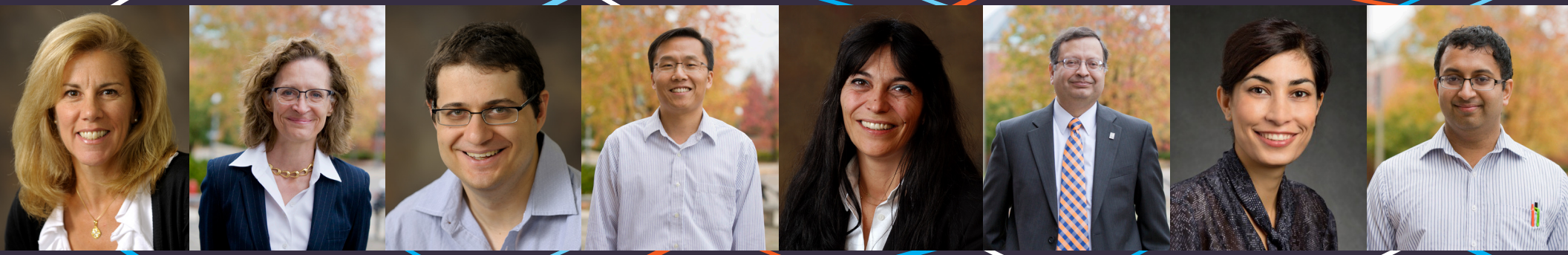
ISE Industrial and Enterprise Systems Engineering

ANNUAL REPORT 2015



THE GREAT 8 | ISE's Eight NSF CAREER Award Recipients

ENGINEERING AT ILLINOIS

Professor Girish Krishnan is ISE's newest NSF CAREER Award recipient.

This Faculty Early Career Development (CAREER) Program grant will pioneer the research and development of soft mechanical systems. Soft mechanical systems do not contain stiff components like metals, plastics, motors, joints, or couplings. They are instead made up of stretchable skins, appendages, fibers, and fluids. They are inspired by around 90% of nature's animal species that lack a rigid backbone, like an octopus arm. The unique feature of these systems is that they are flexible yet strong enough to bear large loads. Unfortunately, these systems are not widely used, because a design framework currently does not exist. This award supports research for a design framework.

8 **National Science Foundation Faculty Early Career Development (CAREER) Award winners — 40% of our faculty**

Pictured on cover (left to right):

Carolyn Beck (1998), Deborah Thurston (NSF Presidential Young Investigator Award—predecessor to CAREER Award—1989), Alex Olshevsky (2014), Harrison Kim (2010), Angelia Nedić (2008), Rakesh Nagi (1996), Negar Kiyavash (2011) Girish Krishnan (2015).

Cover Photography by Joanna Strauss.

Message from Rakesh

Rakesh Nagi
Department of Industrial and Enterprise Systems Engineering
Head & Donald Biggar Willett Professor Fellow, Institute of Industrial Engineers.

It's been another exceptional year for ISE@Illinois. I consider myself privileged to be at the helm of such a world class organization. With the support and involvement of our alumni family and corporate partners coupled with peer institution collaborations, we have made great strides toward achieving our vision of academic excellence. We have focused this past year on achieving excellence in our pillars of faculty, students, and infrastructure. Each of these pillars plays an integral and interconnected role in the success of ISE.

Our faculty have had a tremendously successful year. ISE faculty earned two promotions, multiple prestigious awards and grants, and published prolifically in the best journal and conference outlets. We are welcoming five new members this year. ISE had seven new NSF award winners, three Dean's Award winners, two new NSF CAREER award recipients, several best paper awards, and multiple professional society recognitions. ISE faculty celebrated great success receiving grants from the National Science Foundation, industry partners such as Proctor & Gamble, Deere and Toyota, and the Department of Defense, specifically the US Army Engineer Research & Development Center, Office of Naval Research, and the US Air Force. All of these achievements combine to create a world-class faculty that are serving our students and society as a whole.

ISE students are second to none. We are enjoying a 14% growth in our graduate population, and the blossoming potential of our undergraduate population. Our graduate students are participating in and being recognized for their cutting edge research while fostering the engineers of tomorrow through school outreach and camp sponsorship. Our undergraduates are some of the best in the world. They are winning prestigious awards academically as well as athletically and are leading the entrepreneurship revolution.

With the support of our alumni family and the College of Engineering, we have improved our laboratory and student spaces as well as the overall appearance and atmosphere of the Transportation Building. We have invested over $600,000 in: new equipment for our Flexible Manufacturing laboratory, remodel of the student lounge and study space, transformation of two bathrooms, and installation of new flooring and lighting on the first floor. These investments aim to improve the student learning and faculty research environments while instilling a sense of pride in all who call/have called ISE@Illinois home.

In the midst of these blessings, I hold the greatest gratitude for the ISE alumni board, the greater alumni community, and those who have donated their time and talent by returning to mentor students through the Engineer in Residence Program, supporting a Senior Engineering Project, offering a seminar, or just keeping us in their thoughts. It is largely to you that we owe these great researchers, teachers, and students described in this annual report.

Contents

Many articles included here may be read in an expanded form online at ise.illinois.edu

The Department of Industrial and Enterprise Systems Engineering (ISE) at the University of Illinois, Urbana-Champaign, ***innovates*** the engineering discipline with leading-edge research and scientific discoveries; ***educates*** a new generation of leaders in general, systems, industrial, and financial engineering; and ***serves*** education, industry, and society.

The ISE Annual Report is produced by William Gillespie, the ISE Communications Office, and Single Stereo Design. Contact us at gillespi@illinois.edu

Additional unattributed writing provided by William Gillespie, Emily Scott, and the College of Engineering. Photography by L. Brian Stauffer, Cary Frye, Doug McDannald, Joanna Strauss, and William Gillespie. Special thanks to Amy Summers for proofreading above and beyond the call of duty.

The University of Illinois is an equal opportunity, affirmative action institution.

Printed on recycled paper with soy-based ink. 12.038

ISE Innovate. Serve. Educate. ISE.

ENGINEERING AT ILLINOIS

From the Managing Editor's Desk

I remain thrilled to be part of the revitalization of ISE. As the first ever ISE marketing team—myself, some carefully hand-picked freelancers and vendors, and supernaturally talented student employees such as Emily Scott—I continue to face many challenges (Google "I Love Lucy Chocolate Factory"). But one challenge I am spared is having to play the classic used car salesman. In other words, I have the confidence of one attempting to "sell a product" of true quality. The department is small enough that I am fortunate to have frequent contact with students—our life blood—and the students I meet are superstars, happy to be here, they wear the shirts I design with pride, and they continue to remain connected to their four years at ISE even as they go on to careers that make me proud (and even jealous!). In our first issue, we attempted to reclaim our storied history and bring it to the future; it was a large issue. In our callus back room talk, we say Issue 1 was the *brick*, Issue 2 is the *razor*. Here we focus on the engineering and science research accomplishments of faculty and alumnae. Please enjoy, and do not hesitate to contact me. As I said, while I remain very busy, the department is small enough to allow me to make time for ISE family and friends worldwide.

— William Gillespie, Communications and Marketing Coordinator
gillespi@illinois.edu
(217) 265-6594

Photography by L. Brian Stauffer

ISE FACULTY Thenkurussi "Kesh" Kesavadas

Jump Simulation Center

Emily Scott

ISE Professor Thenkurussi "Kesh" Kesavadas has been named co-director of the new Jump Simulation Center alongside Dr. John Vozenilek, chief medical officer of Jump Applied Research for Community Health through Engineering and Simulation (ARCHES) in Peoria.

The creation of the new Jump Simulation Center, which recently received $10 million in funding from Jump Trading, resulted from the collaboration between ARCHES and the College of Engineering at Illinois.

jumptrading SIMULATION & EDUCATION CENTER

Kesavadas is also the director of the Health Care Engineering Systems Center and said he works closely with the Jump Trading Simulation and Education Center in Peoria through the ARCHES program.

According to Kesavadas, the Jump Simulation Center will provide simulation training to medical students, a place for faculty to test their research, and an environment for collaboration between engineering and medical students.

"I've been involved right from the beginning, building the vision of how it should be, how it should look, all the way to the architectural design of the building," Kesavadas said.

The Jump Simulation Center is set to be completed by 2018.

Kesavadas said the center will include a wide variety of resources, including simulated operating rooms, team building programs, a basic skills lab, and possibly even a virtual reality training environment.

These resources will help students learn everything from basic skills such as developing an interpersonal relationship with a patient and how to insert an IV to how to dissect tissue and perform surgeries.

Kesavadas said the Jump Simulation Center will also likely have some state-of-the-art, advanced facilities.

The fact that it will be located literally within the College of Engineering—it will be based in Everitt Laboratory—also makes it unique. Often times, colleges of medicine are located on separate areas of a campus than colleges of engineering.

This closeness will allow for collaboration between engineering students and medical students, Kesavadas explained.

"This is really a fantastic opportunity for the engineering students who will do projects or learn about simulation or even do some simulation," he said. "Think of what this can do for us."

New technology to assist in-home rehab care

Kim Gudeman, CSL

In the future, the occupational therapist helping you relearn how to use a fork following a stroke might be a computer.

Professor "Kesh" Kesavadas and colleagues are developing new technology that could assist stroke victims and others with occupational and physical therapy at home. The project, "Cognitive Haptic-Based Rehabilitation System for Patient-Centric Home," is funded by the National Science Foundation at $708,000 for three years.

"When people go back home after a stroke, they are rarely monitored and often decline in abilities," said Kesavadas, director of the Health Care Engineering Systems Center at Illinois and a professor of industrial and enterprise systems engineering.

"Our primary goal is to use very advanced technology to help people do fine-motor rehab at home."

The research comes at a time when health care costs are driving stroke victims to reduce time spent in in-patient rehabilitation care and return home before recovering fully. Stroke is a leading cause of disability among American seniors, with nearly 800,000 strokes occurring each year.

Researchers in Illinois' Coordinated Science Lab are developing a system based on haptics, the process of recognizing objects through touch. The team is working to create a low-cost model that can help enforce proper technique through exercises, which will be designed using data collected by analyzing the motion of healthy subjects. In particular, the work will target fine motor skills—which usually involves synching the hand and fingers to make small movements—over gross motor skills, which are less challenging to rehabilitate.

"This technology could really help assist in teaching any fine motor skill through repetition of movement," Kesavadas said.

Virtual surgery simulation

Mike Koon

Kesh Kesavadas and his staff welcomed the RAVEN II robot assisted tele-surgery for tele-health to the Health Care Engineering Systems Center.

Raven will allow future doctors hands-on training in robotic surgery without the use of a patient. It's one of the first steps that will link cutting-edge medical research already taking place on campus with the engineering-based College of Medicine, opening in 2018.

"In Peoria, we have a full-fledged operating room built to scale," Kesavadas explained. "You can simulate whole procedures—robotic, laparoscopic or traditional open surgery. This allows us to go and test to see how the simulator would work inside an operating room."

The research that Kesavadas's group is working on wouldn't even require a robot for learning the basics of robotic surgery. Instead, through virtual reality and computer simulation, surgeons will be able to replicate the surgery.

"We use a mock interface to control a virtual robot," Kesavadas said. "The goal is to make a surgeon highly skilled before they are allowed to touch a patient."

There are two technologies that have made this type of simulation possible, according to Kesavadas. The first is virtual reality, which can simulate cutting a tissue, tying a knot and advanced engineering principles that are graphically stimulating. The second is haptics, which gives users the sensation of touching objects. For instance, a surgeon could feel tissue even though there is none.

"With computers and the new GPU based technologies, we are able to implement algorithms on a PC which would have required a supercomputer maybe 15-20 years ago," Kesavadas said.

With simulation centers on campus, at Carle Foundation Hospital in Urbana (the university's partner in the College of Medicine) and in Peoria, the University of Illinois is poised to be the epicenter of surgical simulation whether through research or practice.

"We are building a big effort to become national leaders in simulation," Kesavadas said. "Even though others are training in robotic surgery itself, the simulation to train robotic surgery is something that we have a unique strength here. There really is no other center like this in the country. We will have access to everything a student or a fellow will be required to learn. With RAVEN and the new virtual simulator, it helps take our robotic surgery program to the next level."

ISE FACULTY

Harrison Kim

Remanufacturing and design: a promising solution for achieving green, profitable businesses

Rick Kubetz

"As environmental regulations become increasingly stringent and people are more concerned about environmental issues, manufacturers are faced with the challenge of operating both green and profitable businesses," explained Harrison Kim, an associate professor in the Department of Industrial and Enterprise Systems Engineering.

"To maximize the total profit from the lifecycle, the initial design for new and upgrades for remanufactured products must be planned simultaneously."

In his research, supported by the National Science Foundation and several key manufacturers, Kim and his colleagues have developed an optimization model to maximize total life-cycle profit from selling new products and remanufactured products. It optimizes both the initial design and design upgrades at the end-of-life stage and also provides corresponding production strategies, including production quantities and take-back rate. The model is extended to a multi-objective model that maximizes both economic profit and environmental-impact saving.

Remanufacturing typically involves two sequential activities: product take-back and a reprocessing operation. Parts are reused rather than being recycled or discarded, delivering products in "same-as-new" condition at a reduced cost while limiting raw material consumption and waste. Commonly remanufactured products include machinery parts such as pumps and engines, power tools, and electronics products—items whose exterior cases are still good but whose motors, cutters, or batteries need to be replaced or repaired.

"To make remanufacturing profitable, the right quantity of remanufactured products must be produced with optimal part upgrades and offered to the market at a reasonable price, leading customers to choose them over competing products," Kim said. Manufacturers such as Caterpillar, John Deere, Apple, Xerox, HP, and Sony represent the wide range of industries that have turned to remanufacturing.

As functional sales (such as leasing) and asset recovery services by manufacturers increase, remanufacturing is expected to become more popular and prevalent. However, for a company which manufactures and sells both new and remanufactured products, optimizing product design is not a simple task. Product design must be optimized in a way that considers possible part upgrades at the end-of-life stage.

"To maximize the total profit from the entire life cycle of a product, design decisions must be made by considering both stages together," Kim stated. "As the availability of raw materials tightens and the end-of-life disposal costs increase, refurbishing and remanufacturing become more viable and attractive options."

Kim Receives Prestigious John Deere Award

Emily Scott

Left to Right: Kimberly Normoyle, Director, Worldwide Indirect Materials & Services at Deere & Company; Professor Kim; Klaus Hoehn, VP Adv. Technology and Engineering at John Deere

Associate Professor Harrison Kim and his research team were awarded the John Deere Supplier Innovation Award for their Design for Environment and Sustainability project.

Six years ago, Deere initiated a collaborative research effort with Professor Harrison Kim looking to find ways to incorporate sustainability into their product design and manufacturing.

Unlike analyzing the fuel economy of a car, Kim described how it is difficult to analyze complex machines, such as Deere's products, in the context of sustainability.

"There is no well-defined structure to evaluate the sustainability and performance, and it was very difficult because of the nature of the products," Kim said.

These machines are complex because of their size, scale, and variability in the way they are used. They are used in many different environments, locations, under different regulations, and are typically used for a longer period of time than something like a car.

Kim's goal was to develop a way to analyze these complex machines' performances similar to the way cars are evaluated for fuel economy.

Using his expertise in the fields of design, sustainability, and systems engineering, Kim and a team of undergraduate and graduate students from his Enterprise Systems Optimization Lab began to work on this problem.

"To me, it was very interesting because I've done some work in consumer electronics and small-scale products, but now this was a chance to do this on a much bigger scale," Kim said.

Eventually, they developed a methodology that characterizes the environmental sustainability and performance of very complex machines in a very efficient way.

At first, it would take three to six months to complete a set of analyses for one set of machines. Over time, they have optimized this process so that it only takes a few hours.

"We developed different tools and an interface that can automate this process," Kim explained. "Instead of going through this laborious, exhaustive process of collecting data and all these things, now we just put in the product data and it just does it."

The group is the first from a university to be recognized by Deere for this award. Previously, the award had only been given to industry partners.

"It's a lot of fun, and we just renewed for another year," Kim said. "It's been a great run."

The work that Professor Kim and University of Illinois student researchers have produced has served as one of the pillars of John Deere's Product Sustainability Goal—which is one of the suite of (4) 2018 Eco-Goals introduced in 2013. More information on these Eco-Goals and Product Sustainability is available on JohnDeere.com.

ISE FACULTY
DEBORAH THURSTON

Best Paper Award in Manufacturing and Design

Emily Scott

When it comes to using virtual reality to run simulations, people often wish for it to mimic reality exactly. But what if you could make virtual reality better than reality by giving the user more information?

This is the question that researchers Aaron Joseph, James Schreiner, and ISE professor Deborah Thurston, asked in their paper "Impact of Visual Models on Risk Attitude and Decision Trade-offs," which recently won the Best Paper Award in Manufacturing and Design at the 2015 Industrial and Systems Engineering Research Conference (ISERC).

To see if they could improve virtual reality simulations to help users make better decisions, they ran an experiment involving a small group of engineering students using a virtual reality system that simulated repairing damage on an airplane part.

According to Thurston, repairing airplane damage used to be pretty straightforward when planes were made primarily out of aluminum. Now planes are typically made up of polymer composites, which adds more room for mistakes and more steps in the decision-making process.

Their experiment tested three hypotheses: could adding more aspects to the virtual reality help the engineer comprehend what their tradeoffs are; could it affect their stated willingness to make tradeoffs; and could it affect how willing they are to make a risk?

They let the participating students approach an example scenario given to them in a virtual reality simulation—a part of a tail wing had been damaged by hail—different from the traditional way, which typically just provided a description of the damage and data about cost of the repair, the size of the damage, etc.

Instead, the students were given even more information, including photos of the damage and a spreadsheet they could use to weigh options mathematically. The students could look at this information while they worked on the problem within the simulation.

"The basic question we were asking was: if we use the virtual reality system and show these things within the system, does this influence the decision?"

Thurston said they found that it did, proving all three of their hypotheses to be correct. According to Thurston, it strengthened their understanding of tradeoff options and increased their willingness to make tradeoffs and risks.

Thurston said the fact that 82% of the subjects changed their willingness to make tradeoffs is an interesting finding.

Thurston said this research is important because it is typically thought that computerizing or automating a process will make it significantly better. But that is not always the case. "You might be automating something that doesn't work, or something that's really inefficient," she said.

Illinois leads $6.25M initiative to advance multimodal data analysis

Kim Gudeman, CSL

An Illinois-led research team has received a $6.25 million Department of Defense Multidisciplinary University Research Initiative (MURI) award to develop a new information theory for data collection, analysis, and decision-making. The research, housed in the interdisciplinary Coordinated Science Lab, aims to speed up and improve our ability to collect and analyze data and subsequently adapt our decisions as new information comes in. Applications range from social network analysis to interactive machine learning with humans in the loop, such as brain computer/robot interfaces (BCI/BRI) or crowdsourcing.

The grant will allow Negar Kiyavash (associate professor of industrial and enterprise systems engineering and electrical and computer engineering) and her team to make advancements related to the non-commutative information structures that are intrinsic to hierarchical representations, distributed sensing, and adaptive online processing. In non-commutative information structures, the knowledge extracted from the data is dependent on the order of operations and direction of information flow.

Non-commutativity is intrinsic to emerging complex sensing and processing systems. The performance of a distributed sensor network depends on the ordering or partial ordering of the sequence of information sharing actions taken across the network. Multiuser brain-computer interfaces provide directed channels of neural communication from human to machine and between humans. To understand human activities depicted in a video, it is necessary to distinguish among different orderings of sequences of gestures and actions.

In a social network, for example, the theory could help marketers understand how better to propagate their advertising messages. It could also help advance applications in other areas, such as recognizing and describing complex human activities from video, fusion of directed information flows, interactive machine learning with humans, and crowdsourcing and networks of brain-computer interfaces.

Kiyavash says the research will position Illinois as the international center of research in this new area; it will establish design principles for extracting knowledge from non-commutative information structures and fusing dynamic information from such structures, and will develop adaptive learning algorithms that manage the complexity and the large scale of the processing required. The research will be built on the theory of random matrices, free probability, and statistical machine learning, from an information theory perspective.

ISE FACULTY
Negar Kiyavash

ISE FACULTY
Sewoong Oh

Spy Vs. Spy: Rumor Source Obfuscation

Emily Scott

Anonymous social messaging apps such as Secret, Whisper, and Yik Yak have become increasingly popular because they allow users to share opinions or information without revealing their identity. But in some cases, the identity of the source of information can be found.

Researchers Giulia Fanti, Peter Kairouz, Pramod Viswanath, and ISE Assistant Professor Sewoong Oh have developed a way to protect the identity of the source on such anonymous messaging apps using a method called adaptive diffusion. Their paper, "Spy vs. Spy: Rumor Source Obfuscation," which outlines this method, recently won the Best Paper Award at ACM SIGMETRICS 2015.

According to Oh, their research pursuits stemmed from an interest in data privacy and seeing how data is collected and used. They began to look further into the importance of metadata, which is information about data, and not the data itself.

Metadata, Oh said, is much easier to obtain than actual data. Given this fact, Oh said they formulated the idea that when people share messages on anonymous messaging apps and metadata are collected, it's possible to figure out who started the message.

He compared it to the spreading of a rumor among people. After a certain amount of time, many people may know a rumor, and some of them may then work together to find out who started it. With information about who knows whom and other inside information, Oh said it is very possible to figure out the source of the message.

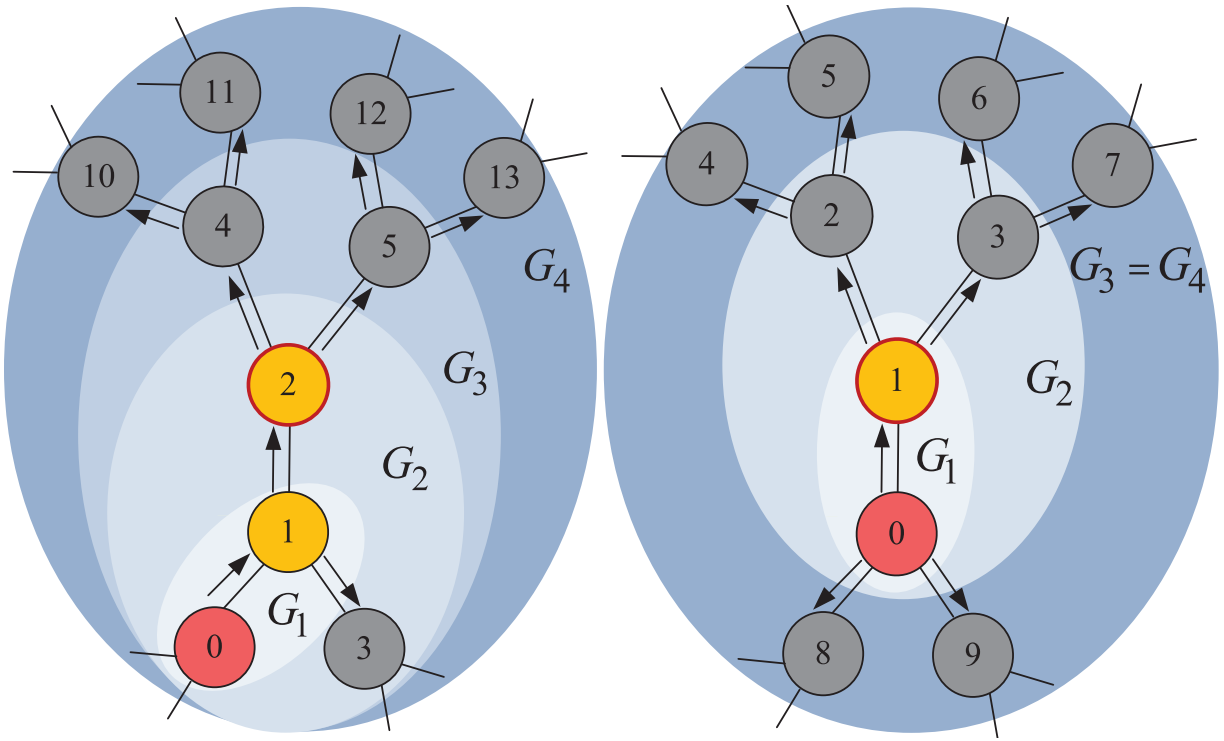
Oh said this led them to realize that it's important to pay close attention to how messages are spread on these anonymous messaging apps so as to better protect the identity of the user.

Specifically, they became interested in anonymous messaging apps such as Secret, Whisper, and Yik Yak, which are all mobile apps that allow users to send messages anonymously.

One way apps like this spread messages is by the amount of "likes" they get, such as in the case of the app Secret. Oh explained how if messages are "liked," they are further propagated on and on throughout the network so more users can see the message.

Normally, the messages are spread in all directions at a similar speed, making the spread look like circles centered at the source. "So, given some inside information, it's easy to triangulate where the source is with metadata," Oh said.

To prevent being able to triangulate where the source is, they propose a method for spreading messages called adaptive diffusion. Adaptive diffusion adds



Adaptive diusion over regular trees.Yellow nodes indicate the set of virtual sources (past and present), and for T = 4, the virtual source node is outlined in red.

delays to the process so that the spreading of messages doesn't look like circles, but instead it is skewed and biased. The delays are "in certain directions at a rate which is carefully chosen so that any node that's infected at any given time, that has the rumor, is equally likely to be the source," Oh said.

"What we did is try to come up with a way of spreading messages, adding more delays on the way and making it faster in some directions, so that it's difficult to figure out who the source was based on the metadata," Oh said.

Currently, they have developed a preliminary desktop version of an anonymous messaging service that uses the method they propose. They are working on developing their prototype for an app.

So why is it so important that users remain anonymous on these messaging apps? Oh said anonymity is crucial in places where citizens may be censored and are sharing opinions that could be harmful to the person.

Nonetheless, even if someone is just sharing secrets that cause no harm, keeping them anonymous is still important. Oh said people usually share sensitive information that they wouldn't share on a site such as Facebook; therefore, this information needs to be protected.

Oh said this research is important to the field of data privacy because it offers a new perspective to problems in this area.

"Most importantly, the main contribution of this is that we're suggesting a new problem … which hasn't been looked at before," he said. "Traditionally, people look at the other side of network forensics, where you're trying to estimate or infer something about it."

Oh described this research as a good balance between something that people are traditionally interested in—network forensics—and something that is new—the privacy angle on which this research has focused.

"We do something that's new that other people have not thought about until now, and at the same time the problem is simple and relevant enough that I think the SIGMETRICS community finds it interesting," Oh said.

Having their research paper win the Best Paper Award at ACM SIGMETRICS 2015 is something that Oh said is rewarding for his career.

"If you look at past winners of this award, those past winning papers have very exciting results," he said. "For us to be a part of that … is a very exciting moment in my career, definitely."

ISE FACULTY

Girish Krishnan

Nature Inspires Professor's Research in Soft Robotics

Emily Scott

An elephant's soft trunk, a snake winding its body around a branch, a tree's resistance to storms—these are some of the aspects of nature that inspire Assistant Professor Girish Krishnan's research in bio-inspired design and soft robotics.

"My aim right now is to look at the fundamental mechanisms behind nature's functionality and translate them as best as we can, within the engineering constraints, to modern engineering products," he said.

After completing his bachelor's in mechanical engineering from the R.V. College of Engineering in India, Krishnan became fascinated with engineering while he earned his master's in engineering at the Indian Institute of Science and his doctorate in mechanical engineering at the University of Michigan, Ann Arbor.

From there, Krishnan knew he wanted to use his skills to make a difference in the more personal aspects of people's lives. Initially, his main interest was in small systems, but as he began to see similarities between nature and engineering, his research evolved.

Krishnan applied for his current position with ISE after completing his PhD and was hired in 2013. Since then, he has advanced his research through his Monolithic Systems Laboratory, taught courses in design, reliability, and flexible mechanisms, and won a National Science Foundation Career Award.

Through his research, Krishnan hopes to find a way to translate the features of nature into products that help people in their everyday lives.

"If you see some plant and animal structures, they are lightweight, reliable," he said as an example. "In areas with tornadoes, you see buildings that collapse, but trees and plants still are not yielding or breaking as much."

One particular translation he has been working on is in soft robotics, which is exactly like it sounds—instead of using hard, rigid materials such as metal, soft robotics uses skin-like, flexible, or even fluid components that are sturdy, yet moveable and incapable of injuring someone.

Soft robotics can be utilized to make personal robots that could assist in the care of the elderly or disabled, or wearable robots that would allow users to perform specific tasks.

Bill Gates, co-founder of Microsoft, forecasted in a 2006 article for *Scientific American* magazine that in the near future, personal robots will be in every home.

"For this, there has to be a fundamental change in the way they are made," Krishnan said. "You can't make them out of rigid materials . . . it can hurt you."

That's where robotics meets bio-inspired design in the creation of soft robotics, with parts that resemble

something like an elephant's trunk or a snake's body. Krishnan plans to translate basic engineering fundamentals into technology that can aid people, such as safe, personal robots.

Soft robotics may bring to mind the Disney movie "Big Hero 6," which features an inflatable personal healthcare assistant robot called Baymax. Krishnan said this is indeed realistic, but he and his research laboratory, the Monolithic Systems Laboratory, are interested in creating smaller robots, such as their pneumatic arm sleeve. The sleeve is designed specifically for children who use crutches and often suffer from problems due to their entire body weight resting on their wrists. Using an inflatable device, their pneumatic arm sleeve transfers the weight load to the entire arm instead of just the wrist.

Another creation he and his laboratory have made are applications called fiber-reinforced elastomeric enclosures, which have a structure similar to an earthworm and can produce motion characteristics that were previously not possible with existing mechanisms—they act similarly to the way a snake wraps itself helically around a branch.

Krishnan has also shown progress in the creation of an entirely inflatable robot which utilizes pressurized air to perform simple tasks on factory floors. As the robot does not use electricity and is inexpensive, Krishnan said this may revolutionize the niche area of factory automation that requires human

"My work right now is to evolve, mature, and investigate engineering concepts that can enable these safe, personal robots in the next 10 to 15 years," Krishnan said.

interaction and the ability to repeat tasks, but not as much precision.

In addition, Krishnan hopes to expand his research further into the area of additive manufacturing, using tools such as 3D printing and rapid prototyping to create applications.

The research laboratory that Krishnan advises, the Monolithic Systems Lab, consists of five graduate students. Together, they strive to reach a balance between serendipity and structure. Often, their methods will lead to breakthroughs and advancements that Krishnan said he is often amazed by.

"The students here are really good," he said. "I feel blessed to work with them."

Though the laboratory has seen progress in its innovative projects, they have to manage being in a field that has no set guidebook.

"It's not something that you can find a whole lot of literature on, so there is no one to guide us when we hit a roadblock," Krishnan said. ". . . It can get pretty lonely along the way."

He described their eventual physical realization—seeing what they've created and seeing it work—as the most enjoyable part of his research and the driving force behind his the laboratory.

Aside from his research, Krishnan also teaches courses in design, the theory of reliability, and flexible mechanisms.

Krishnan said he has received self-assurance since receiving a National Science Foundation (NSF) Career Award, a prestigious honor and form of academic backing which he described as "one of the greatest jump starts that an assistant professor can get." To him, it is a confirmation that his research and line of thinking are valid. He is now one of the nine ISE faculty that have received the award.

ISE FACULTY

Rakesh Nagi

Connecting the Dots: Associating Information from Disparate Sources

Doug Peterson

For the past five years, Department Head and Donald Biggar Willett Professor of Industrial and Enterprise Systems Engineering Rakesh Nagi has been the principal investigator for a $6¼ million, multi-university project developing innovative ways to fuse information from "soft sources," such as human contacts, and "hard sources," such as cameras and physics-based sensors.

By running this and other intelligence analysis scenarios through their system, the research team demonstrated that it is possible to fuse various streams of hard and soft information, track the source of a threat, and determine if a risk exists. The team has made crucial advances in basic research on information fusion, and they produced software that is already being put to use in government laboratories, says Nagi, head of the U of I Department of Industrial and Enterprise Systems Engineering. Funding for the five-year project has come from a Multidisciplinary University Research Initiative (MURI) grant from the Army Research Office.

"With this research, we're trying to save lives," he says. "We're trying to keep our country and all countries safe, because every nation is subject to terrorism."

He points out that since the 9/11 attack in New York, in which nearly 3,000 people died, the number of deaths annually due to terrorism has increased almost five-fold.

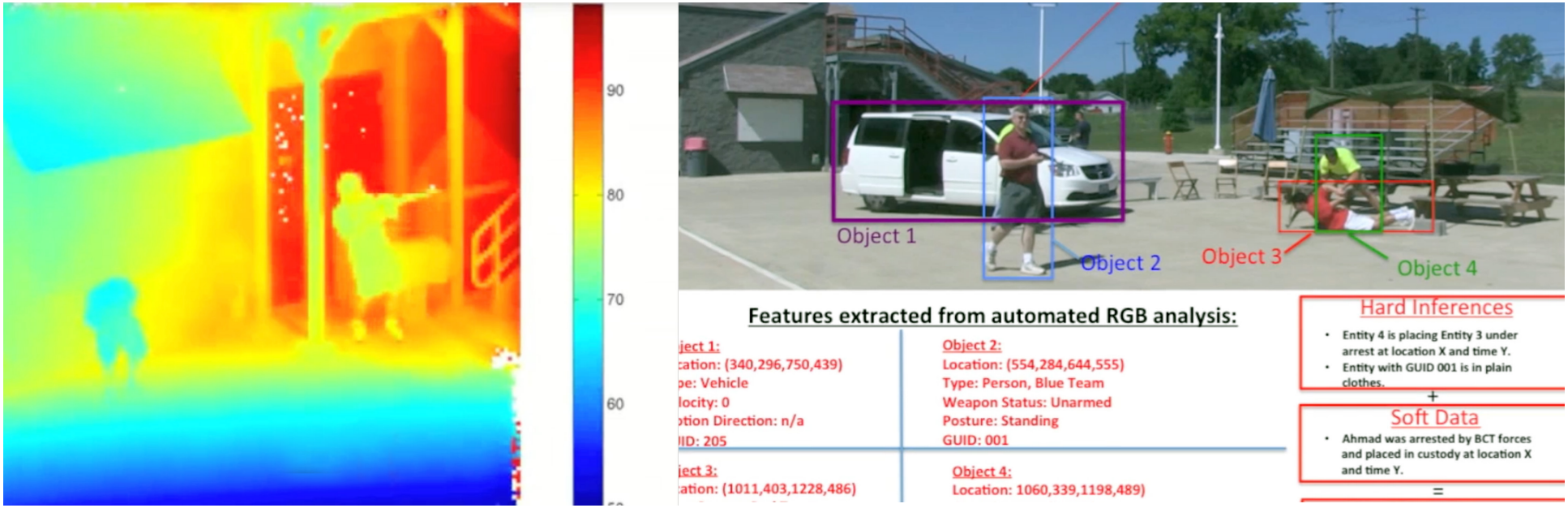
Nagi came to Illinois in 2013 from the University of Buffalo, which is home of the MURI research team working on the information fusion problem, along with Penn State, Iona College, and Tennessee State. He has extensive experience in information fusion, military/applied operations research, facilities design, and manufacturing systems. For example, he worked on information coming from sensors that detected changes in vibrations within helicopters—a way to catch early signs that cracks had formed on the helicopter's gear teeth.

Then in 2001, the attack on the Twin Towers on 9/11 changed the direction of his research.

The daughter of a good friend was scheduled to be working in the Twin Towers on that day, but she just happened to stay home with a sick daughter. This brought terrorism close to home for Nagi, who then began to focus his work on fusing intelligence information.

Intelligence analysts face a classic Big Data problem: How do you pluck critical information out of the ocean of information pouring in and make the connections that ultimately trigger an alert that a terrorist attack might be developing?

Hard data comes from sensors that pick up various types of signals and images to detect the movement of people and vehicles. Hard data can be quantified, but the challenge, Nagi says, is how to fuse it with soft information coming from human observers. A major problem is converting the natural language in observer reports into something that can be associated with hard data.



"We call it soft information because its accuracy depends on how well a person can make an estimate," he says. "For instance, how well can a person judge height or age?"

According to Nagi, accuracy depends on characteristics of the observer, characteristics of the target, and environmental conditions, such as low lighting.

The MURI team ran extensive studies on student observers trying to estimate such characteristics as height and weight; building on these findings, the system takes into consideration the uncertainty that comes from human observations.

"Machines are very good at certain things, and people are good at certain things, such as judging emotion," he says. "The question is how do we take advantage of both strengths?"

Their system processes information in the form of graphs, which include "nodes" and "edges." Nodes represent entities such as people, vehicles, locations, or organizations, while edges represent the relationships among them. Using these graphs, their information fusion system can look at the tangled relationships among various entities and connect the dots.

The system makes associations between multiple graphs and then matches the information with templates that model certain threat scenarios. If a situation comes close to matching one of the templates, it will score high and raise warning flags for an intelligence analyst.

For example, one obvious situation might be the convergence of several factors—a person connected to a suspect organization attends flight school and purchases a one-way airplane ticket. The combination of these details could alert intelligence analysts to a potential 9/11-style attack.

The MURI team also worked on ways to fuse hard data from very different sensors. It found ways to connect the acoustic data on vehicles with the visual images of vehicles to confirm, for instance, that a van moving toward the courthouse is the same white van owned by the suspected terrorist. They also worked on ways to fuse three-dimensional images with two-dimensional pictures to determine if a suspect showing up in both images is actually the same person.

"We're finding ways to assist the intelligence analysts in making sense of this large amount of information," Nagi says.

As he puts it, "We managed to get this research over the hump and into use."

ISE FACULTY

James Leake

GE 402 "Computer-Aided Product Realization"

Emily Scott

GE 402 "Computer-Aided Product Realization," taught by ISE Senior Lecturer James Leake, and Industrial Design Professor David Weightman, provides students with a creative, hands-on experience learning CAD programs, laser scanning, and 3D printing. Students work in teams to develop a product with a 3D printer.

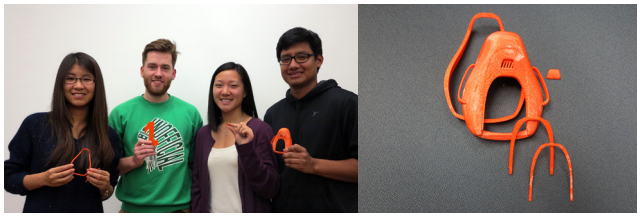
Six years ago, ISE Director of Engineering Graphics and Senior Lecturer James Leake teamed up with Professor of Industrial Design David Weightman, to create a course aimed to give industrial design and engineering students hands-on experience with advanced CAD programs, laser scanning, and 3D printing.

Evolving with changes in technology, the course, GE 402 "Computer-Aided Product Realization," has become a creative team-building experience where students complete a final design project that allows them to work closely with each other and with a 3D printer.

During the first half of the course, which is offered one semester a year, students learn how to use several CAD programs such as SketchBook Pro and Showcase. The second half of the course is focused entirely on the final design project, where teams of students experienced in a variety of disciplines are given a prompt to create a product that could be used in the real world.

In the fall 2014 class, the prompt was to create something that you could wear on your head. Students were given examples and then began brainstorming ideas.

GROUP 1: air filtration mask



Team members: Aileen Bai, Bryan Clark, Jenny Lin, Edwin Lira

The ***Interchangeable mask for air filtration*** allows users to change the filters while wearing the mask and could be used for activities such as biking or working in a factory.

Group 1 used the technologies available to them to develop their products into their best form. Jennifer Lin, senior in Mechanical Engineering, explained how the first few models of her team's product—a face mask with interchangeable air filters—benefitted from using the 3D scanner to make sure it fit to a real face.

"We used the 3D printer to make a few prototypes and I'm really proud of the final product we created," Lin said. "Without all the diverse backgrounds, we wouldn't have been able to make such an awesome product." The mask they created could be used for activities from biking to working in a factory. Users can change the filters in the mask while wearing it.

GROUP 2: SnorkLear

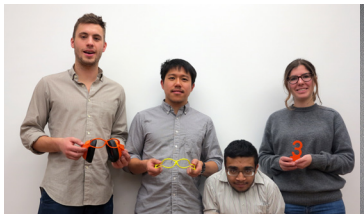
Team members: DJ Mascarenas, Austin Chen, Marcos Frechilla, Lizzie Bertness

SnorkLear is a Snorkeling mask for people in need of prescription goggles if they cannot wear contact lenses or choose not to wear them.

Group 2 used real-life experiences from their own members to envision their product, the SnorkLear, which Lizzie Bertness described as a pair of adjustable optic diving goggles meant for individual sale and rental sale. "The target user is me, actually: an incidental snorkeler/diver that cannot or chooses not to wear contact lenses," she said. She explained how their team's brainstorming process was both unique and a learning experience in itself.

"Both the synergy and dissonance that happens during brainstorming with different people is incredibly valuable, and we ended up with a design that none of us could have conceptualized individually," Bertness, a mechanical engineer, said. "Working with industrial designers allows you to reconnect with your imagination again."

GROUP 3: HearClear



Team members: Avery Bellis, Arsalan Aslam, Zonghe Chua, Marta Ponte

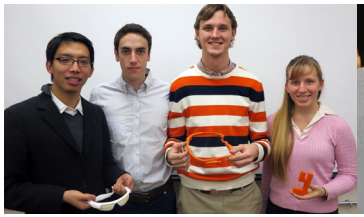
HearClear combines safety glasses and earmuffs into one product, solving the problem of machine operators not wearing ear protection due to their need to communicate with colleagues while working.

For Group 3, their method of coming up with an idea was anything but ordinary. Zonghe Chua, senior in Mechanical Engineering, said that initially, his group was set on creating a form of hearing protection. Another team member then started playing around with an earmuff and realized that "when he flipped the headband over his eye it looked really cool."

"Our project turned around 360 degrees within a two hour brainstorming session between different majors," said fellow team member Arsalan Aslam, senior in Mechanical Engineering. The product eventually transformed into what they named the HearClear, combining both safety glasses and earmuffs into one product, with an added feature of a sound hole that allowed the user to hear outside noise without having to remove it.

"We hope that this would provide an affordable solution to the problem of machine operators not even bothering to don ear protection [due] to their need to communicate with their colleagues while working," Chua explained.

GROUP 4: CycleSmart



Team members: Peiyuan Zhang, Julio Minaya, Andrew Boen, Sarah Hillebrand

CycleSmart are "smart" glasses meant for cyclists that have a camera and a digital screen, and a Bluetooth-enabled earphone to communicate with other cyclists wearing the glasses, listen to music, or talk on the phone.

Julio Minaya, an international exchange student from Spain, described Group 4's creation of smart cycling glasses as a result of a two-week brainstorming period. "It was my first teamwork at this University," Minaya said of the final design project. "I had never worked before with three other students at this University, and this course gave me this opportunity."

After deciding on this particular idea due to the lack of similar products in existence, they designed the rear-view glasses that have a camera and a digital screen, and a Bluetooth-enabled earphone to communicate with other cyclists wearing the glasses, listen to music, or talk on the phone.

"I personally enjoyed this course since it offered to the students the possibility to work with a 3D printer and a 3D scanner, and I had never worked with something like that before," Minaya added. "We were taught at the beginning of the course how to use a relatively new 3D CAM/CAD program called Fusion 360 that I personally loved."

Welcoming New Faculty to ISE

James Davis

Assistant Professor

PhD in Operations Research, Cornell University (2015)

James Davis joined the Department of Industrial and Enterprise Systems Engineering as an assistant professor in August 2015. He completed his PhD in Operations Research at Cornell University after earning his BS in Mathematics from Rutgers University—Camden. His research is focused in revenue management, assortment optimization, customer choice models, combinatorial optimization, and approximation algorithms. Specifically, he is interested in accurately modeling customer purchasing behavior, and using models of customer purchasing behavior to identify high revenue product assortments.

James worked as an Amazon.com research scientist intern in 2014. He was awarded an NSF Graduate Research Fellowship in 2011.

Jugal Garg

Assistant Research Professor

PhD in Computer Science and Engineering, IIT-Bombay (2012)

Jugal Garg will start at ISE in Spring 2016, after a semester at the Simons Institute, Berkeley CA. Prior to that, he was a research fellow at the Max-Planck-Institut for Informatics, Saarbrucken, Germany. Previously, he was a postdoctoral fellow at Georgia Tech. He received his PhD from IIT-Bombay, India in 2012. Jugal's research explores computational and strategic aspects of equilibria in game theory and economics, and their connections with dynamical systems and learning. He is interested broadly in the design and analysis of algorithms, optimization and mathematical programming.

He is a recipient of the Microsoft Research India Rising Star Award 2011. In 2009, he was awarded the Shantanu Deshpande Memorial Scholarship.

Niao He

Assistant Professor

PhD in Operations Research, Georgia Institute of Technology (2015)

Niao He will join ISE in Spring 2016. She completed her PhD in Operations Research and masters in Computational Science and Engineering in the School of Industrial and Systems Engineering at Georgia Institute of Technology under the supervision of Dr. Arkadi S. Nemirovski. Before coming to Georgia Tech, she obtained a bachelor's degree in mathematics from the Special Class of Gifted Young at University of Science and Technology of China.

Niao is broadly interested in optimization and machine learning—specifically fast algorithms and theoretical guarantees for large-scale optimization, with applications including but not limited to machine learning, signal and image processing, financial engineering, and decision-making under uncertainty.

Justin Sirignano

Assistant Professor

PhD in Management Science and Engineering, Stanford University (2015)

Justin Sirignano will join the Department of Industrial and Enterprise Systems Engineering as an assistant professor in Fall 2016. Sirignano completed his PhD at Stanford University in the Department of Management Science and Engineering in July 2015. He received his BSE from Princeton University, majoring in Operations Research and Financial Engineering. In 2015-2016, while an adjunct assistant professor in ISE, he will be a Chapman Fellow at the Department of Mathematics at Imperial College.

His research interests include data-driven modeling, optimization, machine learning, and financial engineering. Recently, Justin was awarded the inaugural SIAM Financial Mathematics and Engineering Conference Paper Prize.

Linwei Xin

Assistant Professor

PhD in Operations Research, Georgia Institute of Technology (2015)

Linwei Xin joined ISE in Fall 2015. He received his PhD in Operations Research from the Georgia Institute of Technology in 2015. His research focuses on stochastic inventory control, optimization under uncertainty, supply chain management, data-driven decision making, revenue management, and risk management.

Linwei worked as a Research Summer Intern at IBM T.J. Watson Research Center in 2013, developing stochastic optimization models and methods for solving problems arising within the context of workforce and sales force projects.

He also worked as a data scientist intern at Walmart eCommerce in 2015, building dual-sourcing inventory replenishment algorithms for Smart Inventory Management System (SIMS).

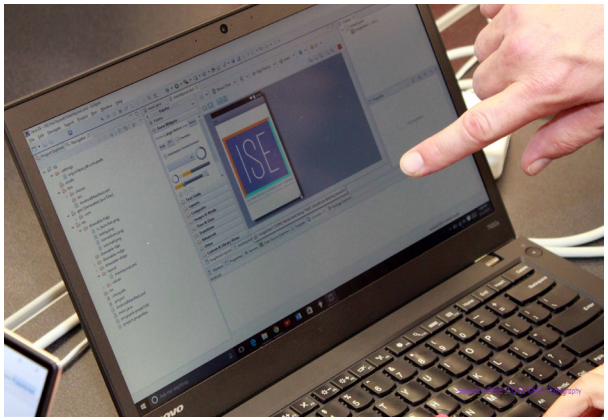
ISE STUDENT NEWS

SATURDAYS@ISE

The Undergraduate Programs Office offered workshops combining design principles, Computer Aided Design (CAD), analysis, and computer programming in an effort to demonstrate the curriculum in action. The students who participated were able to create their own phone application as well as design and 3D print their own bracelet.

Lean Six Sigma Green Belt Training

ISE and generous alumni are subsidizing Six Sigma Green Belt training for interested undergraduate students. The students learn about data collection and the interpretation of the data, specifically as it relates to the processes. At the conclusion of the training, the students sit for the examination to earn their Green Belt. This certification makes each student more attractive to potential future employers.



STEPHANIE RICHARTZ BSIE 2015

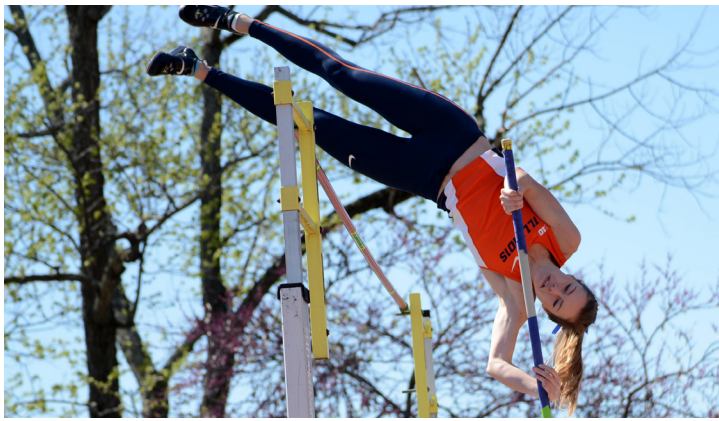
Stephanie Richartz gets a lot of the same types of reactions when she tells people she's an athlete as well as an Industrial Engineering major. "Usually people's first reaction is, 'oh my gosh, that's hard,'" Richartz, a senior, said. "And it is hard."

But with the surprised responses she gets, she said she enjoys the feeling of automatic credibility, especially as a female in engineering. "People admire how much work you have to put into school and how talented you are to be here in the first place, so that's really neat," she said.

The talent is no question—during her athletic career, she has won four Big Ten titles, and she recently won first place at the 2015 Indoor Big Ten Championship Meet.

On graduation weekend, Richartz capped her athletic and academic career with her third Big Ten Outdoor Track and Field Championships pole vault title. Richartz set a new Big Ten Outdoor meet record and broke her own school record, clearing 4.37m (14' 4") en route to the win. Stephanie claimed third place at the NCAA Outdoor Championships which puts her at 12th in the U.S. with a height of 14' 7.25". She subsequently received the Dike Eddleman Award for Illinois' top female athlete of the year.

She also leaves the university with an ISE Engineering Service Award. And her BSIE. Onward and upward!



Photos by Cary Frye

Photo by Doug McDannald

ISE UNDERGRADUATE
AMY DOROFF

Emily Scott

Dean Andreas Cangellaris presents ISE undergrad Amy Doroff with the Technology Entrepreneur Center's Illinois Innovation Prize

Six weeks into Amy Doroff's freshman year of General Engineering at Illinois, she wanted to quit.

"I didn't know what I wanted to do, I just couldn't do physics," she said. "I came to the ISE advising office and told them that I just couldn't do physics and I wasn't going to be an engineer anymore."

Doroff spoke to Heidi Craddock, assistant director of undergraduate programs and chief academic advisor for ISE, who encouraged her to not give up yet.

Three years later as a GE senior, Doroff has more than enough accomplishments to share.

She was awarded the Dan Levengood Excellence in Ergonomics Award for a project she completed at a John Deere summer internship, as well as the third-place Illinois Innovation Prize from the Technology Entrepreneur Center. She also completed an internship at Whirlpool Corporation that has led to a full-time position she will begin after graduating this December.

In high school, she visited several universities and decided to attend Illinois because she felt it was "like having a small, private engineering school across the street from a large, public university."

Doroff chose ISE—and GE specifically—because she wanted to make sure she could receive important skills outside of just engineering.

"The ISE department seemed like it would give me a chance to learn all the different sides," she said. "I was right, it did."

During her freshman year, Doroff became involved in the Society of Women Engineers and in her residence hall. She later became a resident advisor because she wanted a chance to mentor.

Then one day during her junior year, Doroff was walking to Engineering Hall when she saw a recruiting tent for John Deere set up on the sidewalk. She spoke with a recruiter and ended up getting an internship opportunity.

"I like to say I got a Frisbee and a job," she said. "More or less, that's what happened."

That summer, she went to work at John Deere's Harvester Works factory in Moline, Illinois. Two weeks into her internship, she was assigned to a high-profile engineering project that involved working on a lock collar. A lock collar is a part that goes on a combine's rotating shaft to prevent it from moving laterally. However, the process for installing the lock collar Deere was using was unreliable, causing the company to receive many warranty claims and making it unsafe for assembly line operators.

In less than twelve weeks, Doroff ended up creating a tool that fixed both of these problems. Harvester Works leadership took notice of what she had created and nominated the project for the Dan Levengood Excellence in Ergonomics Award at John Deere's Global Ergonomics Conference in Sept. 2014.

The day she attended the conference, Doroff was only thinking one thing as she looked around the room at other innovators from Deere.

"When I saw these people three decades my senior, I thought, I hope to be one of these people one day," she said. "I was sitting there thinking, maybe I'll be as good as them one day. And maybe I'll have the opportunity to come back and actually have a shot at this."

Later that evening, she got a call informing her that her project had won the award.

"I wasn't there to see it. I went to Control Systems, that was a hard class for me," Doroff said with a laugh.

Doroff said she thinks she was able to make such an effective, award-winning tool because she could see the problem from multiple angles. In high school, she worked at Advocate Health Care for four summers as an assembler of patient food trays, which allowed her to get a perspective that she believes most engineers don't have.

"When I went to work at Deere, I had the ability to come up with things in different ways because I knew it from the operator side as well," she said. "The main solution I made for a project was to make it safer to come to work every day. And it happened to be something that could be globally implemented and standardized across the enterprise."

When she returned to school the next semester, Craddock nominated Doroff and her John Deere project for the Technology Entrepreneur Center's Illinois Innovation Prize, an award that recognizes the most innovative student on the Illinois campus.

She ended up making it to the final round as the only undergraduate student to do so. She was awarded the third place prize and $1,500.

"The judges were quite kind to me," Doroff said. "They said they recognized a lot of potential in what I had done, and I had been the only undergraduate in the competition, and my project had also been over the span of less than twelve weeks—some of the PhD research that was going on had been over the span of years."

Amy Doroff with her new Whirlpool colleagues at the ISE Career Fair.

After the award ceremony, she was approached by a representative from a company asking if she'd be willing to do a project for them. She then decided to take this opportunity further and start a company of her own with her award money.

She and Alex Rubocki, a fellow GE senior and Doroff's lab partner from Control Systems class, incorporated Hunter Madison Design LLC, a small tool design company that is named after two of Doroff's golden retrievers.

Her love for manufacturing led her to be accepted into Whirlpool's three-year manufacturing leadership development rotational program that will begin in January 2016.

Doroff is quick to credit a lot of her success to the advisors and faculty in the ISE department who have encouraged her since the time she wanted to quit six weeks into her freshman year.

"If Heidi and the ISE Undergraduate Programs Office let me quit at six weeks in engineering, I wouldn't have had the chance to make it safer to go to work at Deere, and I wouldn't have had the chance to increase assembly yield and be a leader at Whirlpool, I wouldn't have a chance to influence other students, to stand up in front of my peers and have something to say," she said. "These are the people who got me here."

ALUMNI NEWS

Louis J. Mancini

2015 Alumni Award for Distinguished Service

Much has changed in the airline industry over the past 40 years, but one of the constants has been the influence of Lou Mancini. Mancini retired in June of 2014 as Boeing's Senior Vice President for Commercial Aviation Services, where he led the company's customer support and after-market products and services for 12,000 airplanes worldwide. Mancini reenergized product support with a culture of 24/7 and launched a major rebranding of Services, Boeing Edge, which promises customers a competitive advantage over the lifecycle of their airplanes. In 2006, Overhaul and Maintenance magazine gave Mancini an outstanding achievement award for his work in improving Boeing's response to urgent airline issues.

Mancini served as a high-ranking official at Boeing for 12 years, initially as Vice President for Maintenance Services. He managed the unit of Commercial Aviation Services responsible for airplane recovery services, component maintenance and Boeing subsidiaries Continental DataGraphics and AeroInfo Systems.

Prior to his years with Boeing, he held executive positions at both United Airlines (1985-91, 1995-2002) and Northwest Airlines (1991-95). Mancini was Vice President for Engineering and Technical Support at United and Vice President of Engineering, Inspection and Quality Assurance at Northwest. In these positions, he served on the board of ARINC Inc., a company that provides communications and engineering services to the airline industry.

Mancini's influence goes beyond the corporate side. In 1994, he chaired a Federal Aviation Administration (FAA) task force charged with streamlining airline operations and reducing costs. For his efforts, he received a Radio Technical Commission for Aeronautics (RTCA) achievement award. In 1999, Mancini, a Royal Aeronautical Society Fellow, also received the "Nuts and Bolts" award for leadership in maintenance and engineering from the Air Transport Association. Before joining the airline industry, Mancini held management positions at Shell Development Company and Chevron.

Mancini is active in civic and industry affairs, having served on the boards of the San Francisco Bay Area Junior Achievement, the Pacific Science Center and the Museum of Flight in Seattle. He is also a member of the advisory board for the University of Illinois College of Engineering.

Upon Mancini's retirement, Boeing shifted his responsibilities to another Illinois graduate, Stanley Deal.

Lou Mancini: A Career

- Retired, Senior Vice President, Commercial Aviation Services, Boeing Commercial Airplanes
- BS, 1972, General Engineering, University of Illinois
- MS, 1975, Operations Research, Stanford University
- PhD, 1975, Operations Research, Stanford University

Ankur Kulkarni, PhDIE 2010, Associate of the Indian Academy of Sciences

Emily Scott

IE alumnus Ankur Kulkarni has recently been selected as an Associate of the Indian Academy of Sciences.

He received his PhD in Industrial Engineering in 2010 from ISE, studying game theory, and completed postdoctoral research at the Coordinated Science Lab. Since receiving his degree, he has been an assistant professor in the Systems and Control Engineering group at the Indian Institute of Technology Bombay, in Mumbai, India since January 2013.

"Today I do research and guide students on problems in game theory, variational analysis, stochastic control and information theory," he said. "I am particularly interested in foundational questions and in emerging paradigms such Big Data. I also teach graduate-level courses on optimization and game theory."

Kulkarni said he at first had a "sense of disbelief" when he learned he had been selected to his associateship with the Indian Academy of Sciences.

"The Indian Academy of Sciences is extremely selective and they are looking at a large talent pool. Also, historically, engineering-theoreticians such as me have usually not made it," he said. "I am grateful to those who nominated me and to the selection committee."

The Associateship program was created in 1983 with the intention of encouraging young scientists. A small number of scientists below the age of 35 are selected for the program.

Kulkarni said that his selection is a reassurance for his career.

"It tells me that, although my choice of areas and problems has been somewhat unusual, I have not lost my way and perhaps I am even on the right track," he said. "I hope that this recognition will also help me attract greater opportunities for career growth."

In his current position as an assistant professor, Kulkarni said he is making use of convex analysis and optimization-based arguments that he used in his PhD to understand and solve problems from other areas.

He said he hopes his career continues the way it has been so far.

"I will continue to work on core questions, enjoy the joys of discovering something new and hopefully earn the respect of my peers," he said.

Kulkarni said he has fond memories of working with his advisor Uday Shanbhag, Professor Jong-Shi Pang, and Professor R.S. Sreenivas during his time at ISE.

"I shared many happy times with [Sreenivas]. We had a shared interest in Indian classical music and philosophy, and have had some memorable—sometimes all-night long—chat sessions at his home.

"I also fondly remember the old-world charm of the Transportation Building—especially the railway motifs," he said.

Kulkarni's best advice for current ISE students is to take advantage of the opportunity they have to develop skills.

"Take lots of courses," he said. "Work hard on fundamentals and develop strength in them."

ALUMNI NEWS
Grad Student Placement 2015

Xi Chen received her MS in Industrial Engineering with Professor Yanfeng Ouyang. She studied operations research and her dissertation is titled "Integrated Planning of Multi-Type Railroad Service Facilities Under Location, Routing and Inventory Considerations."
Chen will be joining Yahoo as a software engineer.

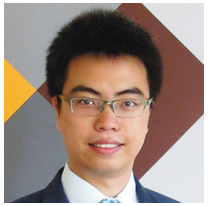
Andrea Hupman received her PhD in Systems and Entrepreneurial Engineering. She studied decision and control systems and her dissertation is titled "Theoretical and Experimental Examinations of Target-Based Decision Making."
Hupman will join the University of Missouri, St. Louis as an assistant professor.

Guanqun Li received his MS in Industrial Engineering with Professor Lavanya Marla. He studied operations research and his thesis is titled "Empirical Investigations of Properties of Robust Aircraft Routing Models."
Li will join IBM in China as a consultant.

Jungmok Ma received his PhD in Industrial Engineering with Professor Harrison Kim. He studied data analytics and his dissertation is titled "Predictive Design Analytics for Optimal System Design."
Ma will join the Korean National Defense University as an assistant professor.

Muhammed Sutcu received his PhD in Industrial Engineering. His dissertation is titled "Approximating Multivariate Distributions with Cumulative Residual Entropy: A Study on Dynamic Integrated Climate-Economy Model."
Sutcu will join Abdullah Gul University in Turkey as an assistant professor.

Praveen Tumuluri received his MS in Industrial Engineering with Professor Lavanya Marla. He studied operations research and his dissertation is titled "A Robust Approach to Vehicle Routing Problem with Pick-Up and Delivery Time Windows Under Demand and Time Travel Uncertainty."
He will join HighRadius Corp in Houston as an analyst.



Xin Wang received his PhD in Civil and Environmental Engineering under his advisor ISE Affiliate Professor Yanfeng Ouyang. Wang's dissertation was "Sustainable and Reliable Design of Large-Scale Complex Logistics Systems Under Competition and Uncertainties."
Wang has joined the University of Wisconsin-Madison as an assistant professor in Industrial and Systems Engineering.

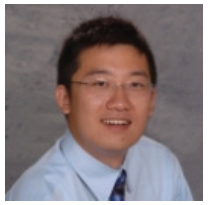
Masters of Science in Financial Engineering

My graduate experience exposed me to the world of research and I feel it has prepared me for the real world by ingraining patience and a quest for excellence.

Lakshmi Gururaja Rao received her MS in Industrial Engineering with Professor James T. Allison. She studied modeling and optimization and her dissertation is titled "Design and Optimization of Computationally Expensive Engineering Systems."
She will join Goldman Sachs as a technology analyst.

ISE is very flexible in its course requirements and encourages students to pursue materials from multiple disciplines.

Zhenyu Hu received his PhD in Industrial Engineering with Professor Xin Chen. He studied operations research and his dissertation is titled "Dynamic Pricing with Reference Price Effects."
Hu will join the National University of Singapore as an assistant professor.



Tianyuan (Tiger) Wang received his MS in Financial Engineering in the winter of 2012. In his 18 months in the MSFE program, he accomplished multiple technical, financial, and data-driven projects, in classes such as Optimization, Financial Derivatives and Stochastic Calculus. In his last semester, he did a project with Wells Fargo under Professor Morton Lane as advisor. Since his graduation, he has been an Equity Option Trader for Peak6 Investment. He is now applying what he learned in the Financial Engineering program into the real financial world.

Mayank Sirsalewala received his MS in Financial Engineering in December, 2013. As part of his last semester, he had the opportunity to gain some real world experience while working on a practicum titled "Enhancing Systematic Student Funding." Currently he works as a trader at Flow Traders, based in New York City. His education as a financial engineer has enabled him to enhance his strategies and approach the world of arbitrage with a different perspective.

Paul Katsen BSGE 2010, Finance Founder, Blockspring

Cristy Gillespie

Recently, we spoke with Illinois Business Consulting alumnus Paul Katsen. His startup www.blockspring.com was accepted into prestigious Y Combinator in the Silicon Valley.

We asked Paul about his time at Illinois and how he got to where he is today.

Q. How did you decide on pursuing both engineering and finance?

There are two interesting stories here. One is how to pick a major without knowing the job you want. The other is how to get around red tape.

Majors are a bit weird. You can look at a major as a path to a job, or as a collection of topics you want to learn about. If you want to be a civil engineer, the path to that job is probably getting a civil engineering major. The sad truth is I spent all of college, and most of post-college, having no idea what job I really wanted. Accordingly, I looked at majors through the second lens, as a collection of topics I wanted to learn about.

For me, choosing a major was a breadth-first search for interesting topics. I liked math and physics going into college, so one obvious path was to go into engineering. I wasn't much of a fan of a few other topics, so I quickly eliminated them (and their associated majors) from my search.

If you know you want to be a civil engineer, specialization is powerful. Since I had no idea what job I wanted, I knew I had to keep my options open. By the end of sophomore year I whittled my interests down to three majors: engineering, finance, and music. I knew given the hours requirements I could only do two out of the three, so I chose engineering and finance because they left the maximum amount of job opportunities open given the topics I enjoyed most. So I guess the lesson is if you know what job you want, finding a major is easy. If you don't, explore a bunch of topics and focus on the ones that you enjoy and that leave doors open for jobs. Personally, I also think specialization too early is dangerous to how people develop, but that's another topic.

Pursuing engineering and finance also came with a red tape problem. When I was in school, you weren't allowed to be in the engineering and business colleges at once. Doing both majors was technically impossible. So I had to hack the system. And doing so taught me an extremely valuable lesson: always start without asking permission.

I struck a deal with an amazing engineering dean to let me continue taking engineering classes for my major even though I would officially transfer into the business college. The only reason he said yes is because I was already taking and succeeding with a full workload of engineering and business classes. I was already doing well on the path, so there was a high likelihood I would still graduate as an engineer. There was little risk for him to say yes.

It turns out this is an extremely powerful trick that works in the real world too. If you want to get promoted to manager, start doing the job of a manager as an analyst. If you want to sell software to a company, show them that their employees are already using it. Always start without permission.

How did the concept for Blockspring originate?

One night, my co-founder and I came to a crazy revelation: no one cares about code.

How is that possible? Coders make a lot of money.

Tech companies are worth a lot of money. It's counterintuitive but true—no one cares about code. Code is just text. The only thing that really matters is what code does. It's functionality.

There are many sites that let you share and discover raw code (like GitHub), but it takes effort to use the code you find. Imagine if a company came along and organized all the world's code into easy to use functionality. That's Blockspring! We let you share and discover powerful functions—visualizations, algorithms, working with databases, finding data, transforming data. It's enormously exciting.

How did you make the connection and get accepted into Y Combinator?

Connections don't work with YC. YC is in the business of helping entrepreneurs solve really big problems in the world. From my perspective, you need to do three things to get into YC: 1) work on a big problem, 2) find indicators that you're making something people want as a solution to that problem, and 3) work really hard.

It's easy to measure whether you're working hard at a problem. The other two questions are non-trivial. The YC application is actually a very good way to self-reflect, so I advise everyone working on an idea, whether they want to do YC or not, to at least fill out the application (http://www.ycombinator.com/apply/).

What's been the most exciting aspect of your time at Y Combinator?

This summer was easily been the most exciting summer of my life, for a few reasons:

- First, I got married. Best thing ever.
- Second, my good friend and former University of Illinois roommate joined us at Blockspring.
- And third, YC worked for us. In fact, it couldn't have worked better.

Here's why: The YC partners are the only people I've met who aren't trapped in the present. Imagine you just finished writing the first page of a novel. If you ask someone for feedback, they'll likely help you edit the grammar on that page or maybe even come up with an idea for the rest of the chapter. If you show that page to a YC partner, they'll immediately start racing through all the possibilities for where the entire story could go. It's unbridled optimism.

Now mix big problems, unique solutions, hard work, and that unbridled optimism, and you get YC. It's super exciting—my only regret was not applying earlier. I should've applied every single semester of college.

What advice would you give students who are thinking about launching a startup?

This is a really important question. The first thing to realize is that a startup is simply a commercialized solution to a problem. You can solve problems without making them a business. And there are two types of problems to solve—someone else's or your own.

Paul Graham tells students not to start startups in his post: http://paulgraham.com/before.html. He says you should explore the world, grow, and be exposed to more problems. Don't search for problems you don't understand solely to start a startup. You'll always be able to do a startup when you're older.

Generally that sounds right. But if you have problems in your life right now, solve them. It seems like an obvious thing to say, but you'd be surprised how many people just live with the problems they have.

Then it's up to you whether you want to dedicate a few years of your life to making something a business. There are probably millions of people in this huge world with the exact same problem you have. The internet makes it pretty easy to find them. And if you can solve your problem in a scalable way —with technology—and the people you're solving this problem for have money, a business might emerge. But it's up to you whether or not to pursue. The question is if you want to spend your 20's solving problems when you could be exploring the world and having fun. You could be doing things that Mark Zuckerberg, even with his billions of dollars, can't do because he's stuck to Facebook. That's a personal question for you.

Regardless, if your life is problem-free, bravo. If not, hack solutions to your own problems and apply to YC.

What was your favorite memory during your time at Illinois?

My 4 years at Illinois were perfect. But my favorite memory was meeting my wife at Joe's.

Aakrit Vaish, BSIE 2008, Entrepreneur

Emily Scott

A new way to access customer support has arrived in the form of an interactive, real-time mobile app.

It's called Haptik, and it was developed by Aakrit Vaish and Swapan Rajdev, both University of Illinois engineering alumni.

Launched in April 2014, Haptik lets users quickly chat with experts to get answers to their questions on a variety of products and services. Questions can be related to services such as banking, products related to shopping and electronics, or even flight information, to name a few of the areas.

The experts, who are specialized in information regarding over 200 companies, respond over the text chat within four to six minutes.

Haptik is available on both iOS and Android, and has been compared to the popular app WhatsApp, with Haptik having more of a focus on products and services.

Its success has been matched with the fact that it recently raised $1 million in startup funds from Kalaari Capital, a venture capital fund based in India that invests in technology companies.

Vaish, who has a B.S. in Industrial Engineering, was the director of Flurry India and the co-founder of Flat.to before co-founding Haptik with Rajdev, who has a BS in Computer Engineering and was previously an engineer at Radius.

The two met in their freshman dorm at Illinois and have now known each other for ten years. "We've always been best friends and it just accidentally happened that we both ended up working in the same industry after graduation," Vaish said. "Then we started doing some basic work together and realized the equation works well. And once the idea of Haptik was born, there was no doubt this was what we wanted to go do full time together."

Their idea behind Haptik was simple: customer support should be easy and convenient, especially in a time when text communication is so far-reaching. "We were always fascinated by the mobile messaging space, right from back in 2010 when WhatsApp and others first launched," said Vaish. "And then one day a friend suggested the thought of users and companies being able to message each other."

Vaish said their "Eureka moment" didn't happen until November 2012. "We were talking to an industry veteran," he said. "He suggested we make it a simple help app where general experts respond to queries, and that's where we are today." Haptik was officially founded in August 2013 and is based out of Mumbai and San Francisco.

So far, the feedback from users has been what Vaish described as "overwhelmingly positive." With over 2,000 ratings averaging to 4.5, it is easy to see that users are fond of the idea. "People love the solution, they just want it to be able to do more," he said, "which we will build out over time."

Looking back, Vaish said that what he did during his time in IE at the University of Illinois translates directly to what he does now. "Industrial Engineering is about optimization, operations, and problem solving," he said. "That is pretty much what I do on a daily basis at Haptik."

"We have a large expert operations team, and we are constantly working on optimizing efficiency," he further explained. "It literally is a problem from one of Dr. Xin Chen's classes!"

Vaish also said that his experience of being the president of the Institute of Industrial Engineers during his senior year gave him the essential skills in building and leading an organization, and managing tasks and people that transcribe to his work at Haptik.

One of his favorite memories of IE was completing his senior design project. "Working on a real world problem at the client site was quite exciting back then, and helped us think what it would take to succeed in the real world," he said.

Fast-forward to now, Vaish is the CEO of a company that recently received $1 million in startup funds. With those funds, they hope to expand Haptik further.

"Our goal in the next 12-18 months is to get Haptik out to as many users as possible across India," he said. "This financing will help towards that— marketing, scaling operations, engineering. We intend to go to one million messages a week on the platform in the next 12 months."

In the long term, they aim to have Haptik reflect "Google meets WhatsApp." "We see Haptik becoming the one-stop shop when you need help for any product or service," Vaish said. They'll soon be adding picture messaging as one of the features of the app, and are working on providing more stability and faster response times.


Swapan Rajdev

Vaish and Rajdev have realized that this journey has come with its share of challenges. "Starting and running a company is the hardest job in the world," Vaish said. The hardest part, he said, is staying motivated even when benefits are not always currently evident. "Each startup has a gestation period during which, as founders, you are not making any money—in fact you are investing more and more—and no one around you cares about what you are doing," he said. "This can get tough, particularly if this gestation period keeps going."

That doesn't mean it doesn't also come with more rewarding moments.

"The most rewarding part is when a random stranger comes up to you and praises the product you have built," Vaish said. "That makes everything worth it."

"It's been an amazing ride so far," Vaish said of working with Rajdev to make Haptik what it is today. "It helps to have the blind faith in each other, particularly when the going gets tough. And more importantly, we know everything about each other on a personal front, which again makes it much easier to plan things."

His best advice for current students who also wish to pursue entrepreneurship is to consider all areas of their idea before implementing them.

"Don't do it because it's 'cool,' " he said. "The only way you will sustain is if you have an idea that you cannot stop thinking about, and can go to any lengths to make it work."

Professor Sara Behdad PhDIE 2013

Emily Scott

Since earning her Ph.D. in Industrial Engineering from the University of Illinois at Urbana-Champaign in August 2013, Sara Behdad has not only earned a professorship but has also become the director of a research laboratory.

While at ISE, Behdad completed her dissertation "Decision Analysis Methods to Handle Uncertainties that Impact Product End-of-Life Recovery" under Professor Deborah Thurston. Behdad is now an assistant professor at the University of Buffalo, State University of New York, with the Mechanical and Aerospace Engineering and the Industrial and Systems Engineering Departments. Her research has focused on sustainable design and manufacturing, remanufacturing, behavioral economics in end-of-use product recovery, design under uncertainty, value-driven design, decision analysis, and simulation and data modeling techniques.

Her research has channeled into the Green Engineering Technologies for Community of Tomorrow (GETCOT Lab), a research and engineering laboratory at the University of Buffalo, of which Behdad is currently the director. The lab is focused on using an engineering approach to create sustainable systems, where the research is sponsored by the University of Buffalo as well as the National Science Foundation.

"To win two NSF grants your very first year is very unusual," Thurston said. The first grant, where Behdad serves as PI, is entitled, "GOALI: Remediating E-waste Problems by Considering Consumer Behavior in Design for Multiple Life Cycles and Design for Ease of Return." In the other grant, she led the organization of a professional development and CAREER writing proposal as part of the 2014 ASME International Design Engineering Technical Conferences.

Currently, GETCOT Lab is studying e-waste and its consumer involvement. Their aim is to develop techniques to create a sustainable way to control e-waste.

Her passion for teaching and research in the design and manufacturing areas began early on in her graduate studies when she started her Ph.D. in Thurston's Decision Systems Laboratory in ISE. "It has been a rewarding experience to be part of Illinois ISE department and have Dr. Deborah Thurston's guidance throughout my graduate education," Behdad said.

"The love of learning instilled in me in Dr. Thurston's Lab is a large part of why I have decided to pursue sustainable design and manufacturing as part of my career plan."

"Sara has really hit the ground running," Thurston said. "It was hard keeping up with her even when she was here as a student!"

Other accomplishments of Behdad's include co-authoring numerous publications that have been accepted into journals and conferences. Works she has contributed to have been published in such journals as the *ASME Journal of Mechanical Design* and the *Journal of Computing and Information Science in Engineering*.

Letter from the Honorable Jerry Hogan BSGE 1959

I am a 1959 General Engineering graduate of the University of Illinois. While there I was president of the Society of General Engineers and also a Knight of St. Patrick's. My professors and instructors included names like Harry Streeter, Jerry Dobrovolny, Randolph Hoelscher, and others. (I even baby-sat Jerry's kids once!)

After graduation I immediately went into the US Army where I stayed for 20 years leaving as a Lieutenant Colonel, a member of the Army Green Berets, and a participant in the Vietnam War. I traveled the world and basically forgot the details of calculus, physics, chemistry, etc., but I did retain the thought processes taught in the GE program. While in the Army I was sent to the University of Arizona where I received an MS in Systems Engineering, and learned the skills of operations research, statistics, computer science, modeling, numerical analysis, etc. Again the thought process initially taught at Illinois was reinforced during the training at Arizona.

After leaving the Army, I became a VP in an IBM Company and then a VP in MCI Tele-communications. I renewed my association with the GE/IE Department during this period and was able to funnel some corporate money to the department. I had a good relationship with Tom Conroy and Howard Wakeland, gave a visiting lecture to one of the senior classes, hired several GE graduates, sponsored several of the senior engineering projects, and was named an Outstanding GE Graduate at one of your annual banquets.

I retired somewhat early as my wife was diagnosed with Alzheimer's at the early age of 47. She died and I remarried… but I had retired from industry and frankly was bored. I didn't like the way the politicians were acting in the Texas county adjacent to Dallas where I lived, so, using the systems engineering approach, I decided I could fix the problems. I ran for County Judge and was elected and have just finished my 4-year term. Things in the county, according to expressions from the citizens, are significantly better.

You probably are asking why all this detail. I want to clearly explain that I have been a player ever since I graduated from High School and entered the U of I. I really liked the GE Department, the profs, and especially the thought process and discipline it took to be an engineer.

I have been successful… and a lot of that is the result of what I learned in your department, and then reinforced and expanded when I went on to get my master's in systems engineering.

My reason for writing is to tell you how impressed I am with your *Annual Report.* In the 55 years since I graduated, I have never seen such a document from a University. It does a magnificent job of explaining the program, the success you are having, and the future you see coming down the road. (It also makes me wonder if I could have even graduated with the program and subjects now required. A Master's in Financial Engineering…fantastic. Crowd sourcing…never even heard of it. WOW!!!) A great job! Thanks for sending it and I too am looking forward to the second *Annual Report.*

Please feel free to pass on these comments to Professor Nagi and his staff. In my opinion you all have it all together and I just wish I was a new freshman entering the Department today.

Jerry H. Hogan
GE Graduate in the Class of 1959

Charles Buchanan BSGE 1965

Emily Scott

Growing up in a small town in Illinois, Charles "Chuck" Buchanan learned a very important value that he kept with him for the rest of his life: if you have a need, you find a solution.

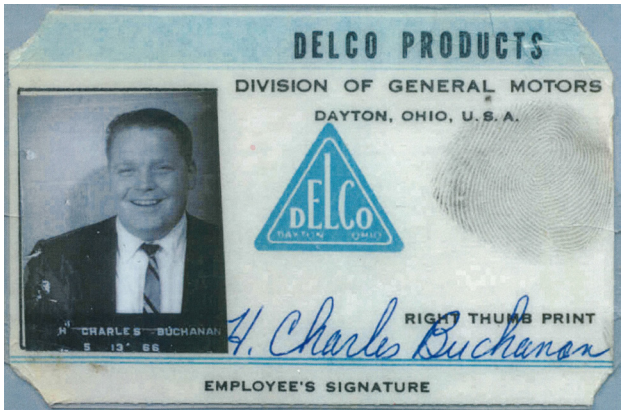
He learned this when he constructed a headboard with a built-in radio for his parents' bed, when he worked to excel in challenging math and science classes in high school, and when he worked his way through college to pay for tuition.

So it's almost natural that Chuck became an engineer —engineers see a need and find a solution. His ability to find solutions in a creative way led him into a successful career during which he acquired 122 patents that greatly contributed to the automotive industry.

Chuck pursued higher education at the University of Illinois at Urbana-Champaign majoring in General Engineering. During his time as a student, he was the president of the Psi Upsilon fraternity, a position that led him to meet his wife, Diane, who was then the president of the Phi Mu sorority, majoring in French.

After Chuck graduated in 1965, he and Diane married that same year. A year later, they moved to Dayton, Ohio for Chuck's first job in the Delco Products division of General Motors.

He worked in product engineering in areas such as windshield wiper systems, engine cooling motors, motors and compressors, and suspensions. Chuck worked for Delco for 27 years and went from being the Staff Engineer for Suspensions, to Windshield Wiper Systems, and then to Advanced Wiper and Actuator Engineering.



ITT Industries bought the Wipers and Motors Business Unit in 1994. In the same year, Chuck and his team of engineers developed the first variable damping shock absorber in the United States.

Four years later, Valeo, Inc. bought the business from ITT, and Chuck became Senior Valeo Expert in the Wiper Branch. He was one of five worldwide Senior Valeo Experts of Engineering professionals.

At Valeo, Chuck began learning about I-TRIZ, a methodology for creative problem solving. Diane said Chuck became a "master" of this approach, which helped him to produce 56 of his 122 patents. In 2004, he was awarded Triz Specialist Certification by Ideation International, Inc., a business that utilizes the I-TRIZ method.

Those who worked with Chuck remember him as a helpful and kind person as well as an innovative creator.

Peter Zhou began working for Chuck in 1989 and described him as his "best friend and greatest boss." Zhou said Chuck helped his daughter and son-in-law learn English when they moved to the United States from China.

"I never knew any other boss who would like to help his subordinate's children to learn English," he said. "We will never forget [his] kindness."

Ralph Edwards worked with Chuck from when they both started at Delco. The story of how they met was one that they laughed about for the rest of their careers.

Edwards, who was in a different division than Chuck at the time, described a time he was working to meet a product deadline when Chuck approached him and questioned a specific part of the product.

"He said, 'Do you ever think about maybe optimizing that, doing some calculations and seeing if you could do a better job?'" Edwards said. "Here's this guy, I don't even know him, he's a young guy, and he's asking me questions like this when I'm having trouble meeting production schedule."

As time went on, Edwards and Chuck became good friends. They often made jokes about their rough first meeting.

"We always laughed about that . . . he would ask me or I would ask him, 'Hey, did you optimize that?'" Edwards said. "For 30 years that was a big joke."

He said what made Chuck different was his ability to come up with ideas and prove them mathematically.

"He had a great sense of humor and personality but was also a very smart guy too, with a whole lot of ideas just bubbling out of his head," Edwards said.

Gordon Lewis worked as Chuck's patent counsel for over 20 years, writing over half of Chuck's 122 patents. As Lewis came to know Chuck's inventions intimately, he attested to the fact that Chuck was able to take risks and think outside of the box.

"Most engineers are very uncomfortable with taking risks, and I guess that is what I would consider Chuck—a technological risk taker," Lewis said. "He was willing to defy convention for new product and new technical developments."

In his 40 years spent in the business, Lewis said Chuck was "without a doubt the most creative single inventor" he worked with.

Chuck retired from Valeo in 2004, but continued to be active and invent. In their home, Diane said he constructed a countertop that could double as a breadboard or a laptop desk.

"Everywhere he went, he was innovating," Diane said. "He was open and sharing in helping people be innovative about their business or ideas."

Over the span of his career, Chuck held 122 patents, but he probably should have held more. According to Diane, he often gave patent credit to young engineers he worked with to encourage them—an uncommon trait in such a competitive field.

Many vehicle features today such as automatic sliding van doors, powered windows, automatic door lock systems, and automatic windshield wipers have evolved with the help of Chuck's work.

Chuck passed away in 2009 with a lifetime of accomplishments behind him. His creative contributions to the automotive world and to his fellow engineers will be remembered.

Marc Spoor, BSGE 1983

Emily Scott

General Engineering degrees have taken University alumni all around the world into a variety of disciplines.

For Marc Spoor, the General Engineering degree he earned in 1983 has taken him to Seattle for a career at Boeing Co. He said his degree gave him a set of tools that made him successful and open to new opportunities, and he encourages other general engineers to look at their degree in the same light.

Spoor began his career at Boeing in 1988 and has worked on a variety of projects. Most recently, he has been involved with Boeing's collaboration with NASA in testing a technology called Active Flow Control (AFC), which aims to provide benefits such as improved environmental sustainability and performance in future flight vehicle designs.

Spoor's role as project engineer in the AFC project has required him to work with engineers in other areas, coordinate the collective effort toward the project, and provide project updates to Boeing's partners at NASA.

His career at Boeing is a testament to the different fields that a degree in GE can lead to.

"I have always been interested in aviation, and a job at Boeing was a dream come true," he said.

He specifically loves the variety that comes along with his position—he has worked on everything from radar-jamming equipment for the military to systems and components of commercial airplanes, and now, cutting-edge technology for future airplanes.

Spoor said this work plays a larger part in society. As society itself becomes more interconnected, he said the field of aviation needs to continually look forward, improve products, and make designs more inexpensive and environmentally friendly.

With more opportunities ahead of him, Spoor said he appreciates the education behind him. He said his GE degree gave him a "big picture perspective" which benefits his current work on complex systems at Boeing.

Looking back at his time at the University, Spoor has fond memories of his Senior Design Project in GE, which allowed him to see "how a 'real-world' project progresses." Now at Boeing, he said he is doing the same thing in his project management role.

"The ability to understand and relate to a wide variety of people with different skill sets and integrate the whole to achieve the desired end results is a key skill a GE brings to the table," he said.

With rapid changes constantly occurring in the field of engineering, Spoor advised students hoping to have a similar career to broaden their knowledge, specifically in the areas of finance and project management.

He said the key is to look at a degree in GE as a set of tools to prepare one to participate in any path they choose.

"Keep your eyes and ears open for opportunities," Spoor said. "Don't let your degree necessarily define your career path." He emphasized networking and taking advantage of available resources as essential to getting involved in new projects.

"Don't forget to have fun and laugh once in awhile," Spoor said. "Find a job you really enjoy, but don't let you work or your career take over your life. Interesting and involved as it may be, make sure it is a means to many ends, not an end in itself."

ISE FACULTY
IN REVIEWED OR REFEREED SCHOLARLY JOURNALS

1. Horea Ilies, Matt Parkinson, Carolyn Conner Seepersad, Michael Kokkolaras, Kenneth Ragsdell, Panos Papalambros, Farrokh Mistree, Christopher Williams, Rahul Rai, Jitesh Panchal, Scott Ferguson, Bryony DuPont, **Allison, J. T.,** "New Perspectives on Design Automation: Celebrating the 40th Anniversary of the ASME Design Automation Conference," *ASME Journal of Mechanical Design*, Vol. 137, No. 5. , 050301, 2015, DOI: 10.1115/1.4030256
2. Anand P Deshmukh, **Allison, J. T.,** "Multidisciplinary Dynamic Optimization of Horizontal Axis Wind Turbine Design," *Structural and Multidisciplinary Optimization*. Published online, to appear in print.
3. D. Katselis, C. Rojas, B. I. Godoy, J. C. Aguero, and **C. L. Beck**, "On the End-Performance Metric Estimator Selection," *Automatica*, Vol 58, pp. 22-27, 2015.
4. **C. L. Beck**, "Modeling and Control of Pharmacodynamics," *European Journal of Control*, Vol 24, pp. 33-49, July 2015.
5. E. Kharisov, **C. L. Beck**, and M. Bloom, "Design of L1-Adaptive Controllers for Human Response to Anesthesia," *Control Engineering Practice*, Vol. 44, pp. 65-77, November 2015.
6. A. Bock, **K. Chandrasekaran**, J. Koenemann, B. Peis, and L. Sanita, "Finding Small Stabilizers for Unstable Graphs," *Mathematical Programming*, Series B, December 2014.
7. **Xin Chen** and Jiming Peng, "New Analysis on Sparse Solutions to Random Standard Quadratic Optimization Problems and Extensions," *Mathematics of Operations Research*, 40(3), pp. 725-738, 2015.
8. Limeng Pan, Mashor Housh, Pan Liu, Ximing Cai, and **Xin Chen**. 2015, "Robust Stochastic Optimization for Reservoir Operation," *Water Resources Research*, 51(1), pp. 409-429.
9. **Xin Chen**, Xiangyu Gao and Zhenyu Hu, 2015, "New Approach to Two-Location Joint Inventory and Transshipment Control via L-natural-Convexity," *Operations Research Letters*, 43(1), pp. 65-68.
10. Ma, J. and **Kim, H. M.**, "Predictive Usage Mining for Life Cycle Assessment," *Transportation Research* - Part D, Vol. 38, pp. 125-143, July 2015.
11. S. Kadloor, **N. Kiyavash**, and P. Venkitasubramaniam, "Mitigating Timing based Information Leakage in Shared Schedulers," to appear, *IEEE/ACM Transactions on Networking.*
12. S. Kadloor and **N. Kiyavash**, "Delay-Privacy Tradeoff in the Design of Scheduling Policies," *IEEE Transactions on Information Theory*, Vol. 61, no. 5, pp. 2557-2573, May 2015.
13. **Krishnan, G.,** Bishop-Moser, J., Kim, C., Kota, S., "Kinematics of a Generalized Class of Pneumatic Artificial Muscles," *ASME. J. Mechanisms Robotics*, DOI: 10.1115/1.4029705, 2015.
14. Hopkins, J. B., Rivera, J., Kim, C., **Krishnan, G.**, "Synthesis and Analysis of Soft Parallel Robots Comprised of Active Constraints," *Journal of Mechanisms and Robotics*, 7(1), 011002, 2015.
15. Khopkar, S., **Nagi, R.**, Nikolaev, A. and Bhembre, V, "Efficient Algorithms for Incremental All Pairs Shortest Paths, Closeness and Betweeness in Social Network Analysis," accepted to *Social Network Analysis and Mining (SNAM)*, Vol. 4(1), Article 220, December 2014.
16. Huang, S., Wang, Q., Batta, R. and **Nagi, R.**, "An Integrated Model for Site Selection and Space Determination of Distribution Centers," *Computers and Operations Research*, Vol. 62, pp. 169-176, October 2015.
17. Gross, G.A. and **Nagi, R.**, "Precedence Tree Guided Search for the Efficient Identification of Multiple Situations of Interest AND/OR Graph Matching," *Information Fusion*, February 2015.
18. Samadi, M., Nikolaev, A. and **Nagi, R.**,"A Subjective Evidence Model for Influence Maximization in Social Networks," *OMEGA*, June 2015.
19. **A. Nedic**, "Convergence Rate of Distributed Averaging Dynamics and Optimization in Networks," *Foundations and Trends in Systems and Control*, Vol. 2, no. 1, pp. 1-100, 2015.
20. M. Raginsky and **A. Nedic**, "Online Discrete Optimization in Social Networks in the Presence of Knightian Uncertainty," *Operations Research*, August 2015.
21. F. Yousefian, **A. Nedic** and U. V. Shanbhag, "Stochastic approximations schemes for non-smooth stochastic multi-user optimization and Nash games," *IEEE Transactions on Automatic Control*, April 2015.
22. S. Lee and **A. Nedic**, "Asynchronous Gossip-Based Random Projection Algorithms Over Networks," accepted in *IEEE Transactions on Automatic Control*, an extended report is on arxiv.
23. **A. Nedic** and **A. Olshevsky**, "Distributed optimization over time-varying directed graphs," *IEEE Transactions on Automatic Control*, 60 (3), pp. 601-615, 2015.
24. Q. Geng, P. Kairouz, **S. Oh**, and P. Viswanath, "The Staircase Mechanisms in Differential Privacy," Selected Topics in *Signal Processing*, April 2015.
25. N. Leonard, **A. Olshevsky**, "Cooperative Learning in Multi-Agent Systems From Intermittent Measurements," *SIAM Journal on Control and Optimization*, Vol. 53, no. 1, pp. 1-29, 2015.
26. P. Davison, N.E. Leonard, **A. Olshevsky**, M. Schwemmer, "Nonuniform Line Coverage from Noisy Scalar Measurements," *IEEE Transactions on Automatic Control*, Vol. 60, no. 7, pp. 1975-1985, 2015.
27. A. Nedic and **A. Olshevsky**, "Distributed optimization over time-varying directed graphs," *IEEE Transactions on Automatic Control*, 60 (3), pp. 601-615, 2015.

28. **A. Nedic**, **A. Olshevsky**, "Stochastic Gradient-Push for Strongly Convex Functions on Time-Varying Directed Graphs," *IEEE Transactions on Automatic Control*, accepted.

29. Haser, A. Behnia, B., McGovern, M.E., and **Reis, H.**, "Monitoring Viscosity in Asphalt Binders using an Ultrasonic Guided Wave Approach," *Insight Non-Destructive Testing and Condition Monitoring Journal*, Vol. 57, No. 1, pp. 25-34, 2015.

30. Zhe, S., Farace, N., Behnia, B. Buttlar, W.G., and **Reis, H.**, "Quantitative evaluation of rejuvenators to restore embrittlement temperatures in oxidized asphalt mixtures using acoustic emission," *Journal of Acoustic Emission*, Vol. 33, pp. 1-15, 2015.

31. McGovern, M.E. and **Reis, H.**, "Damage characterization in Dimension Limestone Claddings using non-collinear ultrasonic wave mixing," *Journal of Optical Engineering*, special issue titled: "Structural Health Monitoring; Guided Waves and Nonlinear Acoustic Techniques," Vol. 55, No. 1, 011012-1/011012-12, 2015.

32. McGovern, M.E., Buttlar, W.G., and **Reis, H.**, "Field estimation of oxidative aging in asphalt concrete pavements using Non-Collinear Wave Mixing," *INSIGHT-- Non-Destructive Testing and Condition Monitoring*, 2015.

33. McGovern, M.E., Buttlar, W.G., and **Reis, H.**, "Effectiveness of Rejuvenators on Aged Asphalt Concrete using Ultrasonic Non-Collinear Subsurface Wave-Mixing," *Materials Evaluation*, pp. 1367-1378, October 2015.

34. Rui Song, **Richard B. Sowers**, and Jonathan Jones, "The Topology of Central Counterparty Clearing Networks and Network Stability," *Stochastic Models*, 30, pp. 16-47, 2014.

35. E. Salimi, N. Somnath and **R.S. Sreenivas**, "A Software Tool for Live-Lock Avoidance in Systems Modeled using a Class of Petri Nets," *International Journal on Computational Science & Applications*, Vol. 5, No. 2, pp. 1-13, April 2015.

36. Y-M Anh, D. Block and **R.S. Sreenivas**, "Autonomous Navigation and Localization of a Quad-Rotor in an Indoor Environment," *AIAA Journal of Aerospace Information Systems*, Accepted, Published Online, DOI: 10.2514/1.I010249, June 2015.

37. C. Franco, **D. M. Stipanovic**, G. Lopez-Nicolas, C. Sagues, and S. Llorente, "Persistent Coverage Control for a Team of Agents with Collision Avoidance," *European Journal of Control*, Vol. 22, pp. 30-45, ISSN 0947-3580, March 2015.

38. A. Zatezalo and **D. M. Stipanovic**, "Control of Dynamical Systems with Discrete and Uncertain Observations," *Discrete and Continuous Dynamical Systems*-Series A, Vol. 35, pp. 4665-4681, 2015.

39. D. Panagou, **D. M. Stipanovic**, and P. G. Voulgaris, "Dynamic Coverage Control in Multi-Robot Networks," *Multi-Robot Systems*, Frontiers in Robotics and AI 3, article 3, pp. 1-17, 2015.

40. G. M. Atinc, **D. M. Stipanovic**, and P. G. Voulgaris, "Supervised Coverage Control of Multi-Agent Systems," *Automatica*, Vol. 50, pp. 2936-2942, November 2014.

41. Berg, L., S. Behdad, J. Vance and **Thurston, D.**, "Disassembly Sequence Evaluation: A User Study Leveraging Immersive Computing Technologies," *ASME Journal of Computing and Information Science in Engineering*, 15:1, DOI: 10.1115/1.4028857, 2015.

42. Haohua Wan and **Qiong Wang**, "Asymptotically-Optimal Component Allocation for Assemble-to-Order Production-Inventory Systems,'' *Operations Research Letters*, Vol. 43, No. 3, pp. 304-310, May 2015.

43. Martin I. Reiman and **Qiong Wang**, "Asymptotically Optimal Inventory Control for Assemble-to-Order Systems with Identical Lead Times," *Operations Research*, Vol. 63, No. 3, pp. 716-732, May-June 2015.

ISE FACULTY GRANTS

1. **Allison, James** (Co-PI), Center for Compact and Efficient Fluid Power, National Science Foundation, "Rheological Design for Efficient Fluid Power," $208,250, 5/2014-4/2016 (PI: Randy Ewoldt, UIUC). (Continuing)

2. **Allison, James** (Co-PI), National Science Foundation, "GOALI: Design with Rheologically-Complex Soft Materials," $450,000, 9/2014-8/2017 (PI: Randy Ewoldt, UIUC).

3. **Allison, James** (PI), Commercial, John Deere, "Development of Generative Algorithm Based Strategies for System Architecture Design Optimization with Large Scale Capabilities," $200,000, 1/2013-8/2015. (Continuing)

4. **Allison, James** (PI), Commercial, Proctor & Gamble Co, "Unrestricted Contribution for the Conduct of Research," (focusing on generative design methods for topology optimization and additive manufacturing of fluid processing systems), $60,000, 6/2015-5/2016.

5. **Allison, James** (PI), Commercial, Toyota Motor Engineering and Manufacturing North America Inc., "Development of Optimization Tools for Integrated Electro-Thermal Power System Design," $75,002, 11/2014-5/2016.

6. **Allison, James** (PI), MathWorks Inc, "Advancing Undergraduate Design Learning Through Extensive Use of Hands-On Model-Based Design Projects," $40,000, 6/2013-6/2016. (Continuing)

7. **Allison, James** (PI), National Aeronautics and Space Association, "Strain Actuated Solar Array for SC Attitude and Instrument Jitter Control," $200,000, 10/2014-9/2016.

8. **Allison, James** (PI) and **Deborah Thurston** (UIUC/ISE), National Science Foundation, "Toward a Method for Achieving Synergy between Heuristic Rules of Thumb and Quantitative Methods in Engineering Design," $150,000, 8/2015-7/2017.

9. **Beck, Carolyn** (Co-PI), National Science Foundation, "CPS: Synergy: Collaborative Research: Engineering Safety-Critical Cyber-Physical-Human Systems," $742,695, 10/2013-9/2016. (Continuing)
10. **Beck, Carolyn** (PI), National Science Foundation, "A Tractable Computational Framework for Dynamic Coverage and Clustering," $381,105, 8/2011-7/2015. (Continuing)
11. **Chen, Xin** (PI), CMMI, National Science Foundation, "Pricing Analytics: Modeling, Theory and Algorithms," $300,000, 5/2014-4/2017. (Continuing)
12. **Chen, Xin** (PI), National Science Foundation, "Cost/Value Allocation in Supply Chain Operations," $300,000, 8/2015-7/2018 (Co-PI **Qiong Wang**, UIUC/ISE).
13. **Feng, Liming** (PI), National Science Foundation, "Collaborative Research: Market-Based Calibration of Pricing Models for Financial and Energy Option Contracts," $340,000, 9/2010-8/2015. (Continuing)
14. **Kesavadas, Thenkurussi** (PI), National Science Foundation, "NRI: Human Cognition Assisted Control of Industrial Robots for Manufacturing," $558,527, 10/2014-6/2016.
15. **Kim, Harrison** (PI), Commercial, John Deere, "Sustainable Product Design," $797,919, 11/2010-10/2016. (Continuing)
16. **Kim, Harrison** (PI), National Science Foundation, "CAREER: Trend-Mining Design - Foundations for Modeling the Mutual Influence between Pre-Life Design and End-of-Life Recovery of a Sustainable Product Portfolio," $412,000, 8/2010-7/2016. (Continuing)
17. **Kiyavash, Negar** (PI), Army Research Office, "Causal Inference in Complex Networks," $56,900, 7/2015-12/2015.
18. **Kiyavash, Negar** (PI), Multidisciplinary Research Program of the University Research Initiative (MURI), Army W911NF-15-0479, "Adaptive Exploitation of Non-Commutative Multimodal Information Structure," $3,750,000, 8/2015-8/2018.
19. **Kiyavash, Negar** (Co-PI), Multidisciplinary Research Program of the University Research Initiative (MURI), Air Force Office of Scientific Research, "Multi-Layer and Multi-Resolution Networks of Interacting Agents in Adversarial Environments," 2010-2015, $407,208. (PI: Tamer Basar, UIUC). (Continuing)
20. **Kiyavash, Negar** (PI), Division of Computer and Communication Foundations, National Science Foundation, "Toward a General Theory of Information Transfer via Timing," $314,965, 2001-2015. (Continuing)
21. **Kiyavash, Negar** (PI), National Science Foundation, "CAREER: A Timing Approach to Network Forensics," $450,000, 2/2011-7/2015. (Continuing)
22. **Krishnan, Girish** (PI), National Science Foundation, "CAREER: Design Methodologies for Bio-Inspired Soft Mechanical Systems," $499,998, 7/2014-6/2019.
23. **Marla, Lavanya** (PI), Obama-Singh 21st Century Knowledge Initiative, US-India Education Foundation, "Cooperative-Competitive, Data-Driven, Operational Strategies for Extremely Resourced-Constrained Settings in Emerging Economies," $189,525, 6/2015-5/2018.
24. **Nagi, Rakesh** (PI), ARL (via CUBRC), "Hard-Soft Data Fusion MURI - Technology Transition," $95,000, 7/2014-3/2015.
25. **Nagi, Rakesh** (PI), United States Navy, "Control of Anarchical and Ordered Systems (CAOS): Mathematical Programming Approaches for Measuring Decentralized and Centralized Network Operations," $142,251, 8/2013-5/2015. (Continuing)
26. **Nedich, Angelia** (Co-PI), CCF, National Science Foundation, "Controlled Sensing, and Distributed Signal Processing and Decision Making in Networked Systems," $1,069,290, 2011-2016. (PI: Venugopal Veeravalli, UIUC). (Continuing)
27. **Nedich, Angelia** (PI), Division of Mathematical Sciences, National Science Foundation, "Optimization with Uncertainties Over Time: Theory and Algorithms," $183,768, 2013-2016. (Continuing)
28. **Nedich, Angelia** (co-PI), Office of Naval Research, "Information Structures, Signaling, and Competitively Optimal Policies in Decentralized Online Optimization," $249,000, 2012-2017, (Jointly with PIs: Maxim Raginsky and Cedric Langbort, UIUC.) (Continuing)
29. **Nedich, Angelia** (co-PI), Office of Naval Research, "Optimization Algorithms for Resource Management: Decentralization, Near-Optimality and the Price of Anarchy," $347,500, 2012-2015. (Jointly with PI: Rayadurgam Srikant, UIUC). (Continuing)
30. **Oh, Sewoong** (PI), National Science Foundation, "TWC: Small: Fundamental Limits in Differential Privacy," $495,190, 8/2015-8/2018.
31. **Oh, Sewoong** (PI), National Science Foundation, "EAGER: A Graphical Approach for Choice Modeling," $87,937, 7/2014-6/2015.
32. **Olshevsky, Alex** (PI), National Science Foundation, "CAREER Algorithms and Fundamental Limitations for Sparse Control," $400,000, 3/2014-3/2019. (Continuing)
33. **Olshevsky, Alexander** (PI), National Science Foundation, "Achieving Consensus Among Autonomous Dynamic Agents Using Control Laws That Maintain Performance as Network Size Increases," $309,914, 5/2015-4/2018.
34. **Olshevsky, Alexander** (PI), United States Air Force (Office of Scientific Research), "Reliable Multi-Agent Control in Failure-Prone Environments via Inhomogeneous Markov Chains," $120,000, 9/2014-8/2017.
35. **Reis, Henrique** (PI), ASNT Fellow, "Quantitative Evaluation of Rejuvenators Using Acoustic Emission towards Effective pavement Maintenance Preservation," $20,000, 7/2014-6/2015. (Continuing)
36. **Sowers, Rich** (PI), National Science Foundation, "Systemic Risk and Topology," $66,099, 11/2012-11/2015. (Continuing)
37. **Stipanovic, Dusan** (Co-PI), National Science Foundation, "NRI: Collaborative Research: ASPIRE: Automation Supporting Prolonged Independent Residence for the Elderly," $1,295,917, 1/2015-12/2018 (PI: Naira Hovakimyan, UIUC).

38. **Stipanovic, Dusan** (PI), Department of Homeland Security, "Efficient Surveillance, Rescue, and Threat Detection Theory and Multi-Objective Control for Multi-Vehicle Systems," $64,000, 7/2015-6/2016.

39. **Thurston, Deborah** (Co-PI with **Harrison Kim**, UIUC/ISE), National Science Foundation, I/UCRC Planning Grant: Center for e-Design, $13,000, 9/2014-8/2015.

40. **Wang, Qiong** (PI), CMMI, National Science Foundation, " GOALI: Inventory Management in Assemble-To-Order Systems: Analysis, Policies, and Asymptotic Optimality," $349,999, 5/2014-3/2017. (Continuing)

41. **Wang, Qiong** (PI), CMMI, National Science Foundation, "Strategic Planning of Internet Services in the Presence of User-Initiated Innovations: Implications for Network Neutrality," in collaboration with Columbia University, $102,724, 7/2014-8/2017. (Continuing)

42. **Wang, Qiong** (PI), Science of Science Policy, National Science Foundation, "Models and Analyses of Industrial Laboratories: Returns, Risks, and Structural Efficiency, with Implications for Sustainability and Science Policy," $261,968, 4/2014-4/2017. (Continuing)

ISE FACULTY CONFERENCE PUBLICATIONS

1. Danny J. Loham, Ercan M. Dede, **Allison, J. T.,** "Topology Optimization for Heat Conduction Using Generative Design Algorithms," in proceedings of the 11th World Congress on Structural and Multidisciplinary Optimization, June 7-12, 2015.

2. Anand P. Deshmukh, Daniel R. Herber, **Allison, J. T.,** "Bridging the Gap between Open-Loop and Closed-Loop Control in Co-Design: A Framework for Complete Optimal Plant and Control Architecture Design," in proceedings of the 2015 American Control Conference, July 1-3, 2015.

3. **Allison, J. T.**, Daniel R. Herber, Anand P. Deshmukh, "Integrated Design of Dynamic Sustainable Energy Systems," in proceedings of the 2015 International Conference on Engineering Design, July 27-30, 2015.

4. Lakshmi Gururaja Rao, **Allison, J. T.,** "Generalized Viscoelastic Material Design with Integro-Differential Equations and Direct Optimal Control," in proceedings of the 2015 ASME International Design Engineering Technical Conferences & Computers and Information in Engineering Conference, ASME, August 2-5, 2015.

5. Lakshmi Gururaja Rao, Jonathon Schuh, Randy H. Ewoldt, **Allison, J. T.,** "On Using Adaptive Surrogate Modeling in Design for Efficient Fluid Power," in proceedings of the 2015 ASME International Design Engineering Technical Conferences & Computers and Information in Engineering Conference, ASME, August 2-5, 2015.

6. P. M. Parekh, D. Katselis, **C. L. Beck** and S. Salapaka, "Deterministic Annealing for Clustering: Tutorial and Computational Aspects," in proceedings of the ACC, Chicago, IL, pp. 2906-2911, July 2015.

7. D. Katselis, C. Rojas and **C. L. Beck**, "Estimator Selection: End-Performance Metric Aspects," ACC, Chicago, IL, pp. 4430-4435, July 2015.

8. Reddy, A., Sankaran, N., Snyder, K., Siddique, A. and **Kesavadas, T.**, "Image Based Automation of Interventional Robotic Surgery of Endovascular Procedures," presented at the Congress of Neurological Surgeons (CNS) Annual Meeting, October 18-22, 2014.

9. Ma, J. and **Kim, H. M.,** "Massive-scale User Preference Clustering for Product Family Architecture Design," International Conference on Human Behavior in Design, October 2014, Ascona, Switzerland.

10. Kwak, M. and **Kim, H. M.,** "Assessing Time-Varying Advantages of Remanufacturing: A Model for Products with Physical and Technological Obsolescence," ICED15, Milan, Italy, July 2015.

11. Quan, N. and **Kim, H. M.,** "Task-Based LCA for Environmental Impact Assessment of Multiple Heterogenous Systems," ICED15, Milan, Italy, July 2015.

12. Quan, N. and **Kim, H. M.,** "A Mixed Integer Linear Programming Formulation for Unrestricted Wind Farm Layout Optimization," ASME IDETC, DETC2015-46876, August 2015.

13. J. Etesami and **N. Kiyavash**, "A Novel Collusion Attack on Finite Alphabet Digital Fingerprinting Systems," in proceedings of the IEEE International Symposium on Information Theory (ISIT), 2014.

14. J. Etesami and **N. Kiyavash**, "Directed Information Graphs: a Generalization of Linear Dynamical Graphs," in proceedings of the American Control Conference (ACC), 2014.

15. A. Truong and **N. Kiyavash**, "Optimal Adversarial Strategies in Learning with Expert Advice," in proceedings of the IEEE Conference on Decision and Control (CDC), 2014.

16. D. Cullina and **N. Kiyavash**, "Generalized sphere-packing upper bounds on the size of codes for combinatorial channels," in proceedings of the IEEE International Symposium on Information Theory (ISIT), 2014.

17. Uppalapati, N., Firere, H., **Krishnan, G.,** "Design and analysis framework for a purely parallel soft pneumatic continuum manipulator with inherent rotation," IROS Conference, 2015.

18. Singh, G., and **Krishnan, G.**, "An Isoperimetric Formulation to predict Deformation Behavior of Pneumatic Fiber Reinforced Elastomeric Actuators," IROS Conference, 2015.

19. **Krishnan, G.,** "Kinematics of a new class of smart actuators for soft robots based on generalized pneumatic artificial muscles," In Intelligent Robots and Systems (IROS 2014), 2014 IEEE/RSJ International Conference, pp. 587-592, IEEE, 2014.

20. Gross, G.A., Little, E., Park, B., Llinas, J. and **Nagi, R.**, "Application of Multi-level Fusion for Pattern of Life Analysis," 18th International Conference on Information Fusion, Washington, DC, July 6-9, 2015.

21. Farasat, A., Gross, G.A., **Nagi, R.** and Nikolaev, A., "Social Network Extraction and High Value Individual (HVI) Identification within Fused Intelligence Data," 2015 International Conference on Social Computing, Behavioral-Cultural Modeling, and Prediction (SBP), Washington DC, March 31-April 3, 2015.

22. Gross, G. A, **Nagi, R.**, Duff, D. and Patel, M., "MapReduce All-source Breadth First Search – Implementation and Data Access Tradeoff Analyses," 2014 Military Sensing Symposia, National Symposium on Sensor and Data Fusion (NSSDF), Springville, VA, October 2014.

23. Date, K., Gross, G.A. and **Nagi, R.**, "Test and Evaluation of Data Association Algorithms in Hard+Soft Data Fusion," 17th International Conference on Information Fusion, Salamanca, Spain, July 7-10, 2014.

24. Gross, G.A., Date, K., Schlegel, D.R., Corso, J.J., Llinas, J., **Nagi, R.** and Shapiro, S.C., "Systemic Test and Evaluation of a Hard+Soft Information Fusion Framework," 17th International Conference on Information Fusion, Salamanca, Spain, July 7-10 2014.

25. I. Necoara and **A. Nedic**, "A fully distributed dual gradient method with linear convergence for large-scale separable convex problems," in proceedings of the 14th European Control Conference (ECC) 2015, pp. 305-309, Johannes Kepler University, Linz, Austria, July 15-17, 2015.

26. **A. Nedic**, **A. Olshevsky** and C.A. Uribe, "Nonasymptotic Convergence Rates for Cooperative Learning Over Time-Varying Directed Graphs," in proceedings of the 2015 American Control Conference (ACC), pp. 5884-5889, Chicago, IL, July 1-3, 2015.

27. **A. Nedic**, S. Lee, and M. Raginsky, "Decentralized Online Optimization with Global Objectives and Local Communication," in proceedings of the 2015 American Control Conference (ACC), pp. 4497-4503, Chicago, IL, July 1-3, 2015.

28. K. Cohen, **A. Nedic**, and R. Srikant, "Distributed Learning Algorithms for Spectrum Sharing in Spatial Random Access Networks," in proceedings of the 13th International Symposium on Modeling and Optimization in Mobile, Ad Hoc and Wireless Networks (WiOpt), pp. 513-520, IIT Bombay, May 25-29, 2015.

29. **A. Nedic** and J. Liu, "A Lyapunov Approach to Discrete-Time Linear Consensus," in proceedings of the 2nd Global Conference on Signal and Information Processing (GlobalSIP), pp. 842-846, Atlanta, Georgia, December 3-5, 2014.

30. S. Krishnasamy, R. Sen, **S. Oh**, S. Shakkottai, "Detecting Sponsored Recommendations," Proc. of ACM SIGMETRICS, Portland, OR, June 2015.

31. G. Fanti, P. Kairouz, **S. Oh**, P. Viswanath, "Spy vs. Spy: Rumor Source Obfuscation," Proc. of ACM SIGMETRICS, Portland, OR, June 2015.

32. P. Kairouz, **S. Oh**, and P. Viswanath, "Extremal Mechanisms for Local Differential Privacy," Advances in Neural Information Processing Systems (NIPS), Montreal, Canada, December 2014.

33. P. Jain and **S. Oh**, "Provable Tensor Factorization with Missing Data," Advances in Neural Information Processing Systems (NIPS), Montreal, Canada, December 2014.

34. B. Hajek, **S. Oh**, and J. Xu, "Minimax-optimal Inference from Partial Rankings," Advances in Neural Information Processing Systems (NIPS), Montreal, Canada, December 2014.

35. **S. Oh**, D. Shah, "Learning Mixed Multinomial Logit Model from Ordinal Data," Advances in Neural Information Processing Systems (NIPS), Montreal, Canada, December 2014.

36. **S. Oh**, Kiran K. Thekumparampil, and Jiaming Xu, "Collaboratively Learning Preferences from Ordinal Data," Advances in Neural Information Processing Systems (NIPS), 2015.

37. Peter Kairouz, **S. Oh**, and Pramod Viswanath, "Differentially Private Multi-party Computation: Optimality of Non-Interactive Randomized Response," Advances in Neural Information Processing Systems (NIPS), 2015.

38. T. Basar, S. R. Etesami, **A. Olshevsky**, "Fast Convergence of Quantized Consensus Using Metropolis Weights," Proc. of the 53rd Conference on Decision and Control, Los Angeles, USA, 2014.

39. A. Nedic, **A. Olshevsky**, C. Uribe, "Nonasymptotic Convergence Rates for Cooperative Learning over Time-Varying Directed Graphs," Proc. of the American Control Conference, 2015.

40. **A. Olshevsky**, "Minimal Input Selection for Structural Controllability," Proc. of the American Control Conference, 2015.

41. Behnia, B., Buttlar, W.G., **Reis, H.**, "Estimation of Low-Temperature Cracking in Asphalt Concrete Pavements using an Acoustic Emission Approach," presented at the Society for the Advancement of Material and Process Engineering (SAMPE) Conference, Baltimore, May 18-20, 2015.

42. McGovern, M.E., Buttlar, W.G., and **Reis, H.**, "Assessment of Oxidative aging in asphalt concrete pavements with unknown acoustic properties," presented at the Society for the Advancement of Material and Process Engineering (SAMPE) Conference, Baltimore, May 18-20, 2015.

43. Haser, A., McGovern, M.E., Behnia, B., Buttlar, W.G., and **Reis, H.**, "Monitoring Viscosity in Asphalt Binders using an temperatures to Oxidized asphalt mixtures using acoustic emission," SPIE Smart Structures and Materials, Nondestructive Evaluation and Health Monitoring, International Society for Optics and Photonics, March 8-12, 2015.

44. McGovern, M.E., and **Reis, H.**, "Linear and nonlinear characterization of limestone," SPIE Smart Structures and Materials, Nondestructive Evaluation and Health Monitoring, International Society for Optics and Photonics, March 8-12, 2015.

45. Sun, Z., Farace, N., Arnold, J.W., Buttlar, W.G., and **Reis, H.**, "Quantitative evaluation of rejuvenators to restore embrittlement temperatures to oxidized asphalt mixtures using acoustic emission," SPIE Smart Structures and Materials, Nondestructive Evaluation and Health Monitoring, International Society for Optics and Photonics, March 8-12, 2015.

46. E. Salimi, N. Somnath and **R.S. Sreenivas**, "A Tutorial on the Synthesis of the Maximally Permissive Liveness Enforcing Supervisory Policy in Discrete-Event/Discrete-State Systems modeled by a Class of General Petri Nets," Indian Control Conference, Indian Institute of Technology, Chennai, January 2015.

47. R. Reck and **R.S. Sreenivas**, "Developing a New Affordable DC Motor Laboratory Kit for an Existing Undergraduate Controls Course," Invited Session on Control Education, American Control Conference (ACC-2015), Chicago, IL, July 2015.

48. E. Salimi, N. Somnath and **R.S. Sreenivas**, "On Supervisory Policies that Enforce Liveness in Controlled Petri Nets that are Similar," 7th IEEE International Conference on Cybernetics and Intelligent Systems (CIS) & Robotics, Automation and Mechatronics (RAM), Angkor Wat, Cambodia, July 2015.

49. R.M. Reck and **R.S. Sreenivas**, "Work-in-Progress: Assessing an Affordable and Portable Laboratory Kit in an Undergraduate Control Systems Course, Innovative Curriculum & Course Design III Section," Frontiers in Education 2015, El Paso, TX, October 2015.

50. G. M. Atinc, **D. M. Stipanovic**, P. G. Voulgaris, and M. Karkoub, "Swarm-Based Dynamic Coverage Control," in proceedings of the 2014 IEEE Control and Decision Conference, pp. 6963-6968.

51. D. Panagou, **D. M. Stipanovic**, and P. G. Voulgaris, "Vision-based dynamic coverage control for nonholonomic agents," in proceedings of the 2014 IEEE Control and Decision Conference, pp. 2198-2203.

52. **D. M. Stipanovic** and I. Shevchenko, "A Design of Strategies in Pursuit-Evasion Games Based on Switching Goal Functions," in the Book of Abstracts of the Ninth International Conference on Game Theory and Management, St. Petersburg, Russia, July 8-10, 2015.

53. Joseph, A., Schreiner, J., **Thurston, D.**, "Design Decision Tradeoffs for Environmental Impact and End of Life Recovery of Cellphones," in proceedings of the ASME 2015 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference, Boston, MA, June 2015.

54. Joseph, A., Schreiner, J., **Thurston, D.**, "Impact of Visual Models on Risk Attitude and Decision Tradeoffs in Aircraft Component Repair," Industrial and Systems Engineering Research Conference, Nashville, TN, 2015.

55. Debasis Mitra and **Qiong Wang**, "Modeling and Optimizing Intellectual Asset Production in Industrial Laboratories," IIE Annual Conference and Expo, Nashville, TN, 2015.

RECONNECT WITH ISE

Support ISE with a Gift

There are many opportunities to give to ISE.

Your gift can be used to fund a student's need- or merit-based scholarship, upgrade our infrastructure, provide start-up funding for a new professor's research program, or create or update a laboratory.

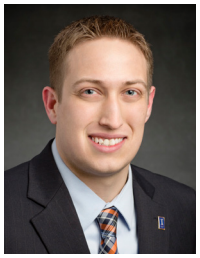
If you're interested in supporting ISE, please contact **John Southwood** at jfswood@illinois.edu.

Alumni and Corporate Relations/ Engineer in Residence Program

Our students value and are inspired by interaction with our alumni.

An Engineer in Residence will:

- Spend approximately 7-8 hours on campus
- Speak to our GE 390 class
- Stay "in residence" for an afternoon and/or morning for individual appointments with students



If you're interested in being an Engineer in Residence, please contact **Lee Zerrusen** at lzerrus2@illinois.edu.

Senior Engineering Project

We invite your company to participate as an Industry Partner in the Senior Engineering Project.

Within this unique class, we routinely accomplish the goals of educating our students with real world problems, solving special problems of our partnering companies and organizations, and introducing your company to potential recruits.

If you have engineering projects that you think may be suitable for this program, please contact **Harry Wildblood** at wildblod@illinois.edu.

Send an Update

Please drop us a line to let us know how your career is unfolding.

We'd like to hear how you're doing. General and Industrial Engineers end up with myriad life paths to choose from. If you have a story you'd like to tell, feel free to reach out. Your colleagues, former mentors, and current and future students will all be excited to see which direction you've taken with the foundational ISE education.

If you'd like to reach out, send an update, offer yourself for a story, please contact **William Gillespie** at gillespi@illinois.edu.

ISE ALUMNI BOARD

The ISE Alumni Advisory Board is a group of ISE alumni who stay connected to the department and help make it even stronger. The Board meets twice a year on campus to learn about department status, programs and plans, and to provide feedback and support. Appointed members are asked to serve for a four-year term and are encouraged to participate in one of the three standing committees. Past activities include mixers, networking events, résumé and interview skills coaching for students, and lectures to scheduled ISE classes in targeted areas of practice.

If you're interested in being nominated for membership, please contact Rick Blackwell at rblackwell@punshui.com.

LEFT TO RIGHT: John Southwood, Lee Zerrusen, Diane Steinkamp, Tom Conry, Jay Goldberg, Marty Lunkes, John Holz, Mike Brunetto, Department Head Rakesh Nagi, Dean Andreas Cangellaris, Brad Ptasienski, Jakub Teply, Todd Antonelli, Jason Struthers, Rick Blackwell, Laura McLay, Kennda Lynch.

Endowments and Annual Support

Faculty Chair | $2,000,000
A named chair allows the holder to conduct innovative research and explore novel teaching opportunities. It is a high honor for distinguished professors and an incomparable tool with which to attract and retain scholars of brilliance.

Named Professorship | $500,000
Endowed professorships allow ISE to continue to enhance its intellectual community by helping accomplished scholars in their pursuit of knowledge and in their education of the engineers and academics of the future.

Fellowships | $150,000
The recruitment of top graduate students allows for a robust top-tier research program. Fellowships help to provide a pipeline of academic excellence for the next generation of faculty members and practitioners. While ISE at Illinois has rich research offerings to entice students, we must also compete against the financial incentives offered by other institutions.

Faculty Scholar | $250,000
The promise of young faculty members is nurtured at the outset of their careers with faculty scholar awards. They are given the freedom to refine their expertise in the classroom and push the limits of their research.

Scholarships | $25,000
Scholarships enrich the ISE program by helping to attract and reward students with diverse talents and experiences. With escalating tuition costs, scholarships can make a world-class education possible for those who may have only dreamed of coming to Illinois.

Lecture Series | $100,000
Allow faculty and students to interact with distinguished leaders who are influencing disciplines, society, the nation, or the world. Income from the fund is used to provide the resources to cover the expenses of bringing such speakers to campus.

Annual Support

One of the most critical ways to support ISE is through annual giving. Your gift, regardless of size, makes a significant difference for our students by nurturing achievement, fostering excellence, and training the next generation of science and engineering leaders. The **ISE Unrestricted Fund** supports operations and programs such as Research Experience for Undergraduates (REU) and Engineers in Residence. Students also benefit from support for awards, career development, conferences, travel, and fellowships.

Our history of engineering excellence continues today largely because of the loyal and consistent support of our alumni.

Dean's Club | $1,000 Annually
Membership in the Dean's Club recognizes those making gifts of $1,000 or more annually to any Engineering at Illinois department or college fund. When you become a Dean's Club member, you partner with a group of dedicated alumni and friends who contribute to the success of our students, faculty, and programs.

Generous gifts from Dean's Club members position ISE to provide the best possible environment for both teaching and learning. Whether your gift helps refurbish a laboratory, fund student scholarships, or attract and retain world-class faculty, it will be contributing to a bright future for Engineering at Illinois.

Show your support online at: http://ise.illinois.edu/

Industrial and Enterprise Systems Engineering

University of Illinois at Urbana-Champaign
ISE Marketing and Communications
117 Transportation Building, MC-238
104 S. Mathews Avenue
Urbana, IL 61801
USA

gillespi@ise.illinois.edu
217.265.6594

Name
Address1
Address2
Address3
City, State Zip
Country