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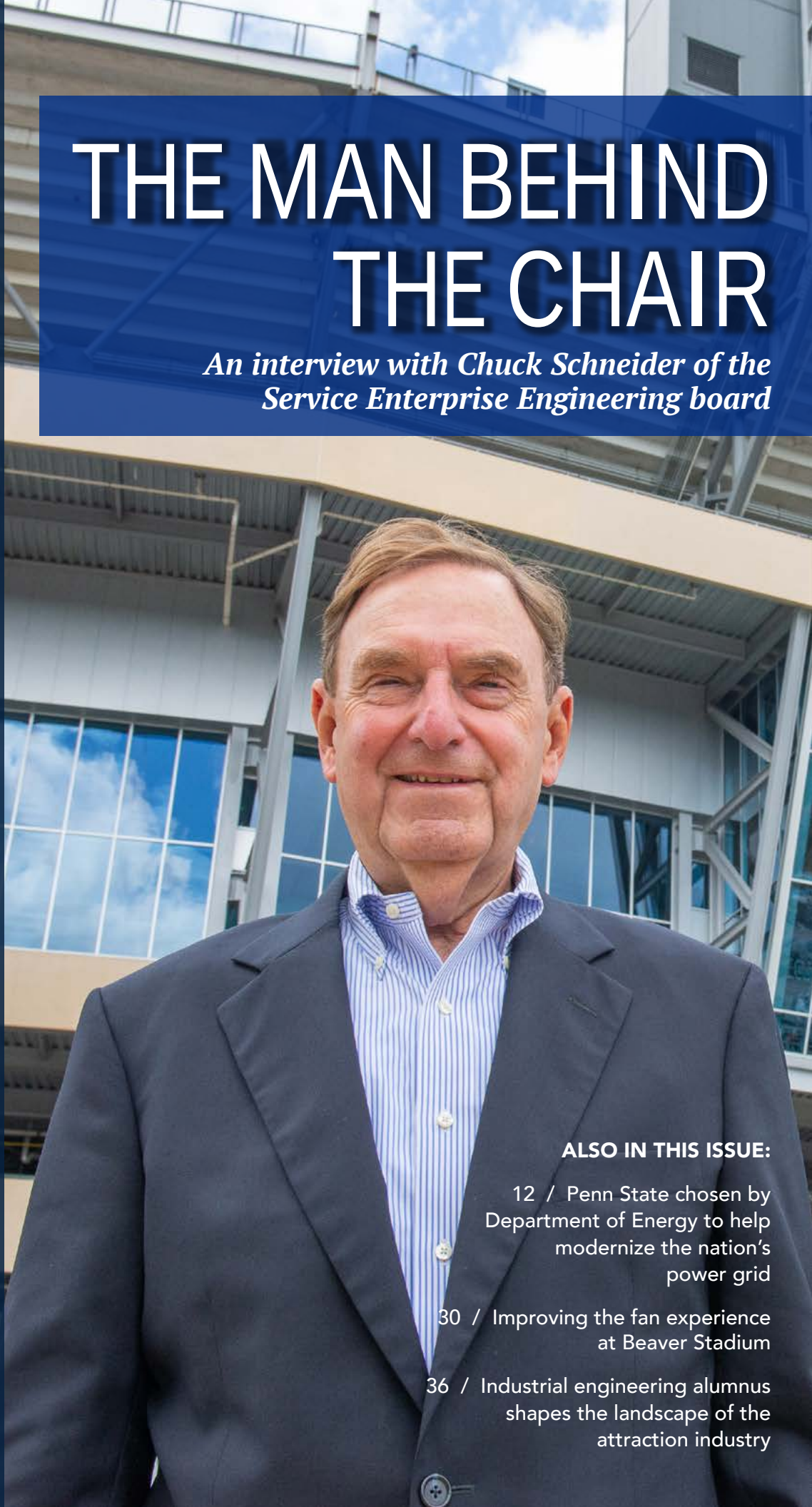
THE MAN BEHIND THE CHAIR

An interview with Chuck Schneider of the Service Enterprise Engineering board



ALSO IN THIS ISSUE:

PennState
College of Engineering

Industrial and Manufacturing Engineering (IME) Newsletter

2019 EDITION, VOLUME 4

Greetings from the Department Head

Welcome to our fall 2019 magazine! In the following pages, you'll find stories on innovation, solutions to societal challenges, and ways we are revolutionizing the service industry.

One such story announces a generous new gift, the result of a partnership between alumnus Charles R. Schneider and Penn State. Schneider has been involved with the department since the late 1990s, and he is currently working on the Service Enterprise Engineering program, otherwise known as SEE 360. You can learn more about the gift and how it will benefit SEE 360 in this magazine.

This magazine also features: new research projects with the National Science Foundation; a new award partnership with the Institute of Industrial and Systems Engineers; a student's road on the path to entrepreneurship; and various stories celebrating our SEE 360 Initiative, such as our very first SEE minor student graduating this fall.

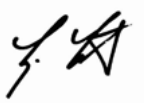
In the midst of these developments, we also launched our new Master of Engineering (M.Eng.) in Industrial Engineering in partnership with the Penn State World Campus. The new degree is flexible and caters to a wide-array of working professionals. From our current programs this past year, we awarded 181 bachelor's degrees, 28 master's degrees, and four doctoral degrees. We are immensely proud of all of our graduates and are hopeful for their fruitful futures as Penn State alumni.

In addition, we have welcomed a new faculty member: Hongtao Sun. Sun is a co-hire of the Penn State Materials Research Institute. He specializes in energy storage, functional materials, and advanced manufacturing. His work is primed to foster collaborations between our units and lead to advances in energy science.

We have launched an international search for our next department head, during which I will serve as the interim until 2020. I have been with industrial and manufacturing engineering at Penn State since 2002 and have seen the department grow under the leadership of three department heads. I look forward to a bright future for the department.

Enjoy reading, and please reach out to share your own stories.

Sincerely,



Ling Rothrock
Interim Department Head

Industrial and Manufacturing Engineering, a newsletter for IME alumni and friends, is published by the College of Engineering's Harold and Inge Marcus Department of Industrial and Manufacturing Engineering.

The Harold and Inge Marcus Department of Industrial and Manufacturing Engineering, The Pennsylvania State University, 310 Leonhard Building, University Park, PA 16802. For more information, visit **www.ime.psu.edu**.

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Celebrating Janis Terpenny

Janis Terpenny, professor and Peter and Angela Dal Pezzo Chair and head of the Penn State Department of Industrial and Manufacturing Engineering, joined the University of Tennessee, Knoxville, effective July 15, 2019.

Terpenny now serves as the Wayne T. Davis Endowed Dean's Chair and dean of the Tickle College of Engineering.

Terpenny joined Penn State in 2015 after serving as the Joseph Walkup Professor and chair of the Department of Industrial and Manufacturing Systems Engineering at Iowa State University. In the past, she served as the technology lead for the Advanced Manufacturing Enterprise, Digital Manufacturing and Design Innovation Institute. She also served as a program director at the National Science Foundation (NSF), along with serving as a professor for Virginia Tech and for the University of Massachusetts Amherst. Prior to her experience working in higher education, she spent many years in industry with General Electric.

She brought vast knowledge and industry experience to Penn State, as the director of the Center for e-Design. The Center for e-Design is a NSF Industry-University Cooperative Research Center (IUCRC) comprised of seven universities nationwide. The center combines industry needs with academic resources to produce more efficient, effective and collaborative electronic design, and smart manufacturing processes and tools.

"Terpenny's tenure with industrial and manufacturing engineering oversaw numerous Institute of Industrial and Systems Engineers awards, nine faculty hires and a significant bump in graduate rankings," said Ling Rothrock, interim department head. "The department's graduate rankings rose from tenth to sixth place nationally over the course of five years. Overall, the department saw research expenditures raise to more than $3.1 million dollars through Terpenny's guidance, faculty effort and staff assistance."

"I have appreciated the opportunity to work with such incredible faculty, students, and staff. It has also been a pleasure working with several advisory boards, industry partners, and alumni who are dedicated to contributing to lasting, impactful change."

During her career, she has served as both principal investigator or co-principal investigator for more than $16.5 million of sponsored research and has authored more than 180 peer-reviewed journal and conference publications.

Her research interests are focused on engineering design and have included topics such as: engineering design and smart manufacturing, including process and methods of early design; knowledge and information in design; product families and platforms; obsolescence in products and systems; complexity of products and systems; and cloud computing for design and manufacturing integration. Other topics include design education, such as multidisciplinary teams; the impacts of project choice and context on engagement and learning; and the retention and success of underrepresented students.

"I am going to miss my colleagues from the department, the College of Engineering and the larger Penn State community as I start a new chapter of my career," Terpenny said. "I have appreciated the opportunity to work with such incredible faculty, students, and staff. It has also been a pleasure working with several advisory boards, industry partners, and alumni who are dedicated to contributing to lasting, impactful change."

New online Master of Engineering degree now offered through World Campus

Today's engineers need to be equipped to meet the ever-changing demands of a modern society and understand how to innovate and better streamline processes.

Penn State now offers a new online degree to meet these requirements: Master of Engineering in Industrial Engineering.

This 30-credit Master of Engineering program, offered online through Penn State World Campus in partnership with the Harold and Inge Marcus Department of Industrial and Manufacturing Engineering, allows students from diverse engineering backgrounds to develop their skills in industrial engineering and in focus areas of their choice.

"The curriculum has been developed to allow engineers to develop strategic skills that will broaden their professional horizons and equip them with specialized knowledge in focus areas they are interested in," said **Robert Voigt**, professor of industrial engineering and graduate program coordinator for the department.

The program is intended to be flexible to suit the needs and interests of the students in the program. It features courses in areas such as product innovation, service system engineering, advanced manufacturing processes and systems, organizational excellence, and human factors.

During the last semester, students will use the skills they acquire throughout the program to identify and complete a capstone project to solve an industrial problem typically based on their workplace needs.

"This program is great for those who want to earn their graduate degree but can't make it back on campus," said Andris Freivalds, Lucas Professor of industrial engineering. "There is great flexibility with online education as it allows professionals to work and study."

Applications for spring 2019 admission will be accepted through December 1. This program is designed for working professionals who a hold bachelor's degree in engineering and want to enhance their knowledge and skills to advance their careers.

Industrial engineering moves to sixth place in graduate program rankings

The industrial engineering (IE) graduate program at Penn State is ranked sixth in the latest annual *U.S. News & World Report* "Best Graduate Schools" rankings.

The 2020 edition shows that the IE program moved up one spot from seventh last year amongst its counterparts at other national universities and up six spots from twelfth four years ago.

According to *U.S. News & World Report*, the rankings are based on peer assessments by department heads in each specialty area, conducted in fall 2018. Department heads rated the other schools that offered a doctoral degree in their specialty on a 5-point scale. The sixth place in the rankings puts Penn State's industrial engineering program in the top 7 percent of programs ranked nationally.

Nanotechnology expert joins industrial engineering department

Hongtao Sun, an expert in nanoscience and nanotechnology, joined the Penn State Harold and Inge Marcus Department of Manufacturing and Industrial Engineering as an assistant professor on Aug. 15. He is also a co-hire of the Materials Research Institute (MRI).

Sun's research is at the intersection of energy science, functional materials, and advanced manufacturing. He focuses on rational design and synthesis of functional nanoscale materials, such as graphene. Graphene is a single layer of carbon atoms bonded in a hexagonal lattice, and is the thinnest, strongest, and stiffest known material, as well as an excellent conductor of heat and electricity.

In order to use these nanoscale properties in devices, Sun develops scalable manufacturing processes to assemble low-dimensional nanomaterials, like graphene nanosheets, into larger macroscopic structures. Before scaling, these nanosheets are less than a few nanometers in thickness, which is around one-ten-thousandth the width of a human hair. The macroscopic structures can be made into one-dimensional graphene fibers, two-dimensional graphene papers, and three-dimensional graphene frameworks.

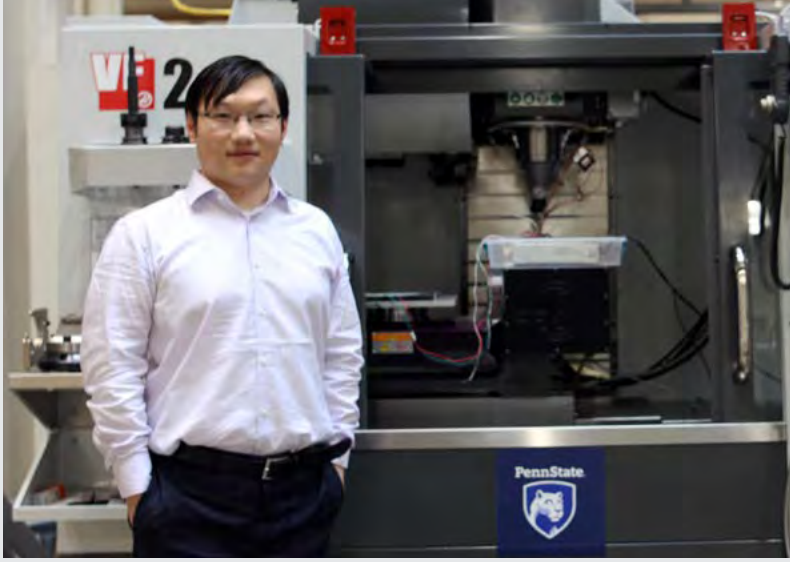
According to Sun, when the size of materials is reduced to the nanoscale dimension, various physical and chemical phenomena cause the material's properties to dramatically differ from its larger counterpart. These phenomena affect how nanoscale materials transport, store, convert, and dissipate energy. Sun is working to manufacture scaled technologies that retain the nanoscale properties, which could have a broad range of implications for various energy applications.

"These manufactured forms enable original innovations for energy conversion and storage, thermal management, and advanced sensing and detection," Sun said.

One such application is the development of cost-effective and energy-saving processes to manufacture high-performance energy-storage systems such as batteries.

However, key challenges exist in the effective assembly of these nanoscale electrode materials into macroscopic electrodes while maintaining high battery performance. The scaling up of nanomaterials is usually accompanied by the loss of exceptional nanoscale properties during assembling processes.

To address this issue, Sun found that assembling active nanomaterials into a 3D architecture allows them to facilitate a rapid charge transport and mitigate diffusion limitations while still working within a larger scale system, such as a large area and thick electrode in a commercial device. This is an essential step for the advancement of battery technologies and practical energy-storage device applications, according to Sun. He also noted that the resulting all-solid-state batteries could be further developed for safer energy-storage technology.



Sun joined the Department of Industrial and Manufacturing Engineering from his prior position as an assistant professor in the Department of Mechanical and Industrial Engineering at the New Jersey Institute of Technology (NJIT).

At Penn State, Sun plans to build an interdisciplinary laboratory to foster effective, collaborative research that could lead to diverse approaches to solve such challenges.

"I look forward to the potential collaboration with the Battery and Energy Storage Technology Center, Center for Innovative Materials Processing through Direct Digital Deposition within the Materials Research Institute, and the Center for Innovative Sintered Products," Sun said.

Ling Rothrock, professor and interim department head of the Harold and Inge Marcus Department of Industrial and Manufacturing Engineering, said he is excited to see what Sun accomplishes through his research and collaborations.

"Hongtao is a wonderful addition to our department," Rothrock said. "He brings a wealth of knowledge, and his collaboration with the Materials Research Institute will give us insight into the future of industrial and manufacturing engineering."

Clive Randall, director of the Materials Research Institute and professor of materials science and engineering, was in agreement.

"I am very excited about having Hongtao Sun join the faculty at Penn State," Randall said. "He has shown some very creative ways of scaling nanomaterials in a manufacturing process. I predict that he will have many fruitful collaborations with our faculty across the University."

Sun previously worked as an assistant professor in the Department of Mechanical and Industrial Engineering at the New Jersey Institute of Technology (NJIT). Sun has published roughly 40 peer-reviewed papers in leading journals, including Science, Nature Reviews Materials, Nature Communications, and Nature Catalysis, with a total citation number of more than 3,000. Prior to NJIT, Sun completed a postdoctoral fellowship at the University of California, Los Angeles. Sun received his doctorate in mechanical engineering from Rensselaer Polytechnic Institute in 2014.

Who's the man behind the chair?

An interview with Chuck Schneider of the Service Enterprise Engineering board

***Charles (Chuck) Schneider**, 1962 graduate in mechanical engineering, has contributed to the industrial and manufacturing engineering department for more than two decades as the driving force behind the department's priority of service enterprise engineering (SEE).*

Service enterprise engineering deals with the design, planning, and control of operations and processes associated with delivery of service. In the United States, services have surpassed manufacturing as the largest component of the nation's economy.

Schneider returned to Penn State in the late 1990s to propose the idea of adding service enterprise engineering to the curriculum. In 2003, the Service Enterprise Engineering Board was created, and, in 2014, the SEE 360 Initiative was founded. SEE 360 aims to enhance the student experience and awareness of issues within the service sector. The SEE minor became available in 2018.

Schneider has served as the chair for the board since its inception. The proponent of education in this up-and-coming field took time to chat with us and answer some questions.

Why did you choose Penn State for your undergraduate education in engineering?
My father taught a preparation course for the professional engineering examination at a Penn State Extension in Erie, Pennsylvania and thought that Penn State engineers generally stood out among engineers from other schools. Upon his advice I went to Penn State, as did my brother—also a mechanical engineering graduate—and so we had the whole family involved. Penn State is very important to us. Two of my grandchildren are currently attending.

What does Penn State mean to you outside of your father and your family involvement?
I had drifted away from the University after college. I went into the Navy for four years, then onto graduate school and into business. At some point a development officer named Dick Swails got me involved by inviting me to University functions. I became a board member of The Leonard Center, serving there for roughly 25 years, and since then have worked on the Service Engineering Program.

I have the greatest respect for Penn State, its values, and the excellent education it provides. Other than my family, my church, and my business, it has been one of the most important relationships in my life.

How would you say your engineering education has contributed to your career?
Primarily, I have used the problem-solving aspects of my engineering education, rather than the specific techniques of mechanical engineering, to my advantage in many responsibilities. My technical background gave me the confidence to deal with issues in all functional areas, pulling the buried facts out of 'the fog' of complicated problems and avoiding being buffaloed by jargon. In any management responsibility, you must do that effectively.

How does this education apply to service enterprise engineering?
An engineering education is a terrific foundation. It prepares you to enter any field, such as law, medicine, or many others, including the service industries. You can readily apply what you learned to solve problems. Perhaps even more importantly, it equips you with the insight of problem finding, identifying poor performance among generally accepted processes. Once identified as unacceptable, the means of problem solving are often quite straightforward.

This engineering problem finding insight is particularly useful in reengineering the services industries. For example, if your iPhone doesn't respond in two or three seconds, it is unacceptable because manufacturing has achieved such a high standard for manufactured product performance. To the contrary in a service setting, people will wait two or three hours in a hospital emergency room or 45 minutes in a line and accept it as just the way it is. This is not the way it has to be, and a service engineer can significantly improve it if someone identifies the situation as a problem.

When did you start noticing these kinds of issues?
I moved into the service area about 40 years ago now. As I looked around, I realized the service industry could be much better engineered. I saw this as a big opportunity for business and the country because services employed 80 percent of the workforce, service industry productivity was low, and our national productivity rate was declining. To raise our standard of living, we must achieve productivity increases. I saw this as a great opportunity for engineers to build a career in services while serving the country's needs.

Why did you choose IME for this partnership?
Penn State was the first college in the U.S. to establish an industrial engineering degree program in 1908. As the U.S. economy in the early 20th century was rapidly industrializing, this was a brilliant initiative. Now there are industrial engineering degrees being offered everywhere, worldwide, and U.S. manufacturing has become the marvel of the world. I believe that service engineering can now do for our much larger service economy what industrial engineering did in the last century for the manufacturing economy, using many of the same techniques taught in industrial engineering. In effect, engineering the twenty-first century economy.

What are some of the goals you have for service enterprise engineering?
We want to make student and practicing engineers well aware of the opportunities in engineering the 21st century service economy and help service-providing businesses and other institutions see how they can improve their customer satisfaction and productivity by engineering the processes. Additionally, we would like to develop new techniques that can advance the science of service engineering.

What advice would you give to engineering students?
One of the things that I like to share with young engineers is that I was hesitant to take a job in the service sector. After several years in the manufacturing sector, I had difficulty envisioning what an engineer would do in a service setting. I learned that there's a great deal that an engineer can do. Your engineering education isn't limited to understanding products and physical things. It engenders a curiosity about how things work and provides the tools to find and solve problems in services as well as manufacturing.

What advice would you give to recent alumni?
Go where the growth is. Generally, when there's growth in an industry or company, there is a need for good people and there will be promotional opportunities.

My other suggestion is to always be alert to finding problems despite being overloaded with solving assigned problems that have already been defined. Finding major, heretofore unidentified, larger problems can result in much greater gains and even completely new business/organizational models. I doubt that the Uber and Airbnb models were the result of someone solving the myriad of day-to-day micro-problems impacting taxi and hotel companies, but rather by finding the much larger problems faced by users and providers of these services. Once identified, the solutions often suggest themselves.

What does higher education mean to you?
It's such an important step to build your skills and grow your interests. Even if you don't practice exactly what you studied, what you learned grew you into a better thinker and taught you to appreciate the world. Education never stops. You should continue to broaden yourself and continue to read. You can't have too much education.

New gift from Penn State alumnus will revolutionize service enterprise engineering

By Andrew Krebs and Miranda Buckheit

Charles R. Schneider and Penn State are partnering on a nearly $9 million investment to greatly expand the College of Engineering's focus on improving processes and efficiencies across the service sector of the economy, a field known as service enterprise engineering.

Schneider, a longtime supporter of Penn State who earned his bachelor's degree in mechanical engineering in 1962, has committed $4 million in support of a scholarship, two professorships, a faculty chair, and two program support funds, all in the area of service enterprise engineering within the Harold and Inge Marcus Department of Industrial and Manufacturing Engineering.

Penn State has committed $3.675 million to support the scholarship, professorships, faculty chair, and a program support fund along with providing additional funding for a program director and director of industry consortia and technology transfer.

Additionally, Schneider has committed to match up to $1 million in Penn State funding for media and outreach initiatives in support of service enterprise engineering.

Schneider's gift, along with the University's investment, will enable the department to create three new degree offerings: a bachelor of science dual degree in industrial engineering and service enterprise engineering, a bachelor of science in service enterprise engineering, and a master of science in service enterprise engineering.

"Chuck Schneider continues to be an incredibly active alumnus who cares deeply about giving back to the college and students," said **Justin Schwartz**, Harold and Inge Marcus Dean of Engineering. "We are grateful for his generosity, as it allows us to expand the reach of service enterprise engineering at Penn State and beyond. Our collaboration with Chuck is creating opportunities for our students to have an impact on society."

Schneider has been on a multi-decade quest to reengineer the service industry sector. After serving in the U.S. Navy for four years, he spent roughly 15 years working with manufacturing firms. He joined the service sector in the late 1970s as group vice president for Borg Warner Security, at the time the world's largest private security company. In 1993, Schneider founded

"Penn State, outside of my family and career, has been one of the most significant relationships in my life. I have always had a wonderful feeling about Penn State and it is like home for me. I want students to benefit from this gift and be prepared to excel in the 21st century work force."

U.S. Security Associates, Inc., for which he still serves as chairman. The company now employs more than 60,000 people.

He began to notice opportunities for improvement. Schneider noted that nearly 80 percent of U.S. employment is within the service industry sector of the economy; however, he noticed that a lack of streamlined processes means that people, like hospital patients, may experience extended wait times for services.

"The lack of engineering expertise in the service industry opens up a wide array of possibilities in research and education," Schneider said. "Engineers need to be able to look for problems in the service sector and find out how it can be done better. Most of the challenge is seeking out those issues because people will often accept bad service."

Since 2003, Schneider has served as chair of IME's Service Enterprise Engineering Advisory Board. The members of the board help guide undergraduate and graduate programming and identify emerging research areas in the field. Under Schneider's leadership, the board has been influential in the inception of the Service Enterprise Engineering Center, the introduction of service engineering as a defined doctoral degree area of focus, the launch of the Service Enterprise Engineering Initiative (SEE 360) and the creation of a minor for undergraduate students.

"I am grateful for Chuck's gift to the department and the university," said **Ling Rothrock**, interim department head for the Harold and Inge Marcus Department of Industrial and Manufacturing Engineering. "It catapults us into global prominence to educate the next generation of leaders in the service industry."

Schneider has long been a supporter of the industrial and manufacturing engineering department. In 2013, Schneider and his late wife Enid gifted the department $1 million to create the service enterprise engineering board and support its activities. In February 2019, they gifted the department an additional $1 million to endow the Charles and Enid Schneider Scholarship in Service Enterprise Engineering. The gift was matched by Penn State through a recently concluded program for a total of $2 million to support full-time graduate and undergraduate students with financial need.

"Penn State, outside of my family and career, has been one of the most significant relationships in my life," Schneider said. "I have always had a wonderful feeling about Penn State and it is like home for me. I want students to benefit from this gift and be prepared to excel in the 21st century work force."

As part of the Service Enterprise Engineering program, Penn State faculty, students, and alumni work together in the study, design, and implementation of new systems for campus institutions like the Berkey Creamery, the Office of Physical Plant, and Beaver Stadium.

Watch the video > bit.ly/2mex8sx

Dr. Katherine Hallock, a dermatology resident at Hershey Medical Center, examines patient Hannah Shrift of Hershey.

Dermatology residents optimize exam that identifies skin cancers

By Zachary Sweger

Dr. Jeffrey Miller

Charles Purdum

Dr. Jeffrey Miller, chair of the Department of Dermatology at Penn State College of Medicine, can pinpoint the moment he realized a routine procedure he performs daily is prone to error.

"I missed a melanoma," Miller said. He began to think about how to prevent making such a mistake in the future.

In a new research study published in the *Journal of the American Academy of Dermatology*, Miller and dermatology residents at Penn State Health Milton S. Hershey Medical Center used engineering principles to improve the accuracy and efficiency of an evaluation that dermatologists frequently use to check patients for skin cancers.

The evaluation, called a total body skin exam, is a full visual assessment of the entirety of a patient's skin surfaces for cancers.

The standard practice at the Milton S. Hershey Medical Center is to perform the evaluation at almost every dermatology visit, whether the patient has a history of skin cancer or not.

"We have found cancers on people who are not coming in with a concern," said Dr. Matthew Helm, a dermatology resident.

According to the researchers, there is no standardized method for performing a total body skin exam. Dermatologists may develop their own approach, which can potentially result in missed areas and lost time. The research team knew that bioengineering principles had helped Olympic athletes make the most of each motion, and they started to wonder whether the same principles could be applied in medicine.

"Efficiency and accuracy are important because we do a lot of total body skin exams every day," Helm said. "If it takes us 20 minutes each time, we will never get through our day. However, we do not want to sacrifice accuracy for efficiency."

To find the sweet spot between efficiency and accuracy, the research team sought assistance from Penn State engineering students.

"Part of our students' capstone program is to work on a real-world problem and deliver results to their sponsor," said **Charles Purdum**, assistant teaching professor and director of industry relations in the Harold and Inge Marcus Department of Industrial and Manufacturing Engineering. "This project was attractive to me because it was a unique application of engineering principles in the health care field."

A mix of biomedical and industrial engineering students formed the team that consulted with Miller on the project. They met on a weekly basis and gave proposals, timelines, updates, and a final report.

"We treat it like an engineer's first project out of college," Purdum said. "It's a great model to show students what industry is like."

The engineering students watched video recordings of five dermatology faculty and five residents conducting total body skin exams on both a male and female patient. They assessed the exam time, physician and subject movements, sequence of body parts evaluated, and whether any body parts were missed.

Using statistics, the students calculated the variability between the evaluations performed by each provider. The engineering students observed that the underside of the neck and armpits were frequently missed areas, and considered that when designing the optimal order of the procedure.

"This project was attractive to me because it was a unique application of engineering principles in the health care field."

After watching the videos a second time, the students proposed a more efficient and accurate technique to Miller and the dermatology residents.

"The proposed method was different from how I had been doing the exam," Helm said. "Now I use the optimized way, and I feel like it has helped me to be a better clinician."

Miller hopes to help prevent errors by teaching faculty, residents, and medical students the new technique. The next phase of the research will measure if that educational objective is successful.

"If we can save one life from skin cancer because we are doing the exam consistently well, then we've succeeded," Miller said.

Dr. Katherine Hallock, dermatology resident, Hershey Medical Center, and Dr. Elizabeth Bisbee, University of Florida Department of Dermatology, were also involved with this research.

Donate to Penn State IME

Higher education presents more opportunities for learning, innovation, and experience than ever before. In an age of rising educational costs, private philanthropy is essential for sustaining the quality of a Penn State education and for making its benefits available to all.

As a donor of the Harold and Inge Marcus Department of Industrial and Manufacturing Engineering, you are supporting the next generation of world leaders in the field of industrial and systems engineering.

Your gift to the department sustains a tradition of excellence and makes a difference for current and future industrial engineering students.

Be part of the difference.
Go to **http://GiveNow.psu.edu/IME** today.

"I am truly grateful to be a 2019-20 recipient of the Marcus Scholarship; this gift enabled me to pursue my passion for process improvement in the IME department. Through the Marcus' generosity, I've had more time to focus on my academic and internship experiences, rather than the financial burdens. Thanks to this endowment, I look forward to my future as an engineer and a Penn State alumnus."

— **Terrence Mikhailo**, senior IE student

CHALLENGE ACCEPTED:

Penn State chosen by Department of Energy to help modernize the nation's power grid

by Erin Cassidy Hendrick

In an effort to modernize and reimagine the United States' power grid, Penn State researchers have qualified for a highly selective, innovative competition sponsored by the Department of Energy.

The Penn State team of researchers, one of only ten universities chosen for the Grid Optimization (GO) Competition's first challenge, is being led by **Uday V. Shanbhag**, the Gary and Sheila Bello Chair and professor in the Harold and Inge Marcus Department of Industrial and Manufacturing Engineering.

"As the United States begins incorporating more renewable energy sources, there are some new and unique challenges that today's infrastructure simply can't handle," Shanbhag said.

Announced by the Advanced Research Projects Agency-Energy (ARPA-E) within the DOE, the competition challenges researchers from universities and national laboratories to solve the fundamental issues facing the electricity infrastructure, while addressing the concerns that widespread renewable energy sources will introduce in the future.

"With a network as large as the U.S. power grid, the optimization problems we need to solve are incredibly large and complex," Shanbhag said. Not only does every power generation facility, including wind, solar, coal, nuclear, and

"Providing for every contingency possible in a network like this, serving more than 65 million nodes, it's a large and nasty problem. And it is one that has to be solved every ten minutes." **– Uday V. Shanbhag**

hydroelectric sources, need to route their energy in a responsive, cost-conserving way, there are also an enormous number of contingencies that arise at a moment's notice.

With the first round of funding, the teams are being challenged to design algorithms that address the next generation of security-constrained optimal power flow (OPF), essentially finding ways to provide electricity more quickly, efficiently, safely, and reliably within the current grid. Distinct from past models, the new set of models are complicated by the need to model the flow of electricity, as governed by power flow equations, with much higher fidelity.

Using the mathematical principles of optimization, the software controlling the grid signals that a certain set of generators need to be "dispatched" to meet current demand. But if one of those generators fails, Shanbhag said, "Can the algorithm controlling the power grid take recourse and keep the lights on?"

"Providing for every contingency possible in a network like this, serving more than 65 million nodes, it's a large and nasty problem," Shanbhag said. "And it is one that has to be solved every ten minutes."

Over the past few decades, the models used in the power grid have been adapted to handle these situations. "But in their expanded, nonlinear form, it is computationally challenging, so coarse approximations were used," Shanbhag said. "But now, it is essential to consider more accurate models that are complicated by size and uncertainty."

Between the sheer number of customers, the speed in which contingencies need to be solved, and the fluctuating nature of renewable energies like solar and wind power, the nation is ready for the next generation of power grid technology.

As researchers, innovating these solutions is a Herculean, but inspiring, challenge ahead of the team.

"There are many reasons why this is a daunting mathematical and computational challenge, and why Dr. Shanbhag's vision for computationally efficient solution methods could be a major game changer," said Hosam Fathy, the Bryant Early Career Professor of Mechanical Engineering. "If the Penn State team wins this competition, it will be an indication that we have made substantial strides in the stochastic grid optimization domain, thereby paving the way toward significant leaps in how the electric power grid is operated both now and in the future."

Their approach will focus on creating a method that is able to both scale appropriately with the size of the underlying optimization problem and address the underlying nonlinearity. The underlying code needs to be able to adapt instantaneously, while also conserving computing resources so the system doesn't become overburdened.

"With this mindset, the power grid will be able to better deal with the challenges expected to emerge in future power systems," said Mort Webster, professor of Energy and Mineral Engineering in the College of Earth and Mineral Sciences. Their project will also aim to develop the mathematical tools to enable a trustworthy infrastructure well into the future.

In the next phase of the competition, ARPA-E will provide each team with sample data from the power grid to test their algorithms. "We'll take this actual network information, apply our algorithms, and see how well we do!" Shanbhag said.

Participants that develop scalable schemes for finding minimum-cost solutions to these problems will advance to the next round.

Capitalizing on interdisciplinary strengths, a team has been assembled from the College of Engineering and the College of Earth and Mineral Sciences, and also comprises of Nilanjan Ray Chaudhuri, assistant professor of electrical engineering and computer science, Fathy, Chiara Lo Prete, assistant professor of energy economics, and Minghui Zhu, assistant professor of electrical engineering.

"Penn State has always been a global leader in energy systems research, but in order to maintain this leadership we need to join forces across different disciplines in order to build larger, cohesive teams in the energy area," Fathy said.

Collectively, the group has been curated to include experience with both the theoretical and applied principles surrounding sophisticated power systems, with a particular emphasis on addressing the new questions that renewable energy pose.

"The hope was to build a team at Penn State that is not just capable of solving today's energy problems, but also to establish a research infrastructure for the future of power systems and markets," Shanbhag said.

Given the University's pursuit to be at the forefront of a re-imagined energy infrastructure, this competition and team of researchers presents a critical turning point.

Fathy added, "This is an example of what Penn State's Energy University initiative is about: it is not about our individual successes within our individual research silos, but rather about how we come together to do something much bigger."

"By bringing these minds together, we believe that we have a chance to solve this problem," Shanbhag said.

Researchers find overdose deaths are likely to increase with 'changing nature' of opioid epidemic

By Ashley WennersHerron

The opioid epidemic could be responsible for 700,000 overdose deaths in the United States between 2016 and 2025, according to a new study published today in *JAMA Network Open*.

"Preventing people from misusing prescription opioids is important and could help prevent some overdose deaths in the long term, but our study shows that the effect would be limited in reducing the overdose deaths in the immediate future," said **Qiushi Chen**, lead paper author and assistant professor in the Harold and Inge Marcus Department of Industrial and Manufacturing Engineering at Penn State. "The majority of overdose deaths are now from illicit opioids, such as heroin and fentanyl instead of prescription opioids, and this changing nature of the epidemic has reduced the potential impact of programs targeting prescription opioids."

In an effort to understand the outcomes that programs to limit prescription opioid misuse actually produce, Chen worked with colleagues from Massachusetts General Hospital, Harvard Medical School, and Boston University Medical School.

Multi-pronged interventions are needed to curb the opioid overdose crisis, according to engineering, health science, and policy researchers

"The opioid crisis has been a national public health emergency for more than a year, and it's getting worse," said Jagpreet Chhatwal, senior paper author and assistant professor at Harvard Medical School and decision scientist at Massachusetts General Hospital Institute for Technology Assessment (MGH-ITA). "We set out to understand how reduction in incidences of prescription opioid misuse, by interventions of restricting opioid prescriptions supply, would influence the outcomes of overdose deaths in the next decade."

Chen and the team developed a mathematical model to simulate the opioid crisis from 2002 to 2025. Using data available from Centers for Disease Control (CDC) and the National Survey on Drug Use and Health (NSDUH), the researchers calibrated the model to match the trends of overdose deaths from specific types of opioid consumption – recreational prescription misuse to opioid use disorder with prescription and illicit opioids – observed from 2002 through 2015. They then used the model to project probable outcomes of the epidemic, based on the continuing trends, through 2025.

The researchers found that, if that status quo continues, the annual number of opioid overdose deaths will increase from 33,100 in 2015 to 81,700 in 202—a 147 percent increase. Eighty percent of those overdose deaths will result from the use of illicit opioids, such as heroin or fentanyl. In every scenario tested, the researchers found that interventions aimed at reducing prescription opioid misuse decreased overdose deaths by three to five percent.

Under an extreme modeling scenario, a hypothetical situation where literally no new incidences of prescription opioid misuse occurred after 2015, the researchers found that number of deaths in 2025 would still remain higher than in 2015.

"More and more people are using illicit opioids. In the past, people might start using pain pills non-medically, which could then lead to illicit opioid usage, but data suggests that even more people are now starting with recreational use of illicit opioids," Chen said. "Prescription opioids are now not necessarily the gateway that people must use to get to illicit opioids."

According to the NSDUH, 30 percent of people who developed opioid use disorder started with heroin or fentanyl. Chen and his team project that the trend will continue, and, by 2025, nearly half of people with opioid use disorder will have initiated their opioid use with illicit drugs.

"This study demonstrates that initiatives focused on the prescription opioid supply are insufficient to bend the curve of opioid overdose deaths in the short and medium term," said co-author Marc LaRochelle, assistant professor in the Grayken Center for Addiction at the Boston Medical Center. "We need policy, public health, and health care delivery efforts to amplify harm reduction efforts and access to evidence-based treatment."

Other contributors on this paper from MGH-ITA include Davis Weaver, now a medical student at Case Western University; Anna Lietz, a research associate; Peter Mueller, a postdoctoral fellow also affiliated with Harvard Medical School; Tiana Raphel, now a medical student at University of Texas Southwestern Medical School; Amy Knudsen, a senior scientist and an assistant professor of radiology at Harvard Medical School; and Pari Pandharipande, an associate professor of radiology at Harvard Medical School and the director of the MGH-ITA. Other contributors include Sarah Wakeman, the medical director of the Substance Use Disorders Initiative at MGH and an assistant professor of medicine at Harvard University; and Kenneth Freedberg, a professor of medicine at Harvard Medical School and MGH and the director of the Program in Epidemiology and Outcomes Research at the Harvard University Center for Aids Research.

Penn State partners to recognize innovation in service systems engineering

Bárbara Venegas with Charles Schneider, chair of the Service Enterprise Engineering 360 Advisory Board and founder and chairman of U.S. Security Associates, Inc.

By Megan Lakatos

At its May 18-21 conference and expo in Orlando, Florida, the Institute of Industrial and Systems Engineers (IISE) partnered with Penn State to recognize the innovative techniques organizations are using to improve the performance of service industries.

The inaugural Outstanding Innovation in Service Systems Engineering Award, co-sponsored by IISE and the Service Enterprise Engineering Advisory Board in Penn State's Harold and Inge Marcus Department of Industrial and Manufacturing Engineering (IME), attracted nominations from academia and industry.

Along with four other finalists, two teams from Penn State—one from IME and another from Penn State Health—delivered final-round presentations at the conference on May 19. The IME team, which presented its model for improved snow removal on the Penn State University Park campus, finished third. The Penn State Health team, which addressed improvements in hip and knee arthroplasty to enhance patient recovery, finished second. The winning presentation on decreasing caregiver turnover in the health care industry was delivered by consultancy firm Salo Solutions.

AN AWARD TO CREATE AWARENESS

"Our mission with the award was to create awareness of opportunities in service industries," said **Vittal Prabhu**, director of SEE 360 and professor of industrial and manufacturing engineering at Penn State. "Since the service industries employ 80 percent of the economy, there are tons and tons of opportunities."

SEE 360 is an initiative within IME with the aim of motivating students to optimize the service industries through engineering. Two goals of SEE 360 are to educate students on the need for engineers within the service industries and to teach students about opportunities within these industries where they can make a difference.

Closely tied to the goals of SEE 360, according to Prabhu, are the industry-wide benefits of developing such an award. By rewarding outstanding innovation in service-systems engineering, SEE 360 is giving a platform to industry innovators and featuring new best practices.

"We want to give the contributors recognition and at the same time disseminate the best practices in service-systems engineering through IISE," Prabhu said.

SEE 360 reached out to IISE in May 2018 with the hopes of developing and sponsoring an award specifically for service-systems engineering. The initiative worked closely with Scott Sink, director of the honors and awards program for IISE, to create the award. Sink was immediately receptive to the idea because of its unique position in the industry.

"I think that there's a growing number of industrial engineers that end up working in the service sector," Sink said. "I think that the department has a critical mass of alumni that are passionate about industrial engineering being applied in the service sector."

Sink selected a committee of six industry practitioners to review the award applications against a rubric developed by Sink and the IISE.

Sink and Prabhu are eager about what the award could mean to the service-systems engineering industry.

"There have been a number of institutions and professional societies that have been able to create awards, brand them and make them globally visible and popular," Sink said. "I think, potentially, this award could be something that's globally recognized; something that is North American recognized and could differentiate our professional society."

PENN STATE'S AWARD FINALISTS ARE:

SEE 360: **Bárbara Venegas**, researcher and associate director of IME's SEE 360 initiative; Vittal Prabhu, professor and director of SEE 360; and 2018 IME graduates **Achal Goel** and Vignexh presented their model for Real-time Optimization for Adaptive Removal of Snow (ROARS). ROARS vastly improved the snow removal operations that take place on the Penn State University Park campus by utilizing and responding to real-time data and weather forecasts.

Penn State Health: Charles Davis, chief orthopaedic joint surgeon; Kevin Black, orthopaedics chair; Tiffany Gibbons, director of orthopaedics operations; Travis Lehman, integration project manager; Andrea Stonebraker, data analyst; Karyn Miller, manager of advanced practice professional clinicians; Betsy Thomas, manager of Periop business services; and Eric Swenson, battalion commander at the 1-345 Brigade Engineer Battalion, presented their research on improvements in hip and knee arthroplasty that significantly enhance patient recovery. They also performed a time-driven, activity-based costing (TDABC) analysis on in-patient stays to identify opportunities to improve efficiency and reduce costs.

Digitizing health care services

By Andrew Severin

As the world continues its transformation into the digital age, thinkers who convert big data into knowledge are essential. This is particularly true when looking at complex systems, where a non-linear structure makes prediction and modeling of the systems difficult.

Hui Yang, associate professor in the Penn State Harold and Inge Marcus Department of Industrial and Manufacturing Engineering, uses his expertise in complex system monitoring, modeling, and control, to teach students how to optimize the design of various service industries through data-driven innovation.

Yang is a proponent of the Internet of Things (IoT). The IoT is a technology that unites all components of a service, manufacturing, or any other complex system, through the internet. This interconnectedness means that a system experiences almost limitless communication of data, which also means increased efficiency across the system.

One of his projects, Better Heart Beats Through Engineering, seeks to improve the modeling of cardiac function through physics-based modeling and sensor-based informatics. Yang believes that physiologists and cardiologists can use this improved modeling system to better understand cardiac functions in health and disease.

Yang teaches various classes on modeling, monitoring, and controlling complex systems in the service industry. Yang emphasizes that understanding this continuity, from modeling to control, is imperative.

"Basically, it goes from design of experiments to engineering analytics, statistical modeling, to stochastic processes, and also to the process optimization and control," he said.

With regard to system modeling, Yang teaches his students to design experiments with a statistical approach for optimal design.

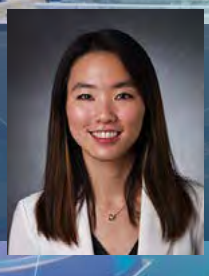
"Optimal design of an experiment means you minimize the cost to run the experiments or minimize the human effort to run the experiments, and any machinery costs," he said. "You want to maximize the effectiveness."

As more data comes in, researchers need to be able to glean out important details. To do so, Yang offers courses in data analytics. He explained that statistics is more advanced than means and averages.

"You have to develop data-driven models to model the data and then use the model to guide the prediction, make the inference, and then guide the optimization of the system," Yang said.

In addition, Yang teaches students to use informatics for control systems. Researchers use informatics to pull useful information from a system to understand a system in a more robust manner. By fully understanding a system, researchers can account for any unpredictability, or stochasticity, in a system.

"Optimal design of an experiment means you minimize the cost to run the experiments or minimize the human investment, human effort, to run the experiments, and any machinery costs to run the experiments."



Professor to tackle large-scale simulation optimization problems

Computer simulations help global companies optimize systems and processes across varying industries and disciplines. Major companies in America have been doing it for years: General Motors uses simulations to test their vehicle trim mix of new products before releasing to the market and Uber uses simulations to decide on pricing policies for Uberpool.

Companies need to make informed decisions within a timely manner, but their decision-making problems are increasingly complex and tricky to solve. Companies may take shortcuts to try to solve a problem quickly, but it doesn't always guarantee that the given answer is the best. So, what can individuals and companies do to ensure they make sound decisions within deadline constraints?

The National Science Foundation's Division of Mathematical Sciences has awarded principal investigator **Eunhye Song**, Harold and Inge Marcus Early Career Assistant Professor of Industrial and Manufacturing Engineering at Penn State, $140,000 to push the frontier of large-scale discrete simulation optimization. Song's goal is to create a new algorithm that is computationally efficient while simultaneously providing a statistical optimality guarantee.

A set of decision variables is said to be discrete if their values are countable, such as the number of kittens in a litter. They are counted as whole numbers, or integers. Song plans to create an algorithm for problems with discrete decision variables to find the optimal solution, the best possible answer among the possible solutions.

"At the highest level, this is a project to solve a decision-making problem within a system," Song said. "Oftentimes, simulation optimization isn't very efficient for large-scale, high-dimensional questions with integer solutions. Our goal is to make an improved algorithm to save time, money, and resources."

Song said an online retailer's warehouse staffing decisions are examples of large-scale problems with discrete solutions that may benefit from simulation optimization.

"Let's say there are 20 departments and you need to choose from employing one to 10 in each department," Song said. "This is essentially choosing from 10 levels for 20 decisions. This number is more than a thousand times the age of the Earth in seconds. This is an example of a large-scale problem and you can't possibly simulate every single solution."

Song states that to solve a problem like this, the algorithm should be able to provide a solution that has the best possible outcome within a deadline. Her approach aims to provide an estimate of the optimality gap of the selected solution to detect if the solution is meeting the defined goal. The optimality gap is the difference between the selected solution and the optimal solution.

"I like to think of this as layers of grids. The globe represents the set of entire possible solutions."

In order to find integer solutions that are likely to include the optimum, Song will employ a multi-resolution algorithm.

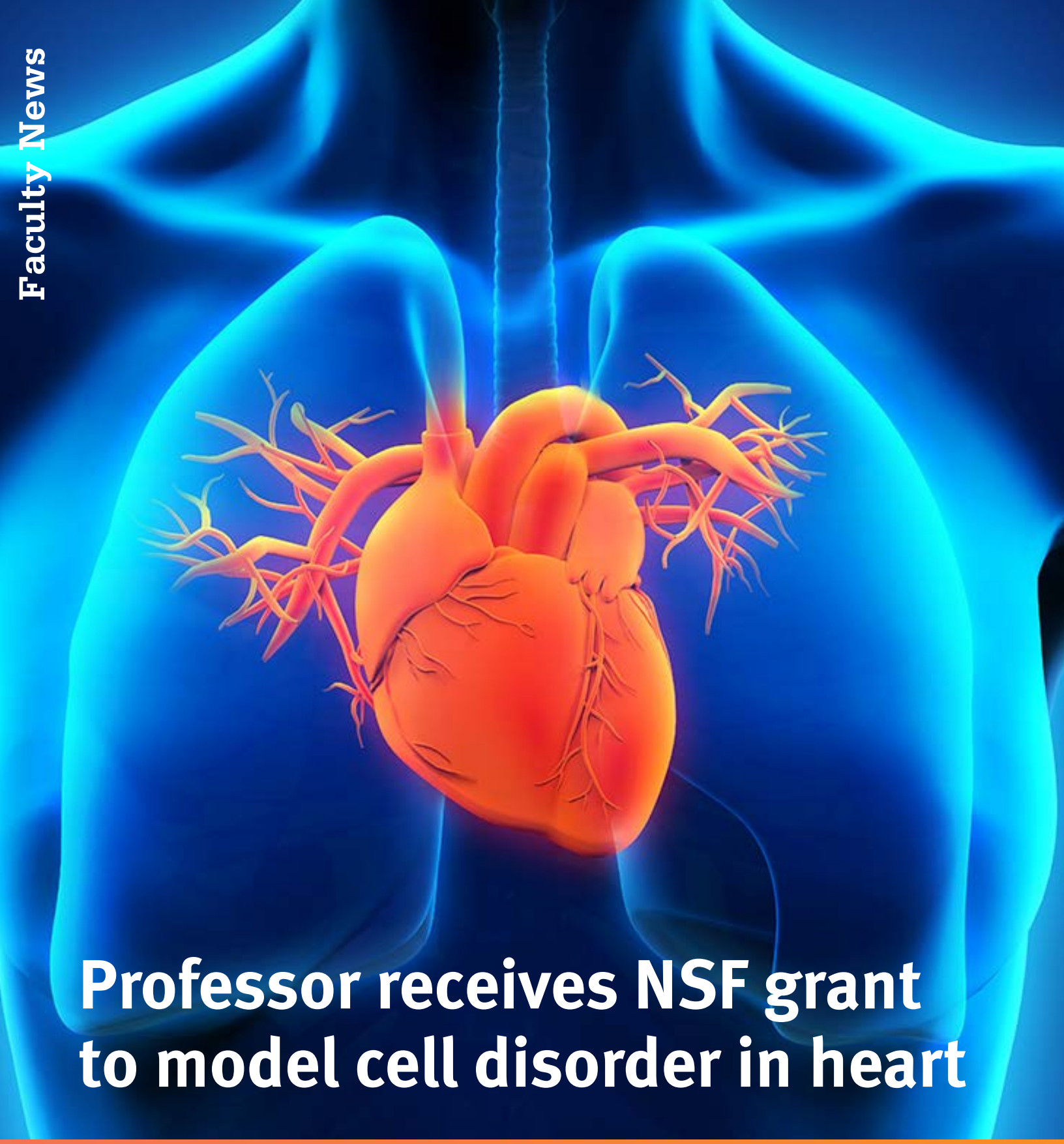
"I like to think of this as layers of grids," Song said. "The globe represents the set of entire possible solutions. To find a near-optimal solution faster, we aim to find the most promising area on the grid and 'zoom in' to it. By further zooming in, we have a more detailed grid of solutions within which we focus our search for the optimal solution; this is how we make the algorithm more efficient. Without this, it's like looking at millions of cities on Google Maps at the same time to pick the best one."

While Song's work is theoretical, the study has real-world implications.

"Once this project is finished, we plan to make it an open-source package for others to use," Song said. "This kind of algorithm can be used in military, medical, the sharing economy, and anywhere that has large-scale decisions to make involving integer solutions."

This project, which began in July 2019, will run for three years. Song will complete the study with Xinru Li, an industrial engineering doctoral student at Penn State.

The grant is in partnership with faculty from Northwestern University's Robert R. McCormick School of Engineering and Applied Science: lead Northwestern investigator Barry Nelson, Walter P. Murphy Professor of Industrial Engineering and Management Science, and co-principal investigator Andreas Waechter, associate professor of industrial engineering and management sciences.



Professor receives NSF grant to model cell disorder in heart

The National Science Foundation grant highlights need for cross-disciplinary research to develop computational tools to understand biological problems.

"Step-by-step, computer experiments are fueling the physical, biological experiment. This advances our knowledge of cardiac cell operations to improve the medical treatments and provide better care to cardiac patients."

On average, the human heart beats anywhere from 60 to 80 times per minute—that's almost 42 million times a year. Each beat consists of billions of cells working together, using their protein channels to pass electrical signals across the muscle. Proteins, the gatekeepers of the cells, orchestrate cell activity based on the signal, but what happens when the signals are wrong?

Hui Yang, Harold and Inge Marcus Career Associate Professor of Industrial and Manufacturing Engineering at Penn State, was awarded a $320,625 grant from the National Science Foundation (NSF) to study exactly how a process called glycosylation can cause proteins to disrupt the harmony of cell activity.

In glycosylation, sugar molecules known as glycans attach to proteins. The glycans assist with proper protein functioning, such as determining the protein's role in the cell and how proteins communicate with cells. When the process goes awry in humans, it can result in a number of metabolic issues, including diarrhea, low blood sugar, various organ problems, severe developmental delays, and even failure to thrive in infants.

While glycosylation disorders can affect all types of proteins, it has the potential to cause even more serious issues when it occurs in contractile proteins—the proteins used in muscle contraction and relaxation. They play a critical role in the heart, where they communicate through the production and conduction of electrical signals. These signals trigger the cell's voltage-gated ion channels (VGIC), which regulate cellular activity based on the extracellular environment. This electrical activity indicates how cardiac muscle cells should move to maintain the rhythm of the heart's beat.

Yang hypothesizes that the process of glycosylation can unintentionally interfere with how cardiac cells communicate. The glycans can leave residues, called sialic acids, along the proteins. Sialic acids are negatively charged, which could confuse the signals sent to the VGIC. Yang will investigate how these sialic acids can alter the VGIC, as well as the potential implications for heart issues such as irregular heartbeats or even heart attacks.

"There is also evidence that physiological cues like development and aging can impact the regulation of glycosylation, which can then impact cell-specific functions and the interactions with ion channels," Yang said.

In collaboration with Eric S. Bennett, professor and chair of the Department of Neuroscience, Cell Biology, and Physiology at Wright State University, Yang aims to clarify how glycosylation is regulated, as well as how glycosylation disorders can affect the VGIC.

"To provide better diagnostic and treatment services, we need to optimize the design of experiments to gain a better understanding of the physics about how glycosylation and its regulation can alter cardiac activity," Yang said. "It is still not clear how unregulated glycosylation alters the activity of cardiac muscle cells."

Yang and his team will use statistical analysis and computer modeling to examine how different sialic acid placements can change the VGIC's behavior. They will also investigate how these changes manifest as varyingly severe health symptoms.

"Step-by-step, computer experiments are fueling the physical, biological experiment," Yang said. "This advances our knowledge of cardiac cell operations to improve the medical treatments and provide better care to cardiac patients."

Yang explained that physical experiments, which involve using actual biological samples, are expensive and have ethical limitations. Simulation models allow researchers flexibility in understanding how to focus the research project as they design more efficient follow-up experiments.

In addition to the research project, Yang plans to develop an interdisciplinary course on computational muscle cell biology that will enable researchers and students to use virtual reality to better model cellular electromechanical functions. This will include a virtual "CardioLab" to provide hands-on interactive experience for students.

Kathryn Jablokow, front; Susan Mohammed, middle; and Scarlett Miller, back, discuss a recent study where students were asked to fill out a series of surveys throughout the design process of a class project to provide team interaction data.

Analyzing design team interaction

by Samantha Chavanic

Imagine being on a team that works seamlessly, easily completing the assigned project. Now, imagine being part of a team that struggles to work together and meet deadlines. How do these teams differ? What can be done to ensure effective teaming happens?

To answer these questions, an interdisciplinary team of Penn State researchers will study how engineering team design performance is impacted by team interactions.

Led by principal investigator (PI) **Scarlett Miller**, associate professor of engineering design and industrial engineering, the team has been awarded $349,792 from the National Science Foundation for "Longitudinal Exploration of Engineering Design Team Performance in Relation to Team Composition, Climate, and Communication Patterns." The project will investigate team structure, and how it and communication capabilities impact psychological safety, a shared belief that a team is safe for interpersonal risk-taking. **Kathryn Jablokow**, professor of engineering design and mechanical engineering, and Susan Mohammed, professor of psychology, serve as co-PIs.

Research results will be used to develop a model showcasing interpersonal risk-taking's influence on teams during the design process.

In a psychologically safe climate, teams are comfortable sharing ideas because mistakes are treated with understanding and failures are learning tools. Current research on team communication and psychological safety focuses on a single design stage. Researchers will expand on this by exploring how psychological safety develops and how it is either maintained or decreased during an engineering team's lifetime.

"Establishing a psychologically safe climate is important because it has been shown to positively predict key team outcomes, including task performance, creativity, information sharing, learning, work engagement, and satisfaction," Mohammed said. "It has been a consistent, generalizable, and multilevel predictor of numerous outcomes important to individuals, teams, and organizations."

Engineering organizations are becoming more team-based, as it is believed teams generate better solutions to complex problems, Miller said. Because of this, engineering is increasingly being taught as a team process. However, little is known about how to teach teaming effectively.

"This lack of understanding is problematic because teams are dynamic entities by nature; when we represent teams as static entities, we cannot effectively train engineers to work in team environments," she said. "Think peer reviews that often occur at the end of a project. While these 'snapshot' methods allow us to understand what went well or didn't go well, it does not allow us to identify when to intervene or what type of intervention would be beneficial."

Researchers will also explore team training execution and effectiveness. Findings will be shared as a free collection of activities.

"Solving complex engineering problems requires collaboration," Jablokow said. "When you improve team performance, you make the process of problem-solving more effective and more efficient, which translates to less time, lower costs, and better solutions."

Explore Penn State IME Graduate Program Opportunities

Degrees Available:

- M.S. in Industrial Engineering—thesis and non-thesis tracks
- Dual M.S. in Industrial Engineering and Operations Research
- MEng in Industrial Engineering
  – Available online through Penn State World Campus
- Graduate Certificate in Human Factors Engineering and Ergonomics
  – Available online through Penn State World Campus
- Ph.D. in Industrial Engineering
- Dual Ph.D. in Industrial Engineering and Operations Research
- Ph.D. in Industrial Engineering with a Minor in Operations Research

Research Areas:

- Human factors and ergonomics
- Manufacturing
- Operations research
- Operations, services, and analytics
- Service enterprise engineering

Consistently ranked as one of the top graduate programs in the United States by *U.S. News & World Report*, the industrial engineering graduate program at Penn State prepares students to go beyond what they thought possible for their careers and their lives.

"After twelve years in academia, I look back and appreciate how rare the breadth of my industrial engineering graduate degree is, and how few programs in the United States cover all areas of research in industrial engineering the way Penn State does. My time as a graduate student not only prepared me technically for my research career, but also taught me how to be a good colleague and an effective mentor to my students."

— **Matthew Frank** ('03 Ph.D.), Associate Professor, Department of Industrial and Manufacturing Systems Engineering, Iowa State University

For more information about the industrial engineering graduate program at Penn State, contact the graduate program office at imegradoffice@psu.edu, call 814-863-1269 or go to ime.psu.edu/students/graduate/index.aspx.

Bus driver seating design improvements get green light

Andris Freivalds

Yiqi Zhang

Bus and truck drivers often work long hours in postures that are known to increase their chances of musculoskeletal issues, including lower back pain, tendonitis, and carpal tunnel syndrome. These positions and operator workstations currently place drivers at increased risk of slower reaction and response times and at a higher risk of sustaining acute injuries in crashes. Poor driver workstation visibility also increases risks for other drivers and pedestrians.

Researchers at Penn State have been awarded $250,000 from the Transportation Research Board to improve bus driver health and safety by transforming operator workstation design, assessment, and ergonomics.

Led by principal investigator (PI) Matthew Parkinson, professor of engineering design and mechanical engineering and director of the Bernard M. Learning Factory, the research team will create a design and assessment toolkit that will simultaneously consider how vehicle geometry, driver body type, vision and posture limitations impact a driver's safety and long-term health. **Andris Freivalds**, Lucas Professor of Industrial Engineering, and **Yiqi Zhang**, assistant professor of industrial engineering, are serving as co-PIs. Heecheon You, professor in the Department of Industrial and Management Engineering at Pohang University of Science and Technology, and David Klinikowski, assistant research professor with Penn State's Larson Transportation Institute (LTI), are serving as investigators.

Current bus operator workstation design and assessment tools are based solely on laboratory data focused on out-of-date workstation conditions and driver population information. The team's research will focus on creating an analysis tool that will direct the design of new vehicles and guides that describe design, assessment, and component best practices.

Several faculty, alumni and graduate students from the Penn State Harold and Inge Marcus Department of Industrial and Manufacturing Engineering (IME) were recognized for their accomplishments at the 2019 Institute of Industrial and Systems Engineers (IISE) Annual Conference and Expo in Orlando, Florida, on May 20, 2019.

Vittal Prabhu

IISE/Joint Publishers Book-of-the Year Award

Vittal Prabhu, professor of industrial and manufacturing engineering, and **A. Ravi Ravindran**, professor emeritus and the provost's emeritus teaching scholar, along with Paul M. Griffin, professor of industrial engineering at Purdue, won

A. Ravi Ravindran

the IISE/Joint Publishers Book-of-the-Year Award. This award recognizes an outstanding published book that focuses on a facet of industrial engineering, improves education, or furthers the profession. Their textbook, "Service Systems Engineering and Management (Operations Research Series)," emphasizes the use of engineering principles to the design and operation of service enterprises, relying on mathematical models and methods to solve problems in the service industries.

IISE Manufacturing and Design Division Outstanding Young Investigator Award

Saurabh Basu, assistant professor of industrial and manufacturing engineering, was presented the IISE Manufacturing and Design (M&D) Division Outstanding Young Investigator Award. This award recognizes an M&D Division member under the age of 35 for technical contribution to manufacturing and design. The recipient must have made high-impact scientific contributions to the manufacturing and design field as evidenced by research endeavors, including publications, intellectual property, and other funding and dissemination activities.

Boeing Excellence Award for Collaboration in Productivity, Workplace Safety and Ergonomics

Andris Freivalds, Lucas Professor of Industrial Engineering, received the Boeing Excellence Award for Collaboration in Productivity, Workplace Safety and Ergonomics. The award recognizes the strategy and policy deployment for productivity, safety, and ergonomics, with a focus on how projects and initiatives fit into the overall organization's operational excellence initiatives. Beyond his research, Freivalds currently teaches five undergraduate industrial engineering courses and three graduate industrial engineering courses at Penn State.

Penn State industrial engineering professor addresses U.S. Congressional Caucus

Soundar Kumara, Allen E. Pearce and Allen M. Pearce Professor of Industrial Engineering at Penn State, spoke at a briefing hosted by the House Manufacturing Caucus, co-chaired by U.S. Reps. Tim Ryan (D-Ohio) and Tom Reed (R-N.Y.).

The briefing, "Artificial Intelligence and Manufacturing: The Power to Make Anything Anywhere Quickly," focused on applying artificial intelligence and manufacturing to revolutionize, strengthen, and expand the manufacturing capacity of the United States.

Kumara was invited to address the caucus due to his expertise in smart manufacturing systems and his cutting-edge research in solving manufacturing and health care problems using artificial intelligence, sensor networks, data analytics and complex networks.

Each speaker was given approximately 12 minutes to explain their perspective. The panelists were Kumara; Jack Beuth, professor and mechanical engineering co-director of the NextManufacturing Center at Carnegie Mellon University; Kevin Jurrens, deputy chief of the Intelligent Systems Division Engineering Laboratory at the National Institute of Standards and Technology; Kristin Morgan, additive manufacturing lead for the NASA Marshall Space Flight Center; and Vincent C. Paquit, data analytics lead in the Manufacturing Demonstration Facility at Oak Ridge National Laboratory.

Grant to study how driver behavior is impacted by autonomous vehicle technology

Yiqi Zhang, assistant professor of industrial engineering, received funding as part of a $60,000 Multidisciplinary Research Seed Grant to develop a driver-in-the-loop vehicle simulator tool in order to better understand the effects that Connected and Autonomous Vehicle (CAV) technology has on commuting behavior.

According to the National Highway Traffic Safety Administration, vehicular injuries and deaths in the United States have spiked for the first time in nearly fifty years. CAVs are shown to be one of the more promising technologies to improve driver safety. They also have the potential to reduce traffic congestion, improve travel efficiency and convenience, and expand mobility options. More advanced high-level CAV technology is able to perform driving tasks with little or no intervention from drivers, allowing motorists to perform other tasks.

While many believe commuters may start to favor longer commute distances in exchange for lower cost homes if they are able to be productive during their commute, a key missing factor in predicting whether this is true is better understanding the effects of CAV technology on drivers' acceptance of longer travel time and changes in commuting behavior.

Zhang, Ilgin Guler, assistant professor of civil and environmental engineering, along with Sean Brennan, professor of mechanical engineering, plan to use the grant to develop a driver-in-the-loop simulator tool that allows drivers to experience dynamic traffic flow simulations. This will help the researchers understand the effects of CAV technology on commuting behavior.

Two faculty members receive awards from PSEAS

Timothy W. Simpson

Sarah Root

Timothy W. Simpson and **Sarah Root** have been recognized by the Penn State Engineering Alumni Society (PSEAS) with its annual PSEAS Awards. Given to engineering faculty, staff, and alumni, the awards recognize outstanding teaching, research, advising, and service in the College. Nominated by their respective departments, honorees are selected by their peers along with members of the PSEAS Board of Directors. The recipients are honored during the annual PSEAS Awards banquet, which will be held on October 21, 2019.

Sarah Root, associate teaching professor of industrial engineering and undergraduate adviser, is the recipient of the PSEAS Outstanding Advising Award. This award recognizes and rewards outstanding advisers of engineering undergraduate and graduate students.

Root has been with the department for three years. She teaches classes in engineering economy, service sector engineering, and the first-year seminar. Root enjoys advising students because she is able to help them navigate the University and see them get the tools they need to succeed academically. She stated that celebrating their successes is her favorite part.

Timothy W. Simpson, Paul Morrow Professor in Engineering Design and Manufacturing, is the recipient of the PSEAS World Class Engineering Faculty Award. This award recognizes a faculty member who embodies the seven characteristics of the world-class engineer in all of their activities including teaching, research, and service. A world class engineer is solidly grounded, technically broad, globally engaged, ethical, innovative, an excellent collaborator, and a visionary leader.

Simpson has been with the department for 21 years. He was selected for this award due to his extensive industry collaborations, broad understanding of other disciplines, global engagement, and dedication to the University. Simpson has a joint faculty appointment in industrial and manufacturing engineering and mechanical engineering, as well as affiliate faculty appointments in the School of Engineering Design, Technology, and Professional Programs and the Colleges of Architecture and Information Sciences and Technology.

Simpson gives guest lectures and conducts workshops around the world and his product platform design course at the Massachusetts Institute of Technology has engaged more than 300 industry practitioners from more than 15 different countries. In addition, Simpson helped launch the College of Engineering's ENGineering for Innovation & ENtrepreneurship (ENGINE) Grant Program and the world's first online and resident additive manufacturing & design graduate program, in which he serves as its director.

Professor funds new engineering endowment to help students travel for success

A. Ravi Ravindran, professor emeritus and a Provost's Emeritus Faculty Teaching Scholar for the Harold and Inge Marcus Department of Industrial and Manufacturing Engineering (IME), has worked in a collaborative effort to establish a $25,000 endowment to fund conference travel expenses for the department's graduate students.

Named the Ravindran Matching Travel Grants, the endowment will provide as much as a one-to-one match with funds provided by IME.

"I've always thought about how I can help students afford travel," Ravindran said. "It is very expensive to attend and present at conferences nowadays. Registrations that used to be free for students can now be more than $300, and they simply don't have that kind of money."

Ravindran said that travel to conferences and presentations is crucial for graduate students to grow their industry network, learn from established professionals, present their research, and find peers with similar goals.

External funding sources can be prohibitively competitive or involve extraordinarily difficult applications for a relatively small grant, according to Ravindran. With his endowment, he strived to make it accessible to all students. Recipients do not need to have a specific grade point average or meet any criteria.

Pilot study in smart systems launched as part of Fulbright-Nehru Fellowship

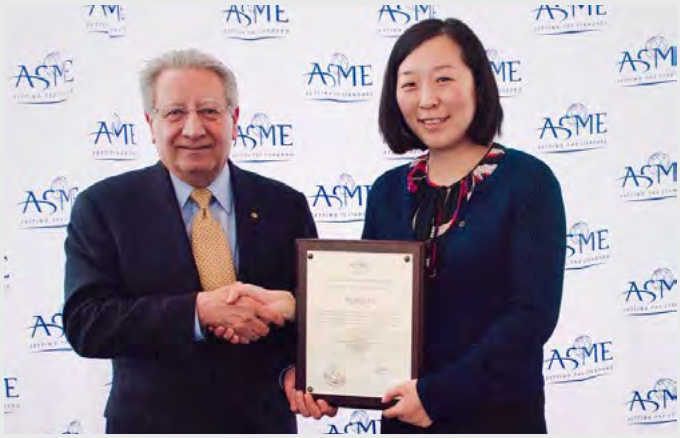
A pilot study involving academic and industry collaborators in smart systems has been initiated by **Vittal Prabhu**, professor in the Harold and Inge Marcus Department of Industrial and Manufacturing Engineering at Penn State, as part of his 2018-2019 Fulbright-Nehru Academic and Professional Excellence Fellowship.

Smart systems engineering involves sensing, networking, and computing of various systems and products in order to automate them. The industrial internet of things (IIoT) system used in this pilot study was procured from RDL Technologies Pvt. Ltd.

"This pilot study is in the context of Manjula Industries, which is an Indian small-to-medium enterprise (SME)," Prabhu said. "We're combining expertise across academic and industry partners to help us better understand how IIoT-based sensors can monitor manufacturing machinery continuously and communicate the data in real-time for cloud storage, data analytics, machine learning, and advanced decision-making algorithms."

Manjula Industries was established in 2000 and is one of the largest regional manufacturers of precision horological components, such as watch crowns. Manjula Industries manufactures more than 250 variants of watch crowns with a capacity of 400,000 components per month. Prabhu became involved with Manjula Industries while on a one-year sabbatical in India.

At this initial stage, the collaborative network consists of partners from the U.S. and India. Key contributors to this study include the Indian Institute of Technology-Kharagpur, the Siddaganga Institute of Technology (SIT), RDL Technologies Pvt. Ltd., and the Sahyadri College of Engineering and Management.



Penn State Professor Honored with Competitive Award from Engineering Society

Jingjing Li, William and Wendy Korb Early Career Professor (associate professor) of Industrial Engineering at Penn State, has been awarded the American Society of Mechanical Engineers (ASME) Chao and Trigger Young Manufacturing Engineer Award.

Li received the award based on her research contributions to the forming and joining of lightweight materials and structures through an understanding of the process-structure-property relationships in thermomechanical processing, the development of new joining technologies for different metals, and the invention of several new materials characterization techniques.

Established in 2011, this annual award recognizes a manufacturing researcher under 40 who has the potential to make significant fundamental contributions to the science and technology of manufacturing processes.

ASME is a not-for-profit membership organization that enables collaboration, networking, and skill development across all engineering fields. Members range from students, project managers, corporate executives, researchers, and more. Currently, the organization has more than 100,000 members in over 140 countries. Roughly 30 percent of the members are students.

The Manufacturing Engineering Division (MED) Honors Committee reviews nominations from all ASME members, making this award highly competitive due to the number of applicants each year.

Student chapter wins fourth consecutive national industrial engineering award

The Penn State student chapter of the Institute for Industrial and Systems Engineers (IISE) has been honored with the organization's Gold Award for the fourth consecutive year.

To determine award recipients, IISE rates each student chapter using the University Chapter Activity Report (UCAR). The UCAR scoring system allows student organizations to track their progress in order to make improvements for each academic year.

"This year we really focused on what we can do for our members," said **Brady Bobbitt**, now an industrial engineering alumnus and the 2018-19 Penn State IISE student chapter president. "We wanted them [the members] to network and develop themselves professionally."

The Gold Award is the highest honor in the professional organization's University Chapter Recognition Program.

Some of the traditional activities planned by the chapter for Harold and Inge Marcus Department of Industrial and Manufacturing Engineering students include a career fair, a Six Sigma Greenbelt training, workshops with potential employers, an award banquet, and a family day. Bobbitt said the group focused on bettering these activities throughout the year.

"I have to give a lot of credit to **Aaron (Meier)** and **Alejandro (Salaverria)**, our student corporate chairs," he said. "They were able to get the career fair in at the Nittany Lion Inn for next year and also get the event registration on the Nittany Lion Careers website. This should really help with attendance because it will make the event easier to find for company recruiters."

Bobbitt also credits the organization's win to the creation of new events, such as Career Days 101. For Career Days 101, the students teamed up with the National Organization of Business Engineering to orchestrate an event during the Fall Career Days. The event provided students with opportunities to prepare for the career fair and interviewing process through a mentoring talk, recruiter panel, résumé review, mock interview, and a headshot photoshoot.

In addition, the group organized Consulting 101, a collaborative effort with Penn State Industrial and Manufacturing Engineering Society to provide students with a panel of consultants with varying backgrounds to give insights to the life of consulting.

The 2018-19 IISE officers include Bobbitt, president; **Gabriel Di Biase**, vice president; **Alejandra Ayala**, treasurer; **Sophia Dyke**, secretary; Aaron Meier, co-corporate chair; Alejandro Salaverria, co-corporate chair; **Dongyoung Choi**, merchandise chair; and **Pawornwan Thongmak**, webmaster. All of the chapter's officers graduated in 2019 with a degree in industrial engineering, except Choi.

SEE 360 students work to improve Berkey Creamery experience for customers

By Shane Ramsay and Miranda Buckheit

Penn State's Berkey Creamery will soon be running smoother than its world-famous ice cream. Students in the Department of Industrial and Manufacturing Engineering's (IME) Service Enterprise Engineering (SEE 360) program are collaborating with the Creamery to optimize the efficiency of the Penn State landmark.

SEE 360 enhances students' fundamental educational experiences by raising awareness of the engineering challenges within the service sector. The program gives SEE Scholars, undergraduate and master's degree students, and SEE Fellows, doctoral students selected based on their research achievements, access to the entrepreneurial opportunities of the sector and facilitate collaboration with industry and alumni partners.

Chintan Patil, SEE 360 Fellow and doctoral student in industrial engineering, leads the project. He's focusing on exactly how supply meets demand in the Creamery's retail store. Patil is developing a model to help the Creamery determine how many workers are needed on regular days versus on game days, which see a significant uptick in demand.

"The main goal is to improve customer satisfaction by decreasing the time spent waiting in line while managing the employee schedule and cost," Patil said. "You need to find the right balance between the two."

The researchers collected data on two different game days during the 2018 season, with focus on the frequency that customers arrive each hour (the demand); service rates, which vary based on the customers and their orders; and customer satisfaction levels—was the wait worth it?

"The model that I'll deliver to the Creamery will allow them to input a forecast of demand," Patil said. "The model will tell Creamery managers how many servers they should schedule throughout the day."

Concurrently, **Madhumitha Sundararaman**, who was a SEE 360 Scholar who earned her master's degree in industrial engineering in spring 2019, researched the Creamery's production management, inventory planning, and waste management.

From August 2018 through January 2019, Sundararaman collected data on which flavors sell best, when those flavors are sold, and how much total ice cream is sold each month. This data will be used to plan production by forecasting what supplies, along with their quantity, are needed in the future.

"We want to collect data to understand the variations that occur within these processes to propose new improvements as time goes by," Sundararaman said.

A key component of these processes includes the historical knowledge of Creamery employees and how to standardize their expertise for future employees.

"We examined how the expertise of long-term Creamery employees can be replaced as they retire," Sundararaman said. "I want to standardize their duties and responsibilities so that the next generation of employees who perform the daily tasks do not have any issues."

Sundararaman noted that while their work to improve business operations and enhance efficiency may seem behind-the-scenes, it is ultimately going to benefit the customers.

"We want to see the legacy of the Creamery continue for another 150 years or more," Sundararaman said.

Other Fellows contributing to this project include **Hyunjong Shin**, research assistant, and **Yidan Wang**, doctoral student in industrial engineering.

Industrial engineering student marshal announced

Juan Gómez Lorente was selected as the student marshal for the industrial engineering baccalaureate degree program at the Penn State College of Engineering spring commencement ceremony on May 3. He received a bachelor of science in industrial engineering with a minor in economics.

A Schreyer Scholar, Gómez Lorente completed an undergraduate honors thesis titled "Soccer Analytics: An Examination of Current Approaches for Game Outcome Prediction and the Potential of Machine Learning with Artificial Neural Networks."

He was the recipient of the National Science Foundation Research Experience for Undergraduates Scholarship, the Schreyer Academic Excellence Scholarship, and the Henderson Memorial Fund Scholarship. He was named to the dean's list every semester.

Gómez Lorente participated in the Penn State Presidential Leadership Academy and served as an undergraduate researcher at the Penn State Complex Systems Modeling, Monitoring, and Control Lab through the National Science Foundation's Research Experience for Undergraduates Program.

He completed two internships at PwC, one focused on internal change management initiatives and the other focused on the revenue cycle in the healthcare industry. He also interned at the Sorolla Museum Fund in Madrid, Spain, where he was involved with international outreach, membership program expansion, and infrastructure investment debriefing.

Gómez Lorente's extracurricular activities included the Penn State Dressage Team. This year the team qualified for the Intercollegiate Dressage Association National Championship Competition for the first time by winning their regional competition.

Gómez Lorente's additional involvement at Penn State included Rotaract Club, Sailing Club, Schreyer Consulting Club, Glee Club, and Philosophy Club.

Following graduation, he joined PwC as an associate.

Student awarded MIT Supply Chain Excellence Award

Kara Nardi (2019, IE) was recognized for the MIT Supply Chain Excellence Award. After graduation, Nardi began working for Appian Corporation in Washington, D.C. as an associate consultant.

Front row L-R: Dr. Robert A. Novak, Kara Nardi, Maria Lucchi, Maria Tartaglia; back row L-R: Danny Yunes, Kaitlyn Rakestraw, Benjamin Vruwink

IE team wins Lockheed Martin Design Excellence Awards

After 15 weeks of hard work, College of Engineering students displayed their capstone design projects at the spring 2019 Capstone Design Project Showcase held on April 25 at the Bryce Jordan Center.

A total of 126 capstone design projects, intended to solve real-world challenges posed by industry sponsors and other clients, were judged by a panel of industry experts, comprised of current and past sponsors as well as members of the Learning Factory Industry Advisory Board.

Of the three winning projects for the Lockheed Martin Design Excellence Awards, one team was all IE:

"R&D; Lab Layout and Work Flow Optimization" for Philips Ultrasound by **Connor Robinson**, **Megan Schwartz**, **Pawornwan Thongmak**, **Madeline Woody**, and **Sonalika Yerra**, advised by **David Cannon**, associate professor of industrial and manufacturing engineering.

Keri Nicolich, a sophomore studying industrial engineering, and Ben Cutler, a junior studying industrial engineering, demonstrate the easy-to-use CastPak system for live streaming videos in HD.

It's almost like being there

IE student designs HD streaming backpack

By Rachel Sternberg

As most entrepreneurs know, not every idea comes to fruition as a fully sustainable business. The members of the CastPak team learned this lesson mere weeks after the 2018 Summer Founders Program officially kicked off.

According to CastPak team member **Ben Cutler**, a senior studying industrial engineering, initial plans were to pursue wearable sensor technology as part of the program. However, after being accepted, Cutler and his teammate, Jack Mentch, realized the business wasn't scalable for a number of reasons.

Relying on their entrepreneurial mindsets and advice from faculty members and LaunchBox staff, the team spent weeks researching new ideas before finally settling on CastPak, a turnkey, portable solution for live streaming such events as local athletic games and festivals in high definition (HD).

Cutler says the product makes it easy for parents and families to virtually attend their children's sporting events even when distance or other factors make it impossible to be there in person.

"Normally, if you're live streaming HD video, you have to have a permanent setup and it's expensive. If you want to use your phone, you can't always get the highest quality and data costs can rack up," Cutler said. "The CastPak allows you to live stream in HD while having the portability of a setup that's all contained in a backpack."

The CastPak idea initially started as part of Hedy's Garage, a Happy Valley LaunchBox program led by Bob Beaury, assistant teaching professor and interim director of Engineering Entrepreneurship in the College of Engineering. Hedy's Garage—named for 1940s movie star and inventor Hedy Lamarr—pairs State College businesses with entrepreneurial Penn State students who can bring their ideas to life.

"We have a lot of energetic, smart, entrepreneurial students, but they don't always have scalable and viable ideas," said Lee Erickson, chief amplifier at Happy Valley Launchbox. "So Hedy's Garage is our attempt to bring industry experts with viable ideas together with passionate students to see if we can create new businesses from those partnerships."

During the spring 2018 Hedy's Garage program, Andrew Przyjemski, a senior studying engineering sciences, was on a team paired up with Videon, a State College company specializing in digital media solutions. Using Videon's edge compute encoder technology to reliably stream HD video, Przyjemski's team started the foundational work of what would become the CastPak startup.

When Cutler and Mentch—both alumni of Hedy's Garage—were brainstorming a new project to pursue during Summer Founders, Przyjemski reached out with the idea to combine efforts and focus on CastPak. Since joining Summer Founders, the CastPak team recruited Keri Nicolich, another Hedy's Garage alumna and a sophomore studying industrial engineering, and Jason Chhay, a sophomore studying computer science, to contribute diverse perspectives to the project.

"It really felt like a true incubator—a hotbed of ideas with people to bounce things off of," Cutler said.

And this entrepreneurial ecosystem extends beyond the Summer Founders Program, according to Cutler, who says it touches nearly every aspect of his Penn State experience.

"All the work President Barron has put into the Invent Penn State initiative has provided many more resources like the Summer Founders Program and the LaunchBox that are truly dedicated to helping foster new ventures," Cutler said. "And it's not only happening outside the classroom but in the classroom, too, with a variety of classes focused on teaching the entrepreneurial mindset."

With the portability of a backpack, CastPak makes it easy for local schools and organizations to live stream their events.

Improving the fan experience at Beaver Stadium

Student projects work to reduce wait time at concession stands and restrooms

By Shane Ramsay

Fans could soon see shorter lines at Penn State home football games, thanks to some innovative thinking from Penn State engineering students.

Penn State's Service Enterprise Engineering initiative (SEE 360) and Beaver Stadium have worked together for more than a year, leading to two capstone projects that occurred in fall 2018. One project, sponsored by Penn State Athletics, focused on optimizing the efficiency of the concession stands and the other project, sponsored by SEE 360, focused on finding solutions for women's restroom lines.

Charlie Purdum, assistant teaching professor and director of industry relations in the Harold and Inge Marcus Department of Industrial and Manufacturing Engineering at Penn State, and faculty adviser for both groups, explained the importance of these projects, saying that football fans deal with a lot of "conflict" during their game day experience, such as parking, bathrooms, and lines. He said improving these customer service issues are vital to keeping fans coming to the games, instead of opting to watch them at home on television.

Reducing concession stand wait time

Students **Lisha Li**, **Andrew Phoebe**, **Saulabhya Shrikant**, **Yijin Wang**, and **Jinyu Zhao** designed their project to improve customer service through decreasing wait times for the concession stands. This centered around the production and service of chicken baskets, which serve as the most popular and profitable item on the menu.

Former SEE 360 collaborator and research coordinator **Anthony Petrine**, who was involved in the planning and data collection portions of the project, described how the group's main objective in its research was improving everyone's game-day experience.

"We wanted to reduce the wait times in the lines, because what ends up happening is you have lower customer service with the longer waits," Petrine said. "People are buying tickets to watch the game, not stand in a line."

The group collected data at the September and October games against Kent State and Michigan State, respectively. This included timing the interactions between customer

and stand attendants, recording stockout frequencies, and documenting the time needed for the cooking and production of chicken baskets. They also spoke with the stand attendants, who are volunteers from Centre County organizations, about inefficiencies from their perspective.

After their final analysis and the completion of a simulation model, the group recommended the implementation of an "express chicken basket," where students would use vouchers or tickets that they purchased the week before the game, presenting those upon their arrival to the stand. They found that this would decrease the average customer wait time by 52 percent from around 19 minutes to approximately eight minutes. It also would increase the number of customers served by almost 10 percent.

SEE Fellow and doctoral student **Kai-Wen Tien**, who also was heavily involved in the project, explained how the knowledge gained by these students in the classroom can be used in a wide variety of ways.

"The method that we used is a very classic method for manufacturing, but we applied it to the service industry," Tien said. "It serves as an example for how we can use manufacturing methods to change other industries."

Reducing wait time for restrooms

The second capstone group, sponsored by SEE 360, was composed of students **Matthew Bessasparis**, **Brady Bobbit**, **Matthew Chabala**, **Hamza Fadil**, **Bowei Han**, and **Zichao Zhang**. Their research sought to tackle a problem that occurs at many large, entertainment venues: disproportionately longer lines for the women's restrooms as opposed to the men's restrooms.

"Our goal was to observe the women's restrooms in Beaver Stadium and try to alleviate the wait times, as well as improve customer satisfaction," said Chabala, a computer science senior. "So, if there is a line, we want to make it as pleasurable as possible for the fans."

Data collection also occurred during the games this past fall against Kent State and Michigan State and involved observing and recording restroom wait times.

"We recorded the times of when they [fans] got in the line, when they got to the front of the line, and when they got out of line, as well as how long it took them to use the stalls and sinks," Chabala said. "And from there, we made models on computers to simulate real life. Once we had those models, we would modify them to see how the efficiency could increase or decrease."

Following the analysis of their simulation model, the group proposed three solutions that would decrease the restroom wait time by about 15 percent. These consisted of signs being placed throughout the stadium to direct guests to under-utilized restrooms, removing a portion of a large wall in each restroom that blocks the view of half of the stalls, and creating a line barrier to improve the flow of the concourse and alleviate line-cutting.

"This project made me realize that service engineering encompasses a large part of our day-to-day life," Bobbit, an industrial engineering senior, said. "It's really cool how you can study these real-life scenarios and look at the customer in terms of their expectations and perceptions of the service and how we can optimize that for a better customer experience."

Cory Chapman, associate athletic director for facility and event operations, believes the athletic department's collaborations with students in the Learning Factory has been "fantastic" and is excited to implement improvements based off their research.

"It's been a great partnership," Chapman said. "We continually look for ways to improve the fan experience at all of our venues. There's already a lot of positive things happening, but these students have looked into ways that we can tweak or enhance the experience for our fans."

Purdum noted how projects like these not only apply to Beaver Stadium but can be universally applied to improve any venue that provides these types of services.

"Any public venue could benefit from these projects, whether it's a stadium, an arena, or a theater," Purdum said. "Any place where you have an event that people are coming to see, and they're buying refreshments or food and they're going to the bathroom, could use this knowledge."

The collaborations with Beaver Stadium continue to be a mutually beneficial experience. The efficiency of the women's bathrooms remains an ongoing project for engineering students, and in the coming semesters, students will begin to research ways to make the entrance lines at each gate more efficient.

"These examples illustrate the opportunity for engineering to contribute to the service sector," said SEE 360 Advisory Board Chairman Chuck Schneider. "Poorly engineered service processes are everywhere around us, waiting for engineers to improve our lives, improve service organization performance, and build rewarding careers while doing so."

Kudos came from other sectors of the University as well. Law Professor Stephen Ross, who directs the multidisciplinary Penn State Center for the Study of Sports in Society, praised leaders in the College of Engineering and Intercollegiate Athletics for their collaboration.

"We are harnessing students' passion for sports to help them gain critical skills," Ross said. "The students displayed not only technological expertise but learned how to solve real-life problems and present their findings to an audience who lack their engineering know-how. The benefit is not just to the students but to Nittany Nation."

Advances in snow removal

IE designs software to reduce the amount of time—and money—it takes to clear Penn State of snow

By Pamela Krewson Wertz

It is well known among the State College and Penn State communities that it takes a lot for University officials to shut the campus down after a major snowfall. In fact, since 2010, the University Park campus has been shut down just three full days due to snowfall.

Much to the chagrin of students—and likely some faculty and staff—the snow day at Penn State may just have become even more elusive, thanks to software developed by recent industrial engineering graduate **Achal Goel**.

Goel, who graduated with a master's degree in industrial engineering in May, came up with a user-friendly program that cuts snow removal time from the roadways and parking lots on the University Park campus while saving the University money in terms of costs associated with clearing the snow.

"Until now, snow-removal operations were done based on the snow-removal equipment that was available at the time and what had worked in the past," Goel said. "The process didn't involve any engineering tools or analytical skills so we wanted to create a software solution that uses real data and methodologies and can effectively decrease the time it takes to clear snow from campus."

The name of this software? Real-time Optimization for Adaptive Removal of Snow or ROARS, for short, which is fitting to be used at the home of the Nittany Lions.

Not only were his classmates and adviser, professor and director of the Service Enterprise Engineering Initiative (SEE 360) **Vittal Prabhu**, impressed. Goel's program also got the attention of Penn State President Eric Barron for the potential time and cost savings to the University.

"The development of this software by an engineering student can have a great deal of impact," Barron said. "Anything that we can do to make the snow removal operations more efficient and more effective will ultimately make our campus safer and that is our priority."

Vikas Dachepalli, another industrial engineering master's degree student, did some initial research with Goel on the project before Dachepalli graduated in December 2017.

The calculations within ROARS—which is run through an Excel-based worksheet—are based on the amount of snowfall in inches and the number of snow-removal vehicles the Office of the Physical Plant (OPP) has available to clear the roadways and parking lots at any given time. It also factors in the number of employees who are working during a given shift and the skill level of those employees.

The amount of time it takes the software to calculate all of the information in order to optimally allocate available equipment and personnel to plowing areas, and also determine the time it will take to clear the snow, is an astonishing 12 seconds.

OPP is the office that oversees snow removal at Penn State and has three different crews working at the same time to clear snow from roads and parking lots (which was the focus of this project), walkways on campus, and building entrances.

Nadine Davitt, supervisor of solid waste and labor operations with OPP, was an integral part in the project and was available to answer any questions Goel had about the snow-removal process at the University.

"Growing up in India and living there all of my life, this whole issue of snow and enough snow falling that it was a safety concern—as well as a concern for a university to operate as expected—was foreign to me," he said. "Nadine's immense knowledge and experience was instrumental in shaping this project."

Davitt is responsible for supervising the staff that removes snow from parking lots and campus roads.

"Our primary challenge with snow removal is getting the snow cleared so the University can open at the normal time while meeting the expectations of the campus community," she said. "This modeling software Achal developed takes into account the size of the areas to be plowed, any obstacles within that area, and the type and size of equipment that is needed to clear that area."

While ROARS was under development for much of last year's snow season, it was tested during the last snowfall experienced by the Central Pennsylvania region.

"I expect to use ROARS as a tool to assist in decision-making this year," Davitt said. "For the first time, we will be able to use real-time information to determine the start time and expected finish time to completely remove the snow, and will be ready to pair the right-sized equipment to the area being plowed."

If the forecast changes, the program can be run again to compensate for the variability of the forecasted snowfall amount versus the actual amount of precipitation that accumulates.

All of this allows the snow marshal, police services, and Penn State administrators to better determine if and when to delay or cancel campus operations based on solid data analysis.

Barron said that this type of student engagement fits perfectly into his Invent Penn State initiative.

"Invent Penn State is designed to enable students, faculty, and staff to take their ideas into the marketplace," he said. "It is wonderful to see a real student participating and solving real world problems. This not only sets him on a career path that is far better than classroom learning alone, it allows him to take the solution beyond the walls of Penn State and into the marketplace where it can improve service and make an impact on a much larger scale."

The project also landed Goel a full-time job for a consulting firm in Atlanta, which he started in May 2018.

"I am so grateful that I had the opportunity to work on this real-world problem at Penn State," he said. "The courses I had in programming, supply chain engineering, and distributed systems and control all came together in solving this one problem that the campus faces every year.

"It is very exciting to have been able to help improve a tangible service for the community and to see the positive impact my education has had on the University."

"The courses I had in programming, supply chain engineering, and distributed systems and control all came together in solving this one problem that the campus faces every year."

First SEE 360 minor student eyes graduation in December

By Andrew Severin

In December 2019, **Pawornwan "Bam" Thongmak** will become the first industrial engineering student to graduate from Penn State with the service enterprise engineering (SEE 360) minor.

Thongmak is sponsored by the Royal Thai Government to study industrial engineering at both the undergraduate and postgraduate levels. She plans to pursue a doctorate after completing her undergraduate studies in December.

The Royal Thai Government offers five types of scholarships to students moving on to college. These scholarships are issued to students who meet various criteria ranging from "wisdom," competency in English, and high scores on academic assessments. Thongmak qualified for the Ministry of Science and Technology scholarship, which was sponsored by King Mongkut's University of Technology North Bangkok.

Thongmak is complementing her industrial engineering degree with an economics minor and a SEE 360 minor. SEE 360 is an initiative within IME that motivates students to use engineering concepts to optimize the service industries.

"I think it's very interesting how engineers can help improve the processes around campus, so I looked into SEE 360 as a whole and I saw that there was an option for a minor," she said.

Thongmak quickly got involved with SEE 360's projects around campus. One of these projects, Real-Time Optimization for Adaptive Snow Removal (ROARS), attracted the attention of college campuses, snow removal companies, and local weather outlets when it was used to optimize snow removal at Penn State this past winter.

While the unique projects were initially enticing, there are other benefits to taking the SEE 360 minor—one of which is practicing human interaction in the otherwise mechanical field of industrial engineering.

"I took human development and family studies classes that were very fun that counted toward the minor," Thongmak said. "It's a fun way to de-stress as well because it's not too technical."

An interesting caveat to Thongmak's sponsorship is a requirement to work for the Royal Thai Government upon completing her studies. For employment within the Royal Thai Government, Thongmak plans to be a professor of industrial engineering. This decision sprouted from a longstanding appreciation for academics.

"I want to pass on knowledge to the next generation of engineers," she said. "I want them to do well academically, but I don't want them to take academics for granted."

Alumni Updates

Eric Burlingame ('14 IE)
Burlingame, business team manager for logistics engineering at Volvo Group, was selected for the Institute for Supply Management's (ISM) 30 under 30 Supply Chain Stars. This program recognizes young purchasing and supply chain management professionals for their passion, creativity, and contributions to supply chain.

Richard Tannenbaum ('92 IE)
In June 2018, Tannenbaum became chief supply chain officer and senior vice president of information technology at Fleet Farm, a Midwest retailer of outdoor products headquartered in Appleton, Wisconsin.

Tim Schoener ('85 IE)
Citizens and Northern Corporation appointed Schoener as a Class III Director of the Board of Directors for the corporation and for the bank at their July 18 meeting. He will fill the vacancy created by the resignation of Jan E. Fisher from the board.

Susan Steadman ('83 IE, '90 M.B.A.)
Steadman received the Institute of Industrial and Systems Engineering Medallion Award for her impact on the industrial engineering profession. The award honors those who have made significant contributions to the field in several areas. Recipients are recognized for exceptional leadership as advisers in developing and promoting young engineers, for creating a body of knowledge for the practice of industrial engineering through innovations in organizing educational materials that advance the development of industrial engineers, and for influencing the productivity of a company through applications of industrial engineering methods.

Kerri Bair ('02 IE)
Bair was the Institute of Industrial and Systems Engineering recipient of this year's UPS Minority Advancement Award. The award recognizes organizations or individuals that, through innovative means, have developed programs or projects with the aim of advancing women, minorities, or individuals with disabilities in the field of industrial engineering. Bair has been an employee of Walt Disney World for more than 13 years and currently serves as the director of planning and industrial engineering.

Rodolfo Portillo ('08 M.S. IE, '09 Ph.D. IE & OR)
Portillo was presented with the Institute of Industrial and Systems Engineering Logistics and Supply (LSC) Chain Division Outstanding Industry Practitioner Award, which recognizes excellence in industry practice of logistics and supply chain courses. The objectives of this award are to show appreciation to the industry practitioners of IISE who are outstanding in implementing logistics and supply chain techniques, as well as encourage practitioners to raise standards in the practice and dissemination of logistics and supply chain concepts in engineering. Portillo currently works for Amazon, overseeing customer service for the Americas and leading the expansion effort for the company in Canada, Mexico, and Brazil.

Terri Green ('81 IE)
Green received the Penn State Engineering Alumni Society Distinguished Service Award. This award recognizes and rewards an alumnus, friend, or former faculty member who has donated time, expertise, and energies in the form of outstanding and special service to a department, unit, or to the College. Green has been recognized for her dedication as former president of the Penn State Industrial and Manufacturing Engineering Society.

Benedick with the ProFun Management staff and Abu Dhabi partner, Mohammed Al Mubarak, at the Ferrari World Theme Park in Abu Dhabi. ProFun partnered with Mubarak to provide the management and operations for the first Ferrari licensed, largest indoor theme park in the world.

Industrial engineering alumnus shapes the landscape of the attraction industry

By Shane Ramsay

Working on something as monumental as the Apollo spacecraft would be the peak of almost anyone's career, but for Penn State alumnus **Jim Benedick**, it was only the beginning.

"I came to Penn State, at first majoring in mechanical engineering, but eventually switched to industrial engineering, because I didn't want to be stuck behind a drawing board," Benedick said. "I wanted something different."

Benedick accepted a position with North American Aviation (NAA), where he used his skills to work on projects that were literally out of this world.

"I spent a year working on the S2 booster for the Saturn rocket and then another year working on the Apollo 1 spacecraft," he said.

For his next move, Benedick began looking for other jobs that would be just as exciting as putting a man on the moon. After seeing an ad in the Los Angeles Times, he found what he was looking for at one of the most magical places on Earth: Disneyland.

Being an industrial engineer at Disneyland is just as exciting as it sounds; Benedick described how they would study every aspect of the park such as the capacities of rides and attractions, queue lines for food and merchandise stands, and the ever-important restrooms. Throughout his ten years there, he became chief industrial engineer and served as area manager for the Main Street, Adventureland, Frontierland, and Tomorrowland sectors.

"When I first moved out here (Southern California), one of the first things I did was go to Disneyland," Benedick said.

Following his time at Disneyland, Benedick spent his next years working on a plethora of different projects throughout North America. He served as the vice president of operations for the 1982 World's Fair in Knoxville, Tennessee, doing consulting work for a total of five World's Fairs, and was the president of the DuQuoin State Fair in Illinois.

Benedick ended up back in Southern California, however, where he would finish his long, illustrious career. He became a partner at management consulting and operational management firm MR-ProFun, the end result of a merger between the firm's Management Resources and ProFun Management Group, Inc. While most may not be familiar with the name MR-ProFun, almost everyone is familiar with their work.

"We've been involved with major, world-renowned projects such as the 9/11 Memorial Museum, the Museum of Natural History in New York, and Ferrari World, which is the largest indoor theme park in the world," Benedick explained.

The firm operates in four distinct sectors, completing projects all over the world. Their previous work ranged from commercial attractions, such as MahaNakhon Observation Deck in Bangkok and Yas WaterWorld in Abu Dhabi, to cultural attractions, including the Aquarium of the Pacific in Long Beach, and the Kennedy Space Center in Cape Canaveral, to corporate attractions, like Warner Bros. Studio Tour: The Making of Harry Potter in London and the World of Coca-Cola in Atlanta, and to exposition and events, namely the 2010 Shanghai World Expo and the 2012 Olympics in London.

This exciting lifestyle has been something that Benedick has been chasing for as long as he can remember, always being drawn to the thrill of the industry.

"As a kid, I was always attracted to carnivals," he said. "As far as the business goes, it's much more fun when you're dealing with other people having fun. I wanted to work in the service industry to help make people's lives more enjoyable."

This passion and commitment to other's enjoyment is what has kept Benedick in the industry for more than 40 years, and these decades of prolific experience have taught him lessons that have been crucial to his success.

"You have to be prepared for whatever you want to get into but know that even the best preparation will never be enough; you're going to have to learn as you go," Benedick said.

Benedick in coaster hydraulic room.

Korbs establish three Open Doors Scholarships in the College of Engineering

Penn State industrial engineering alumnus **William Korb** and his wife, Wendy, who is also a Penn State graduate, have contributed $100,000 to fund and endow three Open Doors Scholarships in the College of Engineering.

Each gift, matched 2:1 by Penn State for a combined total of $300,000 in new scholarships, will support undergraduate students participating in RaiseMe, the Pathway to Success Summer Start Program (PaSSS), the Student Transitional Experiences Program (STEP), Complete Penn State, or Smart Track to Success.

An Erie native, William Korb attended Penn State Behrend for two years before graduating from University Park with a degree in industrial engineering. He is the retired president and CEO of Gilbarco, the world's leading supplier of fuel dispensers, credit card readers, and point-of-scale devices for gasoline stations.

The Korbs have been long-time supporters of Penn State engineering, both at the Behrend and University Park campuses. In 2002, the Korbs established the Korb Family Trustee Scholarship in Engineering at Behrend, and in 2014 and 2015, they gifted approximately $1.34 million to create the William and Wendy Korb Early Career Professorship in Industrial Engineering and the William and Wendy Korb Early Career Professorship in Biomedical Engineering, designed to support talented engineering faculty at the start of their academic careers.

Gary Butler receives Outstanding Engineering Alumni Award

Gary Butler, P.E., a Penn State industrial engineering alumnus, was named a recipient of the 2019 Outstanding Engineering Alumni Award. Butler was honored on April 8 at the College of Engineering's annual Outstanding Engineering Alumni Awards ceremony at the Nittany Lion Inn on the University Park campus.

The award is the highest honor bestowed by the Penn State College of Engineering and recognizes graduates who have reached exceptional levels of professional achievement.

He started his college career in electrical engineering, but soon discovered it wasn't the best fit for his extroverted personality. After meeting with department heads from electrical engineering, industrial engineering, and mechanical engineering, Butler decided to pursue his bachelor's degree in industrial engineering.

After graduating from Penn State in 1971, Gary joined Allis-Chalmers Corporation as a plant engineer, and advanced into various management positions within the company into the 1980s, when the business became Precision Custom Components (PCC). In 1993, Gary left PCC and moved to Pittsburgh, Pennsylvania, to become general manager of an Ionics Corporation business unit.

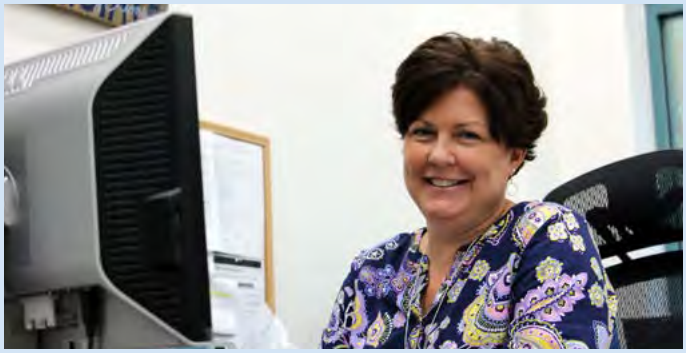
Gary returned to PCC in 1997 as vice president and general manager and became president and CEO in 2001, a position he still holds today. In 2010, the Central Pennsylvania Business Journal named PCC Business of the Year, and in 2011, Gary was recognized by the journal as Executive of the Year.

"Without my industrial engineering education from Penn State, I would have no ability to be doing what I'm doing today," Gary said. "When I was going through the IE program, the curriculum was very broad, which was extremely beneficial to me because I've been able to be involved in all aspects of the business. Industrial engineering was and still is very people oriented. If you're going to be in management and help make decisions in a company, that people aspect in IE is extremely important."

Butler is a registered professional engineer in mechanical engineering in Pennsylvania and is a member of the National Society of Professional Engineers. He was past president of the Penn State Industrial and Manufacturing Engineering Society and the Manufacturers' Association of South Central Pennsylvania, past chairperson of the Penn State York Advisory Board, and is currently president of the York County Science and Engineering Fair.

Lisa Petrine, department head staff assistant, was awarded the Penn State Engineering Alumni Society Outstanding Staff Award. This award is given to those that demonstrate successful performance as a staff member by combining competence of skills, knowledge or subject matter, and successful interaction with others. Awardees are recognized for their positive attitude and work that substantially exceeds the normal expectation for a staff member.

Petrine began her position as department head staff assistant in June 2017. She handles various tasks for the department such as annual reviews, faculty searches, undergraduate scholarships, and aids the departmental award committee. Petrine also serves as the College of Engineering's United Way representative.



Denise Olivett joined the Harold and Inge Marcus Department of Industrial and Manufacturing Engineering in August 2019 as the new undergraduate staff assistant. Olivett joined the department from her prior position with the Bursar.

Olivett will handle all requests from undergraduates regarding scheduling, academic conflicts, and assists with undergraduate events throughout the year.

PENN STATE IE ALUMNI:

Stay connected

with Penn State IME and your peers by joining the alumni society.

What is PSIMES?

The Penn State Industrial and Manufacturing Engineering Society (PSIMES) is an Affiliate Program Group (APG) of the Penn State Engineering Alumni Society (PSEAS).

PSIMES Purpose

- Stimulate the continued interest and professional development of all graduates of the IME Department
- Act as an informal advisory board to the head of the IME Department
- Promote fellowship and communication among the Penn State IME alumni, faculty, and students to actively work for the improvement of the department and College of Engineering

Membership

All graduates of the Penn State IME Department who have provided their full name and email address to the PSIMES Board are members.

Active members are those who participate in one or more committees or projects being conducted by PSIMES.

Structure

PSIMES is governed by the Board of Directors, which consists of 12 members who are elected by the PSIMES membership and five appointed members.

PSIMES Initiatives

- Student Mentorship Program
- Student Job Shadowing Program
- Student Résumé Reviews
- Professional Career Panel Discussions for Students
- Awards and Recognition Programs: Graduate of the Last Decade Award and Faculty Appreciation Award
- Social Media Communication to membership via PSIMES Linkedin Group Page: Network with more than 1,000 Penn State IE alumni!

How to Join

- Send full name and email address to Lisa Petrine at lap31@engr.psu.edu
- Request online membership to the PSIMES LinkedIn Group

There is no fee to join!

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