SHPE gave me a lot of opportunities to make presentations to large groups; now I'm going into technical sales, and that experience was invaluable. Wrestling helped me with my leadership skills. The research I did helped me land internships and a job. Everything I did helped lead to the next thing. As you do more, you find that you're more marketable as an individual.



Art or science? **Which story in the magazine relates to this image?**
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While you're there,
check out the latest
McCormick news and events,
discover new **faculty research,**
or take a **video tour** of McCormick.

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