Engineering

PENN STATE

The Magazine of the Penn State College of Engineering

Spring/Summer 2018

ALUMNUS GREG LUCIER:

Engineering the next innovation in healthcare

INSIDE

From designing better healthcare facilities to creating processes, procedures, and equipment to benefit providers and patients, Penn State engineers are improving the health and quality of life for humankind.

SPRING/SUMMER 2018
Vol. 33, No. 1

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Engineering Penn State is published twice yearly by the College of Engineering Department of Communications.

Telephone 814-865-5544

Printed on recycled paper.

U.Ed. ENG 19-12

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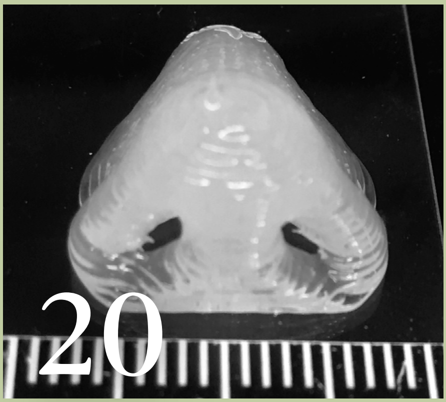

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Greg Lucier, a Penn State industrial engineering alumnus, has made—and continues to make—significant contributions to health technology and health science throughout his career in the healthcare industry. Learn more on page 10.

BONUS CONTENT

Look out for these icons to access bonus videos and photos as well as links to stories to learn more.

Video Photos Story

To sign up for digital delivery of our magazine, email **communications@engr.psu.edu**.

"It is essential that we, as engineers, seek solutions to bettering health."

the **DEAN'S MESSAGE**

Engineering Human Health

There is no part of our society beyond the influence of engineering. Healthcare is no different.

Just scan the National Academy of Engineering's (NAE) Grand Challenges for Engineering and the United Nations' Sustainable Development Goals. Compare their approaches.

In the realm of healthcare, the NAE focuses on areas where engineers have historically made inroads through their Grand Challenges: Engineer Better Medicines and Advance Health Informatics. While these challenge areas encompass the historical role of engineers in healthcare, the UN's goal of Good Health and Well-Being takes a more human-focused approach.

You'll notice that the UN's goal does not mention technology or engineering or any processes or explicit innovations to reach the goal, but that does not mean there is no place for engineering. Quite the opposite!

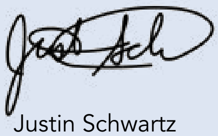
It is essential that we, as engineers, seek solutions to bettering health, such as improving targeted drug delivery, remarkable new diagnostic tools to identify diseases, improved access to healthcare via telemedicine and UAVs, and ensuring the safety of our water, air, and soil by identifying and reducing exposure to dangerous chemicals.

This issue is packed with ways that our students, faculty, and alumni are combining their Penn State engineering education with their passions for humanity, progress, and innovation in healthcare. We are making a difference!

In today's world, our engineering disciplines have become remarkably blended. Increasingly, I see this in our faculty research, the students' projects, and the industries in which our alumni work. **Greg Lucier** ('86 IE) embodies this disciplinary crossover, delivering personalized medicine. Enjoy his story starting on page 10.

We would love to hear your stories of how engineering has positively impacted your life, your career, and your family. Email them to us at communications@engr.psu.edu.

For the Glory,



Justin Schwartz
Harold and Inge Marcus Dean of Engineering
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Former Assistant Dean Pytel passes away

It is with sadness that we share the passing of **Jean Landa Pytel**, former assistant dean for student services and global programs and associate professor of engineering science and mechanics, Penn State College of Engineering, on March 15, 2018.

During her tenure, Pytel was very involved at the University. She had been a member of the Faculty Senate for 24 years; an administrative fellow to the provost; faculty adviser for the Penn State Society of Women Engineers and adviser to the Engineering Undergraduate Council and the Engineering House; and board member of the Faculty Staff Club, where she also served as its president from 2001 to 2002.

She was a member of the Commission for Women between 1986 and 1989 and held memberships in numerous University-wide and College-wide committees, task forces, and boards. In 2000, Pytel was one of the inaugural recipients of the Achieving Woman award from the Penn State Commission for Women.

In addition, Pytel was a member of the American Society of Engineering Education and served as the chair of its International Division from 2011 to 2013.

Donations may be made in memory of Pytel to her scholarship at Penn State: Jean Landa Pytel Study Abroad Scholarship in the College of Engineering.

Invent Penn State names James Adair 'Inventor of the Year'

James Adair, professor of materials science and engineering, biomedical engineering, and pharmacology, was awarded the Invent Penn State "Inventor of the Year" award on Friday, April 20 at the Invent Penn State Venture & IP Conference awards ceremony.

In May 2017, Adair also received the Penn State Faculty Scholar Medal for Entrepreneurship and Innovation. Both awards recognize the impact he's made over the course of his 20-year career at the University and, in particular, for being one of the institution's most prolific inventor-researchers and an inexhaustible collaborator.

Research from Adair has led to $5.1 million in grants for cancer research including a $3 million grant from the National Cancer Institute. Since 1982, he's filed 23 invention disclosures for which he has been awarded 17 U.S. patents and eight foreign patents. There are four more U.S. patent applications pending at the U.S. Patent and Trademark Office with complementary filing of the Patent Treaty Organization for foreign patent filings. Adair holds five licensing agreements with Penn State, with more in negotiation, aimed to move the science into technological application for improved diagnosis and treatment of cancer.

Adair and his collaborators, Jeff Davidson and Mark Kester, who helped co-found Keystone Nano in 2005 to accelerate the development of their discoveries into the medical field, continue to drive the commercialization of the nonmedical formulations. In 2017, his team began a Phase I clinical trial to assess Ceramide Nano Liposome in the treatment of solid tumors.

Dean Justin Schwartz receives FMD John Bardeen Award from TMS

Justin Schwartz

Justin Schwartz, Harold and Inge Marcus Dean of Engineering, recently received the 2018 FMD John Bardeen Award from the Minerals, Metals & Materials Society (TMS).

Given to "an individual who has made outstanding contributions and is a leader in the field of electronic materials," Schwartz was cited for his continuing excellence and contributions in electronic materials, especially in high temperature superconductors for high field devices, and magnetic materials for high frequency communications.

His research interests include superconducting, magnetic and multiferroic materials and the systems they enable, and he has published more than 240 peer-reviewed journal articles on such topics.

Schwartz formally accepted the award on March 14 during the TMS Annual Meeting in Phoenix, Arizona.

New study abroad program in Sweden

The Office of Global Engineering Engagement is offering a new study abroad program for Penn State College of Engineering students in Jönköping, Sweden.

The semester-long program, completed at Jönköping University, is available to sophomores and juniors who are studying architectural engineering, computer engineering, computer science, engineering science, industrial engineering, and mechanical engineering. Several courses are offered, including EMCH 212, ME 340, MATSE 259, as well as numerous major and general electives.

At Jönköping University's School of Engineering, one of Sweden's leading educators in the field of engineering and a member of the CDIO Initiative, students will not only gain knowledge in engineering, but also skills in leadership, communication, management, and sustainability—all of which are increasingly crucial in a high-tech, globalized world.

Gift from FirstEnergy Foundation to support Capstone Design project program

The FirstEnergy Foundation, solely funded by FirstEnergy Corp., has donated $175,000 to support the Penn State College of Engineering's Learning Factory Senior Capstone Design projects at the University Park, Behrend, and Berks campuses.

The Learning Factory is a hands-on facility for engineering students to use for courses, research projects, student organizations, and for Senior Capstone Design projects, where teams of engineering students tackle real-world problems sponsored by clients in industry.

Of the total amount, $100,000 will fund the Penn State Pennsylvania Technical Assistance Program (PennTAP)'s matching grant program for Learning Factory Senior Capstone Design project sponsorships at the University Park campus. This matching grant program allows small- and medium-sized companies within the Commonwealth to participate in the Senior Capstone Design project program, who otherwise wouldn't be able to afford the sponsorship fee.

The additional gift amount of $75,000 will be dispersed to the Penn State Behrend campus and the Berks campus to provide support for their Learning Factory programs—$50,000 and $25,000, respectively.

Don't miss a thing...

For the latest news and information from the College of Engineering, including alumni spotlights, research from our faculty and graduate students, and more, visit engr.psu.edu and follow us on social media.

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Department of Biomedical Engineering offers new study abroad program in Milan

The Department of Biomedical Engineering (BME) is offering a new study abroad program for its students in Milan, Italy, beginning in spring 2019.

The semester-long exchange program, completed at Politecnico di Milano (PoliMi), is designed for BME students to travel during the spring semester of their junior year. In return, master's level students from PoliMi will study at Penn State in fall 2019 and will help to socialize BME students who are headed to Milan.

"PoliMi is one of the top 50 engineering universities in the world and is very highly regarded," said **Keefe Manning**, professor of biomedical engineering, who proposed and implemented the new program. "There's no official partnership with another institution for biomedical engineering. This is the first of its kind for our department."

Founded in 1863, PoliMi is the oldest university in Milan, and with approximately 40,000 students, it is the largest technical university in Italy. According to QS World University Rankings, their engineering program is ranked 24th in the world. Aside from its history and statistics, there are many other facets of the program that are unique.

"There's no break and it's a continuous matriculation," said Manning. "There are three core courses students take over in Milan for their junior year that are equivalent to studies here at Penn State and qualify toward graduation requirements. Typically when studying abroad, students take general education requirements only—not at the higher level where you are matching your major courses."

In addition, Italian students have the potential to perform research at Penn State.

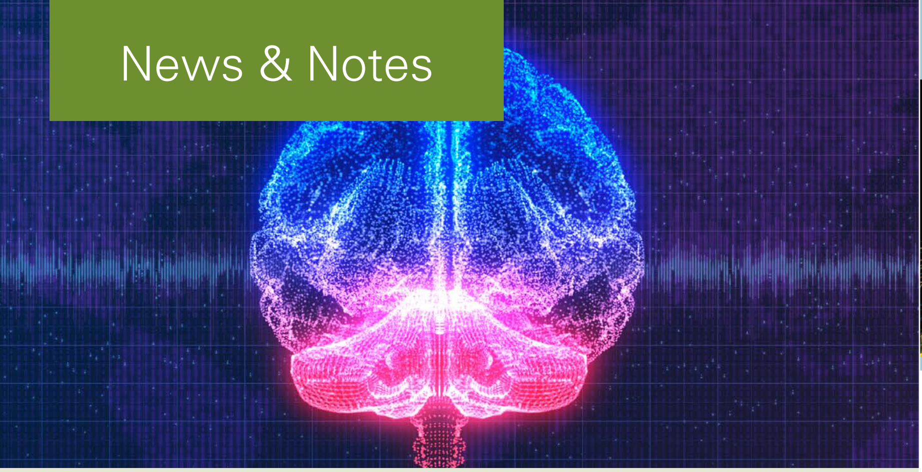
Solar Turbines selects Penn State to establish center of excellence in gas turbines

After completing an extensive evaluation of institutions of higher learning, Solar Turbines Incorporated has chosen Penn State as a university partner to establish a center of excellence in gas turbines. The center involves numerous faculty across Penn State's College of Engineering.

"Our faculty and students are honored that Penn State has been chosen by Solar Turbines to be a Center of Excellence—which is the first of its kind for Solar Turbines," said Karen Thole, distinguished professor and department head of mechanical and nuclear engineering, who played an instrumental role in establishing the Center. "This new collaboration will give us an exciting opportunity to make an impact in this important energy industry."

The Solar Turbines – Penn State Center of Excellence in Gas Turbines is aimed at advancing industrial gas turbines and expands the full range of relevant research, including combustion, aerodynamics, heat transfer, materials and advanced manufacturing.

Top photo: From left to right: Courtney Oliver, managing director, Solar Turbines; Justin Schwartz, Harold and Inge Marcus Dean of Engineering, Penn State; Karen Thole, distinguished professor and department head of mechanical and nuclear engineering, Penn State; Pablo Koziner, president, Solar Turbines; Neil Sharkey, vice president for research, Penn State; Bernhard Winkelmann, director of technology and new product development, Solar Turbines.



$2.3 million NINDS grant to aid interpreting fMRI signal in infants and children

Penn State researchers have received funding from the National Institute of Neurological Disorders and Stroke to determine how the communication between neurons and blood vessels of the brain changes from postnatal development through adulthood, which would enable the use of hemodynamic imaging to study neural activity, plasticity, and neurodevelopmental disorders in infants, children, and animals.


Patrick Drew


Nanyin Zhang

Patrick Drew, Huck Distinguished Associate Professor of Engineering Science and Mechanics, Neurosurgery, and Biomedical Engineering, and **Nanyin Zhang**, professor of biomedical and electrical engineering, are co-principal investigators on a five-year, $2.3 million proposal titled “A Multimodal Approach to Understanding the Development of Neurovascular Coupling.”

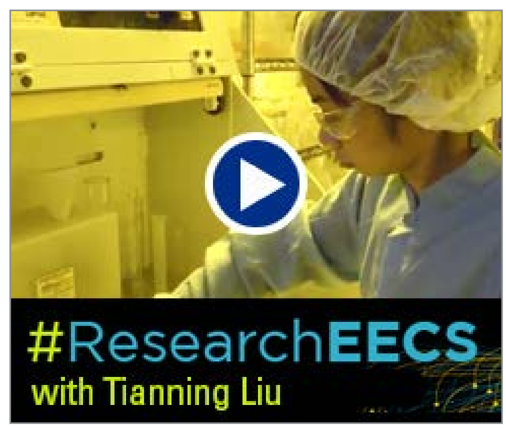
Hemodynamic signals, the basis of functionality for functional magnetic resonance imaging (fMRI), are used to detect active areas in the brain relative to inactive areas. The signals allow researchers to noninvasively assay neural activity and can provide valuable insight into brain activity and cognitive function. However, it is not clearly understood how neural activity is related to changes in blood flow and oxygenation in the neonatal and juvenile brain.

Previous studies in anesthetized animals and sedated humans have come to conflicting results as to the sign and magnitude of neurovascular coupling, and this unresolved issue has stalled the use of hemodynamic imaging in infants and children.

Using this multimodal approach, Drew and Zhang will elucidate the relationship of hemodynamic signals to neural activity from the levels of single blood vessels up to the whole brain, and determine how neurovascular coupling changes during postnatal development, how it impacts blood oxygen level-dependent fMRI signals, and how behavioral state can alter neurovascular coupling.

Drew and Zhang, along with ***Xiao Liu****, assistant professor of biomedical engineering, have also received $3.7 million from the National Institutes of Health for a separate project to investigate the resting state of fMRI techniques and how they can help combat brain diseases.*

Students in Penn State’s School of Electrical Engineering and Computer Science are passionate about their research. Check out these videos to learn more about some of the exciting opportunities in EECS.



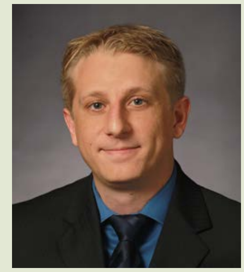
Learn more here: bit.ly/2s2oLQ4

Jason Moore

Scarlett Miller

Kevin Houser

Farshad Rajabipour



Michael Hillman

Charles Bakis

Paul Medvedev

Guha Manogharan

Saurabh Basu

Meghan Vidt

College of Engineering selects seven projects to receive funding through its ENGINE and Multidisciplinary Research Seed Grants programs

The Penn State College of Engineering recently selected three projects for funding through its Engineering for Innovation & Entrepreneurship (ENGINE) grant program and four projects for funding through its Multidisciplinary Research Seed Grants program.

ENGINE grants provide financial support to engineering faculty so they can commercialize their research ideas. The Multidisciplinary Research Seed Grants program supports research that will increase the competitiveness of faculty in attracting high-impact multidisciplinary and center-level research funding from the state and federal government, industry, or foundations.

The following faculty were awarded ENGINE grant research projects:

- **Jason Moore**, associate professor of mechanical and nuclear engineering, and **Scarlett Miller**, associate professor of engineering design and industrial engineering, for their project, "Low Cost Haptic Force Needle Insertion Simulator"
- **Kevin Houser**, professor of architectural engineering, for his project, "Prototype and Demonstration of LED Light Source that Improves Vision at Low Light Levels"
- **Farshad Rajabipour**, associate professor of civil and environmental engineering, for his project, "Next Generation Durability-Enhancing Admixtures to Extend the Life and Reduce the Life-Cycle Costs of Concrete Infrastructure"

The following four projects were selected for Multidisciplinary Research Seed Grants funding:

- "Development and Experimental Validation of Variational Collocation Meshfree Simulation of Fracture of Nanoparticle Toughened Composite Materials," by **Michael Hillman**, L. Robert and Mary L. Kimball Assistant Professor of Civil and Environmental Engineering, and **Charles Bakis**, Distinguished Professor of Engineering Science and Mechanics
- "Enabling the rapid querying of massive sequence datasets," by **Paul Medvedev**, assistant professor of computer science and engineering in the School of Electrical Engineering and Computer Science, and Anton Nekrutenko, professor of biochemistry and molecular biology, Eberly College of Science
- "High Precision In-Situ Testing to Improve Advanced Manufacturing," by **Guha Manogharan**, assistant professor of mechanical and nuclear engineering and industrial and manufacturing engineering, and **Saurabh Basu**, assistant professor of industrial and manufacturing engineering
- "Focused ultrasound histotripsy as a novel therapeutic approach to tendon injury: an assessment of structural and mechanical properties," by **Meghan Vidt**, assistant professor of biomedical engineering, and **Julianna Simon**, assistant professor of acoustics

Engineering the next innovation in healthcare

Through a combination of engineering and entrepreneurship, Greg Lucier is aiming to have a profound impact on health technology and science.

by Megan Lakatos

When it was time to leave home in Norristown, Pennsylvania, and venture off to college, **Greg Lucier** ('86 IE) was certain of one thing: he wanted to gain a superior technical education but be able to apply it to the business world. He found what he was looking for in industrial engineering.

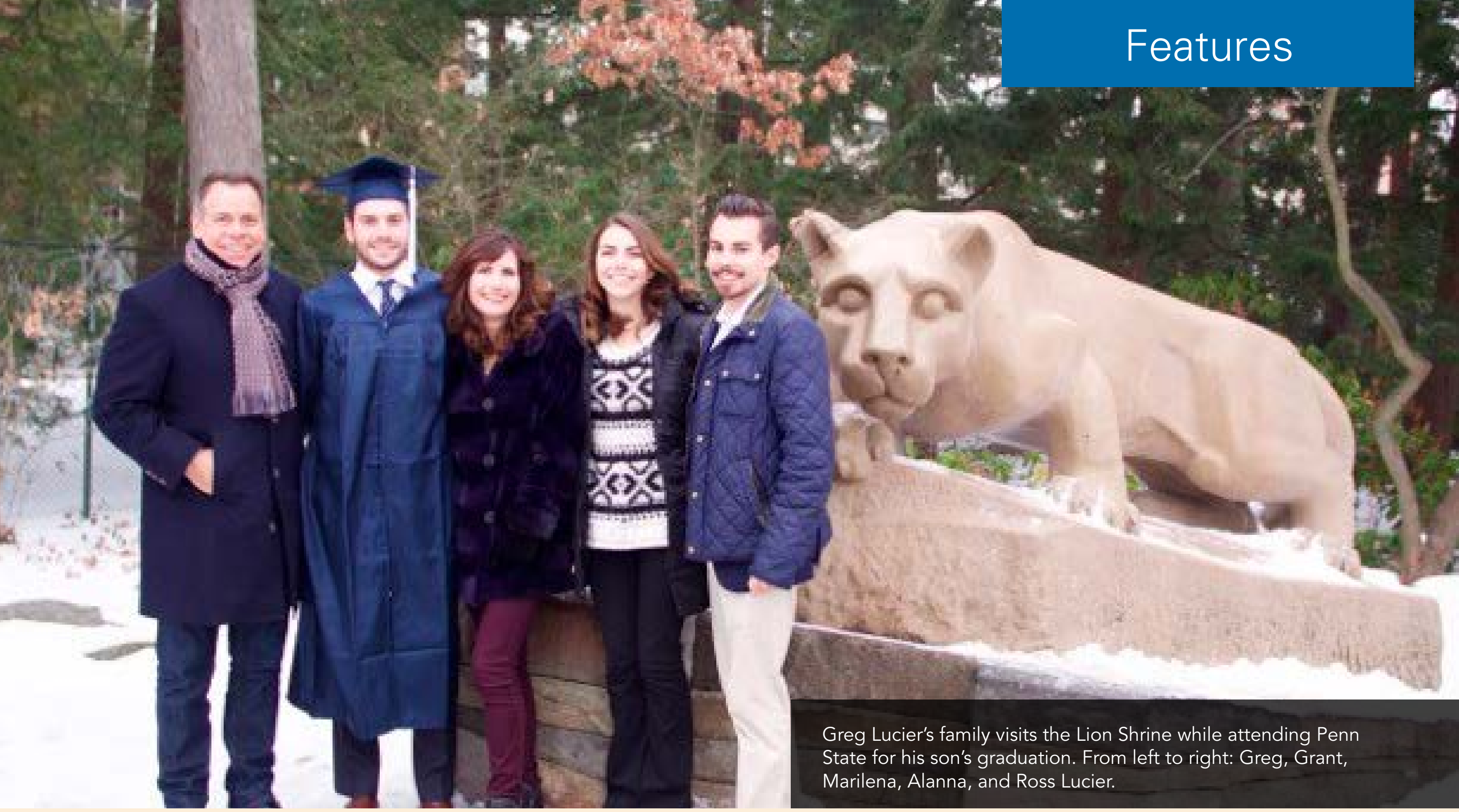
"When I was looking at universities to attend, I realized that an industrial engineering degree would provide an excellent balance of those two strong interests," said Lucier. And knowing that Penn State had one of the top industrial engineering programs in the country, his decision was made, and off he went to University Park.

After graduating with a bachelor's degree in industrial engineering in 1986, Lucier went on to receive his M.B.A. from Harvard Business School.

"I wanted to further develop my understanding of business, and at the time, I had a deep interest in manufacturing, and so at Harvard, I was able to not only learn more about business, but in particular, learn more about the management of manufacturing," he said.

Following graduation from Harvard, Lucier excelled in his career, and was appointed president of General Electric (GE) Harris Electronics, within GE Transportation, in 1995. Then, everything changed when Jack Welch, who was running GE at the time, told him his next assignment would be in healthcare.

He transitioned to GE Healthcare in 1999, where he served as vice president of Global Services. In 2000, Lucier became president of GE Healthcare's Medical Information Technologies, where he oversaw the networking of medical electronic devices, digital imaging, and clinical information systems, turning the company into a multi-billion dollar business that combined healthcare information technology and patient monitoring into an information highway for hospitals.



Greg Lucier's family visits the Lion Shrine while attending Penn State for his son's graduation. From left to right: Greg, Grant, Marilena, Alanna, and Ross Lucier.

Through his exposure to the medical industry, Lucier came to understand that the very thing it centered on was fighting disease.

"Our equipment made a world of difference in the treatment of sickness, but I realized that the root of the problem is to stop the disease from ever starting," he said. "That was something that would have to happen at the molecular level, where the life-controlling functions of the body really take place."

So in May 2003, Lucier took a chance and left his job at GE Healthcare to move to California to become chairman and chief executive officer of a struggling startup biotechnology company called Invitrogen Corporation. In a matter of a few short years, Invitrogen more than doubled in size and acquired several biotechnology companies.

Under Lucier's leadership, the company received Life Science Industry Awards—awarded to leading life science suppliers—for four consecutive years, and several of the company's innovations received accolades, such as its Qubit platform, which received the esteemed R&D 100 Award in 2007 and was named one of the most technologically significant products of the year.

In 2008, Invitrogen acquired Applied Biosystems and merged together to form Life Technologies, with Lucier continuing at the helm as chairman and chief executive officer.

He leveraged his background in industrial engineering, business, and healthcare management to prepare Life Technologies to participate in, and shape the new era of, personalized medicine.

"All three worked together to allow me to have a great technical background, a great business background, and a great industry understanding to pinpoint the next innovation

"Our equipment made a world of difference in the treatment of sickness, but I realized that the root of the problem is to stop the disease from ever starting. That was something that would have to happen at the molecular level, where the life-controlling functions of the body really take place."

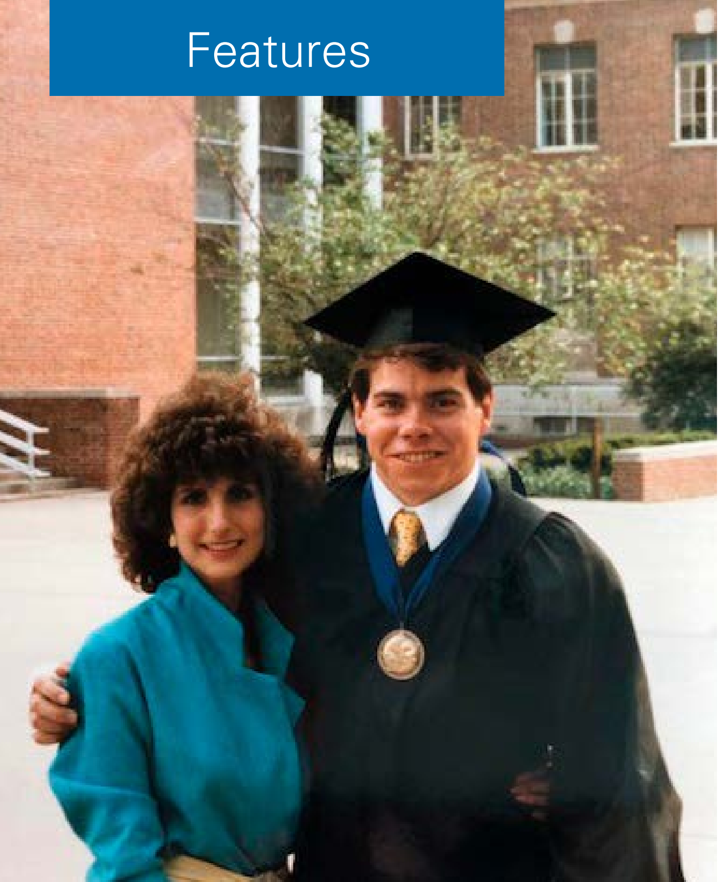
that would be in high demand and go after it, and that's been the story of my career for the last 25 years—finding that next breakthrough that could make a difference in people's lives," said Lucier.

By pushing the barriers of genetic sequencing for cancer research, forensics, and agricultural development, Lucier transformed Life Technologies into a global leader of the biotechnology sector with 50,000 products, 12,000 employees, and nearly $4 billion in sales in more than 180 countries.

Life Technologies not only aimed to improve the human condition through research, drug discovery and development, and scientific exploration, but also by being an environmentally friendly, sustainable company.

Lucier devoted extensive time and resources to achieve zero waste at several of Life Technologies' facilities around the world, and as a result, the company was selected as a new member of the Dow Jones Sustainability World Index.

"A zero-waste output is an incredibly difficult goal, and to accomplish it took years of planning and execution," said Lucier. "I believe industry has to pursue endeavors like that if we're going to have a sustainable, livable planet."



Top: Greg's wife, Marilena, poses with him at his Penn State graduation in 1986.

Bottom: Greg, Grant, and Marilena Lucier pose with the "We Are" sculpture during Grant's graduation.

"When you think about the 21st century, it will be the century of understanding how life works. The healthcare industry is the place where all those innovations will come about to the benefit of humankind. There couldn't be a more exciting place for smart, young people to study, and ultimately apply those learnings to make a difference in the world."

Life Technologies was recognized with several awards, including Fast Company's Top 10 Most Innovative Companies in the United States, it's Austin, Texas plant was named one of IndustryWeek's Top Ten Best Plants for 2011, Best Diversity Company by Diversity/Careers in Engineering & Information Technology, TR50's Top 50 Most Innovative Companies, MIT Technology Review's Top 50 Most Innovative Companies, Newsweek Magazine's America's 500 Largest "Green" Corporations, and Drug Discovery Technologies Company of the Year by Frost & Sullivan.

In April 2015, Life Technologies was acquired by Thermo Fisher Scientific for $15.6 billion—the largest life science/diagnostic transaction in the history of the healthcare industry.

Following the acquisition of Life Technologies, Lucier moved on to become the chairman and chief executive officer of NuVasive, Inc., a leading medical device company whose mission is to improve the lives of patients who suffer from debilitating back, neck, or leg pain by creating cutting-edge products and procedures that revolutionize spine surgery.

With more than 25 locations worldwide and nearly 100 unique products developed to improve spine surgery and patient outcomes, NuVasive's impact is huge – approximately every five minutes, a patient's life is changed by NuVasive technology.

Lucier has received several personal accolades for his contributions to the life sciences. He has been named Corporation Sustainability Executive of the Year, Ernst & Young Entrepreneur of the Year, Corporate Responsibility Magazine's 100 Best Corporate Citizens, Frost & Sullivan North American Drug Discovery Technologies Executive of the Year, and one of the 100 Most Inspiring People in the pharmaceutical and biotechnology industries by PharmaVoice Magazine. He is also a Distinguished Alumni of Penn State, has received the College of Engineering's World Class Engineer Alumni Award, and was the College's commencement speaker in spring 2009.

"My industrial engineering degree has been invaluable. In every stop I've made in my career, manufacturing was a critical part of the value creation," he said. "In fact, here at NuVasive, we're just finishing out building an 180,000 square foot all-digital manufacturing center for spine technology. My understanding of operations has been critical to making that investment pay off."

As an established thought leader in the life sciences, Lucier is certain engineers will have a profound impact on the healthcare industry throughout the 21st century.

"This century will be about the convergence of the life sciences with engineering, and it will unleash a wave of innovation bigger than the one we lived through in the 20th century," Lucier said. "When you think about the 21st century, it will be the century of understanding how life works. The healthcare industry is the place where all those innovations will come about to the benefit of humankind. There couldn't be a more exciting place for smart, young people to study, and ultimately apply those learnings to make a difference in the world."

Biogenic manganese oxide-coated coir fiber collected from the coal mine drainage treatment system in Glasgow, Pennsylvania.

Conceptual artwork of research project using biogenic manganese oxides produced in coal mine drainage treatment systems for point-of-entry treatment of hospital wastewater. Drawing by Audrey Stallworth, graduate student in environmental engineering.

Sanitizing hospital sewage

Researchers find manganese oxide-coated filters remove contaminants from hospital wastewater

by Jennifer Matthews

Researchers at Penn State have developed a water filtration system that removes contaminants and reduces toxicity in hospital wastewater.

Contaminants, including antibiotics, pharmaceuticals, and steroids, are increasingly being detected in surface waters and drinking water sources. These contaminants can have a huge impact on both human and aquatic health, so effective removal is essential to protect the health and safety of water resources.

"There have been a number of urban sewer inventories that have identified hospitals as a major contributor of drugs and hormones and other contaminants that end up at wastewater treatment plants," said **Bill Burgos**, professor of environmental engineering.

In fact, hospitals may contribute upwards of half the total load of contaminants carried to regional wastewater treatment plants, said Burgos. Once there, elimination can be difficult because the chemicals become diluted, yet they still pose a health threat due to their high biological potency.

"One way to destroy these compounds is through chemical oxidation," Burgos said. "Manganese oxides are very powerful oxidants and are known to be nonselective, so they are highly reactive with just about any oxidizable organic compound, including those found in hospital wastewater."

To test the effectiveness of manganese oxides (MnOx), the researchers collected wastewater samples from the Penn State Health Milton S. Hershey Medical Center and obtained biogenic MnOx-coated coir fiber from a metal removal unit in Glasgow, Pennsylvania, operated by EcoIslands LLC. The MnOx-coated fiber was then reacted with the hospital wastewaters to evaluate performance.

Chemical analyses showed that biogenic MnOx-coated coir fiber filters were very effective at removing contaminants from hospital wastewaters. Of the 36 organic micro-pollutants detected, 21 were removed by more than 94 percent after a 24-hour reaction period.

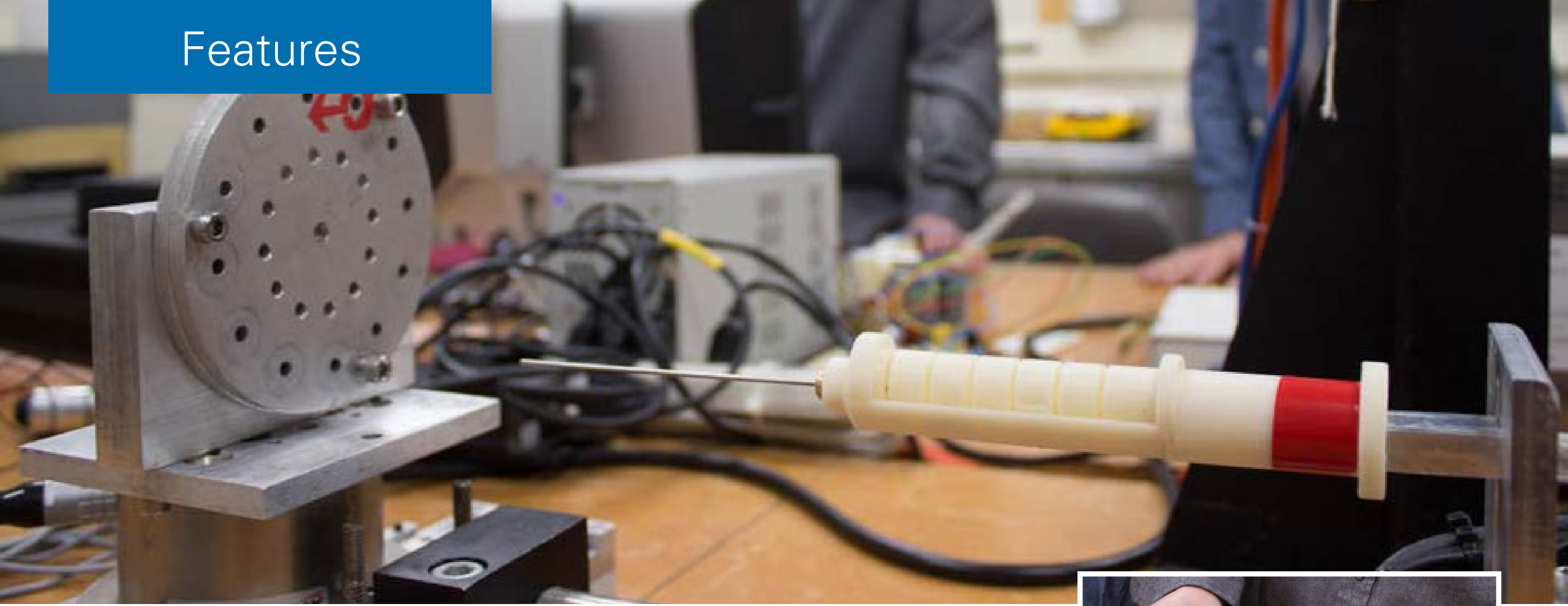
Consistent with these results, bioanalytical assays, which test the potential toxicity of the wastewater to humans, also revealed that biologically active compounds were removed below detection levels.

"Not only do we have chemical evidence that these filters remove these contaminants, we also have biological evidence that the potential human toxicity was dramatically reduced," Burgos said.

In addition, the MnOx used was formed as part of a coal mine drainage treatment system, and its reuse converts a waste product into a commodity.

The team's next steps include reducing treatment times, testing a flow-through configuration, screening different biogenic MnOx sources, and beginning field studies.

Other contributors include Luis Castillo Meza, Travis Tasker, James Farnan, and Boya Xiong, Department of Civil and Environmental Engineering; Paulina Piotrowski and Kyra Murrell, Department of Chemistry; Benedikt Weggler and Frank Dorman, Department of Biochemistry and Molecular Biology; John P. Vanden Heuvel, Department of Veterinary and Biomedical Sciences; and Terry Kreiser, Hershey Medical Center.



Needle simulator aims to revolutionize medical training

Top: The research team works with the software that will accompany the simulator.

Bottom: David Pepley, a doctoral student studying mechanical engineering, tests the needle on a surface that mimics the density of the human body.

by Erin Hendrick

Administering needle-based procedures in anesthesiology, such as epidurals, is a complex and delicate procedure. However, the current training methods for doctors are costly and fall short in preparing them for every patient and situation they'll face.

A newly proposed patent from the Penn State College of Engineering plans to change that.

The haptic force needle insertion simulator, created by a team of researchers led by **Jason Moore**, associate professor of mechanical and nuclear engineering, is a low-cost, hand-held device that simulates the tactic feeling of the instrument passing through several layers of tissue. It also connects to a computer program that can assess the user's performance.

These factors are crucial because the doctor's hands need to produce a steady rate of insertion which can be challenging. "There's a buildup of force upon tissue deflection and a sudden release of force upon tissue puncture," Moore said.

> "Being unprepared for diverse patient scenarios can increase the probability of complications occurring, and this training will help the doctor's ability to adapt."

Currently, the most effective way to train clinicians is to observe other doctors. Sanjib Adhikary, associate professor of anesthesiology at Penn State Hershey and co-investigator of the project, said, "Those of us who teach these procedures find it very difficult to teach the needle, eye, and image coordination skills."

Other training methods, like using mannequins, are more expensive and don't account for the range of body types a doctor would encounter in their patients. Adhikary explained, "It's like a driving simulator using a Tesla then when you're on the road, driving a Subaru."

This device is able to change its simulation based on these different scenarios, like varying skin thickness and excess body weight. Moore added, "Being unprepared for diverse patient scenarios can increase the probability of complications occurring, and this training will help the doctor's ability to adapt."

Eventually, this tool could be adapted to train doctors in other specialties like emergency medicine, radiology, and surgery.

Scarlett Miller, associate professor of engineering design and industrial engineering, said, "This project has the potential to revolutionize training on surgical procedures."

"We're really excited because the device is slated be relatively low cost, less than $100," Moore said. "I would love to see this widely applied, all the way down to undergraduate pre-med programs."

The team hopes to test the device at Penn State Hershey and receive feedback from physicians next fall.

"This project is in its infancy, but we hope it could follow the [central venous catheter] robot we worked on that is now a part of the surgical residency training curriculum at Hershey Medical Center," Moore said.

Miller added, "This project not only has the potential for commercial value, but also for helping save human lives." ■

Treating infection-caused hydrocephalus

by A'ndrea Elyse Messer

Implanting a shunt or endoscopically reducing intracranial pressure and reducing fluid production are equally effective in treating infants with hydrocephalus caused by brain infections, according to an international team of researchers, but endoscopy may have fewer down-the-line complications.

"This clinical trial asked if we could do a version of shuntless surgery, without the need to implant a plastic tube," said **Steven Schiff**, Brush Chair Professor of Engineering in the Departments of Neurosurgery, Engineering Science and Mechanics, and Physics. "Hardware fails at a terrible rate in young children and needs to be repaired. The body becomes dependent on the shunt and patients need to be hospitalized quickly when it fails."

Unfortunately, in Uganda, where the trial took place at CURE Children's Hospital of Uganda, it can take days for the rural poor to get back to the hospital.

While shunts can fail throughout a patient's lifetime, typically, the endoscopic approach tends to fail during the first six months after surgery, and failure is less dangerous, according to Schiff.

> *"We know that to get the best outcome we want to grow the best brain."*

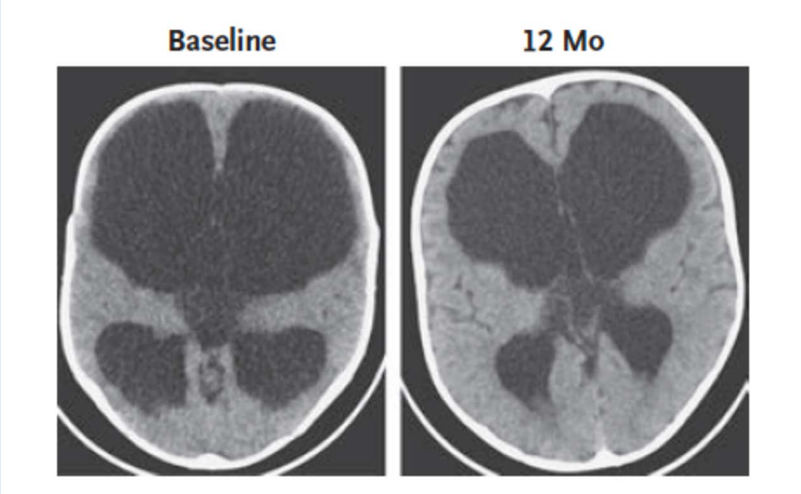
In hydrocephalus, cerebrospinal fluid builds up inside the skull and increases pressure on the brain. In infants, hydrocephalus can enlarge and deform the shape of the skull. The increased pressure can prevent the brain from developing, leading to cognitive impairment or death. The standard procedure for treatment has been surgical implantation of a shunt.

"There are lots of reasons why we don't want to use a shunt," said Schiff. "With a shunt, the fluid overdrains, but without one, there is more fluid. We needed to find out if the children do as well if there is more fluid within the brain."

The researchers reported their findings in the New England Journal of Medicine.

Infants who were enrolled in the trial were randomly assigned to endoscopic surgery or to receive a shunt. The researchers used a cognitive scale to score the infants at 12 months, and tested their motor and language skills. They found no significant difference between the babies with shunts and those receiving endoscopic surgery.

Children in the normal range had more normal brain development, as determined by CT scans.



Top: Drs. Schiff and Mugamba sampling from the brain fluid of infected infants with hydrocephalus in Uganda.

Bottom: CT scans of infant brains. Scan on the left shows infant's brain before endoscopic surgery (ETV-CPC). Scan on the right shows 12-month postoperative scan of the same infant's brain.

The researchers also found that the mechanical pressure on the brain acted as a sort of growth dampener. Higher pressures caused the brain to slow its growth, but when the pressure was lowered, brain growth sped up and in some cases, reached normal growth ranges.

"It looks like we stumbled onto an effect of mechanical pressure on growth," said Schiff. "We know that to get the best outcome we want to grow the best brain."

The researchers would now like to automate analysis of CT and MRI imaging to make it easier to monitor the brain growth of such children.

"Ultimately the answer for hydrocephalus will be in prevention," said Schiff. "Until we can get rid of these infections, surgical approaches are the only answer." ■

Read the full article.

Can hospitals predict if patients will be readmitted...or even die?

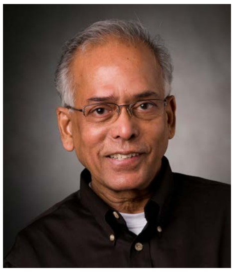
Researchers develop new method to identify patients at risk for readmission, emergency room visits, or death

by Pam Wertz

Historically, hospital patients have been at a high risk for adverse effects after they are discharged. These effects can be defined as unplanned bad circumstances that are directly related to the patient's diagnosis, clinical conditions, or the care they received while in the hospital. Many times these events lead to the patient being readmitted, going to the emergency room, or, even worse, dying.

$17 billion

avoidable re-hospitalizations attributed to Medicare annually



Soundar Kumara

Researchers from Penn State and Geisinger Health System teamed up to find a way to predict a patient's risk for needing further medical care three days after being discharged from the hospital. The model they developed is known as REDD, which stands for readmission, emergency department (ED), or death.

The research team developed the REDD model by using clinical, administrative, and socio-economic data from patients who were admitted to the Geisinger Health System over two years.

"REDD is a machine learning model designed to predict which patients will be at a high risk of adverse events after they are discharged," said **Deepak Agrawal**, one of the Penn State researchers. "Using the REDD model, we were able to leverage large amounts of data to identify these high-risk patients at the point of discharge, which helps physicians target interventions to effectively reduce adverse events."

According to a 2014 Agency for Healthcare Research and Quality report, hospital readmissions cost the United States $41 billion, as of 2011. Medicare's tab alone was $26 billion annually, $17 billion of which was attributable to avoidable re-hospitalizations. This was before Centers for Medicare and Medicaid Services started financially penalizing participating hospitals for 30-day readmissions.

The researchers came to the conclusion that readmissions after 30 days tend to be related to factors such as poor home environment, limited access to service, and little social support.

"However, readmissions closer to discharge are more likely to be related to factors that are actually present but are not identified at the time the patient is discharged," said **Soundar Kumara**, Allen E. Pearce and Allen M. Pearce Professor of Industrial Engineering, who led the Penn State research team.

Researcher **Cheng-Bang Chen**, an industrial engineering doctoral candidate, added that the more time that passes after a patient is discharged, the longer it takes the treating physician to be brought up to speed on the patient's condition.

"After 30 days, physicians don't always remember why a patient was admitted or their treatment, so it becomes difficult to identify what could have gone wrong with the initial treatment if they are readmitted," he said. "Our model focuses on just three days after discharge, which gives physicians a better chance to improve their processes when treating the patient."

In response to the Medicare/Medicaid penalty, Geisinger took the initiative to effectively reduce the readmission rate by targeted intervention, resulting in better quality of care and reduced costs by piloting the REDD model.

"During the six months the program was piloted, Geisinger tracked patients that were identified as high risk and implemented additional services to try to minimize the chances of a patient being readmitted, visiting the ED, or dying," said Eric Reich, manager of healthcare re-engineering at Geisinger.

The intervention that physicians applied to the high-risk patients is multifaceted and includes: scheduling a return appointment with the patient's primary care provider; educating the patient about their prescriptions and post-discharge care plans; having the inpatient clinical pharmacist review the discharge medication list after reviewing the provider's recommendations; having the patient's prescriptions filled before discharge; and having the hospital check on any patient discharged to a skilled nursing facility the day after discharge.

The research was tested and piloted at Geisinger, but the model can be universally implementable in hospitals. Through the data-driven predictive models, hospitals will be able to provide better quality care while efficiently allocating their scarce resources at the same time.

"This research was truly ahead of its time with astonishing results," said Reich. "We brought together a group of highly skilled, educated, and focused individuals from Penn State and Geisinger to determine the risk of not just readmission, but also ED visits and death. We hadn't seen anything like this before."

The research was funded via a Geisinger Health Plan Grant and was published in the Medical Care Journal. The success of the REDD project has led to new collaborative research between Geisinger and Penn State.

"This work has given me immense satisfaction," said Kumara. "It's not just a published piece of research, but a real model that is useful to hospitals and patients across the country."

Agrawal graduated with dual doctoral degrees in industrial engineering and operations research in August 2017. He is now an operations research consultant at American Airlines. ■

"This research was truly ahead of its time with astonishing results. We brought together a group of highly skilled, educated, and focused individuals from Penn State and Geisinger to determine the risk of not just readmission, but also ED visits and death. We hadn't seen anything like this before."

Student-designed lead vests could protect surgeons, improve patient outcomes

by Erin Hendrick

Sam Boland (top left), a senior majoring in mechanical engineering and biomedical engineering, became aware of a unique problem in the medical field during a conversation with his uncle.

"When doing surgeries with radiation imagery, he told me about how wearing the lead vests can lead to all sorts of orthopedic injuries," Boland explained.

His uncle, a cardiac surgeon, was speaking from experience. Injuries are unfortunately commonplace for surgeons, leading to chronic pain and sometimes shortened careers due to injuries from wearing lead vests.

During the mechanical engineering capstone course ME 440, students are charged with tackling a tangible problem for real-world clients, and a project proposal on the issue immediately jumped out at Boland.

Doctors need to wear lead vests because radiation imaging is used frequently during minimally invasive surgeries, such as heart or vascular procedures. The imaging allows doctors to get visual feedback during surgery, but the technology also poses a radiation risk.

"After years and years of having to wear a 40-pound vest for eight hours a day, it can really wear out your joints," Boland noted.

The initial project, creating a new support apparatus to decrease the strain on the surgeons, was proposed by Rachael Snow, a vascular surgeon at Penn State Hershey. With **Rohan Hattangady**, **Thomas Derby** (top right), and **Rebecca Stem**, seniors majoring in biomedical engineering, their job for the semester was to engineer a new apparatus for surgeons to wear the vests and be protected from radiation, while providing top performance and ease of movement.

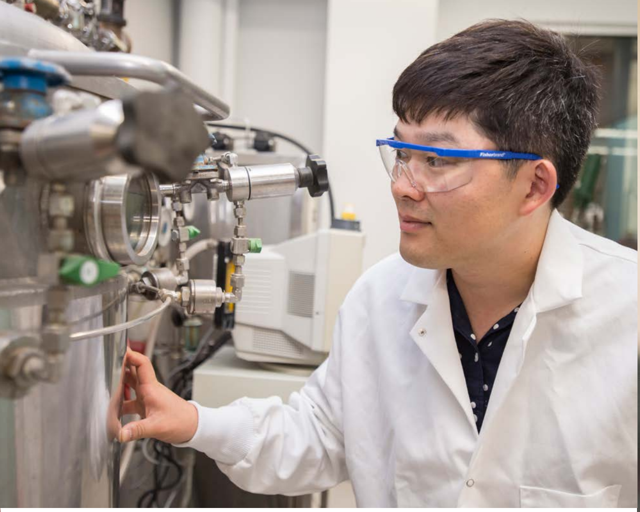
"This has the potential to be a real amazing solution to an important problem. The ultimate goal is to commercialize the device and mass-produce it for surgeons to use everywhere."

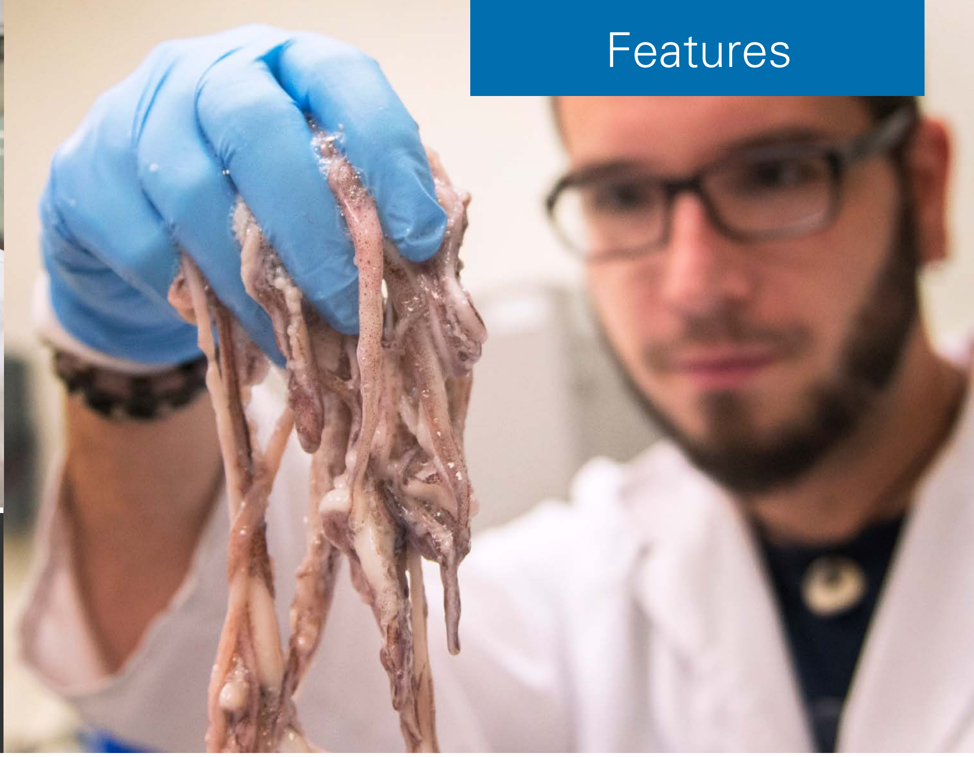
Their goals presented a Herculean task, compelling the team to create several different design prototypes. "You learn by making mistakes and that is so true in engineering design," Boland said. The student team instead designed several iterations in CAD, and worked to improve every subsequent design.

But the team believes they've found their solution.

Their prototype is a rolling structure that suspends the lead vest, conforming to the shape of the surgeon's body. It also features a moving joint behind the surgeon's back, which allows them to move laterally and bend forward without any outside assistance.

"This has the potential to be a real amazing solution to an important problem," Boland said. "The ultimate goal is to commercialize the device and mass-produce it for surgeons to use everywhere." ■





Above: Huihun Jung is using Penn State's fermentation facilities for producing biosynthetic SRT proteins in bacteria.

Right: Abdon Pena-Francesch is extracting native SRT proteins from the suction cups of squid tentacles. These proteins have unique properties of self-healing and high-strength as well as high proton conductivity.

Repetition key to self-healing, flexible medical devices

by A'ndrea Elyse Messer

Medical devices powered by synthetic proteins created from repeated sequences of proteins may be possible, according to materials science and biotechnology experts, who looked at material inspired by the proteins in squid ring teeth.

"The question we had was whether we could make flexible, self-healing medical devices to work on protons the way biological systems do," said **Melik Demirel**, Pierce Development Professor and professor of engineering science and mechanics. "Nature knows how to transfer protons, for example in charging biological energy known as ATP (adenosine triphosphate)."

Proton transfer is an integral part of fuel cells, but these cells use ion-transfer membranes manufactured from polymers that are not biocompatible. The future vision is to have implantable medical devices that could operate without batteries, using proton conduction, but to do that, the proton conductors must be biocompatible.

Polymers manufactured from proteins inspired by squid ring teeth are not only biocompatible, they are also self-healing, flexible, and stretchable. Because they are bio-synthetically manufactured by choosing the DNA sequences, manufacture of these proteins can be programmed to have varying conductivity and flexibility. As long as a material contains 60 percent or more water, proton conduction can occur.

Unfortunately, protein-based proton conductors are not as powerful or efficient as polymer conductors, so the researchers were looking for a way to optimize the proton conductivity of the material.

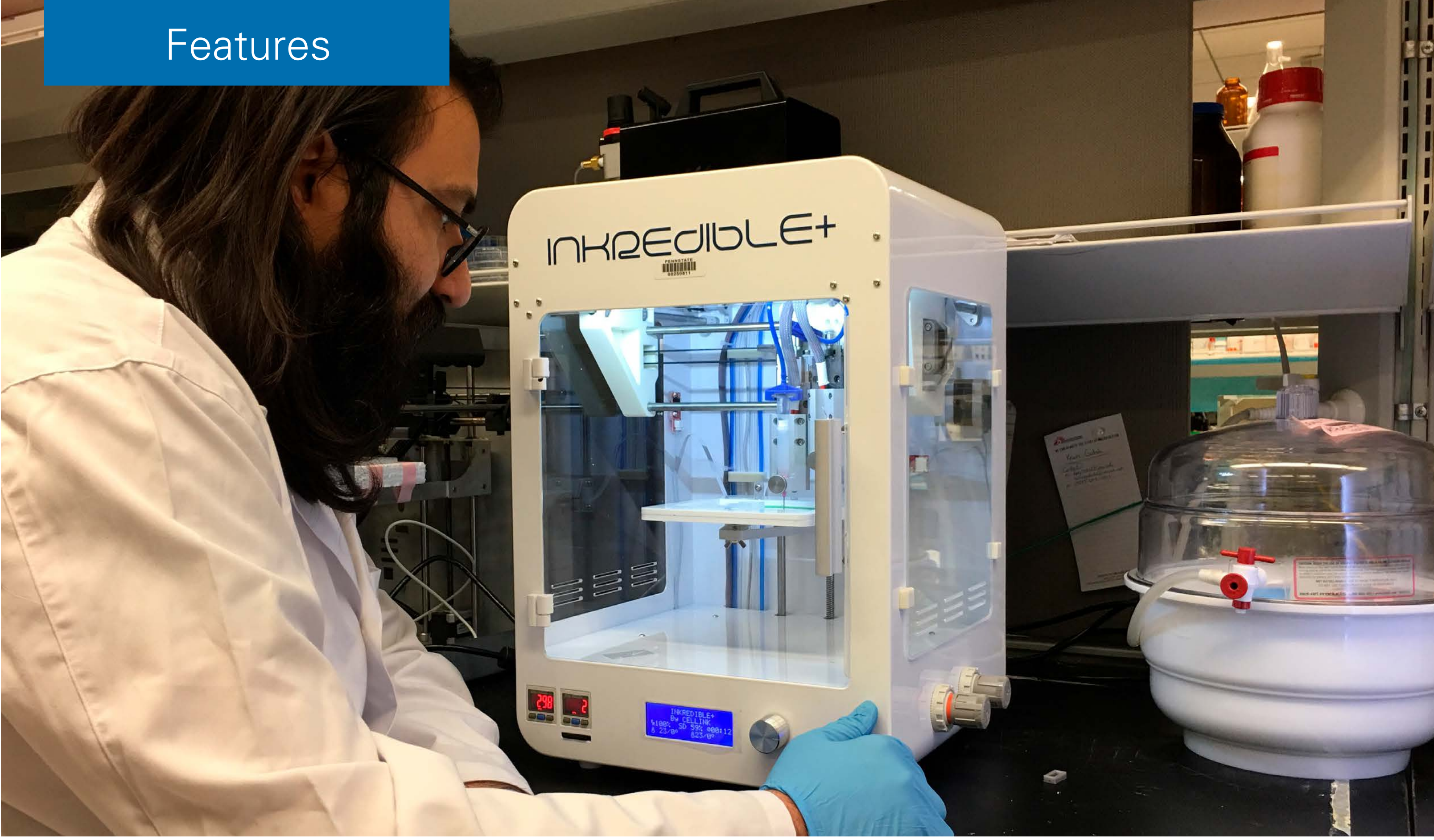
Squid-ring-teeth proteins, made up of amino acids, contain many tandem repeats in their molecular make-up. Tandem repeats are usually short series of molecules that are arranged to repeat themselves any number of times. The researchers created squid-inspired proteins with 4, 7, 11, and 25 repeats. They then created films from these materials.

The researchers found that increasing the number of tandem repeats increased the proton conductivity of the proteins. They tried different combinations of amino acids and found that replacing histidine sequences with alanine—another amino acid—in the protein decreased proton conductivity, which explained why silk is not a good proton conductor.

Looking at the synthetic squid-ring-teeth-inspired proteins, the researchers realized that they are usually composed of amorphous and crystalline sections. They found that stretching the polymer increased the conductivity in the direction of stretch, but not in the perpendicular direction, and that stretching realigned the crystalline segments to conduct better.

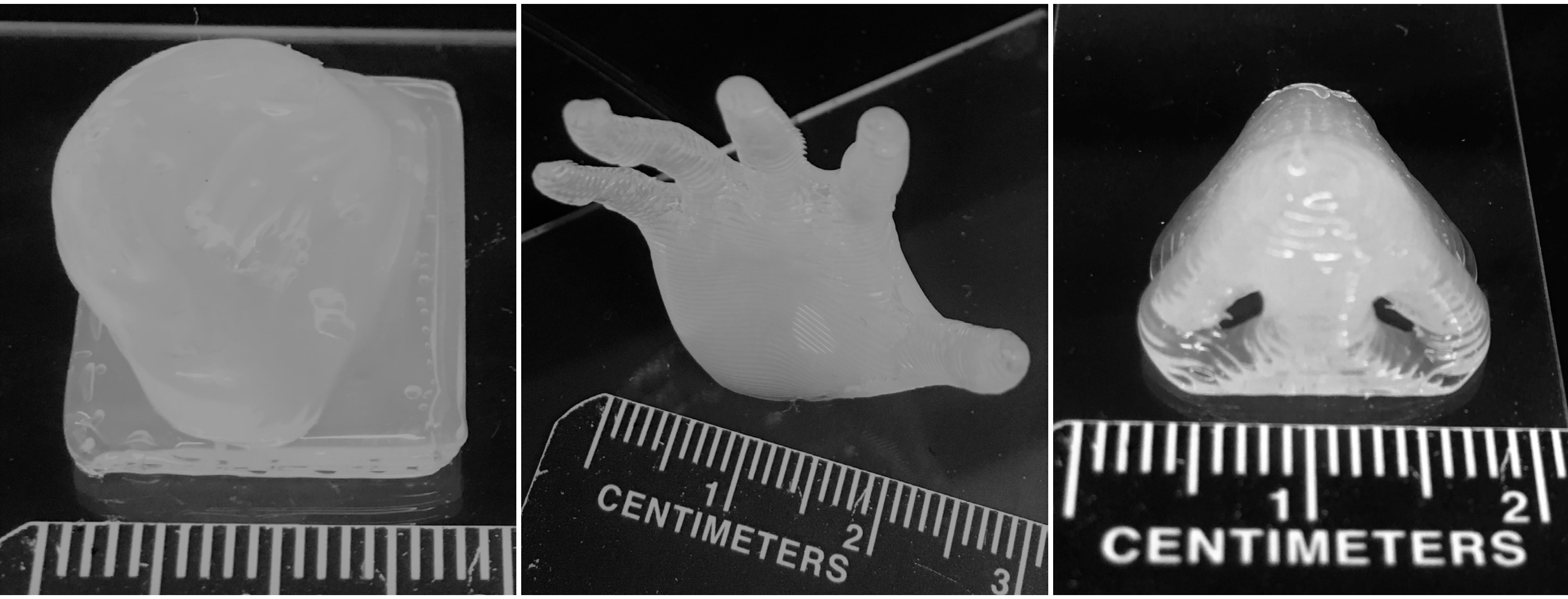
Biological proton conductors do exist in nature, including silk, keratin, collagen, melanin, and bovine serum albumin; however, the synthetic squid-ring-teeth-inspired material conducted far better than natural proteins.

"Our goal is to understand the design rules of biological proton conductors so we can create a synthetic protein that is as good as a nonbiocompatible proton conductor," said Demirel. "Then, can we make a self-healing, flexible pacemaker from this type of device? Can we make protonic bioelectronic devices?" ■



3D printing improves cell adhesion and strength of PDMS polymer

by A'ndrea Elyse Messer



Top: Veli Ozbolat, postdoctoral visiting scholar in the Department of Engineering Science and Mechanics, is 3D printing PDMS in order to build biological structures.

Bottom, from left to right: An ear, a hand, and a nose created using 3D printing of PDMS from National Institutes of Health 3D Print Exchange.

Combining two different polymer forms can switch manufacturing of silicone parts from molding, casting, and spin coating of simple forms to 3D printing of complex geometries with better mechanical characteristics and better biological adhesion, according to a team of Penn State researchers.

"So far, PDMS (polydimethylsiloxane, or silicone) has limitations in formability and manufacturing of devices," said **Ibrahim T. Ozbolat**, Hartz Family Associate Professor of Engineering Science and Mechanics and bioengineering. "Most research is done using casting or micro molding, but this fabrication yields materials with weak mechanical properties and also weak cell adhesion. Researchers often use extracellular proteins like fibronectin to make cells adhere."

PDMS is used to make lab-on-a-chip devices, organ-on-a-chip devices, two- and three-dimensional cell culture platforms, and biological machines. The material is more commonly seen as heat-resistant silicone spatulas and flexible baking pans, but these are geometrically simple and can easily be molded. If the material is used for growing tissue cultures or testing, the geometries become much smaller and more complex.

For any material to serve as "ink" in a 3D printer, it must be able to go through the printing nozzle and maintain shape once it is deposited. The material cannot spread, seep, or flatten or the integrity of the design is lost. Sylgard 184, an elastomer of PDMS, is not viscose enough to use in 3D printing—the material simply flows out of the nozzle and puddles. However, when it is mixed with SE 1700, another PDMS elastomer, in the proper ratio, the mixture is printable.

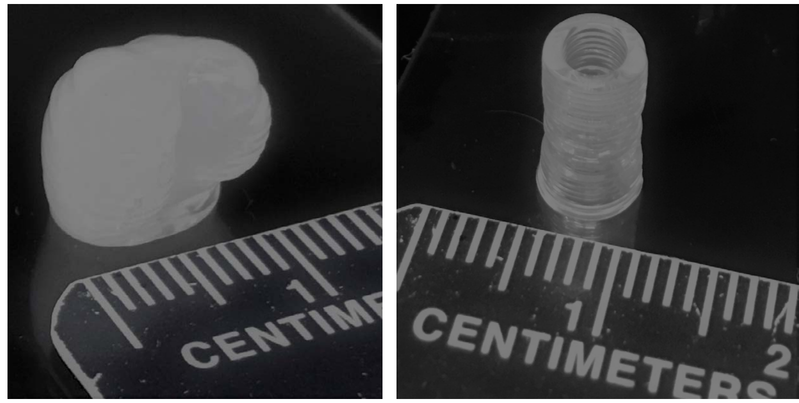
"We optimized the mixture for printability, to control extrusion and fidelity to the original pattern being printed," said Ozbolat.

The researchers optimize the mixture to take advantage of a materials property called "shear thinning." They reported their results in the February issue of ACS Biomaterials Science & Engineering.

While most materials become more viscose under pressure, some materials have the opposite, non-Newtonian response, becoming less viscose. This is perfect for 3D printing because a fluid that is viscose enough to sit in the nozzle then becomes less viscose when the pressure of pushing out the "ink" occurs. As soon as the material leaves the nozzle, it regains its viscosity and the fine threads placed on the object retain their shape.

PDMS, when molded, has a smooth surface. The material is also hydrophobic, meaning it does not like water. Add those two properties together and the molded surface of PDMS is not an easy place for tissue cells to adhere. Researchers frequently use coatings to increase cell adherence. 3D-printed surfaces, because they are made up of thousands of tiny strands of PDMS, have minute crevices that offer cells a place to stick.

To test the fidelity of 3D printing with PDMS, the researchers obtained patterns for biological features—hands, noses, blood vessels, ears, and femoral head, from the National Institutes of Health 3D Print Exchange. Using these patterns, they 3D printed a nose. Organs like this can be printed without support materials and include hollow cavities and complex geometries.



A femoral head and a blood vessel created using 3D printing of PDMS from National Institutes of Health 3D Print Exchange.

"We coated the PDMS nose with water and imaged it in an MRI machine," said Ozbolat. "We compared the 3D reconstructed nose image to the original pattern and found that we had pretty decent shape fidelity."

Because PDMS is forced through a nozzle for printing, the number of bubbles in the final material is far less than with molding or casting. Passing through a micrometer size needle removes most of the bubbles.

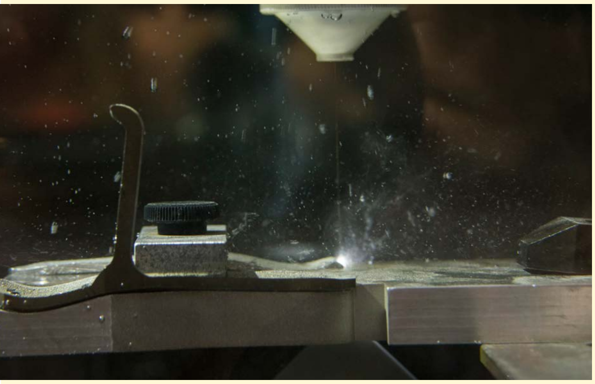
"When we compared the mechanical signatures of molded or cast PDMS with 3D-printed PDMS, we found the tensile strength in the printed material was much better," said Ozbolat.

"We compared the 3D reconstructed nose image to the original pattern and found that we had pretty decent shape fidelity."

Because the PDMS materials are being printed, they could be incorporated with other materials to make one-piece devices composed of multiple materials. They could also incorporate conductive materials to enable functionalized devices.

Other researchers on this project were Veli Ozbolat, postdoctoral fellow in engineering science and mechanics; Madhuri Dey, doctoral student in chemistry; Bugra Ayan, doctoral student in engineering science and mechanics; Adomas Povilianskas, bachelor's/master's student in engineering science and mechanics; and Melik C. Demirel, professor of engineering science and mechanics.

The Scientific and Technological Research Council of Turkey and the Turkish Ministry of National Education supported this work.



Top: Master's student Greg Bicknell (mechanical engineering) and Saurabh Basu observe the 3D-printing process.

Second: The post-processing of a patient-specific shoulder 3D-printed implant.

Third: Guha Manogharan and doctoral candidate Maryam Tilton (mechanical engineering) look at a sawbone test model to study the improvements in 3D-printed implants.

Bottom: Tilton sets up custom fixtures for a 3D-printed implant in a wire-cut electrical discharge machine.

Customizing artificial joints

Engineers work to improve orthopedic implants using 3D-printed titanium

by Pam Wertz

Two Penn State engineers are working to improve the fit and longevity of orthopedic implants by producing the parts out of titanium using additive manufacturing.

Guha Manogharan, assistant professor of mechanical engineering, and **Saurabh Basu**, assistant professor of industrial engineering, are working on the project titled, "High Precision In-Situ Testing to Improve Advanced Manufacturing." The pair received funding as part of the College's Multidisciplinary Research Seed Grants program.

Manogharan relates orthopedic replacements to when someone wants to dress well for a big life event.

"We want something that fits well, that we are comfortable wearing," he said. "When someone needs a joint replaced, shouldn't we think of that implant the same way, rather than having to choose from small, medium, or large models?"

Manogharan's interest in the topic goes beyond the desire to make an impact on the population that relies on these implants; his own father needed a shoulder implant following a motorbike accident a few years ago.

"This is hardware people have inside them for the rest of their lives so these designs should be custom fit. The capabilities of additive manufacturing, particularly using titanium, allow us to model an implant that fits a patient true to form, that is comfortable, that accounts for their age and bone structure, and that will last for the rest of their lives," he said.

One issue that the researchers are mindful of is the wear of these titanium parts as they rub against each other, in the case of a joint replacement.

"To make a custom-designed orthopedic implant that can last a lifetime, we need to know how the implant will behave inside the human body," explained Basu. "This will involve a thorough understanding of how the implant wears over the years. Unfortunately wear is an extremely complicated phenomenon that takes place inside a very tiny zone, much smaller than the thickness of a hair."

"We hope to be the pioneers in linking the inherent nature of additive manufacturing materials and asserting performance in a conducive environment."

Basu went on to note that the zone is too small to see with the naked eye and the phenomenon itself involves fundamentally different physics than what engineers are used to seeing.

"Research funding will allow us to study this phenomenon using electron microscopy. This will enable tuning of the design and material of the implant, significantly improving chances of a successful joint replacement," he said.

Beyond the fundamental biomedical application of the project, the research and methodology can be extended to other applications that may use machining to create 3D-printed metal parts.

"We hope to be the pioneers in linking the inherent nature of additive manufacturing materials and asserting performance in a conducive environment [such as a custom implant]," said Manogharan.

The team is leveraging state-of-the-art capabilities that are available through the Material Characterization Lab in the Millennium Science Complex. ■

Improving breast cancer detection

by Samantha Chavanic

Pat Halpin-Murphy, (right) president and founder of the Pennsylvania Breast Cancer Coalition (PBCC), discusses the importance of better tissue imaging systems and how they can lead to early detection of breast cancer for some women before presenting Sean Knecht (left) with his grant from the PBCC.

For the 40 percent of women 40 and older with heterogeneously dense breast tissue, current mammogram imaging is not able to correctly differentiate breast cancer tumors from their dense tissues. While fatty breast tissues appear dark on a mammogram image, dense tissues appear white—as do tumors.

Sean Knecht, assistant teaching professor in the School of Engineering Design, Technology, and Professional Programs, was recently awarded a $50,000 grant from the Pennsylvania Breast Cancer Coalition to develop a real-time, portable photoacoustic imaging system that can effectively distinguish dense breast tissue from cancerous tumors.

According to the National Cancer Institute, an estimated 252,710 women in the United States were diagnosed with breast cancer in 2017. In the same year, 40,610 U.S. women succumbed to the disease.

A mammogram, or low-dose X-ray, is currently the standard way to image breast tissues. Guidelines suggest women begin receiving annual mammograms starting at 40 years old. Because mammograms can be ineffective at detecting cancerous cells in denser tissues and almost half the women 40 and older have heterogeneously dense breast tissue, many women must be alternatively screened.

Currently, these additional methods include tomosynthesis, 3D mammography, MRIs, and automated whole breast screening ultrasounds. But each of these comes with limitations. Knecht is hoping to change that by creating an easy-to-use handheld device that captures optical contrast images via ultrasound waves.

Knecht will use a well-defined wavelength in the near-infrared region and synthetic nanoparticles that absorb at that wavelength to improve the depth of imaging and contrast. The nanoparticles will be targeted to cancer types, meaning they will congregate within and around a cancerous tumor.

"When we shine in our light...BOOM! We get an acoustic signal that we can measure that must have come from the tumor and not the dense breast tissue," Knecht said. "This should improve the contrast of our detection and imaging system significantly."

By creating a handheld device available at a much lower price than an MRI machine, Knecht aims to make supplemental screening accessible to a much greater population.

"Scientists and engineers have an obligation to do things to improve society. My hope is that this supplemental screening tool can significantly reduce the mortality of breast cancer by helping to catch breast cancer at an earlier stage for those with dense breast tissue so that treatment can begin as soon as it is necessary," he said. "As the Pennsylvania Breast Cancer Coalition says, 'Finding a cure now, so our daughters won't have to.' Or in this case, if not a cure, [we are] at least [finding] a tool to bring the cure to them earlier." ■

Computation

COMBATS CONCUSSION DAMAGE

by Julian Fung

Every football season, fans across the country look forward every weekend to touchdowns, tackles, and tailgating. But recent news about football-induced brain injuries is casting a pall on the sport.

One researcher in Penn State's Institute for CyberScience (ICS) is working to reduce the risk of these injuries—and to reverse the damage they cause—through the power of high-performance computing.

Reuben Kraft is an assistant professor in the Department of Mechanical and Nuclear Engineering and the Department of Biomedical Engineering, and is an ICS co-hire. He specializes in constructing computer models of the human brain that may help to diagnose brain injuries by simulating head impacts.

"These simulations are so important because it's very hard to investigate brain injury experimentally—we can't just hit people on the head and see what happens," said Kraft. "Computer simulation is the only way to investigate injuries of this nature."

Kraft's goal is to prevent brain damage to athletes in football and other contact sports.

"Big-time sports programs have lots of athletic trainers who can diagnose concussions, but think about all the smaller colleges, high schools, and youth programs with no athletic trainers on the sideline," said Kraft. "Athletes in those programs who have concussions might not be diagnosed and could get back in the game, risking further damage. We're trying to protect them."

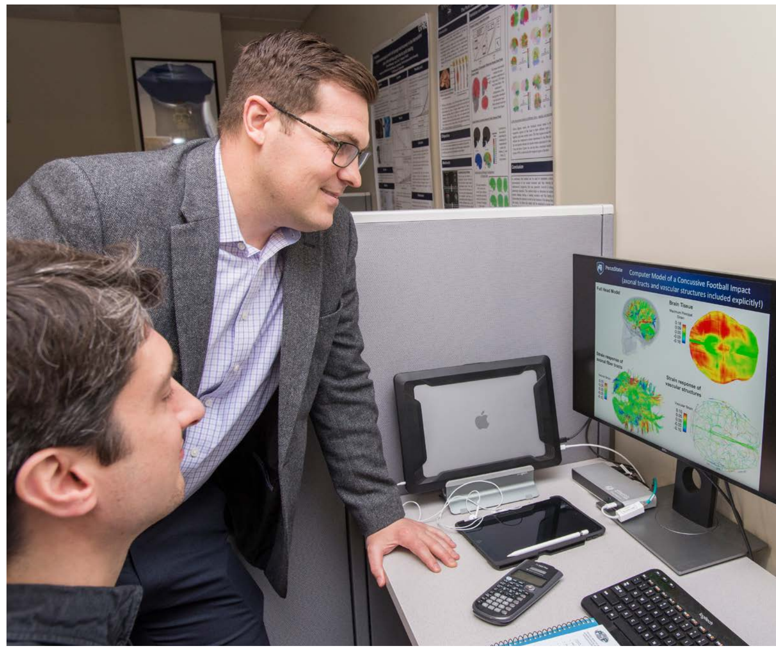
HIGH-IMPACT SIMULATIONS

To create accurate brain models, Kraft's team combines many different equations, each one describing a physical property of one of the many kinds of matter in and around the brain.

Kraft's team then uses the brain models to simulate injuries, determining the specific effects of different kinds of head trauma by changing variables such as the force and angle of impact. Kraft is combining his simulations with biomechanical sensors worn by athletes to provide real-time diagnoses of brain injuries. When a football player takes a hit to the head, the sensors would collect data about the force and location of the impact and send it to a high-performance computer system running Kraft's brain models. The models would then simulate the results of the hit based on the data to determine which parts of the brain are likely to be injured and the severity of the damage.

This information would be generated in moments, and would be sent to the player's coach, who could make sure the player stops playing and gets necessary treatment. The diagnosis would also be sent to the player's parents and doctor.

These diagnoses are crucial because in many sports programs, coaches rely on players to self-report if they have suffered a concussion. A player who has sustained a big hit might not be aware of the damage caused, or might avoid self-reporting to stay in the game.



Kraft and graduate student Jesse Gerber review simulation results that give insight into how the brain resounds to dangerous impacts.

HITTING CLOSE TO HOME

Kraft's interest in preventing and reversing brain damage began around 2009, when he was working at the U.S. Army Research Laboratory (ARL). There, his research focused on soldiers who had been injured in the wars in Iraq and Afghanistan.

But when he left ARL, he expanded his focus to also include sports injuries. The growing controversy over concussions in football made this research area relevant—and it is also a topic in which he has also has a personal stake.

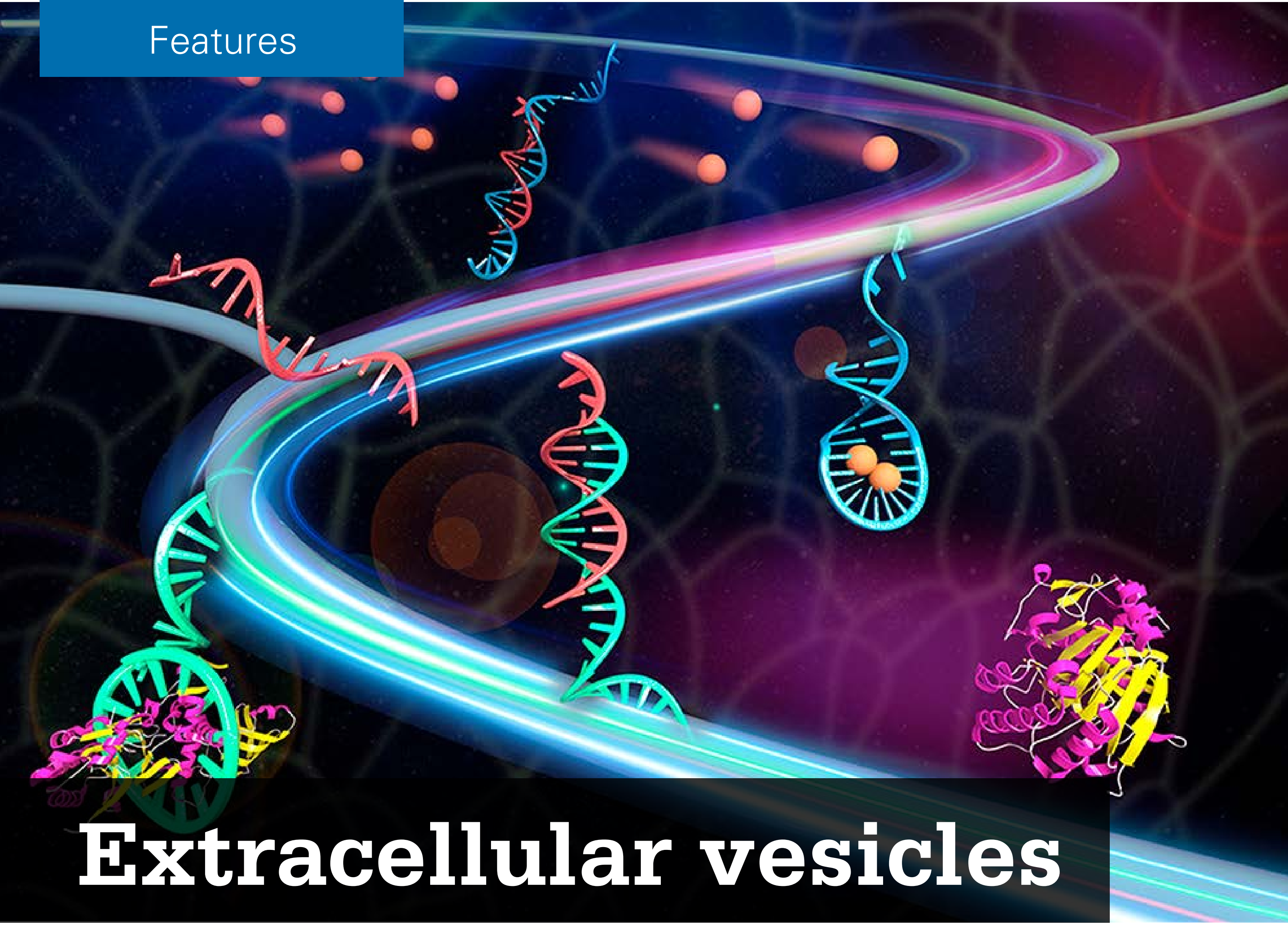
"I was an athlete myself in high school," said Kraft. "I was never officially diagnosed with a concussion, but I probably had them."

His experiences with potential head injuries have motivated Kraft not just to understand the mechanics of the brain, but to make these insights useful to the general public.

"I want to push our technology to a place where most people can access and use it," said Kraft. "I think over the next 10 years, you'll see brain enhancements and tools for measuring brain function become a much more common part of people's lives."

Wherever the field of biomechanics goes, Kraft will be at the cutting edge of it, applying his computational expertise and drive to improve the lives of the people around him. ■

Kraft stands in front of Penn State Institute for CyberScience's (ICS) high-performance computing clusters. These massive computing resources are housed in a specialized building and enable advanced brain simulations that Kraft's research group study.



Extracellular vesicles

could be personalized drug delivery vehicles

by A'ndrea Elyse Messer

Creating enough nanovesicles to inexpensively serve as a drug delivery system may be as simple as putting the cells through a sieve, according to an international team of researchers who used mouse autologous—their own—immune cells to create large amounts of fillable nanovesicles to deliver drugs to tumors in mice.

Nanovesicles are tiny sacs released by cells that carry chemical messages between cells. These nanovesicles are natural delivery vehicles and useful in drug delivery for cancer treatment.

"Currently, natural nanovesicles can be harvested from cell culture supernatant (the fluid surrounding cultured cells) and they are fillable," said **Yuan Wan**, postdoctoral fellow in biomedical engineering. "However, there are two problems using them for cancer treatment. There aren't enough nanovesicles produced in short timescales and they do not have targeting effect."

The researchers developed an approach and platform to create large amounts of fillable and targeted nanovesicles. They reported their results in a recent issue of Cancer Research.

To create targeted nanovesicles, ligands—perhaps short pieces of protein—need to be attached to the nanovesicle wall so they can recognize tumor cells. The process for making targeted nanovesicles now requires using viruses to insert relevant DNA fragments into the genome of the donor cells and then collecting ligand-bearing nanovesicles released from the gene-modified cells.

Yuan, working with **Siyang Zheng**, associate professor of biomedical engineering, developed a simpler and faster method for attaching ligands. The researchers chemically graft the lipid-tagged ligands onto the cell membrane. They do this before they pass the cells through a sieve, which converts the cell membranes into millions of vesicles bearing ligands that can be filled with an appropriate drug to target the cancer.

"Pushing the cells through a filter is the engineered way to produce lots of nanovesicles," said Zheng.

The researchers used mouse autologous immune cells and created the ligand-targeted, fillable nanovesicles in the laboratory. They then infused these drug-loaded nanovesicles into the original mouse to treat tumors.

Left: A synthetic tissue releases therapeutic proteins (maroon/yellow) once triggered by metabolites (sandy brown). The metabolites contact with the double-stranded DNA (red/blue) to release the red triggering DNA. The triggering DNA activates the aptamer(cyan)-protein complex to release the protein. Image: Xin Zou/ Jinping Lai/Penn State

"This approach enables us to create nanovesicles with different ligands targeting different types of tumors in about 30 minutes to meet actual needs," said Zheng. "With this approach, we also can put different types of ligands on a nanovesicle. We could have one ligand that targets while another ligand says, 'don't eat me.'"

Zheng is referring to the body's propensity to clear materials that do not belong from the blood stream. If a nanovesicle has a ligand attached that suggests the vesicle is autologous, then the vesicle, and its drug payload, might remain in circulation longer, making it more successful in finding and killing the target cancer cells.

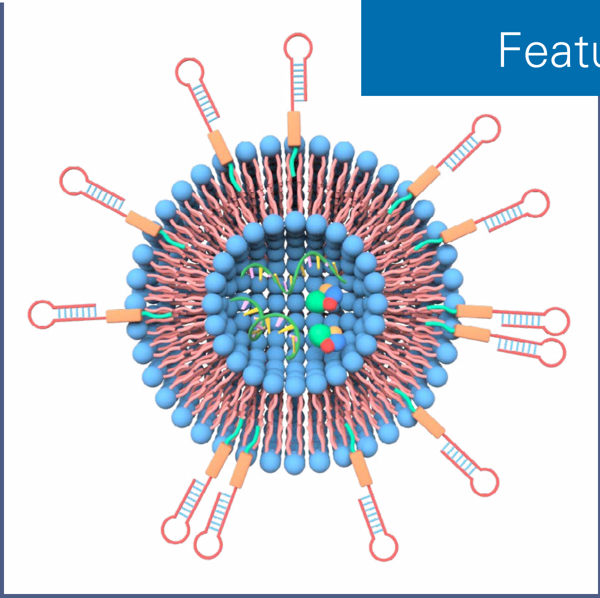
The researchers believe that a variety of other cells, including stem cells, T cells—cells of the immune system—and other cell types could be modified and used as donor cells for extrusion of nanovesicles.

Also working on the project at Penn State were **Yiqiu Xia**, graduate student in biomedical engineering, and **Gong Cheng**, former postdoctoral fellow in biomedical engineering.

Others working on this project include Chuandong Zhu, Qin Zheng, Jinlong Tong and Yuan Fang, Second Affiliated Hospital of Southeast University; Lixue Wang, Second Affiliated Hospital of Southeast University and Jiangsu Cancer Hospital & Jiangsu Institute of Cancer Research; and Xia He, Jiangsu Cancer Hospital & Jiangsu Institute of Cancer Research; all in Nanjing, China.

The Nanjing Science and Technology Development Foundation, Jiangsu Provincial Medical Youth Talent Award, Natural Science Foundation of Jiangsu Province, and the U.S. National Institutes of Health supported this work. ■

"This approach enables us to create nanovesicles with different ligands targeting different types of tumors in about 30 minutes to meet actual needs."



Ligands-grafted extracellular vesicles as drug delivery vehicles

Mimicking biological process, hydrogel signals and releases proteins

by A'ndrea Elyse Messer

An artificial system using a DNA-laced hydrogel can receive a chemical signal and release the appropriate protein, according to Penn State researchers. Further stimulation by the chemical signal continues to trigger a response.

The researchers reported in Chemical Science, "With rational design, this biomimetic hydrogel system would constitute a general platform of controlling the output of signaling proteins for versatile potential applications such as drug delivery, cell regulation, molecular sensing, and regenerative medicine."

The hydrogel, made of polyethylene glycol, is infused with two different types of DNA. One is an aptamer—a short strand of DNA that attaches to the chemical the researchers want to release into the cell. In the case of glucose and insulin, the aptamer would bind with insulin the "drug" the researchers want to release. The other type is a double-stranded helical molecule of DNA chosen to react with the metabolite signal—glucose—and initiate the chemical release.

When the signaling molecule reaches a double strand of DNA, the DNA separates into two strands. One strand binds with the molecule and the other moves toward the aptamer and forces it to release the protein bound to it. The protein can then move through the cells to its normal binding site and perform its normal actions.

The researchers used adenosine as the signaling chemical and platelet-derived growth factor as the signaling protein to be released. The system can repeat the sequence, releasing signaling proteins until there are no more to release.

The researchers tested the adenosine-PDGF-BB hydrogel system and found that without a signal chemical, the amount of signaling protein released by the hydrogel was very small. When the signal chemical—adenosine—was applied, the hydrogel released about 28 percent of the target signaling protein—PDGF-BB. Other chemicals similar to adenosine, like guanosine and uridine did not cause the release of PDGF-BB from the hydrogel.

Others at Penn State working on this project are Jinping Lai, research associate; Shihui Li, recent doctoral graduate; Xuechen Shi, recent master's graduate; and James Coyne and Nan Zhao, doctoral candidates—all in the Department of Biomedical Engineering; and Fengping Dong, doctoral candidate; and Yingwei Mao, associate professor, both in the Department of Biology.

The National Science Foundation and the National Institutes of Health supported this work. ■

$7M AWARD to enlist insects as allies for food security

by Jane Horetsky

Wayne Curtis

A Penn State-led research team is hoping to enlist insects as allies in an effort to make crops more tolerant of environmental stressors, after the crops are already growing in the greenhouse or field.

Led by project director **Wayne Curtis**, professor of chemical engineering in the College of Engineering, Penn State, the researchers are supported by a four-year cooperative agreement worth up to $7 million through the Defense Advanced Research Projects Agency (DARPA) as part of its Insect Allies program. The program is aimed at using gene therapy techniques to—within a single growing season—make mature plants more resilient in the face of natural and man-made threats such as viruses, pests, fungi, herbicides, drought, pollution, salinity, flooding, and frost.

"Currently there is not much a farmer can do to save a crop if weather forecasting predicts a severe drought for the next month," Curtis said. "Even if it's possible to develop a plant variety that can overcome one type of stress, the nature of new diseases and pests threatens to outpace improvements provided by traditional breeding and genetic modifications. We seek to develop a technology for rapid response that will allow delivery of genes to protect plants as needed after they are planted in the field."

The team's approach focuses on reducing the risk of off-target effects by blocking the virus from replicating. To accomplish this, researchers working in a greenhouse environment will use whiteflies to deliver deconstructed viruses encoding beneficial

Top: Benson Chong, project integrator, waters tomato plants in the greenhouse.

Bottom: Fran McCullough, research technologist in Rasgon Lab, maintains whitefly colonies on host tomato plants.

genes into mature tomato plants, with a timing and specificity that improves the plants' natural stress response to drought and disease.

The team hopes to optimize the effectiveness of this approach using computer modeling of the behavior of whiteflies to coordinate trait delivery with the extent and duration of the plant stressors. The information derived from this model could also play a role in improving stress response in other agricultural systems.

The project encompasses three groups working on different aspects of the research: the "Plant" group, led by Curtis; the "Insect" group, led by Jason Rasgon, professor of entomology in the College of Agricultural Sciences, Penn State; and the "Virus" group, led by Jane Polston, professor of plant pathology, University of Florida.

Rasgon's novel work using CRISPR/cas9 technology in mosquitoes dovetails with the project's innovative approach to gene delivery via insects.

Polston's expertise, spanning from whitefly-rearing to virus-indexing to greenhouse management strategies, is relevant for conducting research under biocontainment and quarantine as the technology is developed.

And, although his background is in chemical engineering, project director Curtis' research has always had a strong emphasis on applied biology, especially plants and agriculture.

"My Ph.D., almost 30 years ago, was actually on scaling up production of plant medicinal compounds," he said.

This DARPA award adds another food-security project to Curtis' portfolio, which also includes projects sponsored by the National Science Foundation and the Bill & Melinda Gates Foundation to improve production of yam, a crop that feeds millions throughout western Africa and tropical nations.

"Food security is the foundation of societal stability that is often taken for granted," Curtis said. "DARPA's investment in this technology development recognizes this importance."

Other researchers on the team include Garry Sunter, a plant virus expert from the University of Texas at San Antonio; Michael Axtell, professor of biology in the Eberly College of Science, Penn State; Antonios Armaou, professor of chemical engineering, Penn State; and Joshua Adkins, staff scientist at Pacific Northwest National Laboratory. Project consultants include plant virus expert Linda Hanley-Bowdoin, North Carolina State University, and biocontainment operations expert John Henneman, Kansas State University.

DARPA is funding related projects at Cornell University, Ohio State University, and the University of Texas.

Undergraduate and graduate students and postdoctoral scholars interested in working on the Penn State project can find more information on the Curtis Laboratory's website. ■

"Currently there is not much a farmer can do to save a crop if weather forecasting predicts a severe drought for the next month. Even if it's possible to develop a plant variety that can overcome one type of stress, the nature of new diseases and pests threatens to outpace improvements provided by traditional breeding and genetic modifications."

The reality of simulating healthcare facilities

Graduate researcher aims to improve emergency department patient care through computational facility modeling

by Samantha Chavanic

Healthcare is a fast-paced, ever-evolving industry. To accommodate the needs of patients and healthcare providers, the facilities they occupy must be flexible enough to address the needs of varying patient demands and situations.

Jennifer Lather, a doctoral candidate in architectural engineering, is currently using computer simulations at Penn State Hershey Medical Center (HMC) to better understand how to design for the changing situations in the hospital's emergency department (ED).

Advancements in computer simulation capabilities allow designers to create complex, immersive models of buildings before construction begins. Currently, there is little research to investigate the value of using simulations to improve design decisions. Lather's research will work to understand healthcare industry performance metrics, such as patient wait times and length of stay, before buildings are created.

To do so, Lather is creating two simulations, which she will combine together as one cohesive simulation approach. First, she is working to create a discrete event simulation, which will simulate the processes patients go through in the emergency department. It will include random variations of arrival and healthcare service times.

A second simulation, a virtual reality visualization, will mimic a first-person perspective of the facility.

"In this type of simulation, we use digital content provided by project teams to create an immersive and interactive environment where nurses and doctors can virtually experience their future facility before it is built," Lather said.

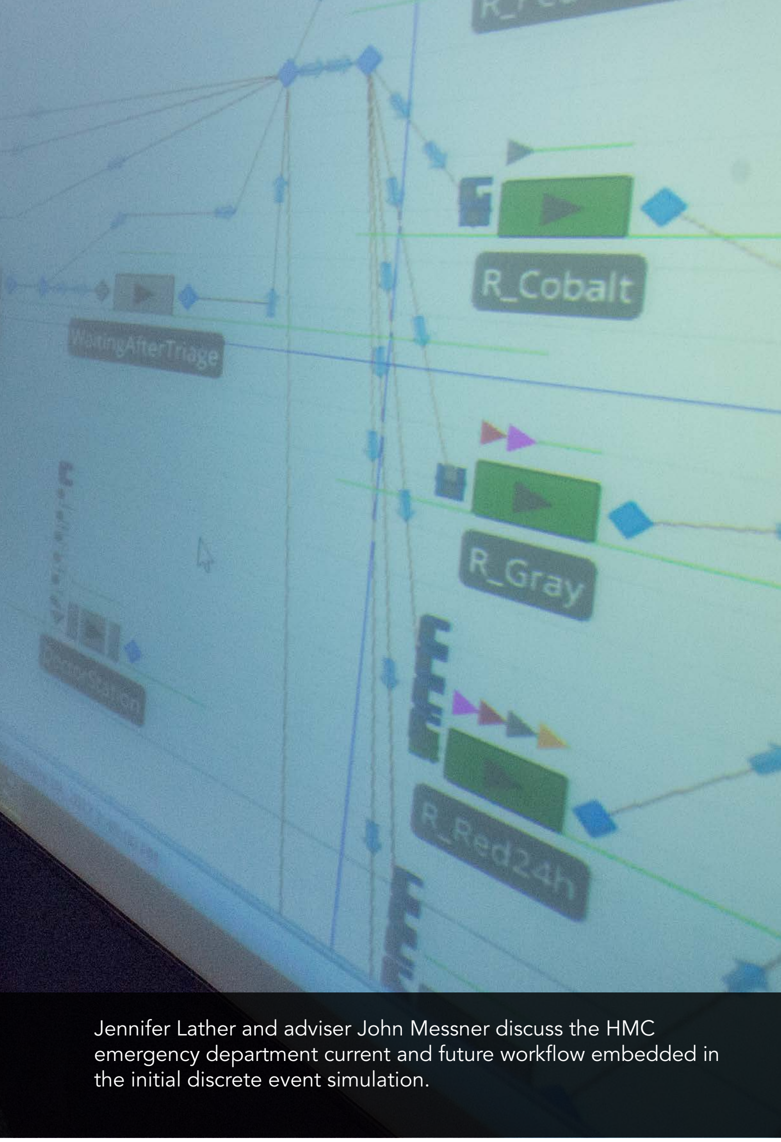
According to Lather, virtual reality visualizations help stakeholders better understand the facility's design and be able to provide directed feedback to the project team. Discrete event simulations provide the data behind operational changes through temporal models of the processes in a facility.

"Through simulation, practitioners can understand if the change [to the facility] will help deliver healthcare more efficiently and effectively," she said.

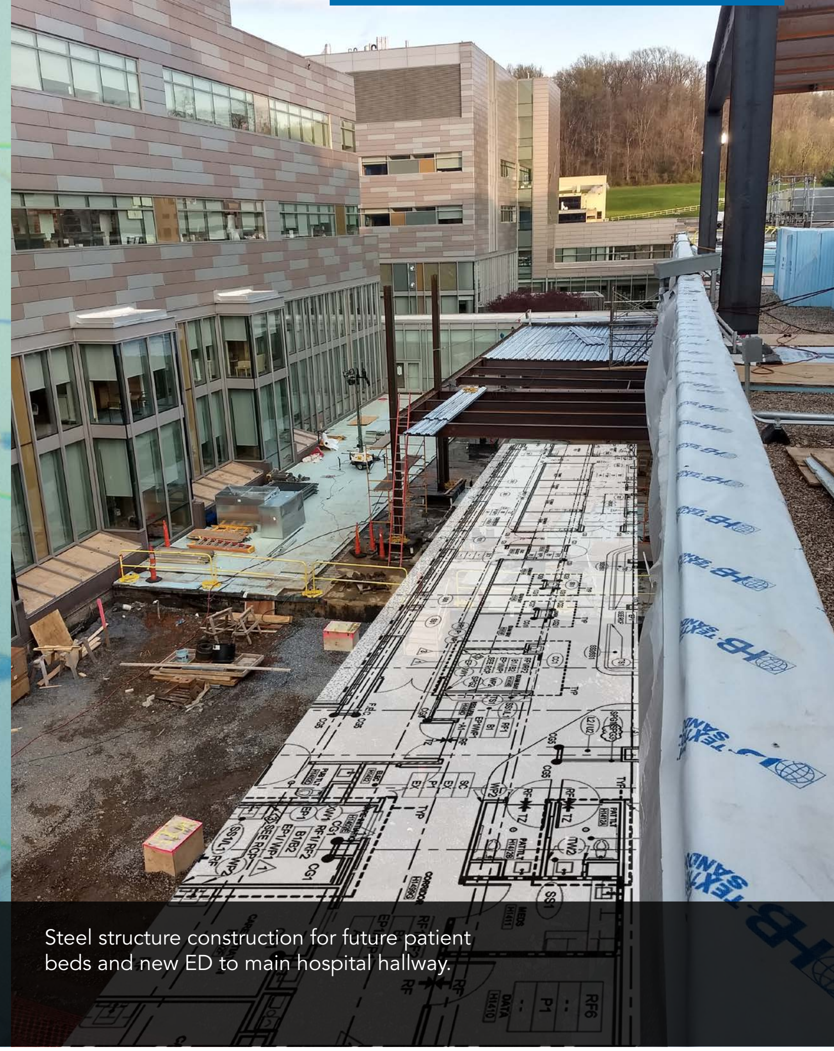
Lather is working with Eleanor Dunham, M.D., medical director of the ED at Penn State HMC, to gather the background information on clinical operations and emergency department flow needed to create realistic simulations.

Dunham feels simulating healthcare facilities is extremely important due to its cost-effective nature and the opportunity it provides to change building design, when needed, in order to lead to better functionality and patient care.

"Hopefully this research will help to make current operations in the emergency department more efficient in terms of staffing and patient satisfaction," she said.



Jennifer Lather and adviser John Messner discuss the HMC emergency department current and future workflow embedded in the initial discrete event simulation.



Steel structure construction for future patient beds and new ED to main hospital hallway.

"Advances in computing technology have enabled us to see future facilities before they are built. If we can find better ways to integrate that information into the complex design process, we can create buildings that respond to humans and not the other way around."

Lather will test how the data from the discrete event simulation can supplement the virtual reality environment. She will test different integration techniques that include having specific information available as healthcare representatives walk through the virtual facility, including waiting room times, overview statistics when in a bird's-eye view, and nurse utilization statistics when visiting different treatment areas.

Five different areas of the ED will be simulated with different layouts to test how changes will impact important performance metrics. Of those, the top three near optimal layouts will be selected. Healthcare practitioners will be presented with these options and asked to choose which layout they prefer. To better understand how they come to their decisions, Lather is gathering data on time taken to make the decision, model understanding, confidence in decision, and the process of decision making.

"Advances in computing technology have enabled us to see future facilities before they are built. If we can find better ways to integrate that information into the complex design process, we can create buildings that respond to humans and not the other way around," Lather said.

Dunham agreed, as she believes better healthcare facility design can impact both the patients and the healthcare providers in many different ways.

"Better design organization not only helps with the tangible, measurable goals such as savings [or] decreased cost, decreased length of stay in the ED, [and] increased efficiencies, but it also promotes better health and well-being not only of the patient being cared for, but [also] for the staff who are caring for the patient."

Lather believes that by engaging a subset of end users, the healthcare practitioners, in the design process, the design of healthcare facilities will be better connected with the operational uses of the facilities.

"Using these simulations, we can assess the impacts from a quantitative and qualitative way and help project teams understand the needs of the users in new ways," she said. "If we can better understand and assess the processes used to deliver care, we hopefully can react better and assimilate new knowledge of best practices easier into the healthcare delivery process." ■

Making an Impact

Engineers Improve a Tradition: Berkey Creamery

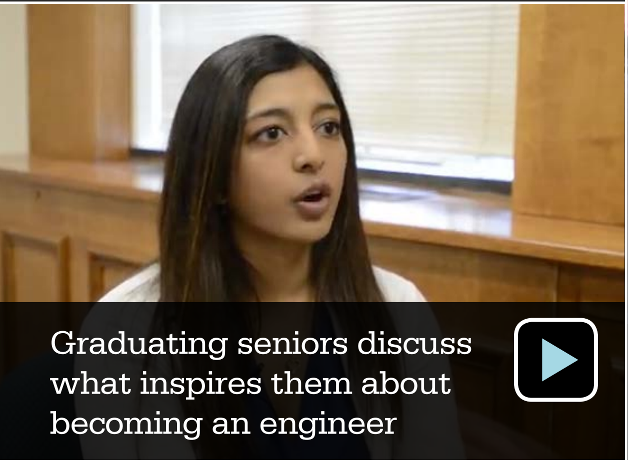
Industrial engineering students are applying what they've learned in the classroom to help improve service at one of the most beloved places on campus.

Annual IndustryXchange

Tucker attends Gates Millennium Scholars Program Celebration

Ladies Night at the Learning Factory

Seeing without sight



Graduating seniors discuss what inspires them about becoming an engineer

IME Industry Open House

Students travel to Israel – "The Startup Nation"

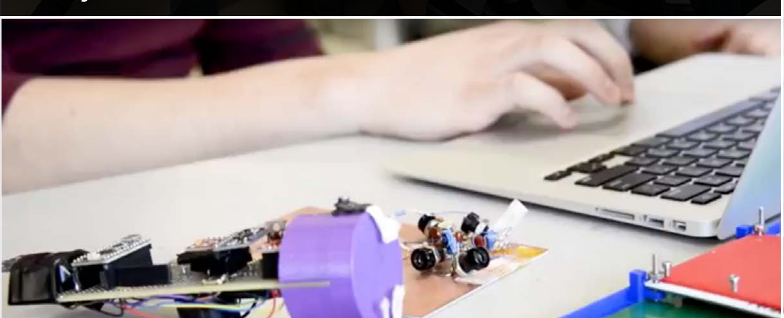
Why Penn State Computer Science and Engineering

The School of Electrical Engineering and Computer Science at Penn State gives graduate students the opportunity to work in exciting collaborative research fields, alongside world-renown faculty.

Penn State College of Engineering: Inspired

2018 Spring Design Showcase

CNEU Nanotechnology Summer School to aid students impacted by Hurricane Maria



Creating technology to launch rockets in the study of earth's magnetic fields

Distinguished Lecture on Engineering and Humanity: Dr. Claude Steele

The Science of a Diverse Community

From the kitchen table to economic summit, Penn State student takes his company to the top

by Varshini Chellapilla

Two years ago, **Itunu Lawani** helped his brother start L&L Foods at the kitchen table in their home in Atlanta. Recently, the company emerged as the winner of the Nigerian Economic Summit startup pitching event, receiving a prize of $15,000.

Lawani, a senior in industrial engineering, founded L&L Foods as a Nigeria-based packaged-goods company focused mainly on the country's peanut market.

Currently, Nigeria is the third largest producer of peanuts in the world. However, according to Lawani, more than 98 percent of the country's market is made of unpackaged, unbranded products. Peanuts are sold in bottles or plastic bags, increasing the probability of the presence of Aflatoxin, a cancer-causing bacterium.

L&L Foods focused on the Nigerian peanut market by developing a brand for its products, while ensuring the removal of Aflatoxin and maintaining an affordable price.

Lawani credits some of his experience to the engineering entrepreneurship classes he has taken at Penn State. He said Robert Beaury, interim director of the Engineering Entrepreneurship program in the School of Engineering Design, Technology, and Professional Programs, urged him to pursue the idea when it was still on the drawing board.

"Itunu is certainly indicative of the best and brightest students we have in the program," Beaury said. "[L&L Foods has] accomplished a great deal in a relatively short amount of time."

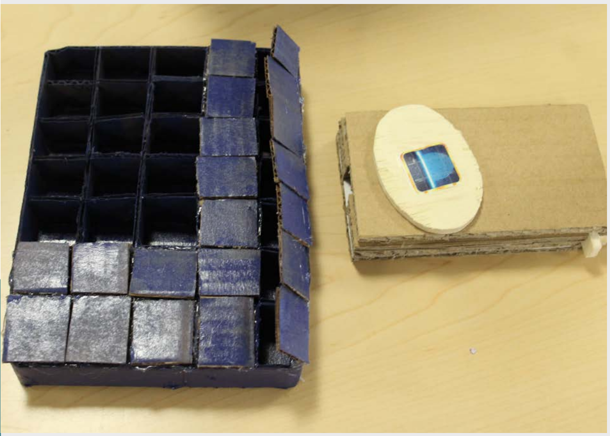
Lawani's interest in entrepreneurship began during his first year at Penn State. Although a few initial ideas didn't leave the drawing board, Lawani doesn't regret them. He believes failed opportunities helped him learn from his mistakes and evolve L&L Foods.

"Now, it's a very well defined brand and also [has] better packaging than when we started," Lawani said. "It's grown into this company with twelve people working for it and a manufacturing plant."

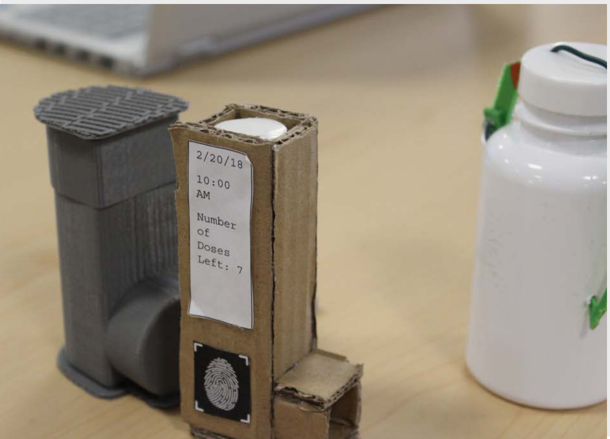
In October, Lawani's brother pitched the startup to judges at the summit, which is organized by the Nigerian Economic Summit Group and the Federal Ministry of Budget and National Planning. After a competitive event involving eight other startups, L&L Foods was declared the winner by members of multinational corporations and the vice president of Nigeria.

The brothers will use their prize to purchase new manufacturing plant equipment. Previously, workers manually peeled and roasted the peanuts. However, since product demand continues to increase, the money will help them invest in machines for production, allowing their supply to better meet the growing demand.

Upon his graduation in December 2018, Lawani plans to move to Nigeria to work full time at L&L Foods. Due to his industrial engineering background, he will focus his efforts on streamlining operations in the manufacturing plant. ■



After working for eight weeks to create a concept, design, and prototype for smarter opioid control, first-year engineering students enrolled in Christopher McComb's EDSGN 100 course presented their ideas and products to McComb and their fellow students. Student teams highlighted the importance of controlling opioid dosages and how their products would lessen accidental overdoses, consumption by someone other than the person the medicine is prescribed for, and the chance for addictions to start.



DESIGNED
to stop the opioid epidemic

Engineering Design 100 students design and prototype products aimed at smarter opioid control

by Samantha Chavanic

On January 10, 2018, Pennsylvania Governor Tom Wolf declared the heroin and opioid epidemic a statewide disaster emergency. According to data from the Drug Enforcement Agency, the number of fatal drug overdoses in Pennsylvania in 2016 was 4,642, a 37 percent increase from 2015. This increase is attributed to the number of fatalities caused by fentanyl and other similar opioids overdoses.

Though overdoses are often caused by the result of illegal drugs and opioids, the misuse of legal prescriptions continues to rise.

To combat Pennsylvania's opioid epidemic, **Christopher McComb**, assistant professor of engineering design and mechanical engineering, challenged his EDSGN 100 students to design and prototype a user-centered product or service aimed at smarter control of opioids. The product or service would ensure prescriptions are consumed at the right time, at the right dosage, and by the right person.

"Engineering exists to serve humanity, but as a first-year student with a full load of coursework, it can be easy to lose sight of that fact. I challenge my students with real-world problems to serve as a constant reminder that engineering should be human-centered," McComb said. "By choosing problems that are relevant to the state of Pennsylvania, I also want to empower them to think about how they can use their skills to improve their community."

4,642
fatal drug overdoses in 2016

Throughout the first eight weeks of the spring semester, McComb's students worked to identify the problem at hand, generate product and service concepts, select a concept, create low-fidelity prototypes, design beta prototypes, evaluate their prototypes, and present on their findings.

Student teams created products which included fingerprint-reading prescription bottles and time-controlled pill dispensers.

Everett Michel, a first-year engineering student, worked on the team that designed and prototyped a pill bottle that can only be opened using a fingerprint scanner at prescribed times each day.

Michel said he feels McComb's design projects have provided him with an advantage that other course projects can't—the ability to apply the engineering design process to a real-world problem and to retain more information.

By presenting the students with a real-world problem currently facing Pennsylvania, McComb helped to expand Michel's understanding of the influence and impact engineers have on the world.

"This project opened my eyes to how engineers are not confined to certain roles in society. We can be a force for change or improvement in almost any field," Michel said. "Engineering is not just about simply building things or even designing a physical product. Engineers come up with all sorts of things that improve our society in more ways than just one." ■

DIVERSITY
The Key to Social Impact

Humanitarian Engineering and Social Entrepreneurship ventures solve international problems through multidisciplinary and interdisciplinary work

by Samantha Chavanic

The Humanitarian Engineering and Social Entrepreneurship (HESE) program brings together students and faculty from multiple disciplines to research, design, field-test, and launch technology-based ventures in low- and middle-income communities around the world. As an integrated learning, research, and entrepreneurship program, HESE is housed in the School of Engineering Design, Technology, and Professional Programs.

To increase the health and well-being of those who live in these communities, HESE students have established seven ventures that seek to impact the United Nation's Sustainable Development Goals.

"The goal of the HESE program is to launch ventures that truly change the lives of people for whom very few products and services are typically developed. We believe that a shift to sustainable business models can make these markets viable for purpose-built products," said **John Gershenson**, HESE director. "Perhaps more importantly than launching these ventures, I believe that HESE does a great job of launching people who have the tools and motivation to go on and impact the world around them in everything they go on to do."

Students travel to a local market in search of tech savvy entrepreneurs.

Students from GreenBriq collect water hyacinth for testing.

KINJENZI

Students launching the Kinjenzi venture are creating a turnkey 3D printing solution for low resource areas. The computer- and computer-aided design-less system includes part libraries that are printed by local entrepreneurs to provide rural healthcare networks with items such as medical devices, anatomical models, and occupational therapy devices. Kinjenzi has been working for nearly two years to deliver healthcare products where existing supply chains cannot.

GREENBRIQ

By creating fuel briquettes from invasive plant species, GreenBriq is working to provide East Africa with a more sustainable, cleaner burning, and cheaper alternative to charcoal. The venture's first focus is creating briquettes from water hyacinth plants. This invasive weed is currently restricting shipping and fishing opportunities in numerous countries located in East Africa. GreenBriq's products will greatly impact the rapid deforestation happening around charcoal production.

The Matibabu team visits the Migosi Sub-County Hospital.

MATIBABU

Matibabu is co-developing a quick and non-invasive malaria testing device with a team in Uganda. Rural healthcare workers will be able to reuse the device on multiple patients, without the worry of blood-borne contamination. The goal of the Matibabu device is to help healthcare workers bring accurate malaria testing to those who ordinarily could not afford to get it, therefore impacting the millions who die from this disease each year.

RESILIENT

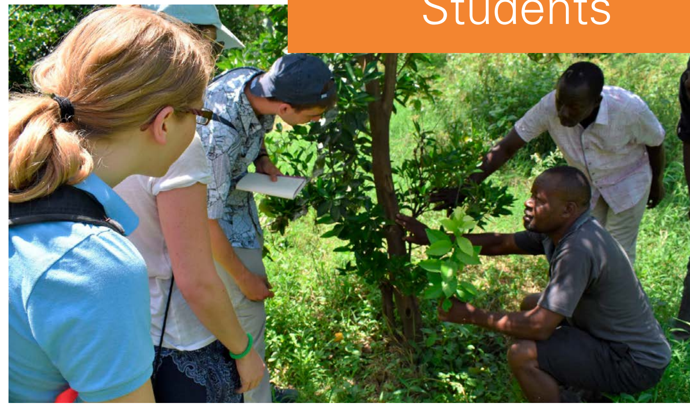
Resilient, modular 3D printers are being developed by the 3D Relief venture. Intended to be used in the toughest conditions by humanitarian relief organizations, the printers have the capabilities to print medical, sanitation, and agricultural parts on-site, off-grid, and in all environments, eliminating the high costs associated with shipping items into devastated areas. 3D Relief works closely with existing relief organizations throughout East Africa to create modular solutions to meet their individual needs.

INAKUA

Inakua is developing a small-scale aquaponics system to aid farmers impacted by climate change. By combining aquaculture, or raising fish, and hydroponics, or growing plants without soil by using water solvents rich with mineral nutrients, Inakua helps to provide farmers with the appropriate education and starting materials to create additional growing opportunities that supplement small farms during unpredictable weather.

"HESE does a great job of launching people who have the tools and motivation to go on and impact the world around them in everything they do."

Check out more photos and updates on the HESE facebook page bit.ly/2LaD9hR or at hese.psu.edu.



Students talk to a local farmer about how small scale farmers graft fruit trees in rural farms outside of Kisumu.

PRODUCE SOLUTIONS

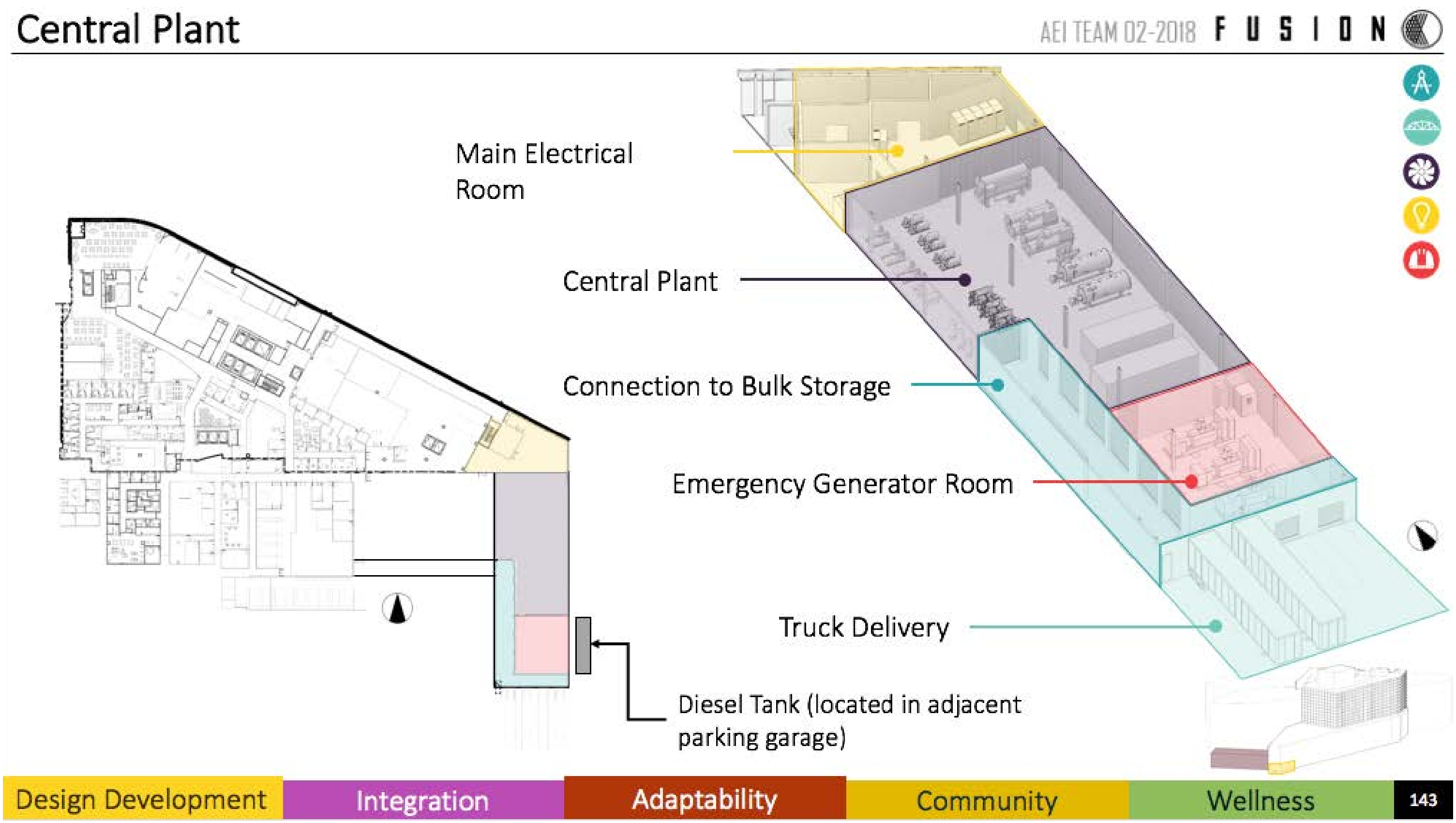
By connecting small-scale farmers with markets via alternative transportation opportunities, Produce Solutions is educating all those in the food distribution chain on the value of crops. The venture emphasizes how this knowledge will help to eliminate the high post-harvest losses which occur when some farmers incorrectly store their products to wait for the right buyer. Produce Solutions is using widespread cell phone technology to bring the market players together.

A fisherman guides the boat through the mess of hyacinth. The hyacinth is so thick in this area that it is difficult to even see the water.

BIOCINTH

Finally, Biocinth is creating bioplastics from various invasive plant species. In doing so, the student team is aiming to increase the volume of biodegradable plastics used in developing communities around the world. By working directly with those affected by the aggressive plants, Biocinth is creating incentives to use the more sustainable bioplastics as an alternative to the traditional petroleum-based plastics.

"I love that HESE students have chosen to work on a diverse set of problems. It shows how the process of spending time to get to know people and their problems results in a wide variety of potential solutions and a wide variety of potential business models," Gershenson said. "The reason for this variety I believe is the diversity of HESE students. They come from all over campus, with all different interests and backgrounds—that is the key to our success." ■



As part of the team's updated and upgraded design, Fusion moved the hospital's central plant to increase building integration and ease of facility use.

Building a better healthcare environment

Architectural engineering students design a flexible, integrated children's hospital for national competition

by Samantha Chavanic

Today's hospitals must be high-performing, versatile, and resilient buildings. They must include innovative and integrated design, maximizing their ability to serve their occupants' current and future needs.

As part of the 2018 national Architectural Engineering Institute Student Design Competition, 10 architectural engineering undergraduate students worked to create a cohesive, adaptable, patient-focused, state-of-the-art children's hospital located in Omaha, Nebraska.

Design challenges included a high-performance and energy efficient enclosure, a roofing system with helipad capabilities, the use of smart building technologies, and flexible spaces for disaster response.

Fifth-year team members **Colleen Aydelotte**, **Brianna Basile**, **Tom Campbell**, **Holly Davia**, **Camille Stefani**, **Devon Nguyen**, **Nicole Stammer**, **Mary Taylor**, and **Josh Walker**, and fourth-year **Alex Gubler**, focused their design on integration, adaptability, wellness, and community.

"A state-of-the-art facility is not just defined by the excellence of the building systems, it is defined by the success of the holistic design," Stefani said.

To fit these ever-changing needs, the team worked to integrate the building's structure, systems, and construction into one seamless project.

"When all architecture, mechanical, electrical, structural, and construction teams collaborate from the beginning of the project process, opportunities between disciplines can be identified early on," Basile said. "This integration allows for innovative, constructible, and cost-effective projects [to be built]."

The team's collaborative and innovative construction, lighting and electrical, mechanical, and structural planning and design created an optimal healthcare facility, with opportunities for future adaptability.

Construction plans focus on prefabrication factory to improve various building components, a detailed build schedule,

2018 AEI STUDENT DESIGN COMPETITION AWARDS

Integration Award: First Place

Innovation Award: Disaster Preparedness

Construction: Second Place

Mechanical: First Place

Structural: First Place

L-R: Mary Taylor, Colleen Aydelotte, Camille Stefani, and Tom Campbell review the building site for the state-of-the-art children's hospital.

a cost-effective design, and a central plant to increase integration and ease of facility management.

Lighting and electrical designs center around RGB + White LED lighting that promotes better circadian rhythm, patient controls, a backup power system that provides 96 hours of emergency power, and microturbines in the building's central plant to produce steam and power.

Improved mechanical systems involve a combined heat and power system to supplement electrical and thermal systems, a rainwater collection system, patient controls, and a double-skin façade to reduce energy loss and to improve overall building acoustics.

Structurally, the design includes concrete cast-in-place shear walls and an impact resistant façade. Composite framing was used to increase coordination with the mechanical, electrical, and plumbing team.

According to Stefani, adaptable healthcare spaces like the one the team designed are critical due to the longer expected lifespan of these buildings.

"The hospital has to adapt to changes in care on both a day-to-day basis and throughout the life of the building," she said. "Each patient has different needs and also preferences, and [our] design team wanted to provide a patient space that allows the medical staff to provide the highest efficiency of care while adapting to each patient." ■

"Each patient has different needs and also preferences, and [our] design team wanted to provide a patient space that allows the medical staff to provide the highest efficiency of care while adapting to each patient."

Fusion team members included 10 undergraduate students representing the four architectural engineering options of construction, lighting/electrical, mechanical, and structural engineering. Back L-R: Josh Walker, Nicole Stammer, Tom Campbell, Camille Stefani, Mary Taylor, Colleen Aydelotte, Holly Davia, and Brianna Basile. Not pictured: Devon Nguyen and Alex Gubler.

OUTSTANDING ENGINEERING ALUMNI

Alumni honored with College's most prestigious award

In April, twelve engineering graduates were honored with the 2018 Outstanding Engineering Alumni Award. Established in 1966, the Outstanding Engineering Alumni Award is the highest honor bestowed by the College of Engineering and recognizes graduates who have reached exceptional levels of professional achievement.

Back row, from left: **Bobby Braun**, aerospace engineering, B.S. 1987; **Ken Graziani**, chemical engineering, B.S. 1970; **Dong-Youn Sohn**, mechanical engineering, Ph.D. 1989; **Allen "Al" Soyster**, industrial engineering, B.S. 1965; **Gregory Riggins**, bioengineering, M.S. 1984; **Donald Lobo**, computer science, M.S. 1991; **Justin Schwartz**, Harold and Inge Marcus Dean of Engineering

Front row, from left: **Kenneth Lindquist**, nuclear engineering, M.S. 1967; Ph.D. 1971; **Thomas A. Seliga**, electrical engineering, M.S. 1961; Ph.D. 1965; **Barbara Covolus Faust**, engineering science and mechanics, B.S. 1964; **Charles Carter**, architectural engineering, B.S. 1990; M.S. 1991; **Susan McNulty-Atwater**, agricultural and biological engineering, B.S. 1999; **Steven Devine**, civil engineering, B.S. 1984; M.S. 1986

Read full bios of our outstanding alumni.

Shannon McCully finds magic in industrial engineering through career at Disney

by Carolyn Cushwa

Industrial engineering is all about efficiency and innovation, incorporating math and science to create new and improved ways to perform tasks. These tasks are accomplished using a variety of methods. For some, the trick might be instinctual, while others rely on science and equations to get the job done.

But for Penn State alumna **Shannon McCully**, there is one thing that makes her career in industrial engineering different from all of the others: magic.

With the official title of manager of industrial engineering, McCully leads a team of experienced industrial engineers to support Walt Disney Parks and Resorts in Orlando, Florida.

A lot of the work that McCully does for Disney is to make the process of visiting one of its locations as easy and enjoyable as possible for guests.

"We're analytical thought partners. I assign work to my team for projects, and then I make sure I review it and make sure the work is sound and that we are making good recommendations to help Disney run more efficiently," she explained. "Our guests dream about visiting and save up to visit Disney Parks, so we want to make sure they have the best experience possible."

McCully graduated from the Harold and Inge Marcus Department of Industrial and Manufacturing Engineering in 1996 with a bachelor's degree in industrial engineering. Within a month, she began her career with Disney.

"Disney called me because Penn State sent my information when a manager who went to Penn State asked for résumés. They contacted me, interviewed me and then invited me down to Florida," McCully explained. "I had a very nontraditional path to the position. I got very lucky and I worked very hard."

In 2003, McCully earned her M.B.A. from the University of Florida.

"I definitely did not think I'd stay with Disney for as long as I have, but it's such a great place to work and I always get to keep learning. Besides, it's Mickey Mouse," she joked.

When asked what her one piece of advice would be for students that are preparing to graduate or begin a career, McCully's advice was simple: Do what you are passionate about.

"You show up for work every day, you might as well do what you love. Even if you don't find it right away, keep looking for it," she said. "School does end. You will get through these classes, and on the other side of that you get to solve some really cool problems that help people. And that's what's great about industrial engineering. We make things run better, and we help people." ■

"Our guests dream about visiting and save up to visit Disney Parks, so we want to make sure they have the best experience possible."

Jennifer Dubuque joins Penn State as senior director of development for the College

Jennifer Dubuque joined the College in November as senior director of development.

Dubuque is charged with guiding and overseeing all development and alumni relations activities. She collaborates with the Harold and Inge Marcus Dean of Engineering, Justin Schwartz, as well as faculty and volunteers, to define fundraising objectives and priorities for the College.

With more than 25 years of advancement experience in both private and public institutions, Dubuque most recently served as the vice president for institutional advancement at Mount Aloysius College in Cresson, Pennsylvania, where she was responsible for planning and implementing the College's fundraising strategy, including annual and campaign support, government and foundation funding, and engagement of alumni and the community.

In addition, she previously held roles as the assistant vice president for university advancement at Florida Atlantic University in Boca Raton, Florida, and the associate director of individual gifts and gift planning at Rensselaer Polytechnic Institute in Troy, New York.

Dubuque received a bachelor of arts degree in communication arts, cum laude, and a minor in psychology from Marist College in Poughkeepsie, New York, as well as an honors certificate from Crehan Commercial College in Dublin, Ireland. She is a Certified Fund Raising Executive and board member of the Association of Fundraising Professionals, Allegheny Mountains Chapter, as well as a member of the Council for Advancement and Support of Education, the American Association of University Women, and the Association of Institutional Advancement & Development Professionals.

Cheryl Moon-Sirianni: Champion for women in civil engineering

by Megan Lakatos

Cheryl Moon-Sirianni always had her sights set on attending Penn State. After graduating from Freeport Area High School in 1983, she went off to University Park to major in petroleum engineering.

Everything changed for Cheryl after her first year. That summer, she had an internship with the Pennsylvania Department of Transportation (PennDOT), where she worked on a bridge project in Kittanning, Pennsylvania. "I was bitten by the civil engineering bug," she says. "I was so intrigued by how the bridge design worked, and knew that civil engineering fitted me better than petroleum engineering."

Cheryl was not only bitten by the civil engineering bug; she was bitten by the PennDOT bug. After graduating with a bachelor's degree in civil engineering in 1987, Cheryl began her career with PennDOT—and has been there for 31 years. In November 2017, she was appointed district executive for District 11, which covers a three-county Pittsburgh region.

As the first woman to lead District 11, Cheryl is responsible for 800 men and women who work in the district, and oversees more than $370 million in construction projects, 2,569 miles of roadway, 1,796 bridges, and four tunnels in Allegheny, Beaver, and Lawrence counties.

Cheryl is a strong advocate for women, especially for women entering the field of civil engineering.

"What I see with a lot of young women is they don't have the confidence—they don't feel they can do everything a counterpart can do," she says. "Never sell yourself short. You are just as capable, if not more capable, than the other folks sitting around you."

In addition, Cheryl is a member of the Penn State Beaver Advisory Board, where she chairs the Recruitment and Retention Committee. A big focus of the committee is to try to attract students from underrepresented communities to engineering, who might think engineering is not an option for them.

"Civil engineering is a great career choice. You can choose to be a public servant, a hydraulic engineer, a bridge designer, a roadway designer, build skyscrapers, you can choose to work in the office, out of the office—there's a lot of flexibility," she explains.

Cheryl has had many professional achievements throughout her career with PennDOT. She received the Secretary's Award for Excellence in 1996; the American Society of Civil Engineers Service to the People Award in 2006; she was a National Award Nominee for the White House Champions of Change, Connecting Transportation and Ladders of Opportunity in 2014; and received the Engineer of the Year Award from the Engineers Society of Western Pennsylvania in 2015.

"You should never be in a job where you're not having fun," Cheryl says. "Enjoy the opportunities you have—life is short so you should live every single day to the fullest."

FROM YOUR PRESIDENT

Engineering Health and Wellness Today

Our healthcare industry is undergoing many changes, with technology being a key driver. Today, more than ever, Americans are being provided tools and technology to help them monitor their health, prevent diseases, and make better, healthier lifestyle choices. It can be as simple as an app for your phone, a mobile health monitor, or an implanted device that helps an individual—or their healthcare provider—make important healthcare decisions. Not only are these technologies helping to treat existing conditions, but they aid in disease prevention and improve our quality of life. Penn State engineers are on the forefront of the innovation in this arena.

For example, the Penn State Department of Biomedical Engineering is one of the fastest growing departments in our College, due, in part, to a growing interest in young engineers wanting to help and serve others. Through its curriculum and research opportunities, the department prepares students to be leaders in the areas of medical device design, instrumentation, medical imaging, healthcare management, biomedical research, and academia.

Industrial engineers are contributing to healthcare by improving medical training, using 3D printing to customize orthopedic implants, and reducing the risk of hospital readmission.

Even in my discipline of electrical engineering, I hear about the ongoing research to reduce the size of implantable devices in order to lower the chance of infection and rejection, and improve power sources to lengthen the usable life of these devices.

With advancements in healthcare happening at breakneck speeds, medical breakthroughs such as new devices, technologies, and diagnostic tests seem to be available every day. Penn State engineers are helping to ensure a healthier world!

On a personal note, my tenure as president of the Penn State Engineering Alumni Society ended on July 1, 2018 and Jane Clampitt ('79 ChE) now serves as your president. It's been an honor to represent you, and meet and work with our alumni community over these past two years. I look forward to staying involved and attending events like the Alumni Tailgate on September 15, 2018. Maybe I will see you there!

For the Glory,

Dale T. Hoffman '72 E E
President, Penn State Engineering Alumni Society
dhoff128@comcast.net

THE PENN STATE ENGINEERING ALUMNI SOCIETY

Building an active, engaged community of engineering alumni since 1959

PSEA

The alumni society provides:

- Membership in a worldwide network of almost 100,000 engineering alumni.
- Fellowship among engineering alumni, faculty, staff, and students.
- Volunteer and service opportunities on campus and in your own community.

We want to hear from you! **Visit PSEAS** on the web to submit your latest news and to learn more about becoming a member.

FOR MORE INFORMATION, CONTACT:

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PennState
College of Engineering

The Pennsylvania State University
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University Park, PA 16802-1400

Calendar of Events


Aug. 11	Summer Commencement
Aug. 20	Fall Semester Begins
Sept. 12-14	Fall Career Days
Sept. 14	Penn State Engineering Alumni Society Board Meeting
Sept. 15	Penn State Engineering Alumni Society Alumni Tailgate (Penn State vs. Kent State)
Sept. 18	Architectural Engineering Career Fair
Oct. 7-13	Homecoming and Military Appreciation Week
Oct. 19-21	Parents and Families Weekend
Dec. 6	College of Engineering Design Showcase
Dec. 15	Fall Commencement