ISE ANNUAL REPORT 2019

IE

Industrial engineers make things BETTER.

SE

Systems engineers make better THINGS.

ILLINOIS

ISE | Industrial & Enterprise Systems Engineering

COLLEGE OF ENGINEERING

ISE

RAKESH NAGI

Department of Industrial and Enterprise Systems Engineering Head and Donald Bigger Willett Professor in Engineering

It gives me great satisfaction to see our department be acknowledged as one of the ten best undergraduate schools in our disciplines.

Our current ranking of nine is the highest our department has ever climbed, in the largest upward leap in recent memory. Our recognition is the result of the teamwork of faculty and staff in our rapidly growing department in the newly renamed Grainger College of Engineering.

According to the college, "Our new name represents the largest amount ever given to a public university to name a college of engineering, with more than $200 million provided in the last six years."

As we grow in size, we also grow in breadth, and become increasingly strong in design, human factors, autonomy, robotics, renewable energy, health care, and other core concerns of our disciplines. We do this while making fundamental and methodological contributions of the highest scholarly standards. From theory to practice, we are spanning the spectrum of impactful research.

Meanwhile, Illinois is growing as well, with the Carle Engineering College of Medicine and the construction of the Siebel Design Center. Opportunities for collaboration abound.

In these pages you will see the research efforts of faculty new and established across industrial and systems engineering in the areas of queueing, autonomous construction equipment, communications in a health care setting, supply chain management, sustainable product design, and epidemiology.

This year we are proud to add two faculty members, Chrysafis "Chrys" Vogiatzis and Yuan Zhou.

In an increasingly networked world, systems engineers face larger problems than ever before. We hope to solve them together.

Please enjoy our stories.

Sincerely,
Rakesh Nagi

Department of Industrial and Enterprise Systems Engineering Head
Donald Bigger Willett Professor in Engineering

CONTENTS

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

ISE Annual Report is edited by William Gillespie. Additional writing by Madeline Kuhl. Photography by L. Brian Stauffer and William Gillespie. Illustration and design by Miriam Martincic.

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The 2 WINGS of ISE

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ISE

BY DOUG PETERSON

IT'S EASY TO MISS when you enter the Transportation Building on Mathews Avenue, the home of ISE. But if you look closely, you'll see images of railroads on the walls and railings. As you approach the main entrance, direct your eyes to the roofline, and you'll see 4 winged locomotive wheels carved in stone, with 2 more winged wheels on the north side of the building and 1 on the south. Even the handrails on the banisters inside carry the design of a train wheel.

The railroad imagery is there because the Department of Railway Engineering was once housed in the Transportation Building. Today, the railway department is long gone, and the Transportation Building is now home to ISE. But these symbols are a reminder that technology is constantly evolving and so are departments, including ISE.

ISE's last major transformation came in the spring of 2006, when the College of Engineering decided to combine the Department of General Engineering (established in 1952) with the college's industrial engineering program. Like the 2 wings depicted on the building's locomotive wheels, this merger brought together 2 important realms of engineering—industrial engineering and systems engineering.

"When I was thinking of coming to Illinois, there was chatter about this brand-new department called ISE," recalls Harrison Kim, an ISE professor. "So, as I was considering options for my career, I knew that Illinois was a top engineering program, and now they were creating a new department. When would I have an opportunity like this again?"

Kim joined ISE in 2005 as one of the inaugural members of the new department, and he never looked back.

There is a lot of overlap between both parts of ISE—systems engineering and industrial engineering—but Kim says that the department's catch-phrases help to distinguish between the 2 wings.

Systems engineers make better things.

Industrial engineers make things better.

In other words, systems engineers develop new systems and new ways of doing things, while industrial engineers take existing systems and improve them at a new level.

"Think of it this way," Kim says. "If you have a gas-powered engine, industrial engineers will find ways to improve it." Systems engineers might go in an entirely new direction, developing an engine using renewable energy.

The following stories focus on research from both wings of the department—systems engineering (making better things) and industrial engineering (making things better). However, some of the professors featured in these stories, such as Carolyn Beck, split their research between systems and industrial engineering.

According to Beck, "Optimization is a big part of ISE's work—trying to make things perform as well as they can. For instance, we have people looking at optimization in respect to financial process, and that was fairly original.

"The department is going in a lot of new directions," she adds. But continual change is precisely what makes a dynamic system. It's also what makes a dynamic department.

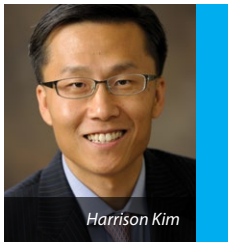
Systems engineers make better THINGS.
Industrial engineers make things BETTER.

It's Getting Easier to Be Green

"Our team calls it Green Profit Design," Kim says. "Companies need to be green and make money at the same time."

JOHN DEERE

GREEN IS the color of both money and the environment, but the 2 are not mutually exclusive, says Harrison Kim, ISE professor. For the past 14 years at Illinois, Kim's lab has been pioneering and refining a methodology that helps manufacturers design machines and devices that are both profitable and more environmentally sustainable.


Harrison Kim

"Our team calls it Green Profit Design," Kim says. "When companies go green simply to boost their public image, it's not going to work. Companies need to be green and make money at the same time."

Kim's methodology can be used for designing products of all types, from cellphones that fit in your pocket to large-scale farm machinery and even airplanes. In fact, Kim's Green Profit Design has been embraced by John Deere, the farm machinery giant known for its green-colored equipment. Deere product designers use Kim's methodology to calculate the environmental impact of a machine over its entire lifespan.

"Our methodology can calculate a machine's global-warming potential, or GWP," he says. For instance, their system might determine that 1 machine design will emit 1.3 kilograms equivalent of CO2 over the equipment's lifespan, while another design will emit 1.5 kilograms equivalent.

What's more, Kim's system makes it possible to do this calculation in minutes.

"An analysis that used to take 6 months to do now takes only 6 minutes," he says.

This groundbreaking methodology earned Kim a John Deere Supplier Innovation Award in 2015—a major award that the company had never given to a university research partner before. Each week, Kim's team has a conference call with Deere managers to talk about product development and manufacturing from the perspective of environmental sustainability.

"Every product generates an environmental footprint over its lifespan," Kim says. Therefore, his methodology takes into account energy consumption over a product's life, and it even factors in energy used during the manufacturing process.

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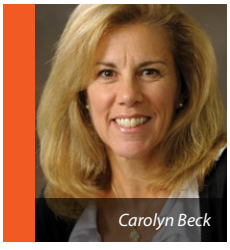
Tracking Epidemics and "Good Infections"

Carolyn Beck has been probing how epidemic processes work, and her models can be applied to diseases of all types, as well as to computer viruses or even the spread of "fake news."

MEASLES WAS officially eradicated from the United States in 2000, and yet 2019 has emerged as the worst year for measles outbreaks in 25 years.

For the past 6 years, ISE professor Carolyn Beck has been probing how epidemic processes work, and her models can be applied to diseases of all types, as well as to computer viruses or even the spread of "fake news."

"Our epidemic models are based on network structures," Beck says. "Humans form what are called human contact networks. So we've been looking at how epidemics spread on these human networks, which are constantly changing. Also, we consider how interconnected different people are and how strong their connections are."



Carolyn Beck

Although this work focuses on disease epidemics, Beck says the models can be used with many other processes that spread and evolve over network structures. For instance, computer viruses.

Beck's epidemic models can even be applied to the spread of opinions over a network, as well as the spread of a tweet on a social network. What's more, marketing people can use these models to track the dissemination of their products.

"Marketers want to know the parameters under which they can be assured their idea or product will rapidly disseminate over a network," she says. For them, the spread of their product is a type of "good infection."

Beck says that over the years numerous research papers have analyzed these kinds of network processes, but in most cases the scenarios being studied are static. But Beck is looking at dynamic networks that are constantly morphing over time—such as an ever-changing disease process.

In the past, she points out, if you had a static network and the ratio of the infection rate to the healing rate was less than 1, than you could safely say the disease will eventually leave the system. But her team is looking at how that ratio holds up in a more dynamic model, in which the population is constantly changing and moving.

"My greatest pride is in my students—where they have gone and what they have done," Beck says. For example, some of her students work on "clustering algorithms," which break Big Data into more manageable subgroups. After researching clustering algorithms in Beck's lab, some of her students went on to apply these techniques at Facebook and Amazon.

In a sense, her students form a dynamic network all their own, spreading the influence of what they accomplished at Beck's lab all across the country—another example of a "good infection."

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Stolyar is one of the country's leading experts in the stability of queues, or jobs lined up to be processed by servers.

Waiting Rooms in Cyberspace

IMAGINE A doctor's waiting room with people coming and going throughout the day. "Stability" means that at any given time, you might have 3 or 4 people waiting to see the doctor, maybe even five. But if the patients begin to back up, filling the room so there isn't a spare seat or magazine to go around, then you've got problems. This is an unstable system, says Alexander Stolyar, ISE professor.

This is also a picture of the kind of work that Stolyar has been pursuing for most of his 30-year career, only the "waiting rooms" in his research are mostly in cyberspace.

"In cloud computing, I look at how to process large amounts of data," Stolyar says. Thousands of servers in a cloud system accept jobs from computers, so the problem is getting the system to distribute these jobs in an efficient way. This is known as a resource allocation problem. With all of the data flooding the servers in the cloud, how do you dynamically distribute the workload in the simplest and most effective way?

Stolyar has a solution to this problem, and he calls it "pull-based algorithms."

Pull-based algorithms make it possible for servers to tell the router, or dispatcher, to send them the load. The servers "pull" the jobs to themselves, rather than wait for the router to "push" the load to them.

His algorithms also deal with "stochastic bin packing." As he explains, some jobs being sent out to servers in the cloud may require a lot of memory but little processing power. Other jobs may require the exact opposite—a lot of processing power but little memory. Thus, the jobs coming in have different "sizes," so the question is how to fit the right job with the right server. It's like packing bins, he says, and hence the name.


Alexander Stolyar


Qiong Wang

"It's a classical mathematical problem," adds Stolyar, who tackled similar problems while working at Bell Labs in New Jersey from 1998 to 2014. One of his colleagues there was Qiong Wang, now also an ISE professor who works in the office right next door to him in the Transportation Building on the Illinois campus. Ironically, Stolyar and Wang never directly collaborated at Bell Labs, but at Illinois they have been working together on some classical problems in inventory theory.

They have completed the proof of concept, and he says, "Now we have big plans on how to make the new inventory control algorithm practical."

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Just What the Doctor Ordered

ANYONE WHO regularly watches medical dramas on TV knows the drill. In the chaos of an emergency, doctors fire off orders right and left as a team gathers around the patient. In the very first episode of the TV show *Grey's Anatomy*, for instance, a patient suddenly goes into convulsions, and the doctor snaps, "Phenobarbital! Load her with phenobarbital!"

No dosage is mentioned—a big mistake, according to a doctor analyzing this particular *Grey's Anatomy* scene in an online show. What's more, he says that in a real situation, the nurse would've repeated the exact dose to make sure communication was clearly received.

Medical shows aren't expected to be 100-percent accurate, but in a real-world setting, this kind of team communication must be clear and coordinated, or the consequences can be fatal, says Abigail Wooldridge, an ISE professor. Wooldridge specializes in studying team communication in all types of medical scenarios; in fact, she recently launched a pilot project that examines teamwork during hospital handoffs.

Handoffs are when the authority, responsibility, and information about a patient are transferred from one set of clinicians to another. This can happen at shift changes, when patients are moved from one health care facility to another, or when they are moved between units within a hospital.


Abigail Woolridge

As Wooldridge explains, handoffs are a double-edged sword. "On the positive side, when you have a new group of people starting to take care of a patient, they might realize something was missed, or they may have a new perspective on what should happen for a patient that could improve the quality of care."

But there are also risks. Information can be lost or missed during handoffs. For example, she says, a clinician might forget to tell the new team that a patient needs a certain dose of a medication.

To study transitions between an operating room and an intensive care unit, Wooldridge is working with the Jump Simulation Center in Peoria. The center has life-sized simulation rooms of both an operating room and an intensive-care unit.

"It's a high-fidelity simulation," she says. "It's a setting that looks like a real operating room and a real intensive care unit."

"If we can improve this really important part of their care—the transition—then we can save lives."

Wooldridge specializes in studying team communication in all types of medical scenarios.

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Balancing Acts

Chen's mathematical models balance inventory so companies can meet online orders, while keeping physical stores stocked.

IN 2018, the Chinese e-commerce giant, JD.com, announced its new mascot—a large-headed, big-hearted dog named Joy. The announcement even came complete with a delightful, Pixar-style, animated short film, *Joy Story*, in which the dog tries to prevent a heron from stealing his master's fishing worms from the boat. When the dog realizes the heron only wants the worms to feed her chicks, he welcomes her back for more.

Joy appears courtesy of JD.com.

You might say that Joy, faced the kind of inventory management problem that ISE professor Xin Chen has been helping the Chinese company tackle in his research.

Joy had to make sure there were enough worms for his master to use for fishing, while still letting the heron fly off with some in her beak. In the real world of business, Chen has been developing mathematical models that can help JD.com do something quite similar—balance the inventory of its new stores, known as 7 Fresh, so it can meet the needs of both online and in-store purchases.

Xin Chen

People can use an app to order fresh food to be delivered from the 7 Fresh stores, but they can also drop in and buy at the store. Chen's mathematical models balance inventory so companies such as JD.com can meet online orders, while still making sure there is enough food on the shelves for those who come to the physical store. He points out that companies try especially hard to keep in-store customers happy because they might make additional purchases while visiting the store.

Chen's lab also develops mathematical models of customer behavior—systems to maximize revenue by modeling the choices made by customers. His team combines data from companies with publicly available data to put their models to the test.

"Currently, companies use simple models, but we're trying to look at more accurate, more complex models," he says. "Hopefully, these models can better capture customer behavior and companies will be interested in using them."

He says models with greater complexity make sense because, after all, "Human beings are quite complex."

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IMPACT STARTS HERE

ISE'S RENOWNED FACULTY make revolutionary breakthroughs to solve some of the world's biggest problems. The rich breadth of their backgrounds and research interests reflect ISE's goal to offer a comprehensive, cross-disciplinary program of teaching and research.

Left to Right: Conrad Tucker, Sarah Behdad, Deborah Thurston, Scarlett Miller, Harrison Kim.

2019 | ISE at ASME

Pingfeng Wang was Program Chair for DAC (Design Automation Conference), organized a special session, and presented four papers with his students.

James Allison presented four papers with his students, and organized a discussion session on graph-based engineering system design.

Girish Krishnan and Yumeng Li each also presented papers with their students.

Two ISE professors and three of their previous graduate students received awards at the 2019 ASME conference

Deborah Thurston: Design Theory and Methodology Award

Professor Thurston received the Design Theory and Methodology (DTM) Award. This award recognizes "sustained and meritorious contributions to research, education, service, training of researchers or practitioners, overall leadership in advancing the field, or any combination of these in the field of Design Theory and Methodology".

"This is sort of like a lifetime achievement award," Thurston said. "It's especially gratifying because DTM was just starting about the same time I first became a professor. Being on the ground floor gave me lots of opportunities to help shape this new field by serving as journal editor, helping to run the DTM conferences, reviewing papers, coordinating reviews, and publishing papers with my students. It's nice to be recognized for my long-term contributions, but even nicer to see the field flourishing."

Something unique about this year's ASME conference was the fact that multiple Illinois students and professors received awards. "Three of our former students received Best Paper Awards, and they themselves are professors now. This is insanely cool, to see our former students making such important contributions" Thurston said.

Thurston says the ASME community has benefited her in many ways. "ISE and the University are my home base." Thurston said. "But it's important to also belong to a community with a critical mass of like-minded researchers. This ASME community has been my external, intellectual home, and a great professional organization to be a part of."

In 2016, Thurston received the Kos Ishii-Toshiba Award, the same one that Professor Harrison Kim was awarded this year.

Harrison Kim: The Kos Ishii-Toshiba Award

The Kos Ishii-Toshiba Award was awarded to Kim in recognition of his "sustained and meritorious contributions to design for manufacturing and the life cycle." The award was named after the late Professor Kos Ishii, who taught at Stanford University.

Kim's recent research with profitability and environmental impact led to him receiving this award.

"My team developed a methodology called the green profit design," Kim said. "It enables manufacturers to recover, remanufacture or recycle end of life products. Not only for the environmental impact, but including profitability for the companies."

"I am really humbled and honored for the recognition," Kim said. "The fact that we have two winners of this award, Professor Thurston and I, in one department is showing evidence that we at ISE and Illinois are leading this area of research."

Sarah Behdad

Sarah Behdad (PhDIE 2013), now at SUNY Buffalo, won the Best Paper Award in Design for Manufacturing and the Lifecycle with her student P. K. Gopalakrishnan, and collaborators J. Cavallaro, S. Jahanbekam for "A Graph Coloring Technique for Identifying the Minimum Number of Parts for Physical Integration in Product Design."

Conrad Tucker

Conrad Tucker (PhDSEE 2011), now at Carnegie Mellon University, won the Virtual Environment Systems Best Paper award with his student C. Lopez and collaborator O. Ashour for "Reinforcement Learning Content Generation for Virtual Reality Applications."

Scarlett Miller

Scarlett Miller (PhDIE 2011), now at Penn State, won the Best Paper Award in Design Education for "Complex Solutions for Complex Problems: Exploring the Effects of Task Complexity on Student Use of Design for Additive Manufacturing" with her co-authors R. Prabhu T. Simpson and N. Meisel.

ASME
SETTING THE STANDARD

William Norris and Colleagues Awarded $4M in Contracts by Army to Develop Autonomous Construction Systems

BY WILLIAM GILLESPIE

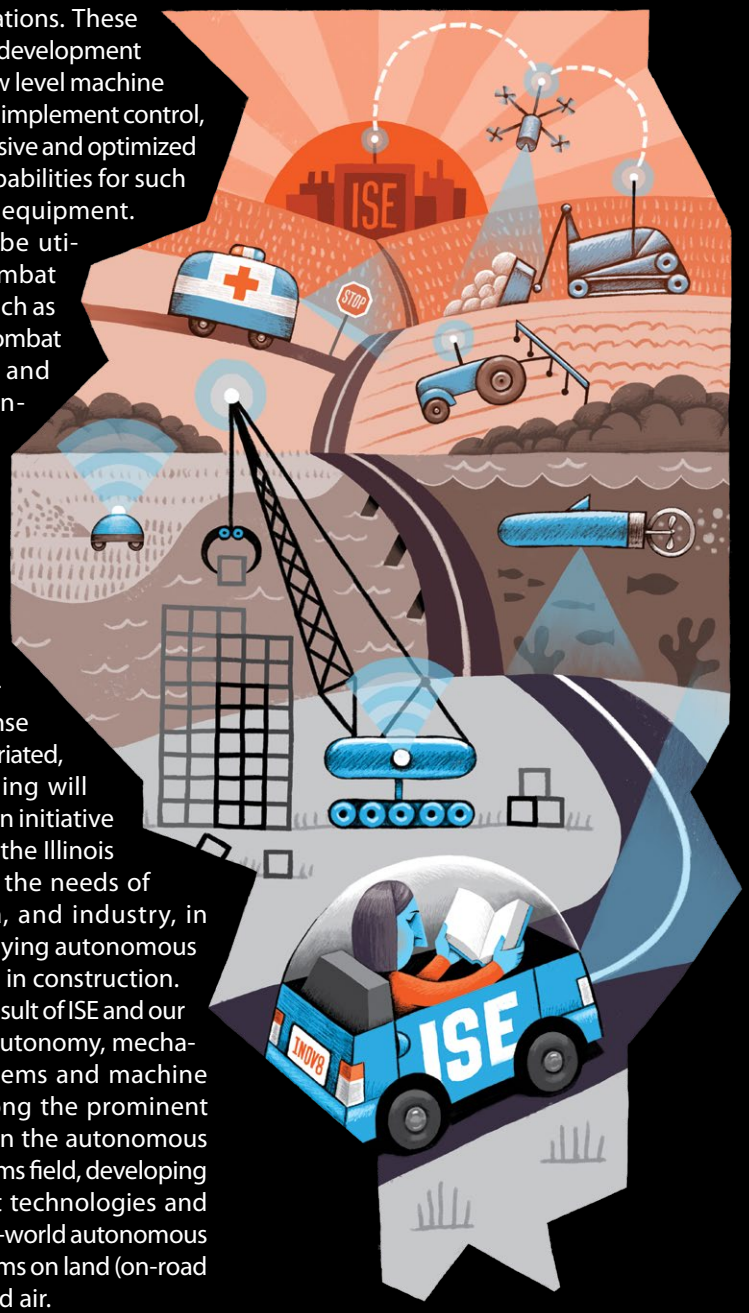
ISE Professor William R. (Bob) Norris and colleagues have been contracted by the US Army Corps of Engineers Engineer Research and Development Center's Construction Engineering Research Laboratory (CERL) to develop autonomous construction systems. The funding represents the largest autonomous system project given to Illinois to date.

The researchers have been awarded two $1.2M 3-year contracts with options for over $1.8M additional for each project. Professor Norris is the sole Principal Investigator (PI) for one project. ISE Department Head and Professor Rakesh Nagi is the PI for the second project, with ISE Professors R.S. Sreenivas and William Norris as co-PIs. These projects are contracts as opposed to grants, which ensures the graduate students who assist will be solving real-world engineering problems of national importance.

Autonomous military systems will operate in challenging and uncontrolled environments that include restricted terrain and limited or completely denied GPS and communications. These contracts specify the development and integration of low level machine control, machine tool implement control, as well as comprehensive and optimized mission planning capabilities for such unmanned military equipment. These systems will be utilized to support Combat Engineer missions such as obstacle reduction, combat route maintenance and repair, and horizontal construction for building contingency bases.

In addition, a $1.5 M plus-up for the defense budget has been ratified by both the US House and Senate for inclusion in the defense budget. Once appropriated, this additional funding will be used to develop an initiative creating a center on the Illinois campus integrating the needs of the DoD, academia, and industry, in developing and applying autonomous system technologies in construction.

Norris says, "As a result of ISE and our team's expertise in autonomy, mechatronics, control systems and machine learning, we're among the prominent technology leaders in the autonomous and unmanned systems field, developing new state-of-the-art technologies and applying them to real-world autonomous and unmanned systems on land (on-road and off-road), sea and air.



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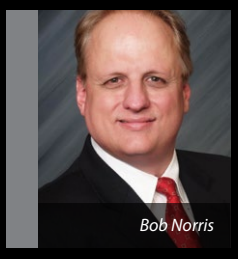
Bob Norris


Rakesh Nagi


Ramavarapu S. Sreenivas

FACULTY ACCOMPLISHMENTS

MAY 2018–MAY 2019

Conference Papers

JAMES ALLISON

1. Zitao Liao, Danny J. Lohan, Nathan C. Brooks, **James Allison**, and Robert C. N. Pilawa-Podgurski, "Multi-Objective Optimization of Series-Stacked Energy Decoupling Buffers in Single-Phase Converters," COMPEL 2018, Padova, Italy.
2. Daniel R. Herber and **James Allison**, "A Problem Class With Combined Architecture, Plant, and Control Design Applied to Vehicle Suspensions," ASME 2018 International Design Engineering Technical Conferences, Quebec City, Quebec, Canada.
3. Satya R. T. Peddada, Daniel R. Herber, Herschel C. Pangborn, Andrew G. Alleyne, and **James Allison**, "Optimal Flow Control and Single Split Architecture Exploration for Fluid-Based Thermal Management," ASME 2018 International Design Engineering Technical Conferences, Quebec City, Quebec, Canada.
4. Tinghao Guo, Daniel R. Herber, and **James Allison**, "Reducing Evaluation Cost for Circuit Synthesis Using Active Learning," ASME 2018 International Design Engineering Technical Conferences, Quebec City, Quebec, Canada.
5. Albert Patterson and **James Allison**, "Manufacturability Constraint Formulation for Design Under Hybrid Additive-Subtractive Manufacturing," ASME 2018 International Design Engineering Technical Conferences, Quebec City, Quebec, Canada.
6. Tinghao Guo, Daniel R. Herber, and **James Allison**, "Circuit Synthesis Using Generative Adversarial Networks (GANs)," AIAA 2019 Science and Technology Forum and Exposition, AIAA 2019–2350, San Diego, CA, USA, January 2019.
7. Danny J. Lohan and **James Allison**, "An Assessment of Structural Optimization Methods for Device-Level Heat Sink Design," 13th World Congress on Structural and Multidisciplinary Optimization, Beijing, China, May 2019.
8. Yong Hoon Lee, Vedant, Randy H. Ewoldt, **James Allison**, "Strain-Actuated Solar Arrays for Spacecraft Attitude Control Assisted by Viscoelastic Damping," 13th World Congress on Structural and Multidisciplinary Optimization, Beijing, China, May 2019.
9. Charul Chadha, Albert Patterson, Iwona Jasiuk, **James Allison**, and Kai James, "Repair of High-value Plastic Components Using Fused Deposition Modeling," 2019 Annual International Solid Freeform Fabrication Symposium, forthcoming.
10. Tonghui Cui, **James Allison**, and Pingfeng Wang, "A Comparative Study of Formulations and Algorithms For Reliability-based Co-Design Problems," ASME 2019 International Design Engineering Technical Conferences, Anaheim, California, USA.
11. Vedant and **James Allison**, "Pseudo-Rigid Body Dynamic Modeling of Compliant Members for Design," ASME 2019 International Design Engineering Technical Conferences, Anaheim, California, USA.
12. Albert Patterson, Yong Hoon Lee, and **James Allison**, "Overview of the Development and

Enforcement of Process-Driven Manufacturability Constraints in Product Design," ASME 2019 International Design Engineering Technical Conferences, Anaheim, California, USA.

13. Albert Patterson and **James Allison**, "Generation and Mapping of Minimally-restrictive Manufacturability Constraints for Mechanical Design Problems," ASME 2019 International Design Engineering Technical Conferences, Anaheim, California, USA.
14. Vedant, Alex Ghosh, Matthew West, and **James Allison**, "Reinforcement Learning for Spacecraft Attitude Control," 70th International Astronautical Congress, Washington, DC, USA, October 2019.
15. Vedant, Alex Ghosh, Oscar Alvarez-Salazar, and **James Allison**, "Impact of Strain-Actuated Attitude Control Systems for Variant Mission Classes," 70th International Astronautical Congress, Washington, DC, USA, October 2019.

CAROLYN BECK

1. Philip E. Paré, B. Kirwan, J. Liu, T. Basar, and **Carolyn Beck**, "Discrete-Time Spread Processes: Analysis, Identification, and Validation," ACC, 2018.
2. Thinh T. Doan, **Carolyn Beck**, and R. Srikant, "Convergence Rate of Distributed Subgradient Methods under Communication Delays," ACC, 2018.
3. Philip E. Paré, Ji Liu, **Carolyn Beck**, and Tamer Basar, "A Coupled Bi-Virus Spread Model in Networked Systems," ACC, 2018.
4. L. Buccafusca and **Carolyn Beck**, "Maximizing Power in Wind Turbine Arrays with Variable Wind Dynamics," IEEE CDC, Miami, Florida, USA, 2018.
5. Thinh T. Doan, Joseph Lubars, **Carolyn Beck**, and R. Srikant, "Convergence Rate of Distributed Random Projections," 7th IFAC Workshop on Distributed Estimation and Control in Networked Systems (NecSys), August 2018.
6. Arturo Melo, **Carolyn Beck**, José I. Pena, Philip E. Paré, "Knowledge Transfer from Universities to Regions as a Network Spreading Process," IEEE International Systems Engineering Symposium, 2018.
7. Philip Paré, Ji Liu, **Carolyn Beck**, and Tamer Basar, "Networked Infectious Disease-Contaminated Water Model," accepted to European Control Conference (ECC), Naples, Italy, 2019.
8. Sebastian F. Ruf, Philip E. Paré, Ji Liu, **Carolyn Beck**, and Tamer Basar, "A Viral Model of Product Adoption with Antagonistic Interactions," accepted to ACC, Philadelphia, Pennsylvania, USA, 2019.

KARTHIK CHANDRASEKARAN

1. K. Berczi, **Karthik Chandrasekaran**, T. Kiraly, and V. Madan, "Improving the Integrality Gap for Multiway Cut," Integer Programming and Combinatorial Optimization (IPCO 2019), 2019.
2. A. Bibak, C. Carlson, and **Karthik Chandrasekaran**, "Improving the smoothed complexity of FLIP for max cut problems," 30th annual ACM-SIAM Symposium on Discrete Algorithms (SODA 2019), 2019.
3. **Karthik Chandrasekaran**, D. Dadush, V. Gandikota, and E. Grigorescu, "Lattice-based Locality Sensitive Hashing is Optimal," Innovations in Theoretical Computer Science (ITCS 2018), 2018.
4. **Karthik Chandrasekaran**, C. Xu, and X. Yu, "Hypergraph k-cut in Randomized Polynomial Time," ACM-SIAM Symposium on Discrete Algorithms (SODA 2018), 2018.
5. K. Berczi, **Karthik Chandrasekaran**, T. Kiraly, and V. Madan, "A tight sqrt{2}-approximation for Linear-3-Cut," ACM-SIAM Symposium on Discrete Algorithms (SODA 2018), 2018.

ALEXANDRA CHRONOPOULOU

1. M. Bays-Muchmore and **Alexandra Chronopoulou**, "First Year Engineering Students Perceptions of Engineering, " accepted to 2018 ASEE Annual Conference & Exposition, Undergraduate Students Division.

RASOUL ETESAMI

1. **Rasoul Etesami**, "Sequential Optimization for State-Dependent Opinion Dynamics," IEEE American Control Conference (ACC), Philadelphia, PA, USA, July 2019.

JUGAL GARG

1. **Jugal Garg** and Peter McGlaughlin, "Improving Nash Social Welfare Approximations," 28th International Joint Conference on Artificial Intelligence (IJCAI), 2019.
2. **Jugal Garg** and László Végh, "A Strongly Polynomial Algorithm for Linear Exchange Markets," 51st Symposium on Theory of Computing (STOC), 2019.
3. **Jugal Garg**, Peter McGlaughlin, and Setareh Taki, "Approximating Maximin Share Allocations," Symposium on Simplicity in Algorithms (SOSA), 2019.
4. Bhaskar Chaudhuri, Yun Kuen Cheung, **Jugal Garg**, Naveen Garg, Martin Hoefer, and Kurt Mehlhorn, "On Fair Division of Indivisible Items," 38th Annual Conference on Foundations of Software Technology and Theoretical Computer Science (FSTTCS), 2018.
5. Rahul Swamy, Timothy Murray, and **Jugal Garg**, "Network Cost-Sharing Games: Equilibrium Computation and Applications to Election Modeling," 12th International Conference on Combinatorial Optimization and Applications (COCOA), 2018.
6. **Jugal Garg** and Peter McGlaughlin, "A Truthful Mechanism for Interval Scheduling," 11th International Symposium on Algorithmic Game Theory (SAGT), 2018.
7. **Jugal Garg**, Martin Hoefer, and Kurt Mehlhorn, "Approximating the Nash Social Welfare with Budget-Additive Valuations," 29th Annual ACM-SIAM Symposium on Discrete Algorithms (SODA), 2018.
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JUSTIN SIRIGNANO

1. **Justin Sirignano** and K. Giesecke, "Risk Analysis for Large Pools of Loans," *Management Science* 65, no. 1 (2018).
2. **Justin Sirignano** and K. Spiliopoulos, "DGM: A deep learning algorithm for solving partial differential equations," *Journal of Computational Physics* 375 (2018): 1339–1364.
3. **Justin Sirignano**, "Deep learning for limit order books," *Quantitative Finance* 1, no. 22 (2018).
4. K. Giesecke, G. Schwenkler, and **Justin Sirignano**, "Inference for Large Financial Systems," *Mathematical Finance* (2019), forthcoming.

RICHARD SOWERS

1. Nitin Srivastava, Peter Maneykowski, and **Richard Sowers**, "Algorithmic geolocation of harvest in hand-picked agriculture," *Natural Resource Modelling* (2018).

RAMAVARAPU S. SREENIVAS

1. C. Chen, A. Raman, H. Hu, and **R. S. Sreenivas**, "On Liveness Enforcing Supervisory Policies for Arbitrary Petri Nets," conditionally accepted to *IEEE Transactions on Automatic Control* (June 2019).

DUŠAN STIPANOVIĆ

1. S. A. Deka, X. Li, **Dušan Stipanović**, and T. Kesavadas, "Robust and safe coordination of multiple robotic manipulators," *Journal of Intelligent and Robotic Systems* 90, no. 3-4 (2018): 419–435.
2. A. Lekić, **Dušan Stipanović**, and N. Petrović, "Controlling the Ćuk Converter Using Polytopic Lyapunov Functions," *IEEE Transactions on Circuits and Systems II: Express Briefs* 60 (2018): 1678–1682.
3. S. A. Deka, **Dušan Stipanović**, and T. Kesavadas, "Stable bilateral teleoperation with bounded control," *IEEE Transactions on Control Systems Technology*, forthcoming, http://doi.org/10.1109/TCST.2018.2871874.
4. N. Petrović, A. Lekić and **Dušan Stipanović**, "Lyapunov Characterization and Analysis of the Operating Modes of the AC–DC Ćuk Converter," *IEEE Journal of Emerging and Selected Topics in Power Electronics* 7 (2019): 1318–1328.
5. S. A. Deka, **Dušan Stipanović**, B. Murmann, and C. J. Tomlin, "Global Asymptotic Stability and Stabilization of Long Short-Term Memory Neural Networks with Constant Weights and Biases," *Journal of Optimization Theory and Applications* 181 (2019): 231–243.

ALEKSANDR STOLYAR

1. D. Mukherjee, **Aleksandr Stolyar**, "Join-Idle-Queue with Service Elasticity: Large-Scale Asymptotics of a Non-monotone System," *Stochastic Systems*, (2019), forthcoming.
2. S. Shneer and **Aleksandr Stolyar**, "Stability conditions for a discrete-time decentralised medium access algorithm," *Annals of Applied Probability* 28, no. 6 (2018): 3600–3628.
3. M. Nazari and **Aleksandr Stolyar**, "Reward Maximization in General Dynamic Matching Systems," *Queueing Systems* 91, no.1-2 (2019): 143–170, http://doi.org/10.1007/s11134-018-9593-y.
4. Y. Guo, **Aleksandr Stolyar**, and A. Walid, "Online VM Auto-Scaling Algorithms for Application Hosting in a Cloud," *IEEE Transactions on Cloud Computing* (2018), http://doi.org/10.1109/TCC.2018.2830793.
5. L. Nguyen and **Aleksandr Stolyar**, "A queueing system with on-demand servers: local stability of fluid limits," *Queueing Systems* 89, no. 3-4 (2018): 243–268, http://doi.org/10.1007/s11134-017-9564-8.

RUOYU SUN

1. **Ruoyu Sun**, Zhi-Quan Luo, and Yinyu Ye, "On the Efficiency of Random Permutation for ADMM and Coordinate Descent," accepted to *Mathematics of Operations Research* (2018).
2. Wei Liu, **Ruoyu Sun**, and Zhi-Quan Luo, "Globally Optimal Uplink Joint Base Station Association and Beamforming," accepted to *IEEE Transactions on Communications* (2019).

PINGFENG WANG

1. A. T. Eshghi, S. Lee, H-J Jung, and **Pingfeng Wang**, "Design of structural monitoring sensor network using surrogate modeling of stochastic sensor signal," *Mechanical Systems and Signal Processing* 133 (2019): 106280.
2. Z. Zheng, B. Chen, N. Fritz, Y. Gurumukhi, J. Cook, M. Ates, N. Miljkovic, P. V. Braun, and **Pingfeng Wang**, "Lithiation Induced Stress Concentration for 3D Metal Scaffold Structured Silicon Anodes," *Journal of the Electrochemical Society* 166, no.10 (2019): A2083–A2090.
3. J. Wu and **Pingfeng Wang**, "A Comparison of Control Strategies for Disruption Management in Engineering Design for Resilience," *ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems Part B* 5, no. 2 (2019): 020902.
4. X. Fan, **Pingfeng Wang**, and F. Hao, "Reliability-based design optimization of crane bridges using Kriging-based surrogate models," *Structural and Multidisciplinary Optimization* 59, no. 3 (2019): 993–1005.
5. N. Yodo and **Pingfeng Wang**, "A Control-Guided Failure Restoration Framework for the Design of Resilient Engineering Systems," *Reliability Engineering and Systems Safety* 178 (2018): 179–190.

ABIGAIL WOOLDRIDGE

1. **Abigail Wooldridge**, P. Carayon, B. Eagan, and D. W. Shaffer, "Quantifying the Qualitative with Epistemic Network Analysis: A Human Factors Case Study of Task-Allocation Communication in a Primary Care Team," *IISE Transactions on Healthcare Systems Engineering*, http://doi.org/10.1080/24725579.2017.1418769
2. **Abigail Wooldridge**, P. Carayon, P. L. T. Hoonakker, B-Z Hose, J. Ross, J. Kohler, T. Brazelton, B. Eithun, M. Kelly, S. Dean, D. Rusy, A. Durojaiye, and A. Gurses, "Complexity of the Pediatric Trauma Care Process: Implications for Multi-Level Awareness," accepted to *Cognition, Technology and Work*.
3. P. Carayon, **Abigail Wooldridge**, B-Z Hose, M. Salwei, and J. Benneyan, "Improving Patient Safety Through Human Factors and Systems Engineering: Opportunities and Challenges," *Health Affairs* 37, no.11 (2018): 1862–1869.
4. B-Z Hose, P. L. T. Hoonakker, **Abigail Wooldridge**, J. Ross, J. Kohler, T. Brazelton, B. Eithun, M. Kelly, S. Dean, D. Rusy, A. Gurses, J. Feckler, and P. Carayon, "Physicians' Perceptions of the Problem List in Pediatric Trauma Care," *Applied Clinical Informatics* 10, no. 1 (2019): 113–122.
5. P. Hoonakker, **Abigail Wooldridge**, B-Z Hose, P. Carayon, B. Eithun, T. Brazelton, and D. Rusy, "Things Falling Through the Cracks: Information Loss During Pediatric Trauma Care Transitions," accepted to *Internal and Emergency Medicine*.

Grants

JAMES ALLISON

1. NSF POETS (IAB Award), 2018, $52,991, I1.008.18 EMI Mitigation for Dense DC-AC Converters via Structured Topological Design Exploration
2. NSF POETS, 2018–2019, $100,000, R1.009.17 Multi-physics Design Optimization Methods for Heat Sink Packaging
3. AFRL (via NSF POETS Directed Funds), 2018–2019, $100,000, I1.010.18 Initial Conceptual-Level Study of Aircraft Power and Thermal System Architecture Generation and Evaluation
4. NSF POETS (IAB Award), 2019, $19,519, I1.011.19 Novel Solution Methods for Optimal Spatial Packaging and Routing of Electro-Thermal Components, PI Kai James, Co-PI **James Allison**

KARTHIK CHANDRASEKARAN

1. NSF: AF, Small, 2018, $250,000, Cuts, Connectivity and Partitioning in Graphs, Hypergraphs and Beyond, joint with Prof. Chekuri

XIN CHEN

1. ZJU-UIUC Institute Research Program, 2018–2019, $75,000, Data-drive perishable inventory management
2. Didichuxing (gift fund), 2018, $14,731, Dynamic pricing in carpooling
3. JD.com (gift fund), 2018–2019, $70,000, Omni-channel inventory management

LIMING FENG

1. NSF, 2018–2020, $175,000, Strongly Polynomial Algorithms for Market Equilibria with Applications to Network Flows and Nash Social Welfare

NIAO HE

1. NSF Computer and Information Science and Engineering (CISE) Research Initiation Initiative (CRII), 2018–2020, $175,000, Fundamental Limits of Conditional Stochastic Optimization
2. NSF CMMI Operations Engineering (OE), 2018–2021, $270,000, Point Processes in Healthcare and Security Analytics: Nonparametric Estimation and Efficient Optimization, Co-PI: Negar Kiyavash
3. National Center for Supercomputing Applications (NCSA), 2018–2019, $25,000, Learning Huge-Scale Diffusion Networks in Real-Time

HARRISON KIM

1. John Deere, 2018–2019, John Deere Grant—Phase IX, $120,000, PI: Sustainable Product Design—Phase IX

GIRISH KRISHNAN

1. JUMP (Arches), 2019–2020, $45,000, Integrating Soft Actuators in a Heart Simulator to Mimic Force Feedback in Cardiac Trans-Septal Puncture
2. NSF, 2015–2020, $500,000, CAREER: Design methodology for bio-inspired soft mechanical systems
3. NSF NRI (USDA/NIFA), 2018–2021, $275,000, NRI:INT Multipurpose Dexterous Soft Continuum Arms for Compact Agbots, Lead: Girish Chowdhary, Co-PI: Mattia Gazzola, Sarah Lovel Taylor

LAVANYA MARLA

1. Deepair Solutions, 2019–2020, $27000, Machine learning models for passenger services in the airline industry
2. Deepair Solutions, 2018–2019, $27000, Machine learning models for passenger services in the airline industry
3. National Science Foundation, 2018–2021, $237,856, COLLAB: Synergetic Drone Delivery Network in Metropolis, PI: Prof. Naira Hovakimyan, Co-PI **Lavanya Marla** and four others

RAKESH NAGI

1. CERL/ERDC US Army, 2019–2022, $1.2M, Mission Planning and Optimization with Multiple Robotic Agents for Engineer Operations in the Deployed Environment, Co-PI Sreenivas and Norris
2. Sandia National Labs, 2018–2019, $65,000, Accelerated Algorithms for Multi-Sensor Data Association for Multi-Target Tracking

RAMAVARAPU S. SREENIVAS

1. Sandia National Labs, 2018, $85,093, Towards a Science of Actionable Intelligence
2. DARPA, 2018–2019, $50,092, A Demonstration Platform for Dynamic Mission Planning with Multi-Domain Autonomous Systems, PI H. Trong
3. Jump ARCHES, 2018–2019, $34,250, Natural Language Powered Platform for Post-Operative Care for Long Distance Caregiving
4. National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR), 2018–2023, $256,258, The Rehabilitation Engineering Research Center (RERC) on Technologies to Support Aging-in-Place for People with Long-Term Disabilities, PI W. Rogers
5. US Army Corps of Engineers, 2019–2020, $100,000, Reliable Autonomy In Denied Environments (RAIDE), PI G. Chowdhary
6. CERL/ERDC US Army, 2019–2022, $365,589, Mission Planning and Optimization with Multiple Robotic Agents for Engineer Operations in the Deployed Environment, PI Rakesh Nagi

RUOYU SUN

1. NSF, 2018, $17,5000, CRII: AF: Towards Faster Algorithms for Large-scale Constrained Optimization

ABIGAIL WOOLDRIDGE

1. Jump ARCHES through the Health Care Engineering Systems Center, 2019–2020, $57,093, Using Simulation to Evaluate and Improve Team Cognition in Handoffs
2. Jump ARCHES through the Health Care Engineering Systems Center, 2019–2020, $46,435, The i-AREA-p; an intelligent mobility-based augmented reality simulation application for pediatric resuscitation training, PI Trina Croland
3. Jump ARCHES through the Health Care Engineering Systems Center, 2019–2020, $5,739, Pediatric Sepsis Guidance System, PI Lui Sha

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