

Industrial Engineering and Management Sciences

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

FALL 2012

McCormick Welcomes Master of Science in Analytics Students

After years of vision and planning by IEMS faculty and staff, McCormick welcomed an outstanding inaugural class of Master of Science in Analytics (MSiA) students with a launch party on September 26.

Thirty-two highly qualified students enrolled in the MSiA program, a unique analytics program housed in the Department of Industrial Engineering and Management Sciences. Organizers originally planned to start slowly, enrolling just 15 students in the first year, but they were so impressed by the caliber of the applicants that they accepted the program's full capacity.

A featured guest at the MSiA launch party was Brenda Dietrich, an IBM fellow and vice president and chief technology officer for business analytics in the IBM Software Group.



McCormick Dean Julio M. Ottino gave welcoming remarks during the event in the Ford Motor Company Engineering Design Center.

"The distinguishing feature of the 21st century is data, data, and more data," Ottino said. "But more data doesn't necessarily translate to more knowledge. You have to make the data speak, and that's why I'm excited about this program."

As more businesses have begun looking to big data to study their customer base and optimize processes, the marketplace has experienced an overwhelming demand for analytics experts. McCormick's MSiA program will provide that expertise, teaching students to identify patterns and trends; interpret and gain insight from vast quantities of data; and communicate their findings in practical, useful terms.

"We conceived this program because we recognized that there aren't enough trained individuals in this rapidly growing field," said Diego Klabjan, professor of industrial engineering and management sciences and director of the MSiA program. "This is a top-notch, elite program, and we have a talented and enthusiastic group of students to work with."

Students in the inaugural MSiA class have work experience ranging from investment banking to business analysis to information technology and hold degrees from

continued on page 11



Above, from left to right, MSiA Program Director Diego Klabjan, IBM's Brenda Dietrich, and McCormick Dean Julio M. Ottino. Below and at left, students in the inaugural MSiA class enjoy a reception following their program's launch party on September 26.

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"The distinguishing feature of the 21st century is data, data, and more data, but more data doesn't necessarily translate to more knowledge. You have to make the data speak, and that's why I'm excited about this program."

Dean Julio M. Ottino

Letter from the Chair

When I joined IEMS in the summer of 1995, we thought a lot about the economics of engineering, but nothing about “financial engineering.” No one put the two words “humanitarian” and “logistics” together, nor had anyone ever heard of “analytics.” And “health care operations” was a dead field for industrial engineers. Today each of these is a core teaching and research area for IEMS with very high levels of activity. Things change, and great universities evolve.

Recently former IEMS financial engineering PhD student **Liming Feng** received promotion and tenure at the University of Illinois, which is a good benchmark for the maturity of our financial engineering program. We have a suite of well-attended classes at the undergraduate and graduate levels, and our students obtain jobs in the financial industry and academia. Pricing is still a core topic, but risk measurement and management have emerged as being equally important. Find out more about all our financial engineering activities at fe.mccormick.northwestern.edu.

Our research efforts in humanitarian logistics are now gaining traction and recognition. For instance, last November Associate Professor **Karen Smilowitz** was part of an elite panel on “Social Media in Emergency Management: Transforming the Response Enterprise” at the Woodrow Wilson International Center for Scholars in Washington, D.C. You can view an archive of the webcast on our Humanitarian Logistics website, hl.mccormick.northwestern.edu. It is well worth your time.

The demand for analytics professionals, and our own belief that operations research and analytics form a perfect marriage, has led to the creation of our newest program, the Master of Science in Analytics (MSiA). We designed MSiA to be a highly selective program, so our

business plan anticipated finding only 15 qualified students the first year, ramping up slowly to a target of 30 per year in steady state. Instead, Program Director **Diego Klabjan** welcomed an incoming class of over 30 exceptional students this fall who were selected from a large, diverse, and deep applicant pool. Complete information about MSiA is at www.analytics.northwestern.edu.

Our nation’s desire for more personalized and proactive medical treatment, elimination of mistakes, and effective health care policy, all in the face of significant cost constraints, has energized the field of health care engineering like never before. IEMS has had a teaching and research presence in health care for some time, but this fall the McCormick School of Engineering and the Feinberg School of Medicine will announce the formation of a major new center for health care engineering research with Professor **Sanjay Mehrotra** as co-director. To support this endeavor, IEMS will be searching for a new faculty member to start in fall 2013 (see job announcement on page 11).

I have always been proud of our leadership roles at Northwestern. New positions include Associate Professor **Bruce Ankenman** becoming co-director of McCormick’s Segal Design Institute—the center of gravity for design activities throughout Northwestern—and Senior Lecturer **Mark Werwath** joining the IEMS faculty full time as director of our Master of Engineering Management program and associate director of the Farley Center for Entrepreneurship and Innovation, which **Mike Marasco** directs.

I have been very fortunate to work with a creative and active Alumni Advisory Board, led by Board President **Craig Asher**. Among the many things they do for us is hosting an annual spring



IEMS Chair Barry L. Nelson

workshop for IEMS students. Last year’s topic, “Making the Most of Your Engineering Degree: A Frank Discussion with IEMS Alumni from Diverse Professional Backgrounds,” included presentations and a panel discussion by Craig, **Tom Brody**, **Shail Godambe**, **Sania Irwin**, **Saba Jaffrey**, **Rajesh Oza**, **Ken Porrello**, and Professor **Bill White**. This well-attended event did a wonderful job of showcasing the plethora of career paths open to industrial engineers.

You will find a full listing of honors and awards on page 3, but a few milestones deserve special mention. Our *U.S. News & World Report* rankings improved to third at the graduate level and seventh at the undergraduate level. Paul Leonardi was promoted to associate professor with tenure, and Diego was promoted to full professor. Paul was also appointed to the Pentair-Nugent Professorship in Manufacturing and Irina Dolinskaya was awarded the William A. Patterson Junior Professorship in Transportation. Finally, we reluctantly accepted the retirement of Professor Bob Fourer after 33 years in IEMS. My retirement address (roast?) can be found on page 10.

Barry L. Nelson
Walter P. Murphy Professor and Chair

2011-12 Gifts to the Department

IEMS is extremely grateful for the generous donations we continue to receive from our private and corporate donors. Below is a list of contributions received from September 1, 2011, through August 31, 2012. Each dollar is used to support the academic, administrative, and research endeavors of our department. Please accept this acknowledgment as our deepest appreciation.

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Department News



Dr. Margaret Brandeau of Stanford University presents IEMS's first Wasserstrom Family Distinguished Lecture Series on May 1.

Wasserstrom Family Distinguished Lecture Series Launched

Dr. Margaret Brandeau of Stanford University launched IEMS's Wasserstrom Family Distinguished Lecture Series on May 1 with her talk, "Operations Research and Public Health: A Little Help Can Go a Long Way." The talk was co-sponsored by the Segal Design Institute and discussed examples of model-based analysis of public health policy questions. This new lecture series was made possible through a generous endowment from the Wasserstrom family.

Faculty Receives Sponsored Awards

IEMS received a number of new sponsored awards. Noshir Contractor received two awards from the National Science Foundation (NSF): "RAPID: Collaborative Research: 3dWomen: Exploring Three Decades of Women's Groups in Sustainable Development and the Impact of Social Media on Women's Professional Networks" and "Collaborative Research: FLASH! Fueling Learning Alliances in Sustainability for Higher Education Using Social Media to Create Knowledge Networks in Sustainability." He also received the National Center for Research Resources award for "CTSA Social Network Analysis: Legacy Resources, Research, and Training."

Diego Klabjan received an NSF award for his project "GOALI: Portfolio of Renewable Energy Generation." Sanjay Mehrotra received an award from the Agency for Healthcare Research and Quality titled "Geographic Inequities in Kidney Transplantation: Investigating Possible Solutions" and a second from the Office for Naval Research titled "Algorithms for Mixed Integer and Stochastic Optimization."

Two awards were also received through IEMS's Optimization Technology Center. NSF awarded Jorge Nocedal for "Collaborative Research: Methods for Stochastic and Nonlinear Optimization" and Andreas Wächter for "Novel Algorithms for Nonlinear Optimization."

Mark Werwath Named Director of MEM Program

In July IEMS hired Mark Werwath as a clinical associate professor and director of the Master of Engineering Management (MEM) program, IEMS's master's program for working engineering professionals. Werwath — an MEM graduate himself — brings a rich background of project/process management and 25 years of new product development experience to the classroom. In addition to his directorship role, Werwath will teach IEMS 325 Engineering Entrepreneurship, IEMS 393 Industrial Engineering Design Project, IEMS 426 Project Management, and IEMS 490 Management of Technology.



Faculty and Student Awards

Bruce Ankenman received the 2012 Charles Deering McCormick Professor of Teaching Excellence Award, an honor that recognizes faculty across Northwestern for superior classroom teaching abilities.



Irina Dolinskaya has been appointed to the William A. Patterson Junior Chair in Transportation for 2012-2015.

Bob ("Fantastic") Fourer has been awarded the 2012 INFORMS Impact Prize for his work in algebraic modeling languages.



Paul Leonardi has been appointed to the Pentair-Nugent Professorship in Manufacturing for 2012-2015.

Leonardi also received the Young Scholar Award from the International Communication Association and the Ascendant Scholar Award from the Western Academy of Management. He also garnered the Article of the Year Award from the Organizational Communication Division of the National Communication Association, and the Best Published Paper Award and Best Conference Paper Award from the Organizational Communication and Information Systems Division of the Academy of Management.

Barry Nelson delivered the Omega Rho Distinguished Lecture at the annual meeting of the Institute for Operations Research and the Management Sciences.

Jorge Nocedal has received the 2012 SIAM Dantzig Prize, a prize awarded every three years to recognize outstanding original research in mathematical optimization.

Ajit Tamhane has been selected to receive the Distinguished Service Award for 2011 from IIT Bombay.

PhD student **Luis de la Torre** was named the 2011 Student of the Year by the Center for Commercialization of Innovative Transportation Technology.

PhD graduates **Hai Lan** and **Jonathan Turner** were co-recipients of the 4th George L. Nemhauser Dissertation Prize.

Bill (Chan Seng) Pun received the Outstanding Teaching Assistant Award for the 2011-12 academic year.

First-year PhD students **Likuan Qin** and **Aaron Schechter** received, respectively, the IEMS Financial Engineering PhD Award and the Harold Richards Graduate Fellowship in the area of organizational theory and systems analysis.

First-year PhD student **Samuel Ellis** received both a National Consortium for Graduate Degrees for Minorities in Engineering and Science (GEM) Fellowship and National Science Foundation Graduate Research Fellowship.

Five undergraduate students received Academic Excellence Awards in the 2011-12 academic year: **Yingnan Nancy Xu, Chengchun Thomas Gao, Alexander Huang, Maxime Ollivier, and Julie Sharp**.

Undergraduate student **Yingnan Nancy Xu** was awarded the Arthur P. Hurter Award for Outstanding Industrial Engineering and Management Sciences Graduating Senior at the Senior Ceremony in June.

Eight undergraduate students were chosen by IEMS faculty to receive the Charles Thompson Senior Design Award for best team project: **Alexander Huang, Alex Ma, Sara Schmidt, Yingnan Nancy Xu, Brandon Zhang, Svetlana Fedorikhina, Molly Hennessy, and Andie Schroeder**.

Undergraduate student **Adam Evans** was selected by IEMS students to receive the Senior Leadership Award.

Seniors **Noah Kimmel** and **Ji Hun Lee** received the IEMS Department Awards. The award recognizes excellence in academics, leadership, or other contributions to the department as nominated by the faculty.

Letter from the Assistant Chair

I am one of the lucky ones. In an economy in which so many people are working jobs simply because they need a paycheck, I am privileged to have a job that I truly love. I get to spend my days with the students I am passionate about helping, dreaming up ideas that I am passionate about implementing. Even better, I work with world-class faculty who are equally passionate about providing a quality undergraduate experience for Northwestern students and about preparing them for twenty-first century careers.

Much of last year (my first year) at Northwestern was spent orienting myself—understanding how IEMS, McCormick, and Northwestern function—and identifying areas for improvement. Because I follow undergraduate chairs who have invested a great deal of time in developing a high-quality curriculum, most of the changes implemented in my first year amounted to low-level process improvements, such as standardizing advising sign-up and formalizing waitlist requests. Beyond that, I spent a great deal of time listening to students and trying to understand what is and is not working well from their perspective.

One of the resounding messages that I have heard from students is that they desire to be part of an IEMS community. Beyond just being part of the same department or taking a few classes together, they want to be part of something bigger and join together to contribute to their department, their school, their university, and their community. So this will be my mission in the coming academic year: to foster deeper connections between students and faculty by encouraging and nurturing more meaningful advising relationships; to build community among students by growing our student Institute of



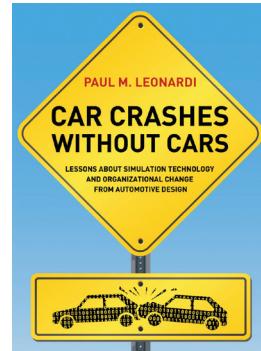
Assistant Chair Jill Hardin Wilson

Industrial Engineers (IIE) chapter; and to develop student networks by connecting them with IEMS alumni. Leading the charge is a dynamic group of new officers for our student IIE chapter. They are passionate about this vision of community and have already been brainstorming ideas for building it.

Building a stronger community in which students feel they can readily share their ideas is a good place to start. I look forward to a second year with IEMS, during which I can watch our students grow, our community benefit, and our department mission strengthen.

Jill Wilson
Assistant Department Chair for Undergraduate Studies

Faculty Publications



Car Crashes without Cars: Lessons about Simulation Technology and Organizational Change from Automotive Design
by Paul Leonardi

Every workday we wrestle with cumbersome and unintuitive technologies. Our response is usually, “That’s just the way it is.” Even technology designers and workplace managers believe that certain technological changes are inevitable and that they will bring specific, unavoidable organizational changes. In this book, Paul Leonardi offers a new conceptual framework for understanding why technologies and organizations change as they do and why people think those changes had to occur as they did. He argues that technologies and the organizations in which they are developed and used are not separate entities; rather, they are made up of the same building blocks: social agency and material agency. Over time, social agency and material agency become imbricated — gradually interlocked — in ways that produce some changes we call “technological” and others we call “organizational.”

Drawing on a detailed field study of engineers at a U.S. auto company, Leonardi shows that as the engineers developed and used a new computer-based simulation technology for automotive design, they chose to change how their work was organized, which

then brought new changes to the technology. Each imbrication of the social and the material obscured the actors’ previous choices, making the resulting technological and organizational structures appear as if they were inevitable. Leonardi suggests that treating organizing as a process of socio-material imbrication allows us to recognize and act on the flexibility of information technologies and to create more effective work organizations.

Foundations and Methods of Stochastic Simulation: A First Course
by Barry L. Nelson

Developed for the IEMS 435 course, *Foundations and Methods of Stochastic Simulation* is a first course in computer simulation for PhD students. The book found its genesis when Dr. Nelson and a student created a homegrown code to address a modeling and simulation problem. In its final state, the book covers modeling, programming, experiment design and the underlying mathematical theory of simulation.

The objectives of the book are:

- To prepare students who have never had a discrete-event, stochastic simulation course to build simulations in a lower-level programming language.
- To prepare students to use simulation in their non-simulation research.
- To prepare students to go into an advanced course on simulation methodology, including independent studies directed by their advisers.
- To provide a solid mathematical/statistical grounding in simulation, and some (but not all) tools to solve actual problems.

The book will be published by Springer-Verlag in January 2013. Software supporting the book is provided in VBA, Java, and Matlab. A distinguishing feature is a chapter on using simulation in research.

Charles Thompson: A Vernacular Version of Vita

Charles W. N. Thompson's curriculum vitae is one you might expect from a respected engineer/attorney/consultant whose career spans nearly seven decades. The 28-page resume documents a diverse education — law degree from Harvard, MBA from Ohio State, and PhD from Northwestern — and a varied career, from Air Force engineer to business consultant to a 40-plus-year professorship in McCormick's Department of Industrial Engineering and Management Sciences.

Then there's Thompson's "Vernacular Version of Vita," a one-page summary he wrote to highlight his less highfalutin accomplishments.

"Got kicked out of kindergarten," the list begins.

Thompson takes great pride in relaying the rabble-rousing tales of his youth — and the rabble-rousing tales of his adulthood. He says he was wrongfully kicked out of college in the early '40s for lighting a fire in a dorm room; school officials let him back in when his classmates signed a petition on his behalf. (He maintains that he didn't start the fire, though he admits to several other indiscretions in his early adulthood.) After serving in World War II he attended graduate school, where, he says, he "majored in gin rummy, bridge, and poker." His professional life sounds equally intriguing: he worked as a spy and as a criminal attorney before starting an illustrious career in engineering.

Then again, it's hard to know what to believe.

"I'm a storyteller," says Thompson.

Luckily, Thompson's engineering skills are well documented. From his early childhood Thompson was expected to become a lawyer — "I was scheduled to go to law school when I was three years of age," he says —

"One of the advantages of being old is that a whole lot of people you know are dead. They can't defend themselves." *Charles Thompson*

but service in the Air Force during World War II put him on a new course to becoming an industrial engineer. After the war ended he graduated from law school, but he was recalled to active duty just a year later with the Strategic Air Command, where he spent nearly two years as a strike team member. It was the early 1950s, and World War II had sparked great organizational advances in the fields of operations research, systems engineering, and counter-measures. Still, he and his team faced great inefficiencies and a serious lack of equipment.

"These aircrafts would land and instead of going to the taxi strip, they would stop at the end of the runway," Thompson recalls. "People would run out, take the antennas off the plane, then run over to another plane and put the antennas on so it could take off."

These problems prompted General Curtis E. LeMay to send Thompson and three other men to Wright-Patterson Air Force Base in Dayton, Ohio, where they were charged with accelerating the procurement process. Once his military commitment ended, Thompson stayed on as a civilian; in total, he remained at the base for six years and was promoted to the title of "section chief."

"I made major changes in system procurement," recalls Thompson. "Some of my most important work was accomplished at Wright Field."



Charles Thompson

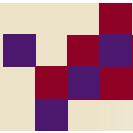
After 12 years working in industry, Thompson moved on to academia. He received his PhD from Northwestern and accepted a faculty position shortly thereafter. But the McCormick that Thompson joined in the 1960s bears little resemblance to the McCormick of today. Notably, he says, women were scarce among both faculty and PhD students, something that was characteristic of the time but troubling to Thompson. He says he has worked to improve those numbers. Throughout his career, nearly half his PhD candidates have been women; at one point, he says, a National Science Foundation researcher said he was among the top engineering professors in the country in terms of the number of female PhDs he had produced.

Thompson's contributions to his department have been noteworthy. Barry Nelson, IEMS chair, calls Thompson a "pioneer" in "field research methods" — the process of improving organizations and systems by observing and surveying them, rather than running experiments on them.

"How does one remain active and relevant over such a long career? By doing many things, and also being willing to try something new," says Nelson. "Charles has been a researcher; he has taught at all levels, from undergraduate to graduate to professional masters; he has continued to develop new courses; and he has been active in the business of the University."

Thompson continues to teach, even introducing new or radically changing courses; four years ago, he introduced Methods, Standards and Work Design (IEMS 210) to teach students the foundations of the industrial engineering practice. He is especially revered for his Systems Project Management course (IEMS 392), a class in which students apply project management methods to a real-world system. Outside the classroom, he continues to serve as secretary at McCormick faculty meetings. And he continues to relay stories, from the earliest days of the IEMS department to the 1,000 hours he logged on an RB-36 strategic reconnaissance aircraft during the Korean War.

"One of the advantages of being old is that a whole lot of people you know are dead," Thompson said, "They can't defend themselves."



IEMS 2012 Graduation

Hundreds of purple-robed undergraduate students, master's students, and PhD candidates graduated from the McCormick School of Engineering on June 15 and 16 as part of a sunny and warm weekend of Commencement festivities. The graduation ceremonies began at Ryan Field Friday morning with Northwestern University's 154th Commencement, which featured a speech by Paul Farmer, a physician, anthropologist, and Harvard professor known for his pioneering work in global health, particularly in Haiti.

In the 2011-12 academic year, IEMS graduated 12 PhD students: Kenan Arifoglu, Xi Chen, Steven Goldbeck, Jian Hu, Kuo-ling Huang, Neda Ebrahim Khanjari, Soonhui Lee, Lingfei Li, Linlin Li, Luis Chavez Bedoya Mercado, Yunpeng Sun, and Mengxiao Zhu. These graduates went on to academic and industry positions at places like Google, the University of Washington, the Chinese University of Hong Kong, and Johns Hopkins University.



IEMS 2012 Senior Ceremony

On June 15, nearly 100 IEMS undergraduate students and their families celebrated graduation at the IEMS 2012 Senior Ceremony. In tribute to the graduating class, the event highlighted special student awards and achievements, and provided time for students, faculty, and family to connect.



Engineering Medicine: New Collaborations at the Boundaries of Discipline



Daniela Ladner, assistant professor of surgery at the Feinberg School of Medicine, and Gordon Hazen, professor of industrial engineering and management sciences, work together to make liver transplant decisions more efficient.

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

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

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

It's a problem with no easy answer—and it's an example of the type of problem that professors from McCormick and the Feinberg School of Medicine are teaming up to solve. From studying transplant allocation to creating anatomy models with sensors to developing new kinds of drug-delivery methods and prosthetics, faculty in the two schools are calling, e-mailing, and traveling across Chicago to create connections that will ultimately improve all aspects of medicine. In

2010 more than 100 McCormick and Feinberg professors authored papers together, and new programs like mini sabbaticals—where McCormick professors spend a quarter at Feinberg doing research—are inspiring new partnerships at all levels.

Health Care Engineering

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

Take the liver decision problem—an issue Hazen, professor of industrial engineering and management sciences and an expert on health care decision analysis, has studied. In response to the

long liver transplant waiting list, the United Network for Organ Sharing (UNOS), the national organ donation organization, has started encouraging organ procurers to consider more of what physicians refer to as "donor after cardiac-death" (DCD) livers.

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

To explore the problem, Hazen created mathematical models that take into account what happens to patients on the liver transplant

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

While helping individual patients is, of course, a desirable outcome, the ultimate goal of the collaboration is to better inform and change transplant policy to reduce death rates of those on transplant waiting lists and improve decision making. "I began working in this area because I was interested in decision analysis but also because I wanted to do research



IEMS Professor Sanjay Mehrotra became interested in the health care field after several bad experiences in the system. Along with former PhD student Jonathan Turner, he seeks to make health care processes work better.

waiting list, including patient mortality and morbidity. Those models were used to predict what would happen if the number of DCD livers available for transplant increases or decreases. Hazen's research showed that unless the liver patient is in critical need of a new liver, it does not make sense to take a DCD liver.

Hazen collaborates with surgeons at the Northwestern University Transplant Outcomes Research Collaborative (NUTORC)

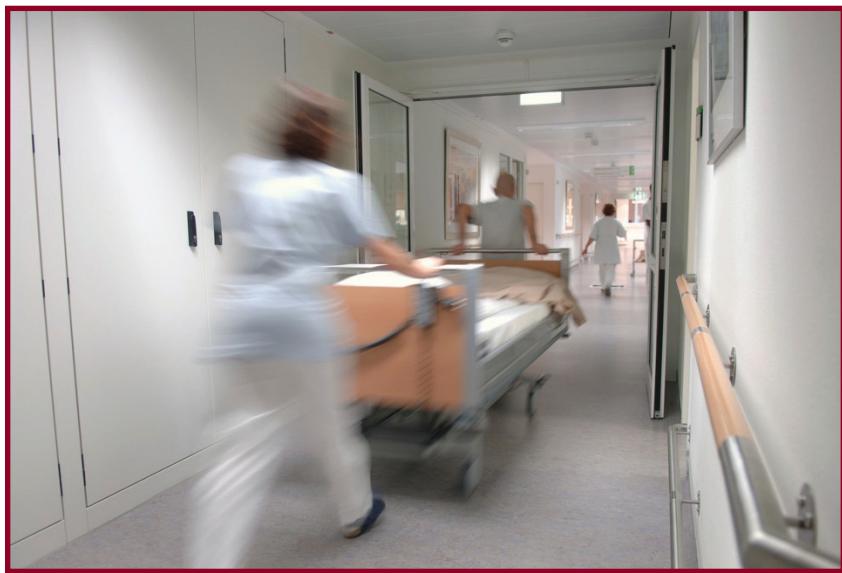
in something grounded in reality," Hazen says. "Hopefully my models will help influence leaders and create change."

Learning the Language of Medicine

While Ladner and her colleagues work with Hazen on risk prediction, they turn to Sanjay Mehrotra, professor of industrial engineering and management sciences and an optimization expert, for research on organ access and allocation

"Industrial engineers and operations researchers have helped develop a large analytical toolkit over the last 50 years. Historically, we could not use these tools for health care problems because the data were not as widely available. That's changing. We can use our tools to better manage hospital systems, improve policy, and help make scientific discoveries."

Sanjay Mehrotra, professor of industrial engineering and management sciences



throughout the United States. Over the past few years he has developed a half-dozen collaborations with Feinberg professors.

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

With NUTORC, Mehrotra and his graduate student Ashley Davis have studied kidney allocation. Nearly 90,000 people in the United States are waiting for kidney transplants. The country is divided into 11 regions managed by UNOS,

and most kidneys are distributed within the same geographic zone in which they are donated. As a result, there are major regional inequalities in access to organs: a person in one state might get a kidney within a year, while someone in another state might wait up to four years. Many people die while waiting. "It violates the 'Final Rule,' a government mandate about organ equity," Ladner says. Mehrotra and Davis have created a new politically viable kidney distribution model to promote kidney sharing between regions.

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

In the course of researching the problem, Davis spends much of her time at NUTORC being mentored by Ladner and other clinicians. She essentially went through a mini-medical school boot camp to teach her how to think as both an engineer and a clinician. "When you have people who understand both disciplines, you can open entirely new areas of research," Ladner says.

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

quiz, did every lab, and I survived. I learned the basic vocabulary."

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

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

Health Care Engineering beyond Graduation

One of those graduate students was Jonathan Turner. A student of Mehrotra who received his PhD in May 2011, Turner spent six months at Northwestern Memorial Hospital shadowing surgery residents and collecting data for what would ultimately become the subject of his dissertation: improving surgery education.

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

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

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Bob Fourer Retirement Roast

After 33 years in the Department of Industrial Engineering and Management Sciences, Professor Robert (4er) Fourer has retired. Below is Barry Nelson's address at his retirement party.

"We are gathered here today to pay our respects at the passing of our esteemed colleague, Robert 'Bob' Fourer... oh, sorry, wrong speech."

"We are actually here to celebrate Bob's retirement."

"Bob received his bachelor's in math from MIT and an MS and PhD from Stanford, where he was George Dantzig's student. In operations



Bob Fourer

citations. The foundation for research in this area was Bob's paper "Modeling Languages vs. Matrix Generators for Linear

Programming" that appeared in *ACM Transactions on Mathematical Software* in 1983.

"Bob has received numerous awards and distinctions during those 33 years: The Medallion Award from IIE in 2003 for being all around great

"Bob is quiet, low-key, and never draws attention to himself. And he travels a lot. So clearly he has something to hide. But what is it? Is Bob really a mild-mannered professor for a major metropolitan university? Or is he a strange visitor from another planet?" *Barry L. Nelson*

research you can't get much closer to God than to have worked with George Dantzig.

"Bob spent his entire career here at Northwestern, 33 years. He was department chair from 1989 to 1995, and I like to think his most satisfying accomplishment was hiring me."

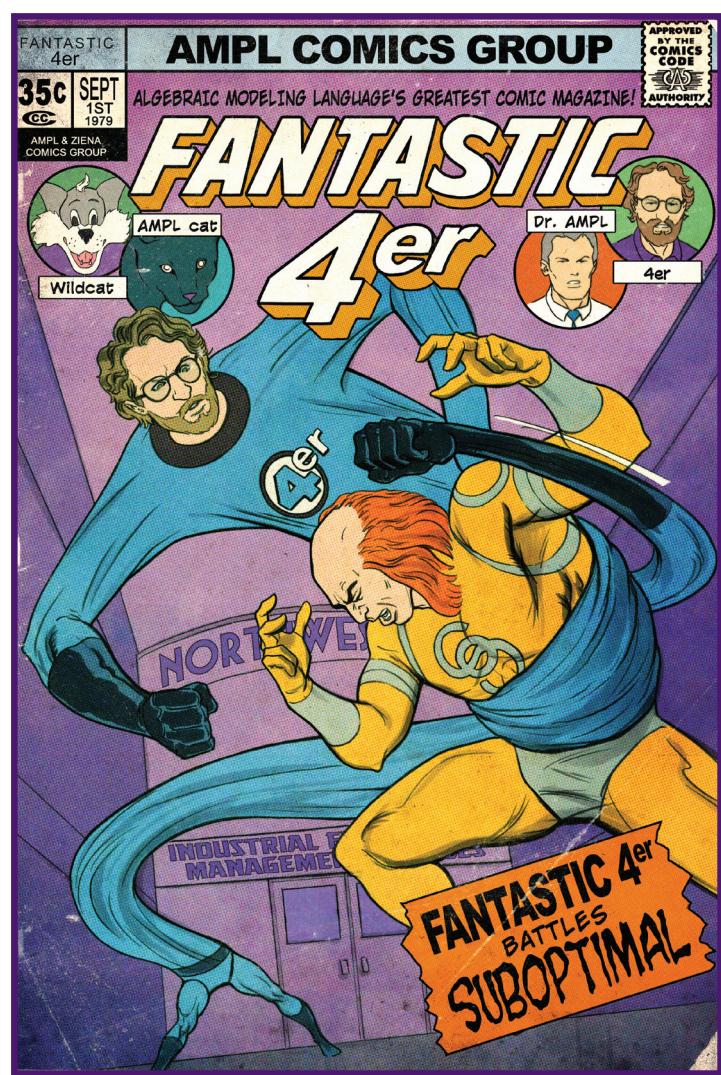
"Bob is best known for AMPL, his algebraic modeling language for mathematical programming. The idea behind algebraic modeling languages is to separate the formulation of an optimization problem from the solution method applied to it. This removes barriers to formulation and implementation, reveals structure, and allows you to throw more than one solver at the problem. Bob's AMPL book with Gay and Kernighan has gone through two editions and has at least 2,000

at everything; Fellow of INFORMS in 2004 (a year in which three NU IEMS faculty were inducted); and he just won the best paper award from *Computational Management Science* for "DrAmpl: A Meta Solver for Optimization Analysis," which shows that he has not been taking it easy.

"Those are the public facts. But what do we really know about Bob Fourer, the man? I asked people for juicy stories about Bob. Art [Hurter] said he was pretty sure Bob has never worn a tie. That was about all I could find."

"Bob is quiet, low-key, and never draws attention to himself. And he travels a lot. So clearly he has something to hide. But what is it?"

"Is Bob really a mild-mannered professor for a major metropolitan university? Or is he a strange visitor from another planet? [CUE CHEESY



SUPERHERO MUSIC] Just think about all of the people AMPL has saved from suboptimality: A restaurant owner needs a nutritious diet at minimum cost—AMPL is there; a refiner wants optimally blended gasoline—AMPL to the rescue; an auto manufacturer has to have minimum cost transportation of steel coils—AMPL turns up just in time; and when a furniture maker has cutting stock that needs to be cut, it's AMPL once again.

"But what is the connection? Just a week ago we got a break-through. Our extensive research found a crumpled comic book cover stuck in a first edition of Dantzig's *Linear Programming and Extensions* buried deep in the bowels of Stanford's library. We have blown it up to poster size so that today we can reveal that our colleague is not just mild mannered Robert Fourer, he is in fact Suboptimality's biggest foe... Fantastic 4er." —Barry L. Nelson

MSiA Students, *continued*

institutions including Stanford University, the University of California Berkeley, and Northwestern. Most completed their undergraduate degrees in related fields such as industrial engineering, mathematics, and economics, though backgrounds in physics and psychology are also represented. The students range in age from 22 to 48; one-third are women and one-third are international students.

Throughout the 15-month program, the students will be exposed to industry through multiple channels, including a practicum, internship, capstone project, and coursework. While other master's programs tend to be focused on one aspect of analytics — such as modeling or data mining — McCormick's MSiA curriculum is more comprehensive, covering big data, unstructured data, and data visualization.

"In 15 months you will speak three languages," Klabjan told the students at the launch party. "IT, science, and business."

The curriculum will be supplemented with guest lectures from influential analytics professionals. Two lectures are scheduled for the fall quarter: Bill Franks, chief analytics officer for Teradata, will speak on November 1, and Janet Wejman, former chief information officer for Continental Airlines, will speak on November 15.

For more information about the MSiA program and upcoming events, visit <http://www.analytics.northwestern.edu>.

Engineering Medicine, *continued*

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

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

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

"I want to be a facilitator," Turner says. "I want to say, 'Here is a problem, and here is the best person in McCormick to work on that.' I can distinguish whether a project might make a good dissertation or an ideal undergraduate assignment. I plan to make McCormick faculty aware of good research projects that are outside my skill set."

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

McCormick

Northwestern Engineering

Applications Invited For a Faculty Position

We invite applications for one full-time, tenure-track faculty appointment at the assistant or associate professor level to begin September 2013. Applicants should hold an earned Ph.D. or be near completion of their doctoral studies with demonstrated research potential in health care engineering and strong methodological background in industrial engineering, operations research or analytics. Industrial experience is desirable; a strong commitment to rigorous and relevant research is essential.

The Department offers an undergraduate program, a Ph.D. program, a full-time professional master's degree in analytics and a part-time professional master's degree in engineering management. Both the undergraduate and graduate programs have been consistently ranked among the top ten by *US News & World Report*.

Applications must be submitted electronically to www.iems.northwestern.edu/career/. Materials to be uploaded include a cover letter and a curriculum vitae detailing educational background, research and work experience. Applicants at the assistant professor level should also include a statement of their current and future research program. Candidates should also provide letters of recommendation from three references to be mailed or e-mailed directly to the address below. To receive full consideration, all materials should be received by December 31, 2012, but earlier application is encouraged.

Chairman, Faculty Recruiting Committee

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Student Highlight: Aaron Lucas

Aaron Lucas is in his final dual degree year, poised to graduate in June 2013 after four ambitious years in pursuit of both a doctoral degree in industrial engineering and a master's degree in public health. This unusual cross-breeding of degrees echoes a familiar refrain elsewhere in this newsletter: the core principles of industrial engineering are capable of illuminating health care problems and providing valuable insight into improving our health care system; with health care at the forefront of the national discourse, this area is becoming more and more popular among students.

Lucas' interest in health care engineering stems from his work with The Urban Institute, a social and economic think tank based in

Washington, D.C. After receiving a bachelor's in mathematics from Vassar College, Aaron took a research position at URBAN. His modeling and statistical work there contributed to health reform policies and resulted in recommendations to the U.S. Department of Health and Human Services.

In 2009, Lucas entered graduate school at Northwestern. Under the guidance of Benjamin Armbruster, his interest within health care engineering focused on the control and prevention of infectious disease. His research has resulted in three major projects. The first project modeled a unique alternative intervention of an intermittent "month-off" from risky sexual behavior in sub-Saharan African countries with highly endemic HIV

conservative in large part due to the recent recommendations for the initiation of antiretrovirals and the marked reduction in viral load due to antiretroviral initiation. His final and most current project is exploring the efficiency of discrete time versus continuous time network simulations of disease spread.

"I want to be a leading influence in the debate surrounding the future direction of HIV policy," Lucas said.

After graduation, Lucas is looking to move into a position where his modeling can have broad impact in policy change, while also offering his services pro-bono to nonprofits to help them create a more efficient structure within their companies and placing more of their monies in the pool that benefits their demographic.



Aaron Lucas

prevalence. The *Bulletin of the World Health Organization* published the resulting research in July 2012. The second project dealt with evaluating the most recent CDC guidelines for HIV testing in the United States. His research found that the CDC guidelines are likely to be too

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Design: Amy Carlson Design

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