Industrial Engineering and Management Sciences

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

FALL 2011

IEMS Undergraduates Follow the PhD Track

Many of our BS IEMS students later get a graduate degree, most often an MBA or a master's in industrial engineering. But a few of them can't stop until they have attained a PhD. Gigi Yuen (BS IEMS and civil and environmental engineering '01, PhD from Northwestern '06); Rachel Johnson (BS IEMS '03, PhD from Arizona State University '08), and Christine Nguyen (BS IEMS and engineering science and applied math '09, PhD from University of Southern California expected '14) are in that category.

Gigi Yuen-Reed is a senior managing consultant in IBM's Business Analytics & Optimization (BAO) practice. Her primary focus is to help clients make data-driven decisions, which often involves solving their business problems using analytical tools, from predictive modeling to text analytics to simulation to optimization. Gigi's dissertation, under the direction of professors Wally Hopp and Seyed Iravani, was entitled "White Collar Workforce Agility"; it applied models traditionally used in manufacturing to examine how white-collar organizations can function more effectively. Gigi got a PhD because, she says, "I was curious – I wanted to get a better understanding of what goes on 'under the hood' of the models that we build. I also wanted to be challenged, exploring something that no one has done before."

One of Gigi's favorite memories from her undergraduate time at Northwestern was senior design, where she and two other students worked on a project sponsored by the petroleum supply company UOP. "We had so much fun working together as a team for a real client!" And she continues to do that for IBM today.

Rachel Johnson (Silvestrini) is currently an assistant professor in the operations research department of the Naval Postgraduate School in Monterrey, California. "As a professor, my job consists of a mix of teaching, research, and service," Rachel

Gigi Yuen-Reed *Rachel Johnson* *Christine Nguyen*

says. "I teach a variety of courses in the OR department, including Probability, Statistics, Manpower and Personnel Modeling, and Experimental Design. My research is primarily in the field of experimental design applied to military-related problems. Here at NPS, our student body consists of approximately 97 percent military officers. Many of the officers have been deployed multiple times and have worked in a very diverse set of jobs for our U.S. military. The professors, including myself, benefit from the past experiences of our students because often they bring interesting problems to the department and provide us the opportunity to have meaningful applications for the research we do in the department."

At Arizona State, Rachel worked with professors Douglas Montgomery and John Fowler on her thesis, "The Design and Analysis of Computer Experiments." Montgomery is one of the most renowned engineering statisticians in the world, and Fowler is an expert in computer simulation. Rachel started graduate school not knowing if she would get a master's or continue for a PhD, but her time there convinced her she wanted to be a professor. While Rachel was an undergraduate at Northwestern she did research with professors Bruce Ankenman and Barry Nelson on computer simulation of queueing networks.

Christine Nguyen is a third-year PhD student in industrial engineering at the University of Southern California. Although still early in her studies, she is currently looking at inventory and routing strategies in cooperative supply chains for agriculture or perishable products. This past summer she worked as a graduate associate at the RAND Corporation in Santa Monica, California. Christine's PhD adviser is Professor James Moore, whose BS degree is also

Inside this issue

Letter from the Chair

IEMS Chair Barry L. Nelson (at left); new faculty members (from L-R) Andreas Wächter, Ohad Perry, Jill Hardin Wilson, and Jorge Nocedal.

For IEMS, 2010-11 will be remembered as the year of constant interviews. As a result, this fall we welcomed three new faculty to the department and got a bigger piece of a shared faculty member. The real scoop follows; a more lighthearted introduction to our new faculty can be found can be found on page 5 of this newsletter.

Jill Hardin Wilson is our new assistant department chair for undergraduate studies. Jill is a 2001 PhD graduate from Georgia Tech. Her research interests are in integer programming and educational innovation for teaching mathematical modeling, and she is an area editor for the *INFORMS Transactions on Education*. Jill joins us after 10 years on the faculty of the Department of Statistical Sciences and Operations Research at Virginia Commonwealth University. See her message in this newsletter that describes one of her first innovations.

Ohad Perry received his PhD from Columbia University in 2010 and was a postdoctoral fellow at the Centrum Wiskunde & Informatica in Amsterdam last year. His dissertation was titled "Heavy-Traffic Limits via an Averaging Principle for Service Systems Responding to Unexpected Overloads." Ohad will be teaching and conducting research in queueing and stochastic modeling, with applications to call centers and inventory systems.

Andreas Wächter was most recently a research staff member in the Department of Mathematical Sciences at the IBM T. J. Watson Research Center. A 2002 PhD graduate from Carnegie Mellon, Andreas' research is in large-scale nonlinear optimization and development of software to implement such methods. He is an associate editor for the *SIAM Journal on Optimization and Mathematical Programming Computation* and was awarded the INFORMS Computing Society Award in 2009 and the 2011 Wilkinson Prize for Numerical Software.

Jorge Nocedal, who for many years had a joint appointment in IEMS and the Department of Electrical Engineering and Computer Science, transitioned to 100 percent IEMS starting in fall 2011. Jorge does research and teaches courses in nonlinear optimization, and he developed a new course in machine learning this fall.

In other faculty news, I am pleased to report that Mike Marasco, director of the Farley Center for Entrepreneurship and Innovation, was promoted to clinical full professor. Long-time faculty

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member and former department chair Bob Fourer will retire in the spring, but we hope to entice him to stay closely connected to the department.

Looking forward, this will be our year of "analytics." IEMS is introducing a new master's of science in analytics (MSiA) degree starting fall 2012. Analytics — predictive, prescriptive, and descriptive — exploits advanced data analysis skills, such as data mining, and combines them with knowledge of information technology and the ability to employ sophisticated optimization and simulation tools to bring companies a competitive advantage. Analytics has become a primary focus of the Institute for Operations Research and the Management Sciences (INFORMS), one of our key professional societies, and we believe the time is right for an elite master's program. The MSiA will be directed by Diego Klabjan, and you will find more about it on page 6 of this newsletter.

Barry L. Nelson, Chair

Faculty and Student Awards

Irina Dolinskaya received the Transportation Science & Logistics Section of the Institute for Operations Research and the Management Sciences best dissertation award. Irina also received the IEMS Graduate Teaching Award for 2010-11. The award is based on voting by the first-year PhD students.

Robert Fourer and his former post-doc Dominique Orban received the 2010 best paper award from the journal *Computational Management Science* for their paper, "DrAmpl: A Meta Solver for Optimization Problem Analysis," which appeared in Volume 7, Number 4, pp. 437-463.

The Hurter Award for top graduating senior went to **Justin Gavil**; **Alvaro Maggiar** received the Hurter Award for best first-year PhD student.

Paul Leonardi had two papers that tied with each other for the Article of the Year Award for 2009 from the Organizational Communication Division of the National Communication Association. He also received an NSF CAREER Award for his proposal, "The Role of Advanced Simulation Technologies in Innovation Processes."

Our course NUvention Medical, which is taught by **Mike Marasco**, was named in "Best Courses 2011" by Inc. Magazine.

Sanjay Mehrotra has been elected chair-elect of the INFORMS Optimization Society.

Barry L. Nelson was named a fellow of the Institute of Industrial Engineers. And with former PhD student **Shing Chih Tsai**, he received the 2010 Best Paper Award in Operations of the journal *IIE Transactions* for their paper, "Fully Sequential Selection Procedures with Control Variates."

Jorge Nocedal is the new editor-in-chief of the *SIAM Journal on Optimization*.

Changhyeok Lee and **Ashley Davis** shared the Hurter Award for best teaching assistant.

Karen Smilowitz and **Irina Dolinskaya** received a Google Research Award for their project, "Using Advances in Mapping Technologies and Real-time Information to Improve Humanitarian Relief Routing."

Karen Smilowitz was named McCormick Adviser of the Year for 2010-11.

PhD student **Timothy Sweda** was named Student of the Year by the Center for Commercialization of Innovative Transportation Technology.

PhD student (now graduate) **Jonathan Turner** won the 2010 Doing Good with Good Operations Research student competition of the Institute for Operations Research and the Management Sciences for his

project, "Improving the Educational Outcomes of Future Surgeons."

Andreas Wächter, who was at the IBM T. J. Watson Research Center before joining IEMS as an associate professor this fall, was awarded the 2011 Wilkinson Prize for Numerical Software. The Wilkinson Prize is given once every four years and is sponsored by Argonne National Laboratory, the Numerical Algorithms Group of the UK, and the National Physical Laboratory, also of the UK.

Jill Hardin Wilson, who was at Virginia Commonwealth University before joining IEMS as assistant chair this fall, received the Distinguished Teaching Award from the College of Humanities and Sciences at Virginia Commonwealth University.

Cover story, continued

from Northwestern. In her first year in graduate school Christine received the METRANS Outstanding Student of the Year Award. METRANS, a partnership of the University of Southern California and California State University, Long Beach, is a U.S. Department of Transportation-designated University Transportation Center. Its mission is to solve transportation problems of large metropolitan areas through research, education, and outreach.

Christine remembers, "The IEMS department puts together a great seminar series. It was one of the contributing factors in my decision to get a PhD. The seminar series provides a great overview of the current research trends for industrial engineering and operations research." At Northwestern Christine did undergraduate research on simulation languages with Professor Nelson.

Letter from the Assistant Chair

Assistant Chair Jill Hardin Wilson

As I have spent time with faculty and students in the department, one sentiment I have heard repeatedly is a desire to strengthen the community of undergraduate IE students. My sense is that students are eager to get to know their professors outside the classroom, and also that IEMS faculty enjoy their interactions with undergraduate students. I also hear repeatedly that Northwestern students work incredibly hard and are under a lot of pressure. We want to foster meaningful connections between students and faculty while providing students with temporary relief from the stress that often accompanies the pursuit of an engineering degree.

Thursday, October 6, marked the beginning of dIvErsion, a weekly gathering of the IEMS undergraduate community over cookies and lemonade. By providing an organized time and place where IEMS undergraduates, faculty, and graduate students can gather — and a really good reason to do so! — we give students the opportunity to meet other IEMS students and to interact with their TAs and professors outside the classroom. Although our first event was well attended, we expect it to grow further as students spread the word and it becomes a habit. Several students have already commented that they love the idea, and even some who haven't yet been able to attend because of scheduling conflicts have stopped by to tell me that they support it.

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Our hope is that dIvErsion eventually becomes a mainstay of the IEMS undergraduate program. If it continues to enjoy the support currently shown by students and faculty, that will happen sooner than we imagined.

Jill Hardin Wilson, Assistant Chair

IEMS Creates Awards for Entering PhD Students
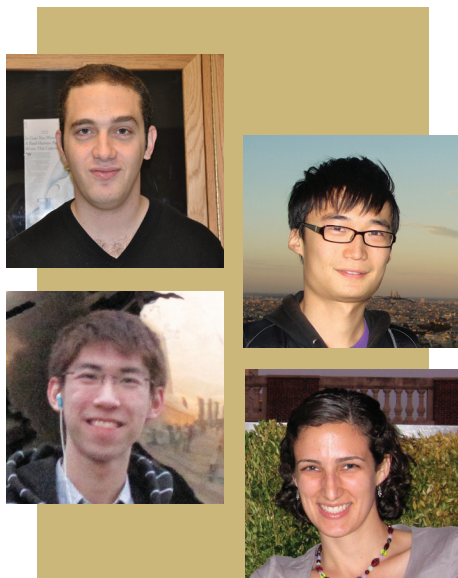
Thanks to generous gifts from donors, the IEMS department has been able to establish $5,000 awards for exceptional incoming PhD students in three research areas. One award is for an entering student planning to study financial engineering. A second, the Benjamin K. Sachs Graduate Fellowship, is for a student in the area of statistics for enterprise engineering. In organizational theory and systems analysis, there is the Harold Richards Graduate Fellowship.

The department offers the awards at the time of acceptance into the PhD program. The awards were created to attract top students to Northwestern and to support their research. Each award consists of a $3,000 supplement to the incoming student's stipend and $2,000 in research funding.

Three current first-year PhD students received IEMS Financial Engineering PhD Awards: **Ben Feng**, who joins us from the University of Waterloo, **Yutian Nie** from Tsinghua University, and **Imry Rosenbaum**, a graduate of Tel Aviv University. **Samantha Meyer,** who was most recently a New York City high school math teacher, won the Harold Richards Graduate Fellowship. The Benjamin K. Sachs Graduate Fellowship went to **Jun Li**, a student at the University of Illinois, who will enter Northwestern in fall 2012.

Incoming PhD students (clockwise): Imry Rosenbaum, Yutian Nie, Samantha Meyer, and Ben Feng

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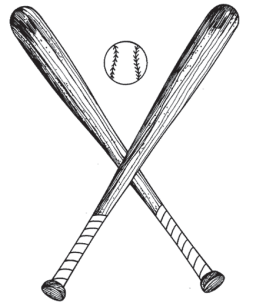
Press Release

Industrial Engineering & Management Sciences adds depth and power in off-season acquisitions!

Biggest changes since the Apley, Staum, and Homem-de-Mello buying binge in 2003!

EVANSTON, Ill., SEPTEMBER 18, 2011 — In moves that have to leave No. 1 Georgia Tech looking over its shoulder, General Manager Julio Ottino opened his pocketbook last year to let IEMS strengthen an already impressive lineup. "Spending on IEMS always pays off," said Ottino. "Those guys are efficient, effective, and continually improve." IEMS will take the field this year with four new faces:

• **Jill Hardin Wilson, Assistant Coach**: To bolster their aging-but-crafty skipper Barry Nelson, IEMS hired fast-track coaching phenom Hardin Wilson away from Virginia Commonwealth. Hardin Wilson is being brought in to elevate the undergraduate line. "When I saw what she can do with a tablet computer," Nelson notes, "I figured I better keep up or get passed by."

• **Ohad Perry, Stochastic Striker**: Coming off a break-out year in the European league, Perry adds the sort of unpredictable scoring that is essential to taking down some of IEMS' fiercest rivals. "With the inside dope that Ohad and I bring about Cornell and Columbia, we can hit them where it hurts, and (of course) where they least expect it," says IEMS stochastic veteran Jeremy Staum.

• **Andreas Wächter, Left Watson**: Not since Michael Jordan tried his hand at baseball has there been so much buzz about an athlete changing sports. But unlike Jordan, IEMS is confident Wächter will have an immediate impact. "What he doesn't know, we can teach him," opines Nelson, "but what he does know kicks butt."

• **Jorge Nocedal, Right AboveUs**: After spending most of his career splitting time between two teams, IEMS convinced perennial slugger Nocedal to commit to IEMS, adding needed star power and stability. "With this year's rookies, plus Armbruster and Dolinskaya, IEMS is still a very young team," states Nocedal. "As a veteran used to pressure, I can help keep them all feasible."

New Master of Science in Analytics Program Meets Corporate Demand for Skilled Analytics Professionals

In fall 2012, a small group of students will enter McCormick's new master of science in analytics program; 15 months later they will enter the workforce with highly formed skills in data analytics — skills that are in increasing demand in today's competitive marketplace.

The field of data analytics has exploded in the past decade as corporations seek to turn mountains of collected consumer data into actionable business intelligence. But U.S. academic institutions have lagged behind in providing students with the skills they need to meet these 21st-century workplace challenges.

Northwestern's new program, housed in the Department of Industrial Engineering and Management Sciences, draws on the expertise of top-of-the-field professors and renowned lecturers from major corporations to combine scientific studies with instruction in advanced information technology, data management, and business. Unlike programs at other institutions, the curriculum covers all three areas of data analytics: predictive, prescriptive, and descriptive. It is also a full-time cohort program that includes a summer internship in industry.

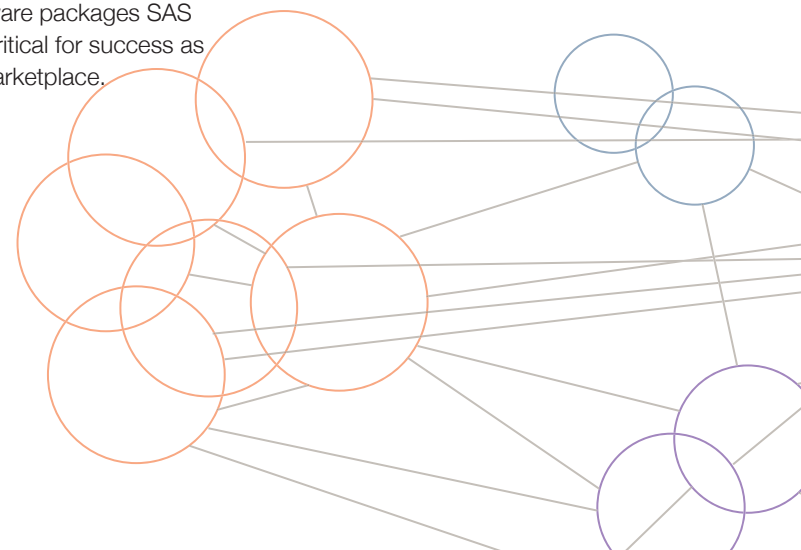**A sampling of classes that will be offered in the MS in Analytics program:**

Statistical Methods for Data Mining
Quantitative Methods
Analytics for Competitive Advantage
Introduction to Databases
Optimization/Heuristics
Analytics for Big Data
Computer Simulation for Risk and Operations Analysis
Soft Analytics

Students learn to identify patterns and trends; derive optimized recommendations evaluated through simulations; interpret and gain insight from vast quantities of structured and unstructured data; and communicate their findings in practical, useful terms that help drive business success. The students will be challenged to think about innovative analysis of data.

The program teaches that naïve data analysis can be misleading, that large-scale problems are not amenable to simple solutions, and that working with unstructured field data is different from working with the results of a designed experiment. In addition, students learn practical skills, such as the data analytics software packages SAS and SPSS, which are critical for success as an analyst in today's marketplace.

"We conceived this program because we recognized that there are not enough trained individuals in this rapidly growing field," said Diego Klabjan, the director of the master of science in analytics program and an associate professor in the Department of Industrial Engineering and Management Sciences. "McCormick is at the cutting edge in analytics, and we are looking forward to starting the program next fall. The department and school want to be at the forefront of data analytics in education and research."

Program details are at www.analytics. northwestern.edu.

Have you ever wondered why…

… airline prices change every hour?

… Facebook often finds your acquaintances as potential friends?

… Netflix frequently recommends the movie you really wanted to see?

… grocery cashiers know to hand you coupons you might actually use?

… it is better to charge an electric vehicle overnight and not during the day?

… the Oakland A's were so successful in the early 2000s, despite a low payroll?

It's all because of one of the hottest trends in business today: data analytics.

Modeling Best Locations for Electric Vehicle Charging Stations

Electric vehicles, previously only spectacles of auto shows, science fiction, and a failed launch attempt in the late 1990s, are now becoming a consumer reality; there are an estimated 56,000 electric cars (mostly retrofitted) currently in use in the United States. The Nissan Leaf and Chevy Volt recently became the first electric cars released by major automotive companies, and projections show that by 2015, a million electric vehicles will be on U.S. streets.

But while drivers of gas-powered vehicles can easily stop at a station to fill up, drivers of electric vehicles currently have no such option. That, combined with electric vehicles' limited battery capacity (the Nissan Leaf has a range of 100 miles, in the best conditions), leads to "range anxiety" — the fear that the car will run out of juice before getting to a battery charger.

But how many charging stations are needed, and where should they go? That is the question Diego Klabjan, associate professor of industrial engineering and management sciences, aims to answer. Working with the Chicago Area Clean Cities Coalition and other partners around the United States, Klabjan and his team are using innovative analytical methodologies to determine the best locations in the Chicago area for electric vehicle charging stations.

"Because Chicago does not yet have many electric vehicle drivers, we must use proxy data to develop a smart way to model where charging stations should go," Klabjan says. "That way, the infrastructure will be in place as more people turn to alternative energy vehicles."

Klabjan, who is part of the school's Center for the Commercialization of Innovative Transportation Technology, uses several factors to determine charging locations, including where and how people drive, and where potential electric vehicle drivers might live. To determine this, Klabjan has collected data on areas with a large number of solar installations (under the premise that residents who use solar power are more likely to adopt alternative energies), data on where drivers of hybrid cars live, and some additional contemporary and relevant data streams.

But gathering data on potential electric vehicle drivers is not enough; researchers must also consider where these drivers might want to spend their time while their car charges. Charging an electric vehicle can take anywhere from a half hour (through direct current, called "fast charging") to two hours (through standard alternating current charging), so charging locations would ideally be near places where people could go while their car charges (like the grocery store or the mall).

"It wouldn't make sense to put a three-hour charging station near a coffee shop, but it could make sense to put it in the parking lot of a mall where people could charge their cars while they shop," Klabjan says.

Klabjan takes this data and uses discrete choice modeling to determine demand measurement, optimization techniques to find the best locations, and simulations to assess system performance.

Electric Vehicles: By the Numbers

56,000 estimated number of electric vehicles currently in use in the United States

1 million number of electric vehicles projected to be in use in the United States by 2015

100 the driving range of a Nissan Leaf, under optimal conditions

1½ to 2 hours required to charge an electric vehicle

Diego Klabjan

Eventually, his results will drive a web-based decision support software application where users can conduct what-if studies on investment budget, electric power-grid, geographic, and infrastructure constraints.

"We are in the early stage of electric vehicles, so right now the main goal is to make customers happy," Klabjan says. "We want to make it easy for people to drive electric vehicles."

Klabjan has been working on this project for two years. Although this research project focuses on the charging network, the underlying concepts and methodologies are also applicable to other alternative fueling technologies, such as compressed natural gas, hydrogen, or biofuels.

Klabjan was drawn to this project because of his interest in environmental issues. He has previously used data analytics to answer environmental policy questions, like how subsidies influence buying patterns, and he himself is expecting a Nissan Leaf in December.

"My goal is that this type of decision making will be adopted across the United States," he says. "It's data driven, and will save a substantial amount of time deploying charging stations."

The system is now being commercialized by Eco Green Analytics LLC, a start-up company established by Klabjan.

McCormick

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IEMS Seniors Receive Design Awards

*Left (from L-R): Andrea Voigtmann and Nicole Flammer
give the student media presentation, a review of life in IEMS
by representatives of the senior class, on June 17.
Top (from L-R): Lavanya Babu, Melissa Getzeiler, and
Chintan Mehta accept awards for best IEMS senior design
project with Associate Professor Karen Smilowitz.
Not pictured: group members Eujin Lee and Steven Pals.*