IME

# MOVING FORWARD

## The Future of Penn State Industrial Engineering

**ALSO IN THIS ISSUE:**




PennState
College of Engineering

# Greetings from the department head

Welcome to our fall 2020 magazine! This is my first of what I hope to be many introductions to the magazine. As everyone is painfully aware, this year has been unprecedented. Our classes were in person at the start of the spring semester before moving to fully remote and then to a hybrid mix of in person and remote for the fall. Faculty and staff are mostly working from home, everyone on campus is socially distancing and wearing masks, and there are no in-person meetings.

This has been a tremendous challenge, and I couldn't be more proud of the instructors, staff, and students. Everyone is putting in overtime to keep things running as smoothly as possible and to deliver the top-notch Penn State education that everyone has come to expect. Students are working under undesirable conditions to learn in classes that are held remotely, largely losing out on all of the communal experiences that make university life so wonderful and that make learning a more social activity. Yet, somehow, everyone has pulled together to not only make the best of a bad situation, but to progress and succeed.

Part of the normalcy that everyone's efforts have been able to maintain are our research activities, several of which are highlighted in this edition. Inside these pages you'll find stories on health care innovation, manufacturing improvements, and ways we are using our industrial engineering skillsets to drive societal change. You'll also find out how researchers here in the department are utilizing artificial intelligence to inform drug interactions, how researchers are being deployed across the state to innovate manufacturing plants, how a World Campus additive manufacturing graduate student is using his education to help his business, and the ways that our faculty members are finding new methods to help mitigate the spread of COVID-19.

I'm sure you'll find all these efforts as exciting and important as I do. They are continuing examples of how the department's researchers and students are having a profound impact on our world.

There is even more going on in the department, of course, than such critical research.

There are changes being made to the Penn State University Park West Campus, with the addition of several new engineering buildings in close proximity to our Leonhard Building. Renovations are also being made to the Leonhard Building's lobby to convert it into a student maker space. Personnel-wise, former Department Head Staff Assistant Lisa Petrine has moved over to become the Service Systems Engineering program manager, and we've added Christine Luzier as the assistant to the department head. Lastly, we've been lucky enough to welcome back former department head (2009-2014) Paul Griffin. Paul is a co-hire of the Penn State Social Science Research Institute, where he is working within the Consortium to Combat Substance Abuse. As a health systems engineering expert, Paul will focus on health systems engineering and care delivery, health analytics, cost effectiveness modeling in public health, and health supply chain coordination.

I'd be remiss if I didn't make three additional call outs. First, IME has among the most dedicated alumni anywhere. Our alumni group, PSIMES, is extremely engaged with the department, working nonstop to provide mentoring, virtual job shadowing, and webinars for our industrial engineering students and alumni. If you are not a member of PSIMES, I encourage you to join and become involved! Second, our advisory committee has been providing me with invaluable guidance to help lead the department to even greater recognition as the best industrial engineering department in the world. Lastly, my personal gratitude goes to Ling Rothrock, who went way above and beyond the call in leading the department through the COVID-19 crisis in the spring. He had no idea that he was signing up for that job, but he stepped up to it and, for that, the department will be forever grateful.

I hope you enjoy our 2020 edition, and I am eager for what our future holds.

Sincerely,

**Steven Landry**
Department Head


## Industrial and Manufacturing Engineering (IME) Magazine

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# New department head named to lead industrial engineering

*By Miranda Buckheit*

**Steven Landry**, previously professor of industrial engineering and associate department head of the School of Industrial Engineering at Purdue University, was named department head of the Penn State Harold and Inge Marcus Department of Industrial and Manufacturing Engineering (IME). He began on July 1, 2020.

As associate department head at Purdue, Landry oversaw the industrial engineering graduate and undergraduate curriculum, including the development of new programs, administration of existing programs, and curriculum assessment and redesign. Landry's research focuses on air transportation systems engineering and human factors, particularly on design systems that integrate humans and automation. He also has taught undergraduate and graduate courses in human factors, statistics, and industrial engineering.

"Distinguished as both a researcher and educator, Steve also brings with him to Penn State abundant experience as an accomplished administrator," said **Justin Schwartz**, Harold and Inge Marcus Dean of Engineering at Penn State. "Under Steve's leadership, I am confident that IME will continue to shape the future of industry in new and exciting ways."

Landry has been recognized multiple times for both research and teaching. He has published more than 80 peer-reviewed journal articles, conference papers, and book chapters on areas including flight deck automation, human-computer interaction in aerospace, and human factors in aviation. His work has been funded by a variety of agencies, including the Federal Aviation Administration and the National Aeronautics and Space Administration (NASA).

Before joining the faculty at Purdue in 2005, Landry was an aeronautics engineer for NASA at the Ames Research Center, researching and developing air traffic control automation. He previously served as an aircraft commander, instructor, and flight examiner with the U.S. Air Force. Landry received his doctorate in industrial and systems engineering from the Georgia Institute of Technology, his master's in aeronautics and astronautics from the Massachusetts Institute of Technology, and his bachelor's in electrical engineering from Worcester Polytechnic Institute.

In addition to his work with Purdue, Landry is a member of Sigma Xi; the Institute of Electrical and Electronics Engineering Systems, Man, and Cybernetics Society; the Human Factors and Ergonomics Society; and the Institute of Industrial and Systems Engineers. In addition, he is a senior member of the American Institute of Aeronautics and Astronautics.

"I am truly excited and honored to join and lead one of the nation's top industrial engineering departments," Landry said. "I will work hard to contribute to and help build upon the excellence that has been displayed by the faculty, staff, students, and alumni at Penn State across so many decades, as we work toward having an even greater impact on society."

As department head, Landry succeeds Ling Rothrock, who has served in the role in an interim capacity since July 2019. Rothrock rejoined the department's faculty as a professor.

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# Q and A with Steve Landry

*By Miranda Buckheit*

**IME Mag: Welcome to Penn State! The industrial engineering community is glad to have you. Have you had a chance to experience the State College area?**

**Steve Landry (SL):** I am very happy and excited to be here and contribute to the department and college!

I have visited here a few times before and have experienced some of the campus and town, but not much. Outside of those prior visits, I have not, unfortunately. With the pandemic going on, we've stayed pretty much in our house, yard, and neighborhood since we arrived. We hope to start exploring, even if it is just driving around and seeing the surrounding area, in the next few weeks. Hopefully things will return to normal and we'll be able to venture out relatively soon.

**IME Mag: Can you tell the industrial engineering community more about your background?**

**SL:** I have somewhat of an unusual background for an academic. I grew up in Massachusetts and studied electrical engineering at Worcester Polytechnic Institute. I went through Air Force ROTC, mainly to pay for school.

The Air Force then sent me to pilot training and I spent the next eight years flying C-141B aircraft in New Jersey. The C-141B is a large, four engine jet aircraft with a crew of five to eight people. I very much enjoyed my time in the military, which was dominated by, first, the Panama invasion and then a little later the Persian Gulf War, but included many unique and interesting experiences. The Air Force gives relatively young officers a lot of responsibility and authority, so it was a great job.

However, the desire to be a scientist or academic never left me and I decided to go back to school after my initial commitment to the Air Force was over. I went to MIT for a master's degree in aeronautics/astronautics, then to Georgia Tech for my Ph.D. in industrial and systems engineering. My research was focused on human-systems integration engineering in the air transportation system.

As I was finishing up my Ph.D., I left Georgia Tech and took a job as, effectively, a research scientist at NASA's Ames Research Center in California. I spent three years there working on air traffic control automation. Again, NASA allows individuals to take on a lot of responsibility, if one so desires, so it was a great job, and I'm proud of the work we did there. However, I still had an itch to teach and have the ability to branch out into new areas in my research, so after finishing my Ph.D. I applied for faculty jobs and was hired at Purdue University in the School of Industrial Engineering.

At Purdue I followed a typical path—teaching and doing research, but also becoming involved in administration and service at all levels, from the department to the college to the university. I apparently had somewhat of a talent for it, because I was asked to continue and even expand my involvement. After being promoted to full professor, having spent many years working as the associate head, and one year as the acting head, I applied for and was hired here at Penn State.

**IME Mag: What made you accept this role with Penn State?**

**SL:** This is a question you know you'll be asked during interviews, so I had to think about it a lot. Upon reflection, I realized I had taken on service positions such as committee work, search committees, college committees, university senate, associate head, and acting head, mainly because I saw that there were problems or inefficiencies that weren't being worked on and I thought I could help. That really is why the head of IME at Penn State appealed to me—the department, college, and University are very similar in many ways to Purdue, so I feel I understand how things operate, where there might be opportunities to improve, and how I can help.

**IME Mag: Do you have any goals in mind for your first year as department head?**

**SL:** I do have goals, although I haven't written them out, so these are very formative. I do want to work on operational efficiency—getting processes and procedures written down and implemented to reduce the repetitive "every semester" problems. This will let the administrative staff work on improving things rather than just constantly solving problems. It will take longer than one year, but I'm hoping to make significant improvements this year.

But apart from that I am hoping to:

- Set up processes to track and continuously try to achieve a more inclusive department at all levels;
- Re-evaluate and update the undergraduate curriculum, beginning with manufacturing, so that it is positioned to serve the needs of our stakeholders, which includes industry and graduate faculty;
- Update and obtain facilities and equipment that enable us to deliver the curriculum efficiently and effectively;
- Provide resources and opportunities to improve the preparation of our graduate students for faculty jobs (and later on for government and industry jobs); and
- Provide resources and opportunities for faculty to become known for their expertise both inside and outside of academia.

There are of course many other initiatives I'm hoping to launch, but this list is probably already too long for one year!

**IME Mag: As the new department head, what is something that matters greatly to you?**

**SL:** I guess there are a few things that matter to me. The first is transparency—I want everyone, like faculty, staff, students, and alumni, to understand how things operate and where we stand as a department. I also value trust. Everyone should trust that I, and the department, make decisions based on policy that is equal for everyone and are not based on personal opinions or feelings. On the other side, I want to be able to trust that everyone is open, honest, and working hard to get the best outcomes for the department. Lastly is that we're all working together continuously on improving the department and not just on "keeping things running."

**IME Mag: What makes you most excited when you think about the future of industrial engineering at Penn State?**

**SL:** Penn State IME is one of the few departments that includes human factors; operations research; operations, systems, and analytics; and manufacturing. As a complete, and the first, industrial engineering department, it should be the leader of the discipline. Given the people and resources here, there is no reason it can't be recognized as the best industrial engineering program in the world. It is a hard climb, as it involves changing people's perceptions, but it is possible here, and it is truly exciting.

**IME Mag: With your experience, how do you think industrial engineering, via its various aspects, can help shape the way we work, play, and live?**

**SL:** Industrial engineering (IE) started out, and remained, a work management discipline, affecting mainly manual labor industries. Over the years it has grown to include how to design systems so that humans can operate them, how to operate an enterprise hyper-efficiently, how to use data to inform decisions, and how manufacturing will be done over the next few generations, at least. IE has grown to be the most important discipline in engineering. IEs are critical to enabling the next jump in productivity, where we use automation, data, and hyper-efficient processes to greatly exceed our current abilities in manufacturing and services. While it may not be as visible as a bridge or an airplane, IE touches everything and makes it work more efficiently, effectively, and safely.

**IME Mag: Generally speaking, what does higher education mean to you?**

**SL:** The key word here is "education." Our department does not train individuals to fix problems. We train engineers to understand what is wrong and to develop novel solutions to address those issues. These issues have no known solution, so it takes a well-educated engineer, with a host of possible approaches and tools, to figure it out.

From having to do this partly and for a period of time remotely, we are also finding out that part of what we do is provide the environment in which young engineers develop. In addition to coursework, methods, and approaches, it is critical that we provide support for learning the other abilities that will help our engineers succeed, including an understanding of the value of diversity and inclusion, ethical behavior, and communication of information. These are just as, if not more, critical as learning how to approach problems using math and science.

**IME Mag: Do you have any advice to share with the industrial engineering students?**

**SL:** Take advantage of your time here. The University has an immense wealth of resources that you will largely lose access to, or at least the ability to take advantage of, after you graduate. Be curious about what the University has to offer and make time to avail yourself of all the resources here—don't just get your degree and a high GPA and leave. If you do that you will have wasted a chance to really become educated. As an undergraduate in particular, you probably don't yet fully know what you like and don't like in terms of work. Here at Penn State you can try things and figure out what it is you find value in, and what you don't.

**IME Mag: Considering the unique situation we have found ourselves in with the complications of COVID-19, how do you hope to keep students and faculty on track?**

**SL:** Fortunately, we have some of the best faculty and staff in the world, and

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they've risen to this immense challenge, so they don't need me to keep them on track. They are actually the ones keeping the whole department on track, and I'm here to help in whatever way I can. Their incredible effort, professionalism, and dedication means I can focus on how I can help move us forward rather than on how to deal with this terrible and hopefully temporary disruption. We have regular faculty and staff meetings virtually where we get together, discuss how things are going, and share best practices, but my job there is mainly to just set it up and listen!

**IME Mag: Is there anything else that you think is important for people to know about you?**

**SL:** Perhaps just that I view this job as a service role. I bristle when people suggest I am "in charge" of things. Yes, the responsibility for many things ends up with the department head and I am the contact person for the department. But to me, the faculty, of which I am also one, are in charge of the department, and myself and the rest of the administrative staff are here to provide information, leadership, and support.

**IME Mag: If you had to pick, do you have a favorite Berkey Creamery ice cream flavor?**

**SL:** You saved the hardest question for last. I will be extremely happy the next time I'm able to comfortably visit the Creamery! Not being from here, I am very pleased I will have a lot of time to try everything, and my answer to this question will likely change as I do so. But I think the first one I'd try is the WPSU coffee break, since my favorite ice cream growing up was coffee chip ice cream, and I'm intensely interested in trying Berkey's version!

## Health systems engineering expert returns to industrial engineering

**Paul Griffin**, an expert in health systems engineering, returned to the Penn State Harold and Inge Marcus Department of Industrial and Manufacturing Engineering (IME) as a professor on Aug. 15. He is also a co-hire of the Consortium to Combat Substance Abuse (CCSA) within the Social Science Research Institute (SSRI).

Griffin served as the Peter and Angela Dal Pezzo Chair and Head of the Department from 2009 to 2014. He departed to join Georgia Tech as the Virginia C. and Joseph C. Mello Chair in the H. Milton Stewart School of Industrial and Systems Engineering. He served in this role until 2017, at which time he moved to Purdue University to serve as the St. Vincent Health Chair and Director of the Regenstrief Center for Healthcare Engineering (RCHE).

"I missed working with the IME faculty and students," Griffin said. "Also, CCSA is helping to identify where engineering and technology researchers can help fill the gaps for social scientists. In order to solve complex societal problems, you need to be connected with a broader research community."

Via his dual appointment with SSRI, Griffin will focus his research on health systems engineering and care delivery, health analytics, cost effectiveness modeling in public health, and health supply chain coordination.

His current work with RCHE aims to help mitigate substance abuse using a community-wide systems approach. In particular, the RCHE group focuses on improving patient care for opioid addiction treatment and referral management, integrating heath information technology and supporting analytics, public health evaluation, modeling syringe services programs, and developing point of care technologies.

"There are a variety of entities that make up health care systems like triage, emergency departments, and intensive care units," Griffin said. "I want to know how these work together and what happens when you make a change. It's not just the providers that play a role in patient care, so how can these systems be improved?"

"CCSA is focused on novel, interdisciplinary solutions to the systemic problems of substance use," Stephanie Lanza, professor of biobehavioral health and director of the Edna Bennett Pierce Prevention Research Center, said. "His focus on health systems analytics will bring new research perspectives to Penn State's efforts, and he will provide important leadership to the consortium's efforts moving forward."

Griffin is a fellow of the American Institute for Medical and Biological Engineering and serves as co-chair of the bi-annual INFORMS Healthcare Conference. He received his doctorate in industrial engineering from Texas A&M University.






Led by Scarlett Miller and Jason Moore, a multidisciplinary and multi-institutional research team aims to develop an innovative robotic training system to reduce the number of complications associated with central venous catheter placement.

# Decreasing complications of catheter procedures

*by Samantha Chavanic*

Each year, **more than five million central venous catheters (CVC) are placed** in a large vein in the neck, chest, or groin to provide patients with fluids, blood, or medications. The thin, flexible tubes empty their contents into or close to the heart, providing almost immediate treatment. Of these five million patients, close to 1.7 million experience some sort of complication related to the catheter insertion—that is one in every three patients.

A Penn State-led, multidisciplinary and multi-institutional research team aims to develop an innovative robotic training system to reduce the number of complications associated with CVC placement.

Through a five-year, $2,233,411 grant recently awarded by the National Institutes of Health's (NIH) National Heart, Lung, and Blood Institute, principal investigators **Jason Moore**, associate professor of mechanical engineering, and **Scarlett Miller**, associate professor of engineering design and industrial engineering, will lead a team of engineers, medical professionals, and graduate students to build upon their previous dynamic haptic CVC work supported by the NIH.

The new project will use the team's innovative concept of dynamic haptic robotic training (DHRT), where a programmable robot is used to apply force to a surgical resident's hand to replicate the feeling of inserting a needle into a patient's body, to develop and implement an entire CVC procedural training system. The new DHRT+ system will integrate a mixed-reality smart tray, advanced testing surface, high-functional fidelity virtual ultrasound imaging, and real-time, adaptive feedback assessment.

"We can make it [training] be much more effective for the user and help eliminate some of the patient complications that we see," Moore said. "If somebody is trained with the DHRT+, we hypothesize this will have a strong impact on patient well-being at the end of the day."

Miller explained that by focusing on the process from beginning to end, the team will decrease not only mechanical complications but also infectious complications. Infections can happen from not using appropriate sterile techniques, both before and after the central line placement.

"As engineers and engineering designers, we are constantly trying to create innovations," she said. "We always say, 'It could be you in the hospital setting having this procedure done.' The training of that person leading up to that moment is really important. It's not just you—it could be your family member or close friend having this done. The reason that drives me to improve our health care system for this procedure that is done so commonly, but has such a high complication rate, is that opportunity to have that impact on people's lives."

# AI could offer warnings about serious side effects of drug-drug interactions

*By Matt Swayne*

The more medications a patient takes, the greater the likelihood that interactions between those drugs could trigger negative side effects, including long-term organ damage and even death. Now, researchers at Penn State have developed a machine learning system that may be able to warn doctors and patients about possible negative side effects that might occur when drugs are mixed.





In a study, researchers designed an algorithm that analyzes data on drug-drug interactions listed in reports—compiled by the Food and Drug Administration and other organizations—for use in a possible alert system that would let patients know when a drug combination could prompt dangerous side effects.

"Let's say I'm taking a popular over-the-counter pain reliever and then I'm put on blood pressure medicine, and these medications have an interaction with each other that, in turn, affects my liver," said **Soundar Kumara**, the Allen E. Pearce and Allen M. Pearce Professor of Industrial Engineering. "Essentially, what we have done, in this study, is to collect all of the data on all the diseases related to the liver and see what drugs interact with each other to affect the liver."

Drug-drug interaction problems are significant because patients are frequently prescribed multiple drugs and they take over-the-counter medicine on their own, added Kumara, who also is an affiliate of the Institute for Computational and Data Sciences, which provides supercomputing resources for Penn State researchers.

"This study is of very high importance," said Kumara. "Most patients are not on one single drug. They're on multiple drugs. A study like this is of immense use to these people."

To create the alert system, the researchers relied on an autoencoder model, which is a type of artificial neural network that is loosely designed on how the human brain processes information. Traditionally, computers require labeled data, which means people need to describe the data for the system, to produce results. For drug-drug interactions, it might require programmers to label data from thousands of drugs and millions of different combinations of possible interactions. The autoencoder model, however, is suited for semi-supervised algorithms, which means it can use both data that is labeled by people, and unlabeled data.

The high number of possible adverse drug-drug interactions, which can range from minor to severe, may inadvertently cause doctors and patients to ignore alerts, which the researchers call "alert fatigue." In order to avoid alert fatigue, the researchers identified only interactions that would be considered high priority, such as life-threatening, disability, hospitalization, and required intervention.

"Essentially, what we have done, in this study, is to collect all of the data on all the diseases related to the liver and see what drugs interact with each other to affect the liver."

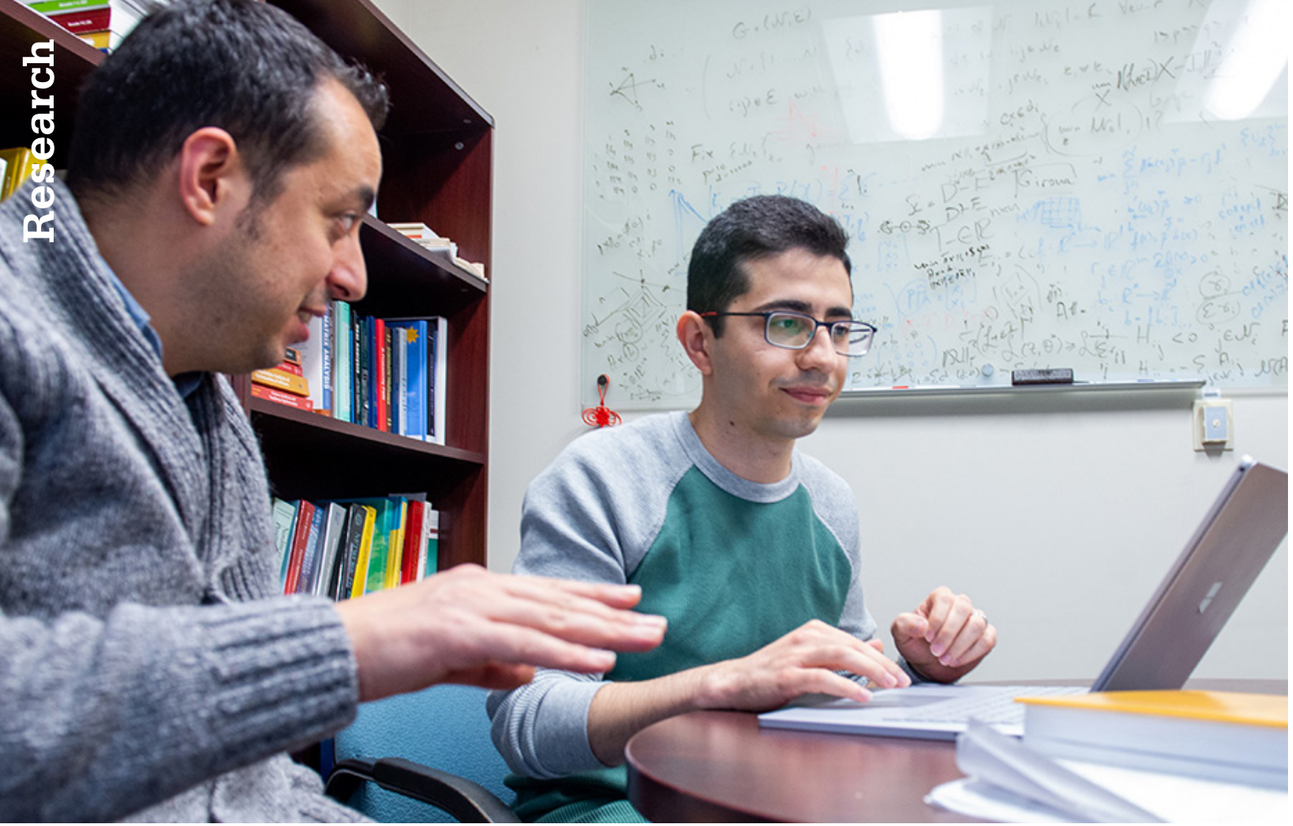
Kumara said that analyzing how drugs interact is the first step. Further development and refinement of the technology could lead to more precise—and even more personalized—drug interaction alerts.

"The reactions are not independent of these chemicals interacting with each other—that's the second level," said Kumara. "The third level of this is the chemical-to-chemical interactions with the genomic data of the individual patient."

The researchers, who released their findings in a recent issue of Biomedical and Health Informatics, used self-reported data from the FDA Adverse Event Reporting System and information on potentially severe drug-drug interactions from the Office of the National Coordinator for Health Information Technology. They also used information from online databases at DrugBank and Drugs.com. Duplicate reports and reports about non-serious interactions were removed.

The list included about 2,891 drugs, or approximately 110,495 drug combinations. The researchers found a total of 1,740,770 reports on serious health outcomes from drug-drug interactions.

Kumara worked with **Ning Liu**, former doctoral student in industrial engineering and operations research and currently a data scientist at Microsoft; **Cheng-Bang Chen**, former doctoral student in industrial engineering and operations research and currently researcher and assistant coordinator at the Center for Health Organization Transformation; and **Dolzodmaa Davaasuren**, former master's degree student in industrial engineering and currently a doctoral student in the Penn State College of Information Sciences and Technology.



# Engineering associate professor develops safer, quicker data processing method

*By Miranda Buckheit*

Aybat, pictured left, and Hamedani, pictured right, found a way to minimize cost across a whole communications network with implications for applications such as coordination and control in drones, bandwidth estimation in wireless sensor networks, and more.

**A novel algorithm to solve big data resource sharing problems over large networks, developed by researchers in the Penn State College of Engineering, may also have implications for energy savings and data security.**

The recent work led by **Necdet Serhat Aybat**, associate professor of industrial engineering, was published in the Society for Industrial and Applied Mathematics Journal on Optimization.

"Sometimes, when you minimize cost in one part of a network that has common resource constraints, it may skyrocket the cost in another part," Aybat said. "Through this algorithm, we found a new way to efficiently minimize cost across the whole system in a decentralized manner."

Modern society's wealth of big data creates such high levels of information that are often difficult to process quickly and safely, because they require significant energy and bandwidth.

The traditional method of centralized optimization—gathering all of the data into one place for analysis—can be resource-expensive for large datasets because of the required memory storage and processing power. This traditional way of computation also raises concern for potential privacy issues.

If the centralized system breaks, all of the data is at risk for exploitation.

To improve the process of analyzing big data, Aybat's algorithm efficiently computes optimal resource sharing over a decentralized system that interacts over a communication network. Rather than compiling all of the data in one location, the system breaks out the information into various agents, or independent computing modules. Each agent is responsible for solving one task that affects the whole system.

To heighten the privacy of the information in the system, the agents are only aware of their own task and their teammates' messages, meaning that they are unaware of a neighbor's task. Once an agent solves its job, the agent only passes on the answer to its neighbors. This process repeats itself until every agent agrees on a common optimal resource allocation decision.

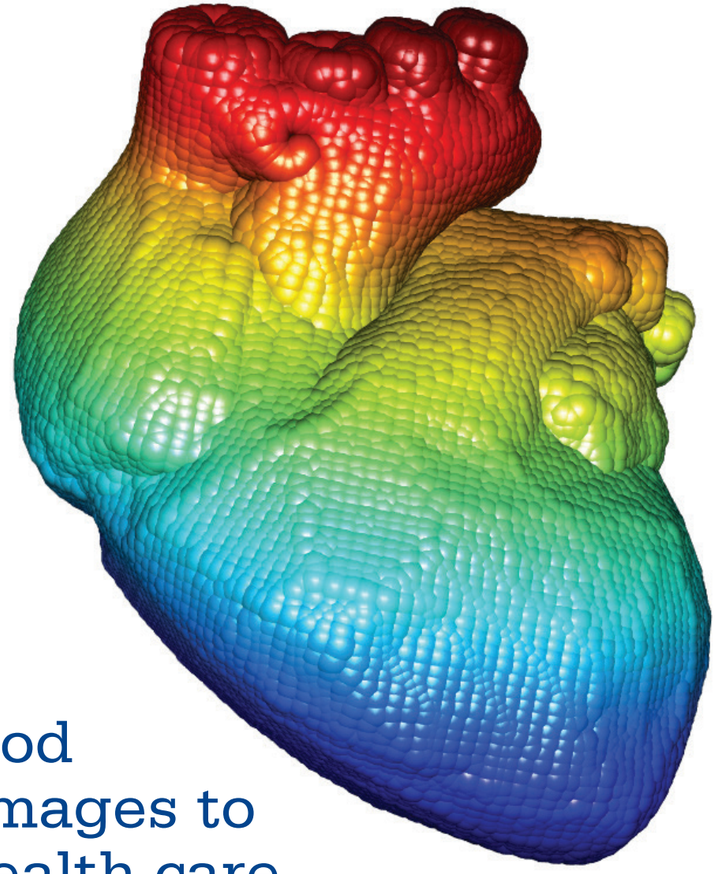
Decentralized optimization over communication networks has garnered attention for its use in a range of areas such as coordination and control in drones, bandwidth estimation in wireless sensor networks, machine learning data analysis, and power control in cellular networks.

"The complication arises when neighbors are changing," Aybat said. "If agents are moving, it could possibly cause the communications network to change over time. Since the agents can talk to only certain [other] agents at any given time, and you want to minimize the system cost, it becomes a difficult problem. You're trying to carefully steer the information exchange among agents to share the scarce common resources while collectively minimizing the total system cost."

The proposed algorithm, utilizing the decentralized optimization method involving multiple rounds of communication at each repetition, enables these agents to appropriately divvy out the common resource among them in such a way that accomplishes the goal.

"Working on this project has shown me the great applicability of both the methodology of mathematical techniques and its application in the real world," said **Erfan Yazdandoost Hamedani**, a doctoral student in Aybat's lab and co-lead author of the paper. "This work can be useful in the area of machine learning because this domain generates large amounts of potentially sensitive data."

*The National Science Foundation's Directorate for Engineering within the Division of Civil, Mechanical, and Manufacturing Innovation, and the Army Research Office supported this work.*



# New method analyzes images to improve health care and manufacturing

Hui Yang and Soundar Kumara have developed a novel algorithm, which has implications for health care and manufacturing.

Patterns appear in both natural and human made systems, but they can be difficult for humans to recognize and analyze, especially in dynamic systems like the human heart or factory machines. To address this issue, researchers in the Penn State College of Engineering have developed a novel algorithm, which has implications for health care and manufacturing.

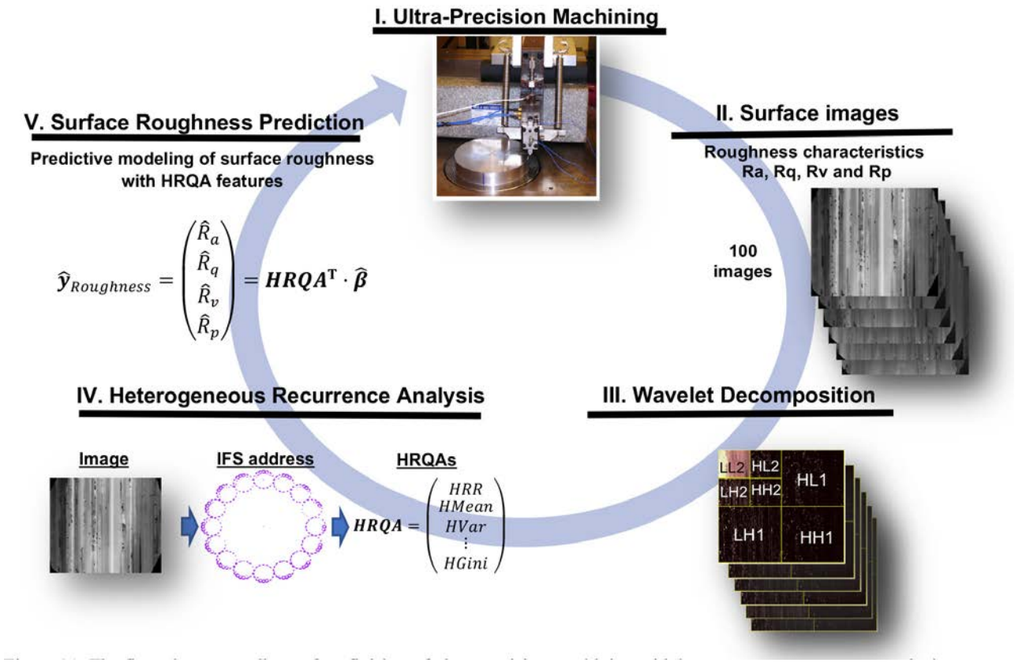
The researchers focused on understanding patterns in nonlinear, dynamic systems, as these intricate systems are challenging to analyze due to their nature—they fluctuate over multiple dimensions, such as space and time, and are near impossible to understand via human observation.

Led by **Hui Yang**, Harold and Inge Marcus Career Associate Professor, **Soundar Kumara**, Allen E. Pearce and Allen M. Pearce Professor of Industrial Engineering, and **Cheng-Bang Chen**, lecturer in the Harold and Inge Marcus Department of Industrial and Manufacturing Engineering, the methodology was published in the American Institute of Physics Chaos Journal.

"Our methodology analyzes different kinds of recurrences in data to provide a better understanding of the world around us," Yang said. "This work allows us to build a bridge between biological patterns, like in human anatomy, and man-made patterns, like in manufacturing."








"This work allows us to build a bridge between biological patterns, like in human anatomy, and man-made patterns, like in manufacturing."
—Hui Yang, associate professor of industrial engineering.

To create the novel algorithm, the team analyzed spatial data in complex, microscopic images produced by ultra-precision machining (UPM). UPM, a manufacturing process that uses single-crystal diamond tools to refine metal workpieces at the atomic scale, is widely used in modern industries such as semiconductors and aerospace to produce highly precise cuts or polishing.

The spatial data showed a variety of surfaces over the UPM images, ranging from flat to rough to severely rugged. Good, quality products should have a similar surface, and bad quality products might have different textures on the surface.

This operation captured and reiterated the behaviors of recurrence variations in the spatial data from the images to represent, characterize, and quantify spatial patterns in the UPM images. The surface characteristics were shown to be highly correlated with the spatial recurrence patterns within the imaging data.

According to Chen, in the past, researchers had to physically measure a piece to get the quality of surface finishes when manufacturing. Their work now allows surface roughness to be approximated by using the images, which ultimately leads to cost savings and resource conservation.

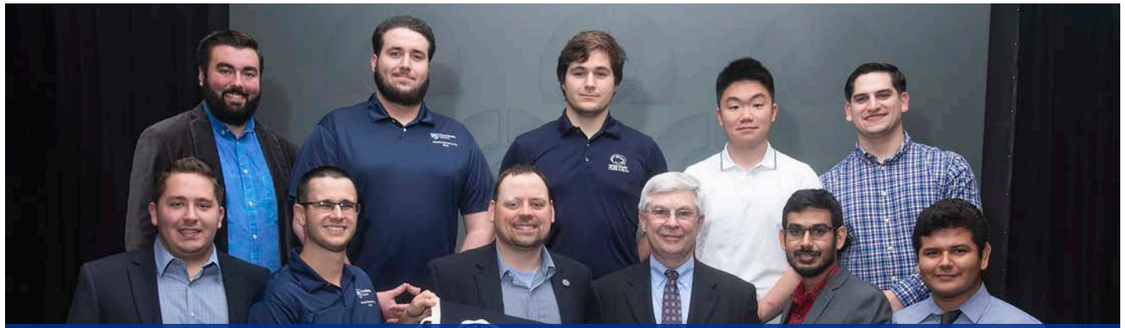
In the future, this methodology can improve predictive models for the quality of UPM surface finishes to enhance the quality of manufacturing.

"The algorithm teaches you new things about the system as a whole," Kumara said. "Take for example: a signal impulse happens in one part of a system at a given time and space. Later, it has an observed repetition at a different point in time and space. If that pattern is found, then you can use it to predict such behaviors in the future."

According to Yang, the algorithm has broad implications for medical applications such as monitoring organ function, analyzing cancer images, and detecting organ dysfunction over time.

"You can use this algorithm on complex-structured data that is measurable or observable and is represented in 2D, 3D, or high-dimensional images," Yang said.

*The National Science Foundation, the Allen E. and Allen M. Pearce Endowment, and the Harold and Inge Marcus Department of Industrial and Manufacturing Engineering supported this work.*



# Team of engineering researchers to help improve Pennsylvania's foundries

*By Miranda Buckheit*

A team of Penn State engineering faculty and students is working with small- to medium-sized foundries across Pennsylvania to aid in the transition away from using harmful silica sands in the metal casting process and to reduce costs through 3D printing.

The project is being supported by two grants totaling $140,000, funded by Pennsylvania Governor Tom Wolf's Pennsylvania Manufacturing Initiative. The initiative is part of a statewide push to drive new technologies and processes in the manufacturing sector.

According to the American Foundry Society (AFS), metal casting, a $33 billion industry, provides American workers with nearly 200,000 jobs. Currently, Pennsylvania sits at No. 2 on the AFS metal casting list, which is ranked by the number of reported foundries in each state in the United States.

The Penn State team is comprised of **Robert Voigt**, professor of industrial engineering and graduate program coordinator for the Harold and Inge Marcus Department of Industrial and Manufacturing Engineering; **Guha Manogharan**, assistant professor of mechanical engineering; and **Paul Lynch**, assistant professor of industrial engineering at Penn State Behrend.

"This project is close to home for me," Lynch said. "I grew up in Pennsylvania, and there was a foundry near my town that was a significant source of our economy. I want to help in any way that I can to help keep these smaller foundries ahead of technological curves."

Due to new regulations mandating control of silica exposure from the Occupational Safety and Health Administration, some foundries have begun to switch from silica sands to ceramic sands. Silica sand, due to the fineness of its particles, can lead to the development of silicosis—a lung disease caused by breathing in silica. A worker's exposure to silica particles can cause lung scarring, which affects the worker's ability to breathe and can lead to long-term issues, such as needing a device for oxygen support.

Different from silica sands, ceramic sands, which are often artificial, are safer due to their spherical shape and rigorous testing to ensure uniform grain, chemistry, and physical properties, according to the researchers.

The first grant will send Penn State undergraduate and graduate students, supervised by members of the research team, to work with foundries across the Commonwealth on the deployment of non-silica aggregates in metal casting. Additionally, faculty members will provide webinars for Pennsylvania foundry leadership on implementation strategies and conduct training workshops in conjunction with the Pennsylvania Foundry Association.

"It's a close connection and full-service operation in which we develop, implement, utilize, and train," Voigt said. "Many people can develop new technologies, but it's much harder to deploy them."

The second grant, a project being led by Lynch and Manogharan, will focus on the improvement of 3D printing to reduce the costs inherent to metal casting.

Currently, foundries prepare wax patterns for investment casting by injection molding via permanent metal molds. Investment casting is a process in which the wax takes the shape of the metal form but melts away under high heat. Subsequently, wax patterns are dipped in ceramic slurry, a semiliquid mixture, to create a shell. The ceramic is then heated and the wax is retrieved from the new ceramic shell. Once the ceramic has cooled, metal is poured into the shell for the final casting. Once the ceramic is shaken off, the final metal casting is ready.

The casting process is lengthy, expensive, and results in just a single metal product at the end. If the design of the object needs to change, a whole new mold must be created. Lynch and Manogharan's project will work to skip the metal mold process entirely by directly 3D printing the wax molds.

"Now we can print wax, which makes it cheaper, faster, and easier for foundries to do their casting," Manogharan said. "This project is ideal for Penn State, not only because of being a leader for knowledge transfer within PA and beyond, but it brings together our strengths in 3D printing and metal casting."

Voigt added that these projects could help keep the doors open for Pennsylvania's small- to medium-sized foundries that otherwise may have to shut down when they can't keep up with the changes.





# COVID-19: Researchers to model novel coronavirus for spread mitigation

In an effort to help mitigate the disruptive effects of the deadly COVID-19 virus, an interdisciplinary team of Penn State researchers are developing a novel methodology to analyze its spread and the impacts on policy with a goal of creating better-prepared and more-resilient health care systems.

The team, with faculty from Penn State's College of Engineering, College of Health and Human Development (HHD), and Penn State Health Milton S. Hershey Medical Center, received a $200,000 grant for Rapid Response Research from the National Science Foundation (NSF).

**Hui Yang**, associate professor in the Harold and Inge Marcus Department of Industrial and Manufacturing Engineering (IME) and director of the Penn State Center for Health Organization Transformation (CHOT), will leverage data analytics and simulation models to gain a better understanding of how human movement spreads the virus across geographic locations. This understanding has implications for three types of crisis strategies: regional health care infrastructure, regulatory measures, and transparent information distribution.

Using machine learning and artificial intelligence, Yang will simulate transmission rates of COVID-19 in local, state, and federal capacities.

"If there is a specific geographic region and ill people move to it, then healthy people will be at risk, so how can we model this and respond to the virus spread?" Yang asked.

Health policy experts in HHD will weigh in on strategic decision making and public interventions based on this data. The HHD team will use the data and simulation models to investigate how various policies and infectious disease control can help health care systems become more resilient and respond more efficiently to disruptive events like the COVID-19 pandemic.

Dennis Scanlon, distinguished professor of health policy and administration, said that several features of the novel coronavirus make it unique, which creates uncertainty for policy makers. For example, the high degree of infectiousness, the ability for asymptomatic individuals to spread the virus, and the lack of good data on the underlying population infection rate are important factors when developing simulation models.

"Underlying the magnitude of this crisis is the type of health care that people need and the limited resources that we have in the United States," Scanlon said. "For policy makers, this requires quick decisions with uncertain information. Inevitably, some decisions will be less than optimal."

Dr. Christopher DeFlitch is the chief medical information officer and an emergency physician for the Milton S. Hershey Medical Center and a professor at Penn State College of Medicine. Nearly 10 years ago, he founded the Penn State CHOT, and he is a long-standing member of NSF CHOT. DeFlitch has worked with Yang in the center for more than two years.

DeFlitch sees this new project as an opportunity to collaborate and help alleviate some stress for the medical professionals that are currently going "above and beyond" in their line of duty to provide bedside care.

"This is the first pandemic of our lifetime, and it has potential long-lasting impacts for our health care delivery systems," DeFlitch said. "It's critical to bring together this team to provide theoretical and practical problem-solving approaches, and Penn State, as a research powerhouse, is the place to do it."

Yunfeng Shi, assistant professor of health policy and administration, said that everyone has a stake in this pandemic and that the new collaborative research can help potentially improve reactions.

"I was trained as an interdisciplinary researcher, so I believe that working across disciplines to holistically analyze this issue provides an important perspective to better address the current problem and future crises," Shi said.

**Marta Ventura** and **Yidan Wang**, IME doctoral students and members of CHOT, will assist on the project.

"We have to do what we can, where we are, right now," Yang said. "Our team has complementary expertise; we can work together, and we can do this no matter where we are. The mission of Penn State CHOT is to advance the knowledge and practice of transformational strategies in evidenced-based health care management and clinical practice. We can help now and for the future."

**ASSESSMENT:** Physicians at the Milton S. Hershey Medical Center try on 3D-printed filtration mask prototypes. Photo credit: Jason Plotkin

# NO TIME TO LOSE

## Engineers drive Penn State's fast-moving COVID-19 alliance

*by Erin Cassidy Hendrick*

As Pennsylvania prepared for COVID-19 in early spring, Penn State engineers worked quickly to harness the University's broad research enterprise and the dedication of a community interested in helping during a time of dire need. To that end, the Manufacturing and Sterilization for COVID-19 Initiative (MASC) was launched in March. The coalition's unwavering focus was to deliver rapidly scalable solutions and generate tangible impact, particularly within the Commonwealth.

"It speaks volumes about the Penn State family—faculty, students, alumni, industry partners—who are willing and able to do whatever they can to help," said **Tim Simpson**, Paul Morrow Professor in Engineering Design and Manufacturing.

Quickly growing to more than 350 participants through Simpson's leadership, the College of Engineering became the thriving nucleus of the University's response.

Through a collaborative relationship with Penn State Health and the Center for Medical Innovation at Penn State College of Medicine, MASC became a grassroots rallying force for researchers to receive calls to action, connect with multidisciplinary experts, and draw resources from every corner of the University—such as recruiting costumers in the theatre department to sew gowns and masks, co-opting University Park's Breazeale Nuclear Reactor to sterilize surgical gowns using gamma rays, and engaging plastics engineers to construct face shields.

"The many ventures MASC has spearheaded are an incredible example of how Penn State researchers can join together for the common good," said **Justin Schwartz**, Harold and Inge Marcus Dean of Engineering. "I'm extremely proud it began in the College of Engineering and reflects the spirit I see every day in their work."

And their work continued into summer 2020.

"We now span 21 Commonwealth Campuses and multiple colleges, all with intending to have a direct and immediate impact on our local health care providers and communities," Simpson said. "We are leveraging our Penn State connections across the entire state."

MASC has rapidly evolved in its short tenure by finding new avenues for impact. The MASC case study that follows represents only a portion of its undertakings since March, with hundreds of professors, students, and staff members devoting personal time and juggling existing work commitments to contribute to the initiative.

"This is all volunteer work from our team, which shows the commitment," Simpson said. "This has become a way for Penn Staters to channel their existing energy and passion into something that can directly help those affected by the current pandemic. That is what keeps us working overtime, which everyone seems to be willing to put in."





MASC case study:

## Proactively preparing nursing homes

"If we can visualize the spread better, we can let nursing homes know, 'get ready, this is at your doorstep' and then provide them with a surge pack, maybe 1,000 gowns, 500 masks sent out at a moment's notice."

**DELIVERY:** The final design of the MASC-designed filtration mask shell.

Nursing homes and assisted care facilities have been particularly susceptible to the spread of COVID-19, largely due to the nature of community living of high-risk populations. As MASC was beginning to take shape, Penn State was recruited by the Pennsylvania Department of Health and Human Services to assess the basic needs of local facilities and determine if their staffs had the appropriate supplies and knowledge to respond to an outbreak.

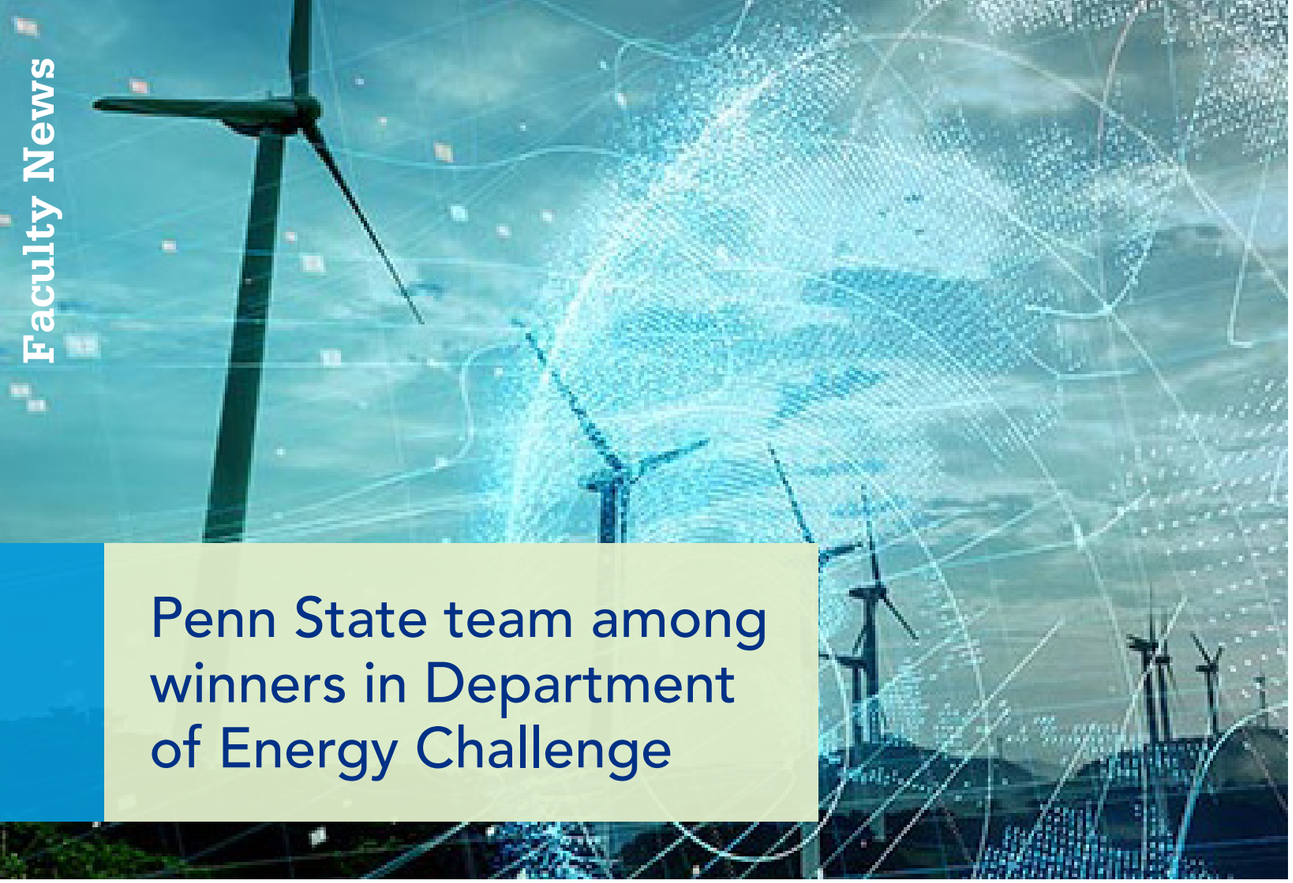
"This is an unprecedented situation, particularly for nursing homes," Dr. Nicole Osevala, an assistant professor and interim chief of geriatric medicine at Hershey Medical Center, said. "Most nursing home aides don't have time to read the 1,000-page documents or hour-long webinars. What we are doing is providing that information in real-time and how to apply it directly to their work."

While solving these immediate problems were critical, Osevala, Sue Purdum, instructor of supply chain and information systems in the Smeal College of Business, and a team of medical students, were encouraged to take things one step further.

By sourcing information from the 221 nursing homes and long-term care facilities in central Pennsylvania, they developed a PPE demand model in conjunction with the Harold and Inge Marcus Department of Industrial and Manufacturing Engineering.

"We are applying predictive analytics to figure out where we think the infection is spreading and get those facilities geared up before it happens," Purdum explained. "If we can visualize the spread better, we can let nursing homes know, 'get ready, this is at your doorstep' and then provide them with a surge pack, maybe 1,000 gowns, 500 masks sent out at a moment's notice."

The team is hopeful the new framework will help well into the future, to predict future surges and better prepare facilities for what they'll face.



# Penn State team among winners in Department of Energy Challenge

A team of Penn State researchers is part of the first round of winners for the Department of Energy's (DOE) Grid Optimization (GO) Competition. Presented by the DOE's Advanced Research Projects Agency-Energy (ARPA-E), the selective competition presents challenges for the development of optimization algorithms for a crucial set of operational problems faced by the United States' power grid.

The team, 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 (IME) in the College of Engineering, received $100,000 to advance their methods and share their technology with industry partners.

"Keeping the lights on is a necessity, and optimization plays a key role," Shanbhag said. "Optimization theory can help provide a foundation for developing, implementing, and analyzing algorithms that can be applied in settings of profound importance."

Along with other universities and national laboratories, Shanbhag and **Shiseng Cui**, an IME postdoctoral scholar in Shanbhag's lab, worked to create a solution for the enhancement of the United States' current electricity grid, as well as for the country's future power problems concerning renewable energy sources. Early support was also provided by former IME postdoc **Jinlong Lei** and former IME doctoral student **Wendian Wan**.

Halfway through the project period, the group started receiving assistance from the Institute for Computational and Data Sciences (ICDS) at Penn State to facilitate implementations on high performance computing (HPC) environments. The Research Innovations with Scientists and Engineering (RISE) team members serve as consultants with their extensive supercomputing experience and strong background in academic research.

"The computational research expertise provided by the ICDS RISE team contributed to the success of this talented research team in the competition," said Jenni Evans, director of ICDS and professor of meteorology and atmospheric science. "RISE team members have a variety of research expertise, providing a strong computational foundation for research groups throughout the University."





## How they answered the challenge

The team had to design an algorithm to rapidly determine the dispatch of electricity efficiently, safely, and consistently within the current grid for both traditional and renewable energy sources, otherwise known as security-constrained optimal power flow (OPF).

Challenges arise when developing algorithms that need to cope with the various possibilities that can arise when implementing the final dispatch decisions. For instance, a particular transmission line or power plant may fail or there may be a sudden and unforeseen surge in demand.

"The next generation of algorithms needs to contend with a multitude of such contingencies by being able to reliably allocate energy across the system at a moment's notice when an incident occurs, such as a natural disaster or energy failure," Shanbhag said.

Over time, models used in solving power grid problems have adapted to provide approximate answers, but today's society needs far more accurate models that can contend with the fundamentally nonlinear nature of this problem. The task is not small: the power grid has more than 65 million nodes, and a solution has to be provided every 10 minutes.

The task is not small: the power grid has more than **65 million nodes**, and a solution has to be provided **every 10 minutes**.

Their approach focused on creating an algorithm that can properly gauge the size of the optimization problem, address its nonlinear nature, and conserve computing resources so they did not overburden the system.

**Shisheng Cui**, formerly one of Shanbag's graduate students, explained that the nonlinearity is challenging and is exacerbated by the size of the system; the data is not organized sequentially and cannot be easily handled for solving the problem. Conventional solutions are incapable of addressing such problems and the team built their algorithm from scratch while leveraging existing solutions for solving smaller structured problems.

After the algorithm was designed, the team was provided sample power grid data from ARPA-E to test their algorithm and showcase its ability to find minimum-cost solutions. After the first trial ended and the team received their results, Shanbhag sought the assistance of RISE to aid in developing High Performance Computing (HPC) implementations.

Justin Petucci and Danying Shao, computational scientists with the ICDS RISE team, worked to restructure the algorithm's code to operate in an HPC environment, remove redundancies, and provide overall code optimization to speed up the algorithm for an HPC environment.

**"Optimization theory can help provide a foundation for developing, implementing, and analyzing algorithms that can be applied in settings of profound importance."**

– Uday Shanbhag

After the code optimization, Petucci and Shao estimated that by leveraging parallelism and aynchronicity, the model was running up to 10 times faster than its previous rendition. This increase in speed proved to be a success.

"The assistance from Justin and Danying was crucial," Shanbhag said. "One such instance required determining a particular switch that facilitated improved operation and addressed communication failures. This was akin to finding a needle in a whole slew of haystacks. The code had to perform in a computational environment that was hard to simulate and my team didn't have the resources to run similar tests."

## What's next?

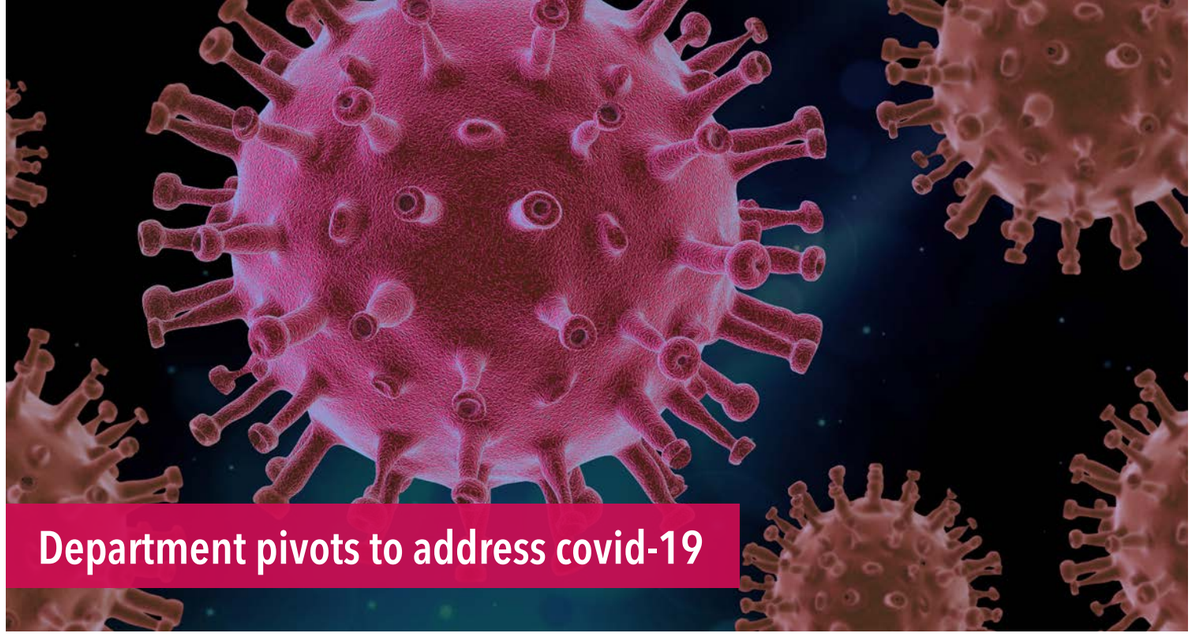
Future competitions, beginning with challenge two, will build on the models used in challenge one, but may include complicating factors such as solving larger network models, optimizing power flows over both transmission and distribution systems, contending with uncertainty and discreteness, leveraging power flow control devices, and increasing model detail. Challenge two will likely continue its focus on OPF and disburse fewer, but larger, awards.

The ICDS RISE team members are excited for the potential to continue their involvement on this project, as Petucci explained that this kind of project is the poster child for RISE.

"RISE brought the ability to rapidly test on the ICDS Advanced CyberInfrastructure (ICDS-ACI)," Petucci said. "If they ran it on the competition system, they could only test five times a day, whereas the ICDS-ACI could run it nearly 10 times more."

Based in interdisciplinary teamwork from the College of Engineering and the College of Earth and Mineral Sciences, the original team consisted of Shanbhag; Hosam Fathy, former Bryant Early Career Professor of Mechanical Engineering and now a professor at the University of Maryland at College Park; Mort Webster, professor of energy and mineral engineering and Ryan Family Faculty Fellow; Chiara Lo Prete, associate professor of energy economics; **Nilanjan Ray Chaudhuri**, assistant professor of electrical engineering and computer science; and **Minghui Zhu**, associate professor of electrical engineering and ICDS co-hired faculty member.

Lei and Wan graduated in 2019. Lei has taken a faculty position with Tongji University in Shanghai, and Wan now works with Amazon.



# Department pivots to address covid-19

## Modeling COVID-19 vulnerability

In an effort to lessen COVID-19 spread, **Soundar Kumara**, Allen E. Pearce and Allen M. Pearce Professor of Industrial Engineering, brought together a team to design an advanced artificial intelligence and machine learning model to assess vulnerability counties in the United States.

The team includes Kumara; **Paul Griffin**, professor of industrial engineering and interim director of the Consortium to Combat Substance Abuse; and doctoral students **Mihir Mehta** and **Juxihong Julaiti**.

The team gathered data from various public sources such as the U.S. Census, Centers for Disease Control and Prevention, Global Heath Data Exchange, and The New York Times to obtain county level statistics for confirmed COVID-19 cases, including age, gender, population density, diabetes, cancer, hypertension, and overall county disease mortality.

The model was designed to potentially assist intervention and preparation for resource allocations, health policy, and health care systems. The team also designed the model to be used at the recovery stage in order to assess the viability of re-opening counties and re-distributing resources.

## Using artificial intelligence (AI) to allocate testing

Utilizing the zip-code level of COVID-19 data from the Pennsylvania Department of Health, researchers in the Penn State National Science Foundation Center for Health Organization Transformation (Penn State CHOT) have developed an AI tool to make the optimal allocation of diagnostic testing possible.

According to **Runsang Liu**, a master's student in IME, and **Hui Yang**, director of Penn State CHOT and associate professor of industrial engineering, the density of a population, number of confirmed cases, and size of vulnerable populations can provide critical information to help optimize the allocation of testing centers such as drive-thru testing sites; however, optimality depends greatly on a site's accessibility, location, and region coverage.

Their AI tool aims to help balance accessibility and testing equity for each region in Pennsylvania, allowing the flexibility to make site adjustments based on data.

"Artificial intelligence is an indispensable tool to help realize the full potential of data for decision support, as well as to optimize accessibility and equity in health systems," Yang said.

## Modeling COVID-19 spread

According to Yang, simulation modeling of virus spread is essential for making health systems respond in a fast and proactive manner to protect people from COVID-19 exposure and disease propagation risk.

Via a $200,000 grant for Rapid Response Research from the National Science Foundation (NSF), Yang gathered a Penn State CHOT team to develop a simulation model of human movement patterns and COVID-19 spread dynamics to predict real-time positions of infected populations in a spatial network.

The provision of a graphical user interface (GUI) software for the simulation allows the user to select different types of spatial networks, provides flexibility to define the population size and heterogeneity, and enables the prediction of real-time positions for unaffected, infected, recovered, and deceased people in a spatial region.

Additionally, the GUI tool enables "what-if" analysis that can possibly allow population centers at any scale to dynamically adjust health policies, plan near-term health care capacity, and control virus spread with rapid and timely measures.





"Simulation modeling overcomes practical and ethical limitations in real-world experiments and provides a much higher level of flexibility to analyze different control variables and alternative policies," Yang said.

## The Manufacturing and Sterilization for COVID-19 Initiative (MASC)

**Timothy Simpson**, Paul Morrow Professor of Engineering Design and Manufacturing in the College of Engineering, is leading MASC, an effort to address the growing need for face masks, ventilators, and other personal protective equipment (PPE).

An interdisciplinary team of more than 350 Penn State faculty, staff, and students mobilized to address the widespread shortage of protective gear by creating fast and scalable solutions for sterilizing and manufacturing PPEs.

When the opportunity arose, Vittal Prabhu, professor of industrial engineering and Charles and Enid Schneider Faculty Chair in Service Enterprise Engineering, jumped on the chance to assist.

Prabhu's advisees, doctoral student Amol Kulkarni and master's student Rohit Rawal, rapidly developed a working data visualization map to identify local supply chain systems in Pennsylvania and provide a quick way to search and identify Food and Drug Administration-registered companies.

The map is able to quickly aid users to make effective decisions via various filter criteria with the simple click of a button.

"There are health care workers, retailers and others that are working on the frontlines," Prabhu said. "If engineers can help them be more productive, then I view it as our call of duty to contribute."

## IME joins for night of togetherness

Students, faculty, and staff from the Harold and Inge Marcus Department of Industrial and Manufacturing Engineering (IME) came together on Friday, April 3, for a virtual evening of togetherness.

Soundar Kumara, Allen E. Pearce and Allen M. Pearce Professor of Industrial Engineering, imagined the idea as a way to unite the department for an evening of relaxation and bonding, even from a distance.

Nearly 50 participants logged in to see the performances that included stand-up comedy, poetry, singing, piano, electronic music, violin, and juggling. The group also played trivia and a guessing game on faculty and staff's high school photos.

Danielle Fritchman, administrative support assistant, helped to organize and plan the event while Sarah Root, associate teaching professor and undergraduate adviser, served as the master of ceremonies for the night.

## Scarlett Miller becomes director

**Scarlett Miller**, associate professor of engineering design and industrial engineering, has been named the new director of the School of Engineering Design, Technology, and Professional Programs' (SEDTAPP) engineering design (DESIGN) program.

Miller began her duties on Feb. 1, assuming the role previously held by Matthew Parkinson, director of the Bernard M. Gordon Learning Factory and professor of engineering design and mechanical engineering. Parkinson will continue to serve as the director of the Learning Factory and as a faculty member in the DESIGN program and mechanical engineering department.

As director, Miller oversees the DESIGN program and its graduate offerings: master of engineering in engineering design and master of science in engineering design.

Miller has served as a SEDTAPP faculty member since 2011 after receiving her doctoral degree in industrial engineering from the University of Illinois at Urbana-Champaign.

## Enrique Del Castillo returns from Fulbright

**Enrique Del Castillo**, distinguished professor of industrial engineering and professor of statistics at Penn State, returned in early spring 2020 from his Fulbright U.S. Scholar Program, where he conducted research at the University of Coimbra in Coimbra, Portugal.

Awarded by the J. William Fulbright Foreign Scholarship Board, Del Castillo was one of approximately 800 U.S. citizens selected to take their expertise abroad for the 2019-20 academic year through the program. Recipients of Fulbright Awards are selected on the basis of academic and professional achievement, as well as record of service and demonstrated leadership in their respective fields.

The research project for which he was granted the Fulbright Fellowship, titled "Optimization and control of industrial production processes by active learning methods based on 'big' and complex data," sought collaborative research between Penn State's Engineering Statistics and Machine Learning Laboratory and the University of Coimbra's chemometrics group in the Department of Chemical Engineering.

Del Castillo worked on the optimization of production processes via machine learning for various industries with the chemometrics group; in particular, they focused on wine, paper, and pharmaceuticals.

## Hui Yang receives promotion

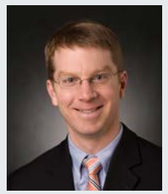
**Hui Yang** has been promoted to the academic rank of professor of industrial engineering. His new appointment became effective July 1.

Yang received his doctoral degree in industrial engineering and management from the Oklahoma State University in 2009. Yang came to Penn State in 2015 after spending six years at the University of South Florida (USF) as an assistant professor and was a founding member of the Interdisciplinary Data Sciences Consortium at USF.

He is currently a Schreyer Distinguished Honors Faculty Fellow, and an affiliate faculty of Penn State Cancer Institute, Intercollege Graduate Degree Program (IGDP) in Bioengineering, Institute for Computational and Data Sciences, and Center for Innovative Materials Processing (CIMP) 3D.

## Keynote talks

**Soundar Kumara**, Allen E. Pearce and Allen M. Pearce Professor of Industrial Engineering, was a keynote speaker for the 27th International Conference on Transdisciplinary Engineering. Kumara virtually presented "AI + ML + MANUFACTURING: The Power to Make Anything Anywhere Quickly."



**Timothy Simpson**, Paul Morrow Professor of Engineering Design and Manufacturing, served as a speaker for the 3D Metal printing virtual conference, which covered the latest technology developments for 3D metal printing.

## Vittal Prabhu becomes faculty chair

**Vittal Prabhu**, professor of industrial engineering, has been named the Charles and Enid Schneider Faculty Chair of the Penn State Service Enterprise Engineering Initiative (SEE 360) in the Harold and Inge Marcus Department of Industrial and Manufacturing Engineering. Prabhu began his new appointment on Jan. 1, 2020.

The position is funded by a recent gift received by the department in support of the growth of service systems engineering. **Charles R. Schneider** and Penn State partnered on a nearly $9 million investment to fund a scholarship, two professorships, a faculty chair, two program support funds, a program director, and director of industry consortia and technology transfer.

Currently, Prabhu serves as director of SEE 360, for which he researches service systems, guides student projects, promotes industry collaboration, and sets the course for future endeavors.

## Jose Ventura receives ROCKET seed grant

**Jose Ventura**, professor of industrial engineering, received a grant from the Penn State College of Engineering's 2020 Research Opportunities for mid-Career Knowledge EnhancemenT (ROCKET) seed grant to fund exploration of new or existing research areas. Ventura will use the grant to explore the practical impact of new mechanisms for combinatorial auctions and exchanges in supply chain procurement, wireless spectrum, and cloud computing. These markets currently lack proper auction mechanisms, given that the value of the goods is not merely the sum of the values of individual goods in the bundle, but rather the process by which they are bundled. In supply chain applications, for example, coordinating procurement and inventory decisions among the various members of a supply chain is a key component in its effective management. By developing a system that incorporates procurement auction mechanisms, Ventura could help companies better bundle goods and price the total process to benefit the company while still appealing to customers.

## Institute for Computational and Data Sciences seed grants

Understanding polarized political opinions, predicting Arctic Sea ice levels, and accelerating quantum computing with machine learning—these are just a few focuses of the dozens of new Penn State research projects that have been funded by Institute for Computational and Data Sciences seed grants, in conjunction with supplemental funding from the colleges of Arts and Architecture, Earth and Mineral Sciences; Information Sciences and Technology; Education; and Engineering.

Of the list of awarded projects, principal investigator (PI) **Saurabh Basu**, assistant professor of industrial and manufacturing engineering, and Co-PI **Christopher McComb**, assistant professor of engineering design and mechanical engineering, received funding for "Automated Design of Multi-Scale Structures: ADeMS."

## Jingjing Li receives Drexel fellowship

**Jingjing Li**, William and Wendy Korb Early Career Professor of industrial engineering, has been selected for the Executive Leadership in Academic Technology, Engineering and Science (ELATES) Fellowship at Drexel University.

Li received the fellowship via nominations by **Justin Schwartz**, Harold and Inge Marcus Dean of Engineering; **Ling Rothrock**, professor of industrial engineering; and Jack Hu, senior vice president for academic affairs and provost at the University of Georgia. Hu served as Li's doctoral adviser.

ELATES at Drexel is an intensive full-year, part-time national leadership development program designed to advance senior women faculty in academic STEM disciplines into effective institutional leadership roles within their schools and universities.

The program selects a wide range of fellows with varying experiences, backgrounds, and perspectives. The admissions panel reviews candidates from multiple institutions and bases its selection on attributes like professional aspiration, achievements, and challenges.

ELATES hosts three in-residence sessions to enhance fellows' knowledge and skills in business practices of higher education, project management with diverse stakeholders, and effective communication in a variety of leadership platforms. Each session is between four and six days long.

## Manufacturing innovation

Five faculty research projects received funding from the Manufacturing PA Innovation Program to leverage their knowledge to improve Pennsylvania's manufacturing industry:

**Andris Freivalds**, Lucas Professor of Industrial Engineering, and **Robert Voigt**, professor of industrial engineering, for "Multiple Core Assembly Production Improvement and Enhancement." The researchers aim to improve the core production and assembly process for metal casting that will enable the production of highly complex, casting shapes with increased assembly production, reduced scrap, improved casting quality, and improved ergonomics at the Benton Foundry in Benton.

**Edward De Meter**, professor of industrial engineering, and **Saurabh Basu**, assistant professor of industrial engineering, for "Enabling AFM Process Analysis for Advanced Technology Development." In collaboration with Extrude Hone Corporation in Irwin, the duo will develop computational fluids dynamics and process analysis framework for the abrasive flow machining process.

**Ling Rothrock**, professor of industrial engineering, **Chris McComb**, assistant professor of engineering design and mechanical engineering, and **Matt Parkinson**, professor in the School of Engineering Design, Technology, and Professional Programs, for "Human Error Reduction in Mack Truck Operations." The team, in collaboration with Mack Trucks of Lehigh Valley, aims to reduce the amount of human errors for the company's conventional assembly area.

**Hui Yang**, associate professor, for "Low-Volume and High-Mix Manufacturing Quality Control." Yang, in collaboration with Argolytics, will design and develop sensor-based statistical quality control methods for advanced manufacturing. The developed software toolbox will be evaluated and validated with real-world data from additive manufacturing, biomanufacturing, and precision machining.

**Guha Manogharan**, assistant professor of mechanical engineering and industrial engineering, and **Hongtao Sun**, assistant professor of industrial engineering, for "Advanced Manufacturing of Ceramics for PA Industries." The duo, in collaboration with Exone, aims to help position Pennsylvania ceramics industries as global and national leaders in the manufacturing of advanced nuclear materials. The group's carefully developed program will help advance Pennsylvania's ceramics industry and supply chain for advanced manufacturing of next-generation ceramics for energy and other high-temperature applications.





Five copies of The Freedman in bronze shown in various stages of polishing from just coated in back, to completion with patina in front. 3D model available for free download on Myminifactory.com in the 3DLirious profile.

# Online engineering student uses education to fuel personal business

*By Miranda Buckheit*

By day, **Tim Ayres** is an employee at Lockheed Martin working on airplanes, fluid systems, and hydraulic parts. By evening, Ayres is a 3D printing entrepreneur and a Penn State World Campus graduate student.

When the online master's degree in additive manufacturing and design was offered in fall 2017, Ayres knew he needed to enroll.

The novelty of the program appealed to Ayres, who was intrigued by the budding technology in the field of additive manufacturing—especially as he runs his own 3D printing shop in Arlington, Texas. The program could help him improve his business, without having to move to Pennsylvania.

"I'm learning far more about the science of 3D printing materials and a bunch of other topics," Ayres said. "3D printing is very multidisciplinary; I didn't have a solid background in some of the things that I am learning, so it's been exciting to dig deep into the various aspects of additive manufacturing."

### The binder jetting process

Ayres joined with fellow University Park graduate student **Santosh Reddy Sama** to investigate novel methods to improve the mechanical and temperature performance of a process called binder jetting, a common practice in additive manufacturing for making 3D pieces. They worked under the mentorship of **Sanjay Joshi**, professor of industrial engineering, and **Guha Manogharan**, assistant professor of mechanical engineering and industrial and manufacturing engineering.

During binder jetting, powder particles like sand, metal, or ceramic are spread across a bed to form a layer. The loose powder particles are bound together by a liquid binder, such as water, that is deposited on the powder layer using an inkjet type mechanism.

"After each layer, more powder is spread across the bed, and the process repeats until you're done," Ayres said.

The completed 3D piece is typically coated with a water-proofing and strengthening infiltrant like cyanoacrylate—otherwise known as super glue—or a different infiltrant, such as wax or epoxy. A second layer can also be added to improve the strength.

Binder jetting that uses plaster as its powder bed has relatively lower mechanical strength compared to other additive manufacturing processes and is mostly limited to nonfunctional applications such as prototyping.

Ayres and Sama examined plaster of Paris, a powder that fully or partially cures into gypsum when it interacts with a binder. Similar to a plaster cast, the powder particles are held together by the chemical change along with the bonding action provided by additional adhesives in the binder.

"The plaster parts are porous and have low mechanical strength, so they need to be infiltrated with a liquid that hardens to improve the structural strength to survive handling," Ayres said. "Gypsum plaster is desirable in part for its ability to withstand high temperatures. We wanted to know what the best impregnation and infiltration methods were to take advantage of this."

To conduct the research, Ayres printed the 3D parts out of his shop and shipped them via mail from Texas to State College. Sama tested the parts in various University Park labs, including the Mechanics and Materials Lab for mechanical testing and the Electroactive Materials Characterization Lab (EMCLab) for thermal testing.

Tim Ayres runs his 3D studio business, 3DLirious, with his wife in the center of Arlington, Texas.

Sama studied multiple methods of impregnating, or fully infiltrating, the plaster pieces with a strengthening coat of various epoxies.

Using statistical analysis to compare the data, Ayres and Sama found that vacuum impregnation resulted in the highest infiltration depth by fully impregnating the 25 mm cubic samples. This method seals the pores and possible leak paths in the print by filling the pores with a sealant while under pressure. In doing so, the sealant cures within the pores and creates a bond between the layers, increasing the print's density.

Additionally, the best performing epoxy showed a 10% increase in mechanical strength, with a 76% reduction in cost.

Their work was published in the December 2019 issue of Additive Manufacturing.

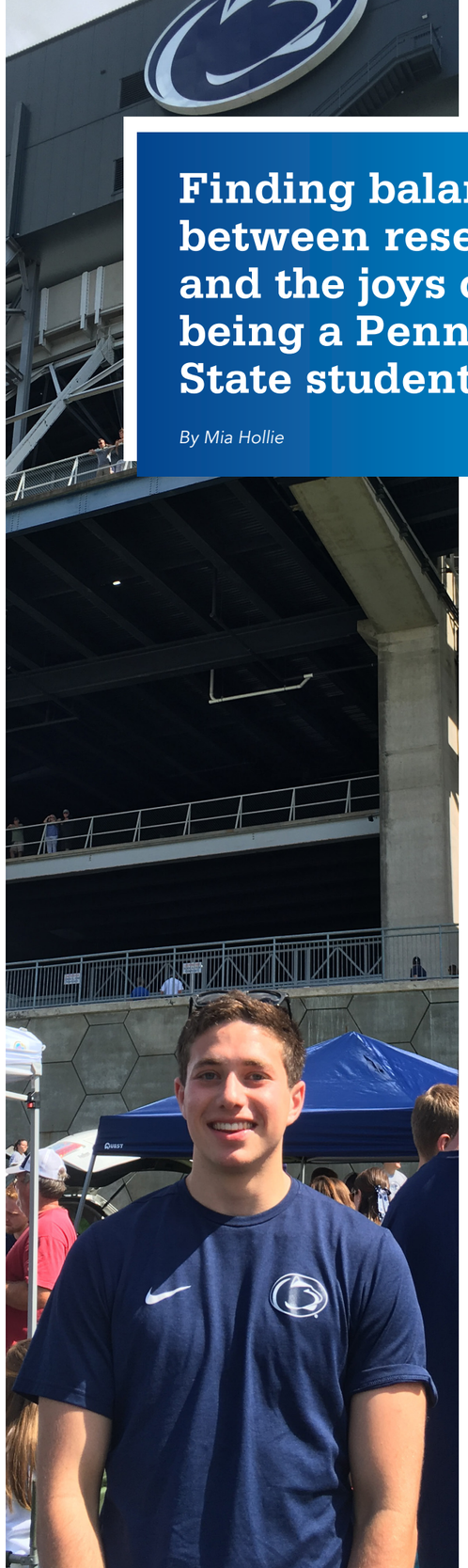
## Industrial engineering students receive scholarships for academic excellence

Three industrial engineering students in the Harold and Inge Marcus Department of Industrial and Manufacturing Engineering (IME) have been selected to receive scholarships from the Material Handling Education Foundation Inc. for the 2020-21 academic year.

The rising seniors were selected for their individual scholarships based on their commitment to the material handling, logistics, and supply chain industry. Applicants must demonstrate this commitment via academic successes such as related coursework, internships, projects, papers, and more.

- **Stephanie Vojtek**, from Pittsburgh, received the Spanco Inc. Honor Scholarship. Vojtek plans to graduate in May 2021.
- **Andrew Briglia**, from Phoenixville, received the Seizmic Inc. of Los Angeles Material Handling Management Society Honor Scholarship. Briglia plans to receive his industrial engineering degree in May 2021 with a minor in entrepreneurship and innovation.
- **Terrence Saylor**, a State College native, was awarded the Mobile Automation Group Honor Scholarship. He plans to graduate in May 2021.





# Finding balance between research and the joys of being a Penn State student

*By Mia Hollie*

From modeling enterprise resource planning systems to improving the Berkey Creamery to dancing in THON 2020, there are not many stones senior Matthew Hoffman has left unturned.

**Matthew Hoffman**, a fourth-year industrial engineering (IE) student, is the embodiment of the age-old saying, "You only have four years in college, so make the most of it."

As a Schreyer Honors Scholar, 2020 THON dancer, and member of several clubs, Hoffman ensured that he made his mark in Happy Valley before graduating in May 2020.

Hoffman's enthusiasm for staying involved led to his research assistant position in Service Enterprise Engineering during his junior year. The project focused on shortening the lines at the Penn State Berkey Creamery. During football season, Hoffman spent his Saturdays gathering data on the number of people in line at the Penn State landmark.

**Vittal Prabhu**, professor of industrial engineering and Charles and Enid Schneider Faculty Chair in Service Enterprise Engineering, encouraged Hoffman to focus his honors thesis on the Creamery, too.

"His work demonstrates that one outstanding engineer can help small-to-medium businesses transform their operations," Prabhu said.

Hoffman worked on a sample enterprise resource planning (ERP) system, a tool that combines all the functions of a company into one shared database to maximize profits and efficiency, using ERPNext software. After designing an ERP profile, Hoffman shifted his efforts to designing a production scheduling optimization tool that could help the Creamery avoid long sanitization processes, which are a result of using ingredients with allergen constraints.

Hoffman was well-prepared to begin his thesis research, thanks to his internship the summer after his freshman year at Frankford Candy, one of the country's largest makers of chocolates and sweets, and his internship the summer before his junior year with Boscov's Distribution Center in Reading.

"That was an awesome experience because there are not a lot of people out there whose job title is industrial engineer, and I worked in an actual industrial engineering office," Hoffman said.

After graduating in May 2020, Hoffman began his first job as a tech consultant at PwC, an international professional services network, in New York City. While graduation typically means an end to learning for many students, he hopes to maintain his student mindset throughout his career.

"I just like to learn," Hoffman said. "I want to do a million different projects, and I want to learn new stuff until one day I find something that will make me say to myself, 'I can do this every day.'"


# MERGING LOVE OF FOOTBALL AND ENGINEERING

*By Miranda Buckheit*

Penn State fans travel far and wide to attend the University's football games each fall semester, but few get to see the behind-the-scenes coordination that it takes to get the players ready for game day.

For **Sam Hammers**, a May 2020 industrial engineering graduate, it was a dream come true to work as a student equipment manager for the Penn State football team and see how his education in distribution process improvement is applied in the real world.

Hammers has loved football his whole life. He was a right guard for the West Allegheny High School football team in Imperial, Pennsylvania, and had offers to play at other schools.

Hammers explained that he chose industrial engineering at Penn State, in particular, because of the department's legacy. He also has found the major to be a "jack of all trades," as it is widely applicable.

## Equipment management … and time management

For Hammers, it was a balance among his education, job, and social life. He spent 40 to 50 hours weekly working for the football team, on top of his full course load.

Hammers began working with the football team during his first year at Penn State, and he worked his way up to a student equipment manager.





Initially, Hammers primarily focused on preparing and restocking football clothing, gear, and other supplies. When he started, the equipment room was typically back in order by Wednesday or Thursday after the prior week's game.

Hammers worked with his two supervisors, Jay Takach, assistant athletics director for equipment services, and Stewart Carter, assistant equipment manager, to help improve the football team's distribution center by optimizing the way it handles stock.

"I thought I would be doing every little task that people told me, but I realized that I could take my industrial engineering skills and help make things better," Hammers said.

In addition to his equipment room responsibilities, Hammers began to help on the field during his sophomore year when he was assigned to the running backs.

Before the games, he managed the sideline set up and helped identify where equipment needed to be set up to be as efficient as possible. During the game, he held up boards and play cards to help direct players. When the game was over, he began to pack everything away once again.

## Without even knowing

Hammers interned for the summer before his junior year with Rogers Athletic, a premier football equipment manufacturer and supplier. Based in Farwell, Michigan, Rogers Athletic was founded in 1968 to supply youth, high school, college, and professional football teams with high-grade equipment like sleds and dummies to improve strength training and promote proper technique.

For Hammers, the internship was an example of being in the right place at the right time.

"I didn't know it at the time, but I was showing a man where to park, and he was the brother of the Rogers Athletic chief executive officer," Hammers said. "We ended up talking about my experience, and he was excited to talk about internships once he found out that I was a Penn State engineer."

During his time with the company, Hammers worked on various projects, such as assisting the company on the shipping design of its 10-foot by 20-foot mobility chute.

A mobility chute, a standard piece of practice equipment, allows players to practice staying low for longer distances. By utilizing four metal poles and height adjusters, a trampoline-like mesh is suspended in the air to make players move beneath.

"In football, the lower person always wins," Hammers said. "To be able to practice at a lower height strengthens the legs and improves stability when taking low hits."

The company encountered shipping problems, as the 20-foot poles that created the length of the chute made the shipping fee spike by over $100. Hammers designed new poles with a split in the center that didn't compromise the integrity of the equipment. The company now sends an additional two packages to deliver six poles instead of four, but the length falls within standard shipping rates.

"When it came to the chute project, I was using industrial engineering principles without even realizing it," Hammers said.

> "I thought I would be doing every little task that people told me, but I realized that I could take my industrial engineering skills and help make things better."

Hammers was able to use the skills he learned in his industrial engineering courses to find ways to improve the design and operation of the football equipment room.

# Industrial engineering students find ‘presidential’ success

*By Miranda Buckheit*

Penn State industrial engineers are known for their ability to tackle topics such as sustainability, innovation, and best practices with a goal of creating systems that help organizations run seamlessly. With these specific skills, another necessary trait becomes apparent: leadership.

Three undergraduate students from the Harold and Inge Marcus Department of Industrial and Manufacturing Engineering—**Benjamin Hartleb**, a May 2020 graduate; **Neel Mehta**, a third-year industrial engineering student; and **Dhir Agrawal**, a second-year industrial engineering student—took their respective skills and broadened their knowledge with the Presidential Leadership Academy (PLA).

The PLA is run by Penn State President Eric J. Barron; Peggy A. Johnson, dean of the Schreyer Honors College; and Melissa Doberstein, PLA director. The mission of the PLA is to prepare students to make decisions in a “gray world.” Students learn how to navigate issues of life at work, at home, and in their communities.

At the end of a student’s first year, they are able to apply for the PLA via a very selective process. Only 30 of the most impressive students are selected each year based on their applications, essays, recommendations, and in-person interviews.

Over the course of three years with the PLA, students take classes with Barron and Johnson that focus on making heavy decisions. Prior semesters focused on University budgets, free speech, and sustainability in the State College community. In addition, they meet special speakers, go on field trips, network, and receive mentoring.

“Ben, Neel, and Dhir are fabulous to work with,” Doberstein said. “They are all super smart, very ambitious, and so personable.”

Hartleb knew that he wanted to get involved with the PLA when he discovered it his first year at the University Park campus. He explained that he always found importance in

“surrounding yourself with people smarter than you” in order to progress and develop as a young professional.

For Mehta, it was a conversation with Barron that opened his eyes to the opportunity.

“I came up to visit University Park when I was a senior in high school because my brother is an alumnus, and I happened to meet Dr. Barron,” Mehta said. “He invited me into his office and while we were talking about Penn State, he told me about PLA. I knew I had to apply.”

Agrawal noted that the access to highly ranked University officials was a draw of the PLA. He explained that the PLA has given him more confidence, and he feels “less overwhelmed being around high-ranking officials in the Penn State community and beyond.”

For all three, the PLA offered an interesting array of networking field trips to notable cities such as Baltimore; Philadelphia; Washington, D.C.; Nashville; Chicago; and Los Angeles.

“It’s important that we get the students out in front of notable members of society; this past semester the students got to meet the mayor of Nashville,” Doberstein said. “The PLA offers a platform for the students to network in and out of class.”

It’s not all fun and games; being a member of the PLA has a host of responsibilities for the students, such as their classes with Barron and Johnson, their bimonthly blog posts, and their class projects.

Doberstein explained that the class projects serve as a way for students to learn more about other majors by communicating and working together to solve tough problems. She explained that her best engineering students in the program are those that “can communicate clearly and work with those outside of their discipline.”

For Hartleb, his project on sustainability encapsulated how to make livable spaces with retail capabilities in the downtown State College area. Hartleb said that the experience opened up his perspectives on the power of effective housing policies.

“I think the biggest thing that I learned in PLA during my project was the ability to just sit back and listen,” Hartleb said.

Agrawal just wrapped up his first year of the PLA. He feels that the experience has been incredibly influential in his life and future goals.

“You can’t doubt yourself,” Agrawal said. “The PLA is all about people and what you bring to the table. Everything that you learn from being in the PLA has correlation to real life.”

Top: Benjamin Hartleb graduated in May 2020 and plans to use his experience from the Presidential Leadership Academy in his professional career.

Middle: Penn State students Dhir Agrawal (far left), Neel Mehta (second to left), and Glorie Josephs, an administrative support assistant for the Presidential Leadership Academy (center), got to enjoy many classes and trips together during their experiences with the Presidential Leadership Academy.

Bottom: Agrawal, the youngest of the industrial engineers in the Presidential Leadership Academy, said that this experience has shown him how people make real-life decisions.





Student News

# MANUFACTURING DESIGN

## Saving time and money via engineering

*By Miranda Buckheit*

A new method for machining hole patterns has implications for cost and time savings in automobile, construction, and tech companies, according to a team of researchers from the Harold and Inge Marcus Department of Industrial and Manufacturing Engineering.

One of the most notable aspects of the research was the engineers' ability to help designers and manufacturing engineers better understand the application and production of feature patterns with sizes constrained by the location of groups of design features—geometric composite position tolerances.

The research, produced by former master's students **Abhijeet Golhar** and **Yiran Jiang** and their advisers, **El Amine Lehtihet**, professor of industrial engineering, and **Edward De Meter**, professor of industrial engineering, was published in the Journal of Manufacturing Science and Engineering.

Currently, the American Society of Mechanical Engineers provides a universal design standard that relays the specification and interpretation of geometric tolerance design constraints, but does not specify ease or difficulty of complying with these constraints.

"This study now provides a baseline for how difficult some of these geometric position tolerance constraints are to create on a shop floor," Lehtihet said. "Sometimes companies don't have the proper equipment to handle certain designs and have to revisit the drawing board, so this insight will save them both time and money."

Golhar's role in the research was to design the patterns and subsequent experiments, as well as get hands-on experience with the department's CNC—computer numerical control—machines to manufacture the parts. The CNC machines use data to control and automate machine movements.

Mainly, the research looked at linear, rectangular and circular patterns of holes of various sizes. After Golhar created and manufactured the patterns, he had to inspect the work pieces using a Zeiss coordinate measuring machine running CALYPSO software, a common measuring tool.

The researchers used the producibility algorithm, designed for the experiment, to determine the inherent ability of the machine tool to satisfy a given pattern, subject to a composite position tolerance constraint. This analysis gave the researchers insight into how to produce particular design specifications, including indicating how difficult they are.

"The results obtained from the algorithm then needed to be analyzed to draw inferences about the patterns, such as how findings may enable designers to assess them," Golhar said. "This enables the engineers to design their manufacturing processes accordingly."

Golhar graduated in May 2018.





## Penn State team places third in Inter-Collegiate Business Competition

Two students representing the Penn State Smeal College of Business placed third in the ethics stream of the Inter-Collegiate Business Competition (ICBC) hosted by the Smith School of Business at Queen's University in Kingston, Ontario, Canada.

Molly Brown, a senior dual majoring in finance and Spanish, and **Natasha Ferguson**, a senior industrial engineering major, were coached by Michelle Darnell, Smeal's director of honor and integrity. A team representing Simon Fraser University, from Burnaby, British Columbia, placed first, followed by a team from the University of Florida.

Natasha Ferguson, left, and Molly Brown teamed up to represent the Penn State Smeal College of Business at the Inter-Collegiate Business Competition. Ferguson and Brown placed third in the ethics stream.

## Biesecker named industrial engineering student marshal

**Christopher Allen Biesecker** was named the student marshal for the industrial engineering baccalaureate degree program. He represented the program at the virtual Penn State spring commencement ceremony on May 9. Biesecker received a bachelor of science in industrial engineering with a minor in Spanish.

**Sarah Root**, associate teaching professor of industrial and manufacturing engineering, served as Biesecker's faculty marshal, an honor chose by him because of Root's mentorship and guidance.

Biesecker is the son of Cindy Biesecker and Gary Biesecker of Dallas. He is a 2016 graduate of Dallas High School.

He was the recipient of the President's Freshman Award and Evan Pugh Scholar Award.

As a junior, Biesecker participated in an undergraduate research project titled, "Predictive Modeling of Surface Roughness in 3D Printing Using Decision-Level Fusion." Biesecker worked to create a program that could provide predictions for the surface roughness of 3D-printed parts while the parts are being produced, informing quality control.

He completed two internships. As an operations, planning and engineering intern for Giant Eagle, Biesecker created and maintained engineering standards to impact a $440 million labor budget. He also interned with Bridges to Prosperity in Bolivia, where he was working as a construction manager to organize logistics for the construction of a 60-meter footbridge in rural Bolivia.

Biesecker's extracurricular activities included Penn State Engineers in Action, where he served as the internal relations officer for the 2018-19 academic year, and Penn State Bridges to Prosperity, where he served as the outreach captain from 2016-17 and cultural relations captain from 2017-18.

Following graduation, Biesecker joined Epic Systems as a technical solutions engineer.

## Alumni updates

**Mike Sherwin ('01 M.S.)**
Sherwin joined the University of Pittsburgh in the Swanson School of Engineering as an assistant professor of industrial engineering. Before becoming a faculty member, Sherwin worked with the Curtiss-Wright Corporation for nearly nine years.

**Morgan Farnsworth ('12 IE)**
Farnsworth was a nominee for the 2019 Women in Technology Award through the Technology Council of Central Pennsylvania in the Art and Design division.

**Thomas Green ('72 IE)**
Green retired in 2019 after 36 years with GM/Delphi, one-year practicing law and eight years consulting as TJGreenLLC.

**Leo Funk ('16 IE)**
Funk has received a promotion to become a finance manager at Amazon.com, Inc. He will be relocating from Carlisle, Pennsylvania to Nashville, Tennesee.

**Karan Arora ('16 M.S.)**
Arora was promoted to local technical specialist to lead the industrialization of Mack Trucks' first electric truck in North America.

**Cyndy Bober ('15 IE & M.S.)**
Bober was selected to move to the International Hilton Office to step into a managerial role covering sales analytics.

**Gabrielle Pfeifer ('12 IE)**
Pfeifer was promoted to the vice president of innovation and digital transformation at Infinite Computer Solutions.

**Katie Blank and Sam May ('14 IE)**
Blank and May, who met in the IME program, were married in November 2020. Blank works for Procter and Gamble, while May works for Sherwin Williams.

**Jane L. Snowdon, ('81 IE)**
Snowdon received the 2019 Achievement in Industry Award from the American Public Health Association's Applied Public Health Statistics Section for outstanding contributions in industry to statistics and public health. She is an associate chief health officer in the Center for Artificial Intelligence, Research, and Evaluation at IBM Watson Health.

The Ned Brokloff Endowment for Alumni Association Affiliate Group Award for Innovation recognizes groups who offer their members a new or innovative program. (Photo credit: Penn State Industrial and Manufacturing Engineering Alumni Society)

## Engineering alumni society wins award for dedication to student programs

In recognition of its job shadowing program, the Penn State Industrial and Manufacturing Engineering Alumni Society (PSIMES) received a Penn State Alumni Association (PSAA) Volunteer Award at the PSAA Volunteer Awards Banquet in October 2019.

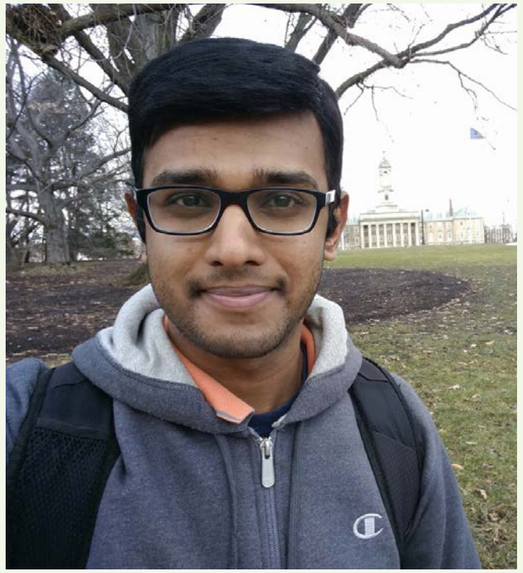
The program gives industrial engineering students an opportunity to spend a day with an industrial engineering alumnus or alumna. Students gain real-life experience, receive career guidance, learn about the skills needed to be successful in industry, and gain direct access to networking opportunities that can lead to potential employment.

On Oct. 18, PSIMES accepted the Ned Brokloff Endowment for Alumni Association Affiliate Group Award for Innovation, marking the third year that PSIMES has received an award from the PSAA. Previous awards received by the organization were in the categories of "Membership" and "Fellowship and Networking."

PSIMES was established in 1998 as an affiliate program group of the Penn State Engineering Alumni Society. PSIMES works to stimulate the continued interest and professional development of all graduates of the Harold and Inge Marcus Department of Industrial and Manufacturing Engineering. The group strives to promote fellowship and communication among industrial engineering alumni, faculty, and students.







## Alumnus uses education and exposure in industry to foster success at Amazon

After graduating from Penn State, Athul Krishna aimed to make a tangible impact

*By Mia Hollie*

For Penn State alumnus **Athul Krishna**, class of 2016, choosing to pursue engineering was a no brainer. The real question was which direction to go after his undergraduate degree.

When Krishna decided to further his education by pursuing a graduate degree, the master's program in the Penn State Harold and Inge Marcus Department of Industrial and Manufacturing Engineering stood out for its balance between academic content and real-world practice.

Though he worked on various projects, Krishna's time as a graduate student was primarily spent on developing workforce planning models for distribution center operations for his thesis.

"Distribution centers lack models and tools to plan workforce efficiently," Krishna said. "Addressing this gap allows businesses to generate additional revenue and save operational costs."

He developed a computational model that estimated the travel time for forklifts used in distribution centers and built analytical and simulation models that examined the impact of workforce capacity on key operational measures. These models were integrated to adapt workforce capacity to variable demand that distribution centers experience in real-world operations.

After finishing his thesis, Krishna wanted to ensure that his work could benefit others in his field. He developed a business intelligence tool called LIONSPAW (Logistics and Operations Planning for Adaptive Workforce), an operational analytics tool that allows businesses to easily build workforce capacity policies for distribution centers.

"Utilizing the research for real-world practice necessitated development of simple self-service tools and technical documentation," he said.

Krishna applied for an operations intern position at Amazon during his master's program. After several interviews, screenings, and aptitude tests, the company offered him the position.

"Most of my time was spent to understand the problem," Krishna said. "What are the different levers impacting operational efficiency, which are the ones negatively contributing to the current state of operations, and what are the root causes for it?"

At the end of the internship, Krishna was offered a full-time position. Soon after graduating with his master's degree in industrial engineering in 2016, Krishna started his role as senior product manager.

In this role, Krishna builds business strategy for technical products and leads product development teams. Over the last few years, Krishna has developed operational technologies for last mile delivery and voice technologies for Alexa.

"Amazon has an entrepreneurial culture," Krishna said. "I like the ecosystem that organically enables you to solve problems with innovative ideas, especially solutions that require artificial intelligence technologies."

Gretchen Macht didn't just receive her bachelor's degree from the department—she also earned her master's degree and doctorate for a total of three Penn State industrial engineering degrees. IMAGE: AYLA FOX

# Industrial engineering alumna uses education as toolkit to solve societal issues

*By Miranda Buckheit*

It's a tale as old as time: undergraduate students who switch their majors because they aren't satiated with their first choice.

For **Gretchen Macht**, Penn State industrial engineering alumna, finding a major wasn't easy until her eye-opening conversation with Elena Joshi, the Harold and Inge Marcus Department of Industrial and Manufacturing Engineering (IME) undergraduate coordinator.

"She wanted to know what I cared about, so she asked me what matters in a stapler," Macht said. "I talked about quality, efficiency, improvement, and waste. She looked at me and said, 'you're already an industrial engineer; welcome to the program.'"

Macht soon realized that industrial engineering was not only a natural fit, but also her passion. After earning her bachelor's degree in 2007, Macht went on to earn her master's degree in 2009 and her doctorate in 2014, all from Penn State's industrial engineering program.

Macht, an assistant professor with the Mechanical, Industrial, and Systems Engineering Department at the University of Rhode Island, explained how her industrial engineering education profoundly impacted her career.

"As a student, you're so hung up on grades and on getting a job that I think everyone just needs to step back and realize just how amazing this opportunity is," Macht said.

"The education surrounding critical thinking can change the world if you stop and absorb it."

## Current work

Macht classifies herself as a computational, community ergonomist because of her interest in how people work. Macht said she enjoys seeing things through the "human lens," such as how people perceive things, how they work, and how they use tools.

In her Sustainable Innovative Solutions (SIS) Lab, Macht's research projects range from electric vehicles, solar power, and team function to communication, sustainability, and voting.

"My interests seem all over the place, but to me, it's this common thread of the great applicability of operations research tools, algorithms, and simulation," Macht said. "You can take these tools and look at human perspectives to ask: How do users use this? I think this is a magical place to live mentally, and I've loved every second of it."

Thanks to Macht's work, Rhode Island is looking forward to improved voting processes for upcoming elections.

The 2016 presidential election brought on a host of issues for the state in the Warwick, North Kingstown, Providence, and Pawtucket areas. There were significant delays, as some people waited in line for three to five hours in order to vote.

After the calamity, Rhode Island Secretary of State Nellie Gorbea created a task force designed to analyze voter feedback and provide best practices.

"The way I got started on this was quite serendipitous," Macht said. "The Secretary of State took a course in graduate school on operations research, so she knew that it existed but didn't know where we [researchers] existed. My Penn State education gave me a toolkit that prepares me to walk into any situation and be ready to help."

Working with the Department of State and the Rhode Island Board of Elections, Macht helped make voting in the state as seamless as possible through the simulation of voting queues and facilities layout planning.

According to Macht, the 2018 midterm elections saw record turnout, nearly 50%, in the state with minimal voting lines. She explained that it was the highest midterm turnout for Rhode Island since almost 2013.

Gretchen Macht, second from right, struggled to pick her undergraduate major but fell in love with industrial engineering at Penn State. IMAGE: GRETCHEN MACHT

## How IME helped Macht achieve her goals

Macht noted that her education taught her to listen first and talk later.

"You have two ears and one mouth," Macht said. "I was young, enthusiastic, and wanted to go in there and change the world. You're going to create solutions and fix their issues. You need to slow down and listen to what the client needs."

Macht noted that she enjoyed working with **Robert Voigt**, professor and graduate program coordinator; **Ling Rothrock**, professor; **Vittal Prabhu**, professor and Charles and Enid Schneider Faculty Chair in Service Enterprise Engineering; and **Soundar Kumara**, Allen E. Pearce and Allen M. Pearce Professor of Industrial Engineering.

Additionally, Macht shared that during her time as an industrial engineering student, the IME faculty made her feel like she was at home. Macht said that the department's personal touch and family environment made the Penn State University Park campus feel even closer.

"These people had a profound impact on my career, and so I put all of them together and try to be like them every day," Macht said. "I couldn't be more thankful for where I grew up as an educator and researcher."

"The education surrounding critical thinking can **change the world** if you stop and absorb it."

# Industrial engineering alumnus shares his path to the C-suite

*By Miranda Buckheit*

Matt White explained that education is important for the success of someone's career and that it can come from both informal and formal settings.

**Matthew J. White**, executive vice president and chief financial officer of Linde, a multinational industrial gases and engineering company, shared his thoughts on what it means to be a successful engineer as part of the Penn State College of Engineering's ExecutiveXcellence Speaker Series. White spoke at the fall 2019 installment of the series on Sept. 13 in the HUB-Robeson Center.

"It's natural to doubt yourself in your career; it's going to happen," White ('94 IE) said. "Sometimes I would wonder, 'where am I going?' You need to be comfortable with your decisions and know what you want and do not want out of life. If you don't like the direction that you're headed, change it."

White joined Praxair in 2004 as finance director. He served as the company's senior vice president and chief financial officer before it merged with The Linde Group in late 2018 to form Linde. Prior to that, White worked at Fisher Scientific, a laboratory supply and biotechnology company, and GenTek, a manufacturing and performance chemicals company. He earned a master of business administration from the University of Delaware in 2000.

White stressed the importance of both formal and informal education to the students and faculty in attendance. He stated that education shouldn't end at graduation and that people can find ways to learn new things from projects, jobs, and peers.

"The best experiences come from jobs that you will least expect and sometimes don't want," White said.

White advised attendees to rip up their five- or 10-year plans and trade them for an overarching view. He explained that "life happens," which can make it difficult to follow a strict plan; rather, he said it is best to opt for a general plan based on interests. He explained that flexibility and patience have a large hand in driving success.

Maintaining his flexible mindset, as well as keeping his general goal of being a chief financial officer in the back of his mind, led White to mentors who greatly influenced his career path.

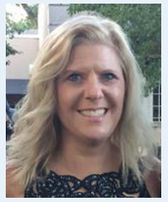
"I listened to my mentors early in my career and they often knew what I was capable of," he said. "The right mentor can shape you and give you insight into things that you are missing because you don't have that skill set yet. People are more perceptive than you think, so remember to be yourself; perception can become reality."

## Staff News

**Lisa Petrine**, former department head assistant, has taken on the new role of program manager of the Service Enterprise Engineering Initiative (SEE 360) within the department.

**Christine Luzier** joined IME as department head assistant on March 2, 2020. Luzier joined IME from her previous role with the Penn State Office of the Physical Plant.

On April 1, 2020, IME welcomed back **Mandy Engel-Herbert** to the new education program assistant position for the undergraduate program. Engel-Herbert was previously the IME undergraduate records specialist from 2015 to 2019.



**Beth Johnson** joined IME as the new financial assistant on Feb. 1, 2020. Johnson came to IME from her prior role as the Spikes Baseball accounting manager.



PENN STATE IE ALUMNI:

# Stay connected

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

UNIVERSITY STUDENT ALUMNI PSIMES PENN STATE

### 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 Christine Luzier at cal89@psu.edu
- Request online membership to the PSIMES LinkedIn Group

**There is no fee to join!**

The Harold and Inge Marcus Department of Industrial and Manufacturing Engineering
The Pennsylvania State University
310 Leonhard Building
University Park, PA 16802-1408

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