

# INDUSTRIAL ENGINEERING AND MANAGEMENT SCIENCES

## IEMS HOSTS BERNARDO PAGNONCELLI AS 2018-19 McCARTER FELLOW

### Pagnoncelli initiated research with IEMS faculty and taught undergraduates

The Department of Industrial Engineering and Management Sciences (IEMS) welcomed Bernardo Pagnoncelli as the 2018-19 Patrick and Amy McCarter Fellow.

Pagnoncelli joined the department from the School of Business at the Universidad Adolfo Ibáñez in Santiago, Chile, where he served as head of the Operations Group. During his yearlong appointment at Northwestern University, Pagnoncelli initiated ongoing research collaborations with Professor **David Morton**, Professor **Sanjay Mehrotra**, PhD student **Daniel Duque**, and postdoctoral fellows **Oscar Dowson** and **Hamed Rahimian**.

At Northwestern Engineering, he taught an IEMS undergraduate required course, Foundations of Optimization, and he served as faculty adviser for two industry-sponsored projects in the IE Client Project Challenge course, one for AbbVie and another for Claire's.

Pagnoncelli earned his bachelor's degree in pure mathematics and his master's and PhD in applied mathematics, all from the Pontifical Catholic University of Rio de Janeiro in Brazil. His research focuses on risk in optimization under uncertainty with wide-ranging applications including portfolio optimization, pension system management, credit risk, forest harvesting, mining, and renewable energy systems.

His research on the Chilean pension system garnered significant attention. His letter to the editor, in collaboration with Arturo Cifuentes from Columbia University, was published in the June 29, 2019, issue of *The Economist*.

As a PhD student, Pagnoncelli studied at Georgia Tech for one year, and he also previously visited Texas A&M University. In 2015, he won the best researcher award from the Universidad Adolfo Ibáñez. A gifted instructor, Pagnoncelli has twice won Instructor of the Year in the International MBA Program for the Universidad Adolfo Ibáñez.

Pagnoncelli believes learning should be student-centered and experiential. In 2012, he attended Harvard University's one-week Global Colloquium on Participant-centered Learning, and in 2013, he founded GameLab, a company producing simulation-based games used by universities to facilitate learning in the classroom.



Professor Bernardo Pagnoncelli (fourth from left) was a loyal participant in the weekly IEMS Friday Faculty Lunch.

### Dear friends and colleagues,

It's an exciting time in the Department of Industrial Engineering and Management Sciences (IEMS), and it has never been easier to convey *what we do*. While data science and analytics pervade business, engineering, natural sciences, social sciences, the humanities, and government, as well as industrial engineering, IEMS is distinguished by focusing on tools for best-possible *decision making* in large modern industrial and service systems.

For instance, infrastructure systems are growing in scale and interconnection. This allows remarkable gains in their reach and efficiency, but subsystems interact in subtle and surprising ways. We build data-driven mathematical models — including optimization, simulation, and statistical models — that capture system performance in the presence of these subtle interactions. The size of modern systems, the speed with which

decisions must be made, and the volume of relevant data push IEMS faculty, and their PhD students, to create new models, algorithms, and software, and to educate our undergraduates in how to use them. Several examples follow:

**Jorge Nocedal, Andreas Wächter,** and **Ermin Wei** are part of a US Department of Energy competition involving the electrical power grid, in which optimization models must address challenges brought by the growing role of intermittent renewable resources, foremost solar and wind power. As this year's Stanislaw M. Ulam Scholar, Wächter is working with colleagues at Los Alamos National Laboratory on electric power systems and their integration with our natural gas infrastructure.

With chemist Marya Lieberman of the University of Notre Dame, **Karen Smilowitz** seeks to detect and disrupt illicit supply chains of counterfeit pharmaceuticals, in research sponsored by the National Science Foundation (NSF). **Sanjay Mehrotra** is improving allocation algorithms to rescue donated kidneys that might otherwise be

discarded, in work sponsored by the National Institutes of Health. Using queueing and simulation models, **Ohad Perry** aims to reduce congestion in patient flows within and between hospitals, in work sponsored by NSF and in collaboration with Stephanie Gravenor of Northwestern Memorial Hospital. Due to these opportunities to improve data-driven decisions in healthcare, IEMS leads the Center for Engineering and Health (CEH) jointly with the Northwestern Feinberg School of Medicine.

NSF is sponsoring **Vadim Linetsky's** work in advancing tools from statistical learning in asset allocation models to improve out-of-sample financial portfolio returns. **Dan Apley**, in collaboration with colleagues in the Department of Mechanical Engineering, is developing statistical learning models to enable scalable nanomanufacturing processes, in work sponsored by the Air Force Office of Scientific Research and NSF. **Seyed Iravani**, in collaboration with Chaitanya Bandi of the Kellogg School of Management's Operations Department, is guiding

proprietary scoring algorithms and fact-checking resources to detect and thwart the spread of fake news in social media networks, in work sponsored by NSF.

Central to the IEMS identity is rigorous creation of the mathematical models, theory, and algorithms — and their implementation in high-performance computational software — to advance the frontiers of *optimization, simulation, and statistical learning*. These three *enabling technologies* allow us to improve decision making in systems of energy, healthcare, finance, manufacturing, and beyond. I hope you enjoy this glimpse into IEMS's activities. I look forward to connecting with many of you in the coming year.



**David Morton**  
David A. and Karen Richards Sachs Professor and Chair

## Analytics Students Collaborate with Greenwich.HR

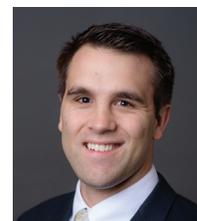
### MSiA 400: Everything Starts with Data supported the project

Students in the Master of Science in Analytics (MSiA) program recently worked with members of the labor market intelligence firm, Greenwich.HR, as part of the program's Everything Starts with Data Course.

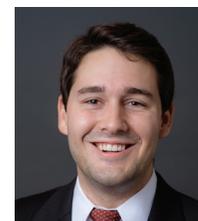
Given that the labor market comprises the largest part of the economy, Greenwich.HR presents understandable job market data to employers, recruiters, and others within this sector in order to

show what is happening in the job market. Greenwich is the leading global provider of labor market intelligence according to *APAC Business Magazine*.

Students learned that demand in the job market can be defined in many different ways, such as scarcity, impact, and volume, making demand metrics difficult to nail down. The team decided to analyze the demand on required skillsets instead of the number of jobs given over time so they could capture the specialized or niche roles, which are also highly demanded. With the use of the TF-IDF method, they were able to detect relevant skills for each job position, which resulted in a new



JD Cook



Michael Fedell

framework for the labor market.

Read the blog post by MSiA students JD Cook and Michael Fedell:

<https://bit.ly/2qmr9nT>

Read Greenwich.HR's post, "Using Skills to Define and Measure Job Demand," about the collaboration: <https://bit.ly/2JiNKYZ>

# IEMS RESPONDS TO STUDENTS IN DISTRESS

By Marita Labeledz Poll

In an effort to support students, the Department of Industrial Engineering and Management Sciences (IEMS) developed and presented “Responding to Students in Distress: A Primer for McCormick Faculty.”

The workshop, held during the spring 2019 quarter, was designed to further educate faculty on responding to students in distress.

The idea for the workshop emerged as Professor **Jill Wilson**, assistant department chair, and myself, as senior academic adviser, discussed opportunities to support students in distress. They felt concerned that stress and anxiety continue to be evident in IEMS students, and faculty expressed an interest in becoming better equipped to handle the challenges arising when student distress manifests in academic settings. The workshop’s purpose was to provide faculty with tools they could use immediately and also to share information on how the McCormick School of Engineering specifically, and Northwestern more broadly, responds to students in crisis.

Interest was high, and 60 participants attended the workshop in April. Participants included Northwestern Engineering faculty and staff who work directly with students (notably, associate directors in the professional master’s programs), as well as faculty from The Graduate School and from Northwestern at large, who are confronted with similar issues.

Dean Julio M. Ottino welcomed the participants and emphasized the need for support of our students around this topic. Presenters included Joseph Holtgrieve, assistant dean for



Sixty community members participated in the “Responding to Students in Distress” workshop.

TOPICS RANGED FROM HOW TO PROVIDE APPROPRIATE ACADEMIC ACCOMMODATIONS AND HOW TO CREATE A CARING COMMUNITY FOR STUDENTS, TO WHEN AND HOW TO REFER STUDENTS WHO ARE IN DISTRESS AND CRISIS.

undergraduate engineering, Mona Dugo, senior associate dean of students in Northwestern’s Office of Student Affairs, and David Shor, director of clinical services in Northwestern’s Counseling and Psychological Services (CAPS).

Topics ranged from how to provide appropriate academic accommodations and how to create a caring community for students, to when and how to refer students who are in distress and crisis. Evaluations of the workshop were extremely positive, and most participants indicated they learned something new about supporting students. A number of survey comments, however, indicated there is still more work to do in educating faculty in this challenging arena.

Ottino provided a letter of thanks to each participant with a magnet printed with critical phone numbers (such as CAPS

and the Dean on Call) as a reminder of how to support and refer students. The workshop was captured on video and made available to the Northwestern community in an effort to increase knowledge across the University. Funding for the workshop was provided by a grant from the Murphy Society.

Because of the high interest in this workshop, and in an effort to continue to educate faculty and staff about supporting students experiencing distress, IEMS has developed a new program that will launch during the fall 2019 quarter. This new initiative, “Mental Health Allies,” will educate McCormick faculty and staff so that they can serve as allies for students who may be experiencing distress or mental health challenges. This program will be funded by a grant from the Alumnae of Northwestern University.

# IEMS 2019 GRADUATION

## PHD GRADUATES

In 2018-19, IEMS graduated six PhD candidates. They are listed below with their current job placements:

**Anh Bui**, Assistant Professor, Department of Statistical Sciences and Operations Research, Virginia Commonwealth University

**Raghu Bollapragada**, Postdoctoral Fellow, Argonne National Laboratory

**Collin Erickson**, Quantitative Analyst, Analytics Department, New York Yankees

**Jacob Mays**, Postdoctoral Fellow, Department of Civil and Environmental Engineering, Cornell University

**Nastaran Shojaei**, Quantitative Analyst, Chicago Trading Company

**Haoxiang Wang**, Postdoctoral Fellow, Center for Nonlinear Studies, Los Alamos National Laboratory

## SENIOR CEREMONY

On June 21, IEMS held a department ceremony for 87 graduating seniors, along with their families and friends. The event highlighted special student awards and achievements and provided time for students to connect with faculty members and families. It also allowed students to share their body of work through student-led presentations, which this year included a student-produced video featuring interviews with faculty and students.



The McCormick School of Engineering graduated 697 master's and 201 PhD students over three ceremonies in June in the Technological Institute and Welsh-Ryan Arena as part of the University's 161st Commencement. Undergraduates also participated in the Northwestern ceremony at Ryan Field where Secretary of the Smithsonian Institution Lonnie Bunch provided the address. After commencement, the Department of Industrial Engineering and Management Sciences (IEMS) also celebrated its undergraduates and PhD students in dedicated events.



Dear friends,

We find ourselves looking forward to another exciting year in the undergraduate program here in the Department of Industrial Engineering and Management Sciences. Beginning September 1, **Marita Labeledz Poll** joined the department full-time as senior academic adviser. In her short time here, Poll has already made significant contributions, including expansion of our advising programs to include peer advisers and alumni advisers, development of programming for faculty and staff addressing the mental health concerns of students (see *her article on the Mental Health Allies program on page 3*), and improved assessment processes for evaluating advising. In the coming year, she will continue to implement improvements to our

undergraduate advising programs and will introduce a new course on Whole-Brain Leadership for our management science curriculum. My only regret is that I may not have time to sit in on her course.

In tandem with Poll's advising efforts this year, my own focus will be on mentorship, a fundamental part of the college experience — taking advantage of the knowledge, expertise, and experience of faculty, staff, peers, and alumni. We find many students do little to take advantage of the numerous mentorship opportunities we offer in the department, particularly relationships with faculty. How can we better help them understand the unique benefit of this access and encourage them to leverage it? I am also concerned with the support we are providing to underrepresented minority, low-income, and first-generation college students. How can we provide stronger support for

them as they learn to navigate Northwestern, engineering curriculum requirements, and careers in industrial engineering? These are the questions I'm exploring and hope to answer and address this year.

Last spring, we offered IE Client Project Challenge (formerly known as "Senior Design"). This class provides students with client-facing project experiences. The course was a success, with anecdotal observations indicating students were more engaged and interested in the work than in previous years. In the coming year, we look to improve by continuing to recruit deep and meaningful projects from engaged and interested clients. We will also leverage the Center for Leadership at Northwestern to provide team coaching for our students. Finally, I will become the primary instructor for the course, working with Center for Leadership staff to develop my

own skills in team coaching. I am grateful to **Bruce Ankenman**, **Barry Nelson**, and **Mark Werwath** for their work on the implementation committee this year.

Finally, I extend heartfelt thanks to those who stood in the breach during my family leave. Although they are too numerous to name here, I owe particular thanks to Marita Poll, **Dan Apley**, and **David Morton**. I'm fortunate to work with such supportive colleagues.



**Jill Wilson**  
Assistant Department Chair  
for Undergraduate Studies

## PhD Student Profile: Collin Erickson

### Following his PhD studies in Gaussian Process metamodeling, Erickson joined the New York Yankees

**Collin Erickson** (MS '16, PhD '19) spent his Northwestern Engineering PhD experience making the most of limited data.

Working in the area of Gaussian Process metamodeling, a means of building a predictive model out of a limited number of experiments, Erickson sought to address some of the approach's limitations by making more informed decisions about the experiments making up the metamodel.

Using an adaptive approach that allowed him to direct sampling choices based on the observed results of completed

experiments, rather than from a list of predetermined design points, Erickson made two significant contributions.

The first was an algorithm designed to produce more accurate results in areas of the model where predicted response is very sensitive to input settings. Rather than focusing on absolute accuracy, this approach provides researchers a greater understanding of areas where small changes to the inputs can produce large changes to the outputs.

The second built on a previous project of his coadviser, **Matthew Plumlee**, assistant professor of industrial engineering and management sciences, in large-scale Gaussian Process metamodeling for up to 100,000 experimental design points. Using an adaptive approach, Erickson was able to build a more informative model out of the limited evaluation points available at that scale.



*Collin Erickson graduated with his PhD from IEMS in June 2019.*

After earning his PhD in the spring, Erickson went on to bolster the New York Yankees' Analytics Department as a quantitative analyst. Major League Baseball teams have placed an increasing emphasis on model-based analysis, with the Yankees among the most advanced. Erickson will be the first Northwestern IEMS alumnus to work for the team since former manager **Joe Girardi**.

## FACULTY NEWS

**Dan Apley** was selected as a fellow of the American Statistical Association.

**Wei Chen** was elected to the National Academy of Engineering.

**Noshir Contractor** received the Academy of Management's Organizational Communication and Information Systems group's Lifetime Service Award at the Academy's 79th Annual Meeting.

Showtime's *Billions* referenced **Vadim Linetsky's** work, where a mathematical genius from a Wall Street hedge-fund firm develops a financial derivative as "an homage to Vadim Linetsky."

**Sanjay Mehrotra** was elected as the founding coeditor of the new Healthcare Management Department for the journal *Naval Research Logistics*.

**Barry Nelson** received the David F. Baker Distinguished Research Award from the Institute of Industrial & Systems Engineers. He also was awarded the IISE Modeling and Simulation Division Teaching Award this year.

**Matt Plumlee** won the department's Graduate Teaching Award, as elected by our student INFORMS chapter.

**Andreas Wächter** is serving as the prestigious Stanislaw M. Ulam Scholar at Los Alamos National Laboratory this year. He was promoted to professor, effective September 1, 2019.

## SPONSORED AWARDS

**Dan Apley** was awarded funding from the Air Force Office of Scientific Research for the project titled "Stochastic Self-Consistent Clustering Theory for Composite Performance Prediction: From Extreme Value Microstructure Attributes to Design of Interphase for Toughness."

**Noshir Contractor** received National Science Foundation funding for "Safe Bets and Risky Propositions: Leveraging Rich Data to Understand Scientific Diversity, Impact, and Potential of Teams." He received two awards from the US Army Research Laboratory, "The Signatures of Success in Human-Agent Teams" and "Wearable Devices for Monitoring Social Networks."

**Diego Klabjan** received funding for two projects from industry sponsors, Allstate Insurance Company and Intel. The projects are respectively titled "Comprehensive AI Architecture: One Model Fits Many Data Sources and Tasks" and "Agile Manufacturing Systems."

**Simge Küçükyavuz** received funding from the Office for Naval Research for "Theoretical Foundations and Scalable Algorithms for Mixed-Integer Convex Optimization with System Choice."

**Vadim Linetsky** was awarded a grant from the National Science Foundation for the project titled "Asset Allocation: A Statistical Learning Approach."

**Sanjay Mehrotra** earned an award from the National Science Foundation for "Equitable and Efficient Scarce Resource Allocation Using Stochastic Fractional Optimization." He also received an award from the National Institute of Diabetes, Digestive, and Kidney Diseases for the project titled "Rescuing Kidneys at Risk of Discard."

**David Morton** received funding from the Department of Energy for his project on optimizing real-time operations for concentrating solar power.

**Barry Nelson** and **Andreas Wächter** received an award from the National Science Foundation for "Collaborative Research: Adaptive Gaussian Markov Random Fields for Large-scale Discrete Optimization via Simulation."

**Jorge Nocedal** received funding from Advanced Research Projects Agency - Energy for "An Iterative Approach for Solving the SCOPF Problem Applying LP, SOCP, and NLP Subproblems."

**Karen Smilowitz** received grant funding from the National Science Foundation called "EAGER ISN: Unraveling Illicit Supply Chains with a Citizen Science Approach," and a participant support grant for the same project.

**Andreas Wächter** and **Ermin Wei** received funding from Advanced Research Projects Agency - Energy for the project titled "Hybrid Interior-Point/Active-Set PSCOPF Algorithms Exploiting Power System Characteristics" and is in collaboration with Lehigh University.

## STUDENT NEWS

Two teams received the IEMS Charles Thompson Client Project Challenge Award: **Jake Atlas, Joseph Kuo, Mo Ran, Lorenzo Siy, and Ege Sozgen** for their work with the National Kidney Foundation of Illinois, and **Ryan Albelda, Erik Birk, Emma Hartley, Jeremy Joseph, and Charles Novak** for their project with Hickory Farms.

**Dipayan Banerjee**, now a PhD student at Georgia Tech, received the Arthur P. Hurter Award for Outstanding Graduating Senior and is a finalist for the INFORMS Undergraduate Operations Research Prize for work coadvised by **Karen Smilowitz** and **Jill Wilson**.

**Moses Chan** received the Outstanding Teaching Assistant Award.

**Caleb Han** won the IEMS Concentrations Award given to a student who has optionally completed a concentration within the industrial engineering curriculum, focusing their elective coursework in a particular area.

**Gökçe Kahvecioğlu** is one of four finalists for the Best Student Paper Award from the INFORMS Section on Data Mining for her paper titled "Optimal Hierarchical Clustering on a Graph."

**Leo Kaplan**, an outfielder for the Northwestern baseball team, was honored as a Big Ten Distinguished Scholar.

**Rachel Katz** and **Yahia Khaled El Bsar** received the IEMS Department Award recognizing seniors who have excelled in academics, leadership, or contributions to the department.

**Jacob Mays** won the Best Student Paper Award from the INFORMS Section on Energy, Natural Resources, and the Environment for his paper titled "Asymmetric Risk and Fuel Neutrality in Capacity Markets."

**Michael Shi** was recognized as an ICML 2019 Top Reviewer for being one of the top 5 percent of reviewers for ICML 2019.

**Tomomi Suenaga** was awarded the IEMS Senior Leadership Award.

**Josh Wang** was awarded the Hurter Outstanding First-Year PhD prize.

## ALUMNI NEWS

**Jacqueline Ng** (PhD '18), now a postdoc at Harvard Business School, received the Best Dissertation Finalist award from the Technology and Innovation Management Division at the Academy of Management. Her dissertation is titled "Organizing in the Digital Age: How Team Collaboration Networks Form and Why They Perform."

## DEPARTMENT NEWS

IEWS welcomed four new postdocs:

**David Eckman**, who received a PhD in operations research from Cornell University; **Xiangwen (Evan) Liu**, who received a PhD in computer/information science from the University of Arkansas at Little Rock; **Balint Neray**, who transferred from Northwestern's Feinberg School of Medicine to work with Professor Noshir Contractor's SONIC lab; and **Masoud Barah**, who received a PhD in industrial and systems engineering from the University of Tennessee.

**Tommaso Colombo** joined the department as a visiting predoctoral fellow from Sapienza University of Rome.

**Simon Risanger** joined the department as a visiting predoctoral fellow from the Norwegian University of Science and Technology.

Professor **Ermin Wei** and her family welcomed their first child this year.

Professor **Jill Wilson** and her family welcomed their second child.

**Noelle Afolabi** joined MS in Analytics as a program assistant in student services.

**Beau Breeden** joined MS in Analytics as a systems administrator.

**Sarah Mitchell** was promoted to associate director of the MS in Analytics program.

**Cindy Nguyen** was promoted to admissions and marketing project coordinator of the MS in Analytics program.

**Borchuluun Yadamsuren** joined MS in Analytics as a research facilitator.

# Master of Engineering Management 2018-2019 Highlights

## Chain Reactions Innovations Program Selects MEM Leaders

World-class energy leaders, including Master of Engineering Management (MEM) Director **Mark Werwath**, will offer their expertise to Chain Reaction Innovations (CRI), the entrepreneurship program at the US Department of Energy's Argonne National Laboratory, as part of a new advisory council.

CRI has named 14 advisory council members, including investors, industry experts, and business executives, to help guide its growth and strategy. CRI provides a two-year program for innovators focusing on pivotal discoveries in energy and science technologies, embedding participants at Argonne to develop their technology and business while collaborating with Argonne scientists and leveraging the resources available at the laboratory.

MEM alumna **Katie Kollhoff** (MEM '19) is one of five innovators in CRI's third cohort. She was selected from more than 120 candidates following a national application process and two-part pitch competition. Starting in June 2019, the two-year program will support Kollhoff's efforts to further develop and scale her proprietary energy and science technologies while also refining the business strategies behind her startup, NUMIX Materials. In addition to dedicated laboratory and office space, she will have access to Argonne's significant R&D resources and network of commercial partners and investors.

## Video Highlights MEM Experience

The MEM program has developed a new promotional video, the first one created in more than five years. The video introduces prospective students to the program's talented faculty, students, and alumni, as well as showcases the MEM experience by going behind the scenes on what it takes to develop management and leadership skills in the context of engineering. Watch the video: <https://bit.ly/2MJd5My>

## MEM Hosts Industry Night with Rob Wolcott

The MEM program hosted its fifth annual Industry Night in January on Northwestern's Evanston campus. This year's keynote speaker was **Robert Wolcott**, cofounder and chairman of The World Innovation Network and clinical professor of innovation and entrepreneurship at Northwestern's Kellogg School of Management. Wolcott's keynote address was titled "Foresight, Proximity, and the Future of All Business." He shared insights into how individuals and organizations can build vision as a capability. More than 120 guests braved the polar vortex to attend the annual celebration of education at the intersection of engineering and business. The event was sponsored by the Chamberlain Group, Chicago Tube and Iron, and Epsilon Economics.

## 2019 Wasserstrom Distinguished Lecturer

**William Cook**, professor of applied mathematics and statistics at Johns Hopkins University, presented the 2018-19 Wasserstrom Family Distinguished Lecture, "The Traveling Salesman Problem: Postcards from the Edge of Impossibility." He is the author of the popular book *In Pursuit of the Traveling Salesman: Mathematics and the Limits of Computation* and a member of the National Academy of Engineering.

## In Team Sports, Chemistry Is a Game Changer

Professor **Noshir Contractor** led research analyzing statistical data from professional sports leagues and online games, finding that past shared success among team members improved their odds of winning future games — results that could have implications far beyond sports.

The researchers studied data sets from NBA games, English Premier League soccer matches, Indian Premier League cricket matches, Major League Baseball games, and game logs for Defense of the Ancients 2, a multiplayer, team-based online battle game.

The group used linear regression modeling to examine the impact of a team's past success on predicting the outcome of games during the season following each league's data set. They found marked improvement in their predictions — between 2 and 7 percent — across each sport when prior shared success was included with the team's overall skill compared to accounting for team skills alone.

While the availability of analytics made sports a natural industry to test, the insights gained from the team's research applies in many more contexts, including business, academia, and even space travel.

