SEEING THE WORLD THROUGH THE ENGINEER’S LENS

As engineers, we’re aware that we see the world differently. We don’t simply marvel at feats, we learn from them—we dig in and investigate how they’re accomplished and use what we’ve learned to create better solutions to the problems we’re tackling.

We don’t simply wonder, “what if?” or “wouldn’t that be nice?” We get tactical—we measure the distance we are from the goal and set up strategies to bring us closer. We have confidence that each idea can be brought to life with the right amount of care, attention and persistence.

We don’t become dissuaded by failure. We wear each misstep as a badge of honor, knowing it helps us better frame the right solution.

This lens through which we view the world is one of our greatest strengths. Here at the Case School of Engineering, it allows us to usher in the new era of connected devices via the IoT, it guides us through the creation of more personalized medical care through deep-learning computer algorithms, it encourages us to look up toward the future of electric air vehicles, and it shows us the way to better develop and inspire the next generation of innovators.

I invite you to explore the world we see through our lens—it’s one of perseverance, dedication and a deep desire to make this world a better place for everyone.

Venkataramanan “Ragu” Balakrishnan
Charles H. Phipps Dean, Case School of Engineering
Case Western Reserve University
Meet Nick Barendt, Internet of Things (IoT) expert and champion, and inaugural executive director for Case Western Reserve’s Institute for Smart, Secure and Connected Systems (ISSACS).

Get inspired by how he’s planning to lead the university’s vision for industrial IoT innovations.

What attracted you to the ISSACS executive director position? I think ISSACS is, in many ways, a startup in a really interesting area. There’s this convergence of technology—the IoT is a big tent of technology, from digital transformation to engineering and software disciplines. But without the other aspects of business, law, medicine, social science and other areas where these technologies are deployed, we’re only solving a technical problem. That’s why we’ve focused on a technology-plus approach—with this convergence of medicine and technology, or business and technology, we’re going to see some amazing things happen in the next few years. I’m fascinated by the way ISSACS is approaching this—developing really broadly rounded teams from a convergent research topic area.

What’s an example of this in action? We recently met with GE Lighting to discuss taking the campus’s Fend Greenway space, which GE Lighting is providing the lighting for—including donating their LightGrid node technology so that together we can turn that space into an IoT living lab. And by that I mean we’re thinking about the societal, neighborhood and community pieces along with the technology. In a traditional lighting approach, you would install lighting on poles to brighten a walkway. Perhaps in the modern era, you would use LED lighting to be more energy-efficient. But from a community engagement standpoint, you could set up a lighting network that is capable of decreasing brightness when the lights aren’t needed in order to decrease light pollution. At the same time, you can build a network infrastructure to deploy other sensing technologies such as an air quality monitor, noise, things like that. GE is interested in continuing to develop smarter lighting, and we’re excited to partner with them to do so.

What is your background? I’m a Case electrical engineering and computer science double alum. After graduating, I worked at Nordson in the electronics industry. I then spent some time in the tech and measurement world, and then went out and did some startups and consulted, where I developed expertise in elements of the cloud infrastructure and deployment. Then I became a partner at the software firm LeanDog and led the design and delivery studio. For also being an adjunct faculty member at Case School of Engineering for a while and have developed and been teaching a course on the IoT (read more on page 6).

What are your primary charges and goals as ISSACS executive director? I’m focused on fostering collaborations across the university and with our external partners—those in industry, nonprofit groups, economic development organizations and other community conversations. I’m also here to help increase research grant proposals in this space. I’m also working with our peers at Cleveland State University and other partners on the IoT Collaborative (read more about the collaborative, a partnership between CWRU and CSU supported by the Cleveland Foundation, on page 7). In that space, I’m helping provide alignment and collaboration around all of the region’s various IoT initiatives.

How is Northeast Ohio, with its roots in manufacturing, positioned to be a leader in this space? Why here? We know how to make things, right? Whether it’s automotive or welding machines or durable goods or medical devices, we know how to make things at scale. We have the manufacturing and supply-chain capabilities. The piece that might be missing is we need broader talent in this area to help translate and apply these innovations. People begin to think about how to adapt their products to move from selling a thing—which becomes a commodity—to selling a thing plus value-added services, to selling an outcome model.

How does a university play a role in the advancement of the IoT sector? A university is very focused on training the next generation of engineers, scientists and business leaders—creating that talent pipeline to support these industries. There’s also research opportunities to work with industry partners that wouldn’t fit into a consultant’s typical area of expertise, that are too cutting-edge from a technical standpoint or are too niche that the expertise doesn’t exist outside of the university’s walls. Universities are here for the long haul. It’s one of the critical assets of a region, a research university’s capabilities, because of that long tenure.

ISSACS is focused more on industrial applications of the IoT. What does that mean and how is that different from commercial applications? The consumer side—you’re Nest thermostat, your Fitbit—they are great and impactful. But the industrial IoT, the IoT, which we would describe as things in industry manufacturing, health care, energy and smart cities and infrastructure—the economic impact of those areas dwarfs the consumer IoT opportunity by a factor of two or more. What it means to deploy these technologies for health care in the hospital or home health care—assistance technologies to allow senior citizens to remain at home but still be connected to the health care system via remote capabilities—or in factories for increased automation capabilities, the economic impact is enormous. As we think about replacing and augmenting our aging infrastructure in the U.S. and around the world—our water systems, roads, bridges—they all have huge opportunity areas for the IoT.

What projects with regional partners is ISSACS engaging with currently? We’ve had conversations with the Ohio Tumpke Commission as they are rolling out their smart, connected system on a section of the tumpke to help them with some of their challenges. We’re also talking with the Cleveland water department about smartly tackling water loss. ISSACS and Cleveland State are also involved in conversations with Cleveland-based business incubator BizEEnterprise and a number of other organizations around the opioid crisis and how we can integrate disparate pools of data to identify opportunities for intervention. Those are just a few of the fascinating conversations we’ve had in the last few weeks. There’s so much potential here.

What gets you the most excited about ISSACS and IoT opportunities? There’s so much value on the IoT ecosystem. There’s so much money on the IoT ecosystem in terms of revenue, profit, economic impact. But without the other aspects of business, we’re only solving a technical problem. That’s why we’ve focused on this technology-plus approach—with this convergence of medicine and technology, or business and technology, we’re going to see some amazing things happen in the next few years. I’m fascinated by the way ISSACS is approaching this—developing really broadly rounded teams from a convergent research topic area.

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From your smartphone or from any internet-connected computer, or from an Amazon Cloud app, you can turn on the desk lamp sitting in your home or office, swipe across a slider to adjust its hue—red, orange, yellow, green, blue or purple—and adjust its brightness. With its connectivity, you can check these levels while you’re away from home. You can even plug in a camera or set a loop for the light to dim and brighten on a schedule.

Would you ever actually need to do any of this? Likely not. But the multi-chromatic, touchscreen-sporting, small tabletop lamp, rocking a 3-D printed shade, and lovingly referred to as “the world’s most over-engineered lamp,” isn’t really about building and remotely controlling a lamp. It’s at the center of the jointly offered EECS 377 technical elective course “Introduction to Connected Devices,” which shows students how to harness the power of the Internet of Things (IoT).

The course is a robust, comprehensive survey of what it takes to design and build a device that is connected to the internet: everything from the hardware to the software firm, the syllabus crams a lot in. But the students thrive on the rapid pace of the content and challenges and couldn’t wait to integrate even more functionality. For their final project for the course, students created their own next-gen for the lamp: everything from making it function with Google Home and Alexa to having the light change color when your bus is close to your stop.

“On the last day of class, I had so many students come up to me and say ‘This was the most amazing class I’ve ever taken,’” said Barendt. “That means a lot to me. That means we’re doing a good job of training the next generation of tech leaders.”
The University of Akron, Ocius Technologies and Case Western Reserve received a $1.5 million grant from the Defense Advanced Research Projects Agency (DARPA) to explore how computationally intensive engineering and physics problems can be more rapidly solved using new types of analog computers. Case Western Reserve’s Soumyajit Mandal has joined the research team for the phase II award, following a successful phase I effort that explored analog co-processors with a focus on simulation and design.

Civil engineering’s Bill Yu is developing an embedded sensor for seat belts that would detect—based on heart and breathing rates—when a driver is getting drowsy and alert them to the issue.

Case Western Reserve, Cleveland State and Mercyhurst universities have formed the North Coast Cyber Research and Training Alliance to develop cybersecurity education, research and training programs in Northeast Ohio and western Pennsylvania.
Nearly $2M in funding from the Cleveland Foundation

Connected to industry, including engagement with 38 alumni serving on our Silicon Valley advisory group, who work at companies like Google, Apple, Y Combinator, NVIDIA and Yelp, as well as serial technology entrepreneurs and academics.

IoT Collaborative
To further extend the impact and the pace of breakthroughs in the Industrial IoT (IIoT), Case Western Reserve and Cleveland State universities have partnered to launch the IoT Collaborative (IOTC) in 2018—combining their expertise to turn Northeast Ohio into the capital of the IIoT.

Industrial IoT (IIoT) will dwarf consumer IoT applications by 2-3x

There were 3.8 billion IoT devices in 2014. 34 billion devices are forecasted to be connected to the internet worldwide by 2020.

In total, $11 trillion will be spent worldwide on IoT solutions by 2025.

Collaborating with 36 companies

IoT Collaborative projects underway:
• Utilizing ground penetrating radar to monitor subsurface utilities
• Collaborating with Cleveland’s Hough neighborhood to identify their greatest community needs and explore IoT solutions
• Pooling data to identify interventions in the opioid crisis

6 initial research pilot projects have been funded via ISSACS to drive IoT innovations, including point-of-care medical devices and smart fire fighting.

Nearly $1M in grants and $12M in philanthropic gifts

4 main research thrusts:
- Energy
- Health
- Manufacturing
- Infrastructure/Smart Cities

Networks, embedded systems and more.

Institute for Smart, Secure and Connected Devices (ISSACS)
Case Western Reserve created the Institute for Smart, Secure and Connected Systems (ISSACS) in 2016 to empower faculty, students and partners to conduct research and catalyze breakthroughs in the IoT space. The institute leverages the university’s strengths in basic science and engineering, as well as health-oriented fields, business, humanities and social sciences. It leads initiatives in data science, cybersecurity, networks, embedded systems and more.

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$8 million+ raised in faculty endowments since 2016

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Collaborating with

36 companies

51 Case Western Reserve faculty members

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TAKING ON THE IOT
The Internet of Things (IoT) is the network of billions of physical devices that contain embedded technology to communicate with each other and interact over the internet. It includes factory automation and technology that monitors agricultural production, transportation, utility infrastructures and even patients remotely.

127 new devices globally connect to the internet every second

100% of industrial manufacturers say IoT is key to drive digital business transformation

BUT

66% of organizations think they aren’t moving fast enough regarding IoT

AND

only 33% have a holistic IoT strategy in place

$11 trillion

Up to $11 trillion will be spent worldwide on IoT solutions by 2025.

2-3x

Up to 2-3x more devices are forecasted to be connected to the internet worldwide by 2020.

<1%

<1% of data captured is used by decision makers

$8 million+

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Cited data sources can be found at engineering.case.edu/report-17-18-data-sources.
Biomedical engineering researchers are using machine-learning algorithms and clinical imaging scans to improve diagnosis and guide better treatment plans for a range of diseases, from cancer to heart failure to Alzheimer’s. 

And, with funding from the U.S.–India Science and Technology Endowment Fund, the center is partnering with the Tata Memorial Centre in Mumbai to develop a predictive algorithm based on digitized tissue slides to help identify aggression in breast cancer to determine which patients will benefit from chemotherapy and which will not. By predicting success based on valid, quantitative information, doctors can put patients on the right treatment track from the start, according to Satish Viswanath, center member and assistant professor of biomedical engineering. Viswanath specializes in applying predictive image analysis approaches to gastrointestinal diseases like colorectal cancers and inflammatory bowel conditions like Crohn’s disease.

“If you can know upfront what’s going to work best for the patient, at every step, you are personalizing the treatment plan. That’s where these programs are going to have the biggest impact.”

-SATISH VISWANATH, PALLAVI TIWARI AND ANANT MADABHUSHI

Machines and machines have come a long way since Archimedes invented the ancient Greek world by experimenting with pulleys and levers. Our tools are more sophisticated than ever—driven by computing power that has, by some estimates, seen a trillion-fold increase since the advent of the first computers in the mid-1950s.

Add the proliferation of big data and large numbers of imaging studies to the mix, and the environment is ripe for a new generation of smart machines capable of helping human users in unprecedented ways. Biomedical engineers at Case Western Reserve University are looking to pack that high-tech toolkit with a fleet of machine-learning algorithms that can help clinicians make more accurate diagnoses and guide more effective treatment plans.

DATA-DRIVEN DIAGNOSES

Simply put, machine-learning and deep-learning computer programs recognize patterns in imaging scans and make predictions based on that information, says Anant Madabhushi, the F. Alex Nason II Professor of Biomedical Engineering at Case Western Reserve and director of the university’s Center for Computational Imaging and Personalized Diagnostics (CCIPD).

Madabhushi and his center are pioneering the use of these programs in health care, applying their predictive power to better diagnose and treat a whole host of diseases.

The researchers build their algorithms based on data from routinely acquired medical images, typically MRI or CT scans or digitized tissue slides, which they say contain a treasure trove of information invisible to the human eye. Some conditions are notoriously tricky to identify based on images alone. For instance, 97 percent of lung nodules are benign, Madabhushi says, but it’s difficult for radiologists to tell harmless nodules from tumors based on the visual information from a scan.

“So you are on the side of caution,” he says. “You order additional tests like follow-up CT scans and biopsies — it’s expensive and invasive.” By identifying quantitative patterns, he says, these decision tools could help radiologists do a better job differentiating these very similar-looking pathologies.

Similarly, radiation necrosis in the brain—a benign condition that results from radiation treatment—is nearly impossible to visually distinguish from a recurrent brain tumor on routine imaging, Pallavi Tiwari, CCIPD member and assistant professor of biomedical engineering, has developed an algorithm that outperformed expert clinicians in telling the difference. On their own, the two neuroradiologists in the original study accurately diagnosed cancer about 50 percent of the time. But when they teamed up with Tiwari’s algorithm, they spotted 95 percent of cancer recurrences.

While these diagnostic programs are sometimes framed as competitors for their human counterparts, Tiwari’s study highlights the power of the human-machine combo. “You can’t teach computers everything,” she says. “But if we can bring human experience together with what computers can do, it’s a powerful combination.”

In collaboration with clinicians at Cleveland Clinic this year, Tiwari received a three-year $200,000 grant from the Dana Foundation. She also received a $577,000 Department of Defense grant to continue testing and validating the algorithm’s performance on multi-institutional studies.

The center’s growing army of automotive engineers is not limited to cancer. Researchers published a study this year in PLOS ONE documenting an algorithm’s 97-percent accuracy in predicting pending heart failure, and they’re applying the approach to diagnosing Alzheimer’s earlier and predicting the progression of kidney disease.

THE RIGHT TREATMENT, RIGHT AWAY

The ability to predict a disease’s aggression level is just as critical as making a quick, accurate diagnosis in the first place, Madabhushi says.

This year, the center secured grants of more than $6 million from the National Cancer Institute and almost $2 million from the Department of Defense to support developing algorithms to predict the aggressiveness of lung, prostate and brain, as well as head and neck cancers. The center is collaborating with Cleveland Clinic, University Hospitals, the Louis Stokes VA Medical Center, and also industry partner Insparta Inc. and, with funding from the U.S.–India Science and Technology Endowment Fund, the center is partnering with the Tata Memorial Centre in Mumbai to develop a predictive algorithm based on digitized tissue slides to help identify aggression in breast cancer to determine which patients will benefit from chemotherapy and which will not.

The researchers’ ultimate goal is to create a more precise approach to healthcare. For many diseases, lack of predictive guidance forces doctors to take a “kitchen sink” approach to treatment, Madabhushi says, in which the same treatment plan is applied across the board, leaving clinicians to react if it’s not effective. Precision medicine can be more proactive, personalized and informed.

“If you can know upfront what’s going to work best for the patient, at every step, you are personalizing the treatment plan. That’s where these programs are going to have the biggest impact.”

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Case Western Reserve will be able to ramp up its research initiatives in computational imaging, machine learning, and personalized medicine thanks to a pair of generous alumni: Jayendra Jeyapura (GRS ’94, computer engineering) and Harita Patel (GRS ’80, computer engineering) committed $500,000 to the university’s Center for Computational Imaging and Personalized Diagnostics, led by Anant Madabhushi, the F. Alex Nason Professor II of Biomedical Engineering.

The California couple—who met at the Case School of Engineering in graduate school before going on to successful careers at Apple—have long been supporters of Madabhushi’s work, which uses predictive algorithms built on routinely acquired medical images to more quickly diagnose and predict response to treatment for a host of diseases, from cancers to heart failure to Alzheimer’s and more.

Thanks to their gift, the center will be able to expand its research into new disease areas.

Student teams in a first-year seminar class about engineering discovered a new pattern in neural activity that shows that as some brain networks speed up, others slow down—suggested that not all of the brain’s networks can operate at once.

What if we could stop pain at the source? Researchers at Case Western Reserve received a $1.8M grant from the NIH to refine the pain-management component of the electric nerve-block device they’ve developed, and to investigate how the technology could be used to treat asthma and heart failure.

A new MRI contrast agent that pinpoints breast cancers early and differentiates between aggressive and slow-growing types was developed by Zheng-Rong Lu, the M. Frank Rudy and Margaret Dormiter Rudy Professor of Biomedical Engineering.

Researchers received a $1.8M grant from the Department of Defense to develop an implantable muscle stimulator to improve muscular health and prevent atrophy-related pressure ulcers and deep tissue injuries that can affect patients with spinal cord injuries.

Biomedical Engineering’s Eben Alsberg developed a tissue engineering technique that coaxes a patient’s own stem cells to assemble into stackable rings that could be used to build artificial tracheas.


dr. Emily Graczyk, a doctor of physical therapy, and Associate Professor Dustin Tyler, the Kent H. Smith Professor of Biomedical Engineering, and post-doctoral researcher Emily Graczyk conducted the first known study of how amputees use advanced sensory-enabled prostheses at home—subjects reported stronger feelings of social connection and an improved sense of well-being.

Seven promising pieces of biomedical engineering technology took a step closer to commercialization with the help of funding from the university’s Case-Coulter Translational Research Partnership. More than $1.1 million was awarded to support the following projects:

- A molecular imaging agent for surgical resection of invasive brain tumors
- A decision support tool for lung nodule risk prediction on screening CT
- Point-of-care device for monitoring and diagnosing oral cancer
- A minimally invasive direct current nerve block
- An ablation catheter with imaging for better treatment of atrial fibrillation
- Point-of-care device for diagnosis of cystic fibrosis in newborns
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ADVANCING POINT-OF-CARE TECHNOLOGY

Researchers at Case Western Reserve are leading the charge to make health care quicker, cheaper and more personalized.

Point-of-care (POC) devices allow physicians to perform tests, make diagnoses and monitor patients in person in a matter of minutes, skipping the lab and the lag time. These devices have the potential to dramatically improve the delivery of care in countries with localized medical systems where a lack of infrastructure complicates the flow of care.

There are currently no FDA-approved POC devices for monitoring patients with a spectrum of blood coagulation disorders.

CLOT CHIP

developed by engineering’s Pedram Mohseni, detects blood clotting ability 95 times faster than current methods using just 1 drop of blood

500M people live with a hemoglobin disorder worldwide

HEME CHIP

70% of sickle-cell-related deaths in Africa could be prevented with early detection

Developed by engineering faculty member Umut Gurkan for the rapid diagnosis of sickle cell disease [read more on page 10]

$2-per-screening, provides results in 10 minutes

Received $150,000+ in funding from the American Heart Association

Health tech company XaTec Inc. raised $9.1M to support Clot Chip’s development

There are zero POC screening options for neurodegenerative disorders like Alzheimer’s

BIO-CONJUGATED, SINGLE-USE BIOSENSORS

Developed by chemical engineering’s Chung-Chiu “C.C.” Liu, the sensors could provide the foundation for handheld sensors to detect biomarkers of Alzheimer’s disease

2M+ units of platelets are transfused annually in the U.S. Limited by 5-day shelf life and need for refrigeration

SYNTHOPLATE

Shelf-stable artificial platelets developed by biomedical engineering’s Anirban Sen Gupta that can treat traumatic injuries or break up life-threatening clots

Supported by $1M DOD grant and more than $4M in NIH and other funding

Oral squamous cell carcinoma is the 6th most common cancer in the world

BETA DEFENSIN INDEX TECHNOLOGY

Handheld device developed by Umut Gurkan in collaboration with CWRU’s School of Dental Medicine, uses a new biomarker to rapidly diagnose and monitor oral cancer

Delivers results in 15 minutes in any dental clinic as part of a regular checkup

Developed by the School of Medicine’s Brian Grimberg, detects malaria in 1 minute [Read how this device has been coupled with Gurkan’s HemeChip into a POC powerhouse on page 8]

Almost half the world’s population is at risk for malaria

MAGNETO-OPTICAL DETECTION FOR MALARIA (MOD)

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**GIVING STUDENT IDEAS A BOOST**

The Student Project Fund at the Larry Sears and Sally Zitnick Sears think[box] offers students unprecedented access to financial assistance to help them pursue their innovation dreams. Through this unique program, all Case Western Reserve students can apply for awards of up to $2,500 to assist them in turning their ideas into realities—including entrepreneurial pursuits, team projects, design competitions, personal projects and more. Realizing that college students frequently have ideas that are bigger than their budgets would allow them to actualize, the funds are intended to help cover the cost of materials, equipment, manufacturing costs and related expenses that would otherwise be out of reach. Projects can be on any topic. This year’s project fund was made available thanks to the generous support of the Reinberger Foundation.

Meet some recent recipients of the Student Project Fund and learn what they’ve built, why they’re passionate about innovating and how the fund and Sears think[box] have had an impact on their lives.

**Jiajie Hu**, a graduate student pursuing his PhD in civil engineering, used the student project fund to build his own 3-D concrete printer.

“My advisor recommended I use the 3-D printer and 3-D scanner in Sears think[box], and I was so impressed and inspired by the 3-D polymer printer there. I applied to the Student Project Fund to use that inspiration to invent a 3-D concrete printer for construction applications. The space and the funds allowed me to pursue something I couldn’t have even imagined before.”

**Kian Chen**, a fourth-year macromolecular science and engineering major who’s planning to attend medical school after graduation, is a member of the Global Health Design Collaborative, an undergraduate student organization at Case Western Reserve that works with Makerere University to develop solutions for identified needs in rural Uganda. Alain’s team sought to design a vaccine carrier that can safely store and maintain vaccines at the proper temperature without refrigeration. The funds gave my team one less thing to worry about during the prototyping process—the financial limitation. It encouraged my design team to focus on the bigger picture without constraints. We were able to experiment with different ideas to implement.”

**Alan Chen**, a fourth-year macromolecular science and engineering major with a minor in biomedical engineering, used the student project fund to build his own 3-D concrete printer.

“Without the funds, we wouldn’t have been able to create two models of the vaccine storage carrier for our trip to Uganda. The funds gave my team one less thing to worry about during the prototyping process—the financial limitation. It encouraged my design team to focus on the bigger picture without constraints. We were able to experiment with different ideas to implement.”

**Emily Long**, a junior majoring in mechanical and aerospace engineering, tapped into the student project fund to prototype a device he’s dubbed a “dielectric barrier discharge plasma actuator,” which is a thin, flexible electrode that uses electric fields to control the flow of air—and could potentially make wind turbines more efficient. Gosh has been innovating since the first grade, when he invented a state-science-fair-winning entry of a shoe that had a touch sensor near the big toe to alert wearers if they put their shoe on the wrong foot.

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“I was attracted to Case Western Reserve because of its research and design opportunities and facilities, but what differentiated it from other schools for me was its focus on global citizenship and innovation for the good of others. When I first started using Sears think[box], it introduced me to the real world of innovating. Just having access to the equipment and resources there changed how I and my group approach design challenges and solutions. It’s allowed us to design and prototype faster and more efficiently than we could otherwise. The student project fund allowed us to purchase vital prototyping and testing materials, and we received valuable feedback on our design and already have ideas for the next iteration. We fully intend to continue to use think[box] resources for our next generation of the prototype.”

**Emily Long**, an electrical engineering and cognitive science double-major with a minor in biomedical engineering, joined the student group Global Health Design Collaborative. The club uses Sears think[box] for all of its brainstorming and prototyping, and Emily helped her team apply to the project fund to develop a durable, cost-effective, handheld pulse oximeter that provides vital information for the rapid identification of pulmonary infection, such as pneumonia, and is designed specifically for pediatric use in low-resource areas.

“I first came to Sears think[box] out of curiosity and to make a gift for my mom. Sears think[box] offered me the equipment to bring my ideas to real life, a place to be creative, and a common space for me to meet other like-minded people. Having all of these offerings in one place is what makes think[box] so unique. With the student project fund, I was able to develop an early prototype and gather early data, and now I’ve filed a provisional patent on the technology and hope to pursue a full patent.”

**Alan Chen**, a fourth-year macromolecular science and engineering major who’s planning to attend medical school after graduation, is a member of the Global Health Design Collaborative, an undergraduate student organization at Case Western Reserve that works with Makerere University to develop solutions for identified needs in rural Uganda. Alain’s team sought to design a vaccine carrier that can safely store and maintain vaccines at the proper temperature without refrigeration. The funds gave my team one less thing to worry about during the prototyping process—the financial limitation. It encouraged my design team to focus on the bigger picture without constraints. We were able to experiment with different ideas to implement.”

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“With the help of the Student Project Fund and equipment at think[box], I was able to purchase the material and electronic components needed to prototype and verify my design, which I modified several times after issues were revealed from the prototype. The end result was a peer-reviewed conference paper I wrote that was published in the proceedings of the IEEE International Conference on Robotics and Automation, a highly competitive flagship robotics conference. I plan to continue improving the device and will frequently be visiting think[box] to do so.”

Xiangyi Cheng, a mechanical engineering PhD student who works in Assistant Professor Kiju Lee’s robotics lab and with clinical advisor Yehoshua N. Laker from the departments of emergency medicine at Long Island Jewish Forest Hills and Staten Island University Hospital, used her award to build a robotic endotracheal intubation device called IntuBot.

“Sears think[box] allowed me to explore the way I thought about the limitations of my creativity. I had always wanted to build, but was too afraid to do so. There’s a distinct feeling of intimidation when getting your feet wet in physical and practical technology as an engineering student. I did not grow up building robots or tinkering with various devices. I personally believe that it was this stereotype of typical engineers that held me back from trying it myself, since I was so afraid to fail. Think[box] inspires and encourages users to create projects of all shapes and sizes, no matter your background. It’s a pressure-free environment where you can develop and practice any skill, and I appreciated this immensely. Their resources, both in terms of people and materials, helped me achieve a level of prototyping competence that I am proud of.”

Turner Montgomery, a senior biomedical engineering student, was inspired by his mother—who was diagnosed with a rare autoimmune disease shortly after he was born. When he started college, he began to dig deeper into her condition, and made a startling discovery: she had been misdiagnosed. When she received a new diagnosis of muscular dystrophy, Montgomery applied to the Student Project Fund and used the award to build an assistive device called an EMG machine to help her with physical therapy to treat her condition.

“I’ve worked on so many projects at Sears think[box] over so many years, and it’s such a part of the fabric of my life at this point, that there isn’t a defining thread other than think[box] itself. It’s a great resource that’s been a huge part of my experience at Case Western Reserve, and I’m proud to be a part of it in turn.”

Kristina Collins, an electrical engineering graduate student who worked at Sears think[box] as an undergrad, had a case study she co-wrote on the use of public makerspaces for multidisciplinary projects accepted for publication at the International Symposium for Academic Makerspaces, which was hosted by Sears think[box] at Case Western Reserve in 2017. She used the Student Project Fund to cover the registration fee so she and her co-authors could attend the conference.
Case Western Reserve ranked 13th in the country—ahead of Harvard, Georgia Tech and the University of Chicago—in a new study by the Brookings Institution on research universities’ effectiveness in translating research breakthroughs into commercial success.

**NEW CWRU STARTUP COMPETITION**

With the support of university trustee and venture capitalist Bob Pavey, the university launched a new competition for startup businesses that include at least one current Case Western Reserve student or recent alumnus. The Morgenthaler-Pavey Startup Competition—which gives entrants a chance to win up to $25,000—was designed to find and support high-potential startup companies coming out of the university, while simultaneously training students to evaluate and ultimately invest in these types of ventures. Learn more at mpstartup.com.

The university was ranked in the top 50 of worldwide universities granted U.S. utility patents in 2017, according to a compilation by the National Academy of Inventors and the Intellectual Property Owners Association.

**A FASHIONABLE INNOVATION**

Engineering and Management student innovator Chioma Onukwuire—who graduated spring 2018—was selected by RAW Artists Cleveland to exhibit clothing from her African fashion business, CHIMU, at their ENVISION showcase at the House of Blues this past March. Onukwuire developed an online platform to make it easier for individuals in the United States to purchase traditional African clothing. Onukwuire collaborates with seamstresses in Africa on the various designs, then buys their work in bulk and sells and ships it in the United States—making for lower prices, online purchasing and easier returns.

**SHOWING OFF INNOVATION AT CES**

For the fifth-straight year, Case Western Reserve showed some of its best innovations from students, faculty and alumni at CES 2018 in Las Vegas, including self-powered “smart building” sensors, a low-cost, hand-held blood analysis device and more among its 10 booths at the Eureka Park display area. CES considered the world’s premier consumer technologies show, draws tens of thousands of thought leaders, inventors, investors, companies and consumers to multiple days of innovation and media buzz.

**INNOVATION HIGHLIGHTS**

Three Case Western Reserve student inventor-entrepreneurs, Xyla Foxlin, Andrew Dupuis and Matt Campagna, showcased their companies before members of the U.S. Congress and other visitors at the CES on The Hill annual event.

The new Case Angel Network, started by university alumni and faculty, seeks to invest directly in promising startup businesses that include university students, graduates, staff, faculty and supporters.

Case Western Reserve was ranked among the world’s top 20 universities for innovation impact by the multidisciplinary journal *Nature* in 2017.
SEARS THINK[BOX]: AN ECOSYSTEM OF INNOVATION

The Larry Sears and Sally Zlotnick Sears think[box] is celebrating its seventh year serving as the epicenter of Case Western Reserve University’s ecosystem of innovation. From a 2,500-square-foot experiment to a 50,000-square-foot innovator’s paradise in the Richey-Mixon Building, Sears think[box] has become one of the most-used facilities on campus and one of the most well-respected university-based innovation centers in the world.

Largest open-access, university-based innovation center in the world

**SEARS THINK[BOX]: AN ECOSYSTEM OF INNOVATION**

FLOOR 7: INCUBATOR

FLOOR 6: ENTREPRENEURSHIP

FLOOR 5: PROJECT SPACE

FLOOR 4: FABRICATION

FLOOR 3: PROTOTYPING

FLOOR 2: COLLABORATION

FLOOR 1: COMMUNITY*

* not yet open

#1 most-used facility by university researchers

said 64% of student users

Sears think[box] was a significant factor in choosing CWRU

$10.1M raised by startups utilizing Sears think[box] and CWRU LaunchNET services

188 student projects have received more than $250,000 in project fund money since 2014

1 of 8 founding members of the Higher Education Makerspaces Initiative (with Berkeley, CMU, Georgia Tech, MIT, Olin, Stanford and Yale)

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1/1,000th OF AN INCH ACCURACY ON OUR TOP-OF-THE-LINE WATER JET CUTTER

4,770 high-resolution parts 3-D printed annually (plus thousands more printed on our desktop 3-D printers each year)

4 LASER CUTTERS

29 3-D PRINTERS

118 How to Think[box] classes offered since 2016

22% growth in visits since 2015

70,000+ annual visits

Open 60+ hours per week during the school year

50,000 SQUARE FEET

Largest open-access, university-based innovation center in the world

More than $50M invested in Sears think[box]’s physical structure, operations and ongoing activities

4,770 high-resolution parts 3-D printed annually (plus thousands more printed on our desktop 3-D printers each year)

50,000 SQUARE FEET

Largest open-access, university-based innovation center in the world

More than $2M in prototyping and fabrication equipment

29 3-D PRINTERS

4 LASER CUTTERS

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Mechanical and aerospace engineering researcher Vikas Prakash is developing structural battery systems that will help power the next generation of electric air vehicles.

We’ve wanted them since long before we went “back to the future” in 1985—in fact, enterprising inventors have been toying with designs for flying cars as far back as the mid 1800s. Now researchers at Case Western Reserve University are helping to get these futuristic rides out of our imaginations and into the skies.

Vikas Prakash, a professor of mechanical and aerospace engineering, is confident that the mechanical and aerospace imagination will soon take to the skies. And that’s just civilian applications. The military is keen to use EAVs for surveillance and supply deployment. “These vehicles could also be indispensable to FEMA for providing immediate relief in areas cut off by natural disasters,” Prakash adds.

So if people have been designing flying cars for centuries, what’s the holdup?

The power problem comes down to a pretty simple equation. Prakash says: Flight takes a sizable amount of energy. Current battery packs have lower energy density than jet fuel per unit of weight, so if you want to add energy using batteries, you also have to add mass—too much mass for efficient flight.

So the challenge is to add battery power while minimizing additional weight. Prakash intends to achieve this balance by building structural batteries—power packs built into the vehicle’s structure that multitask by bearing load and providing energy.

“Traditional design has one component doing one job,” he says. “If we can add functionality too, we start winning because we’re adding power without adding too much mass.”

**BUILT-IN BATTERIES**

This two-for-one approach to applications that extend beyond EAVs, Prakash says. These types of built-in batteries could help power any kind of hybrid or electric vehicle. He says researchers around the world are even exploring the concept in stationary structures like office buildings and military applications like bullet-proof vests with built-in battery packs that power devices and protect the wearer.

There are many challenges that come with trying to embed a battery system into a vehicle’s fuselage or wings, Prakash says. First, the battery packs and the composite materials they inhabit must still be robust enough to withstand the physical stresses of flight, particularly the impact of landing. In addition, all the electrical connections have to stay in place through that somewhat jarring process.

“There’s a lot of applied science behind all this— you can’t just take battery cells and put them inside the structure,” Prakash says. “There are so many discrete components and the structure is always vibrating during flight.”

Prakash and his team are also exploring 3-D printed aerospace batteries that are safe, flexible and can be fabricated in the exact shape of a host structure—like a wing—rather than lining up multiple battery cells. This technique simplifies the embedded battery cell architecture and boosts pack-level efficiency. And 3-D printability makes it easier to scale up manufacturing.

Prakash’s work on NASA’s EAV charge is an extension of his research and commercialization efforts under the Partnership for Research in Energy Storage and Integration for Defense and Space Exploration (PRESIDES), part of Case Western Reserve’s Great Lakes Energy Institute. (Learn more about GLEI on page 30.) He is also working on projects in collaboration with Wright-Patterson Air Force Base in Dayton, Ohio, that aim to refine structural battery technology for applications in hybrid propulsion vehicles.

There are certainly plenty of engineering challenges—and some public perception ones too—to overcome before fleets of autonomous air taxis are awaiting our business. But according to Prakash, the flying cars of the future aren’t too far removed from the present.

Learn more about this project at engineering.case.edu/air-taxi.
Pint-sized signal detection powerhouses

The ultra-thin drumheads developed by engineering researchers at Case Western Reserve may be 100,000 times thinner than the human ear, but they can detect signals across a much wider range. Tiny is the new big deal. Electronic devices have been trending smaller for decades, and the challenge with the constant cycle of downsizing is making sure ultra-small components are not only robust, but also keep reducing power consumption and improving sensitivity at ever-smaller sizes.

Researchers led by Philip Feng, the Theodore L. & Dana J. Pint-sized signal detection powerhouses

According to a team of Case Western Reserve scientists, including Matthew Willard, associate professor of materials science and engineering, there’s a problem with the Earth’s solid inner core: the 760-mile wide ball of crystalized metal shouldn’t exist. The team challenged current models that explain the core’s formation, pointing out a gap in the supersothing process they call the “inner-core nucleation paradox.” So how did the core solidify? Read the team’s theories at engineering.case.edu/inner.

Big investment in small materials: Alp Sahinoglu, assistant professor of materials science and engineering, received an NSF CAREER award to support his work developing self-assembled, higher-dimensional superstructures—essentially, manipulating how groups of naturally arranged atoms come together to control a material’s properties. He also received a $1.2-million grant from the Air Force Office of Scientific Research (AFOSR) to explore the nanoscale structures of atomically thin 2-D oxides, and he is part of a team of researchers led by Purdue University that has been awarded $7.5 million from the AFOSR to study piezoelectric energetic materials.

Student innovator Prince Ghosh pitched his wind-tech startup Boundary Labs at the finals of the U.S. Department of Energy-sponsored Switched On: Student Innovations in Cleantech contest. Big investment in small materials: Alp Sahinoglu

A trio of Case Western Reserve undergraduate students launched a three-year, NSF-funded research project in China studying electrostatic charging by creating sandstorms in a wind tunnel at Lanzhou University.

Julie Renner, assistant professor of chemical and biomolecular engineering, is working with researchers at the University of Arkansas on a $2.4-million NSF project to develop more energy-efficient fertilizer.

A new type of solar cell technology called passivated emitter rear cell (PERC) promises higher efficiency and energy yield. But will the perks of PERC cells last for the long haul? Researchers at the university’s SDLE Research Center received a $5.47 million grant from the U.S. Department of Energy SunShot Initiative to test these cells under accelerated and real-world conditions to see how they stand up over time.

Energy SunShot Initiative sponsored Switched On: Student Innovations in Cleantech contest. Big investment in small materials: Alp Sahinoglu

Made from atomic layers of semiconductor crystals, they can sense or “hear” radio frequency signals across the highest reported dynamic range—which is the range of radio wave oscillations between the highest and lowest detectable levels—for vibrating transducers of their type. The dynamic ranges of Feng’s thin atomic layer drumheads are comparable to the ranges cats can hear. While not designed for any specific technology currently on the market, these new components will likely contribute to making the next generation of ultra-low-power communications and sensory devices smaller and with greater detection and tuning range. The research was published in Science Advances and has been featured by IEEE Spectrum, ASME Mechanical Engineering, NSF Science360 and other news outlets. Learn more at engineering.case.edu/atomically-thin-drumheads.

Big investment in small materials: Alp Sahinoglu

The ultra-thin drumheads developed by engineering researchers at Case Western Reserve may be 100,000 times thinner than the human ear, but they can detect signals across a much wider range. Tiny is the new big deal. Electronic devices have been trending smaller for decades, and the challenge with the constant cycle of downsizing is making sure ultra-small components are not only robust, but also keep reducing power consumption and improving sensitivity at ever-smaller sizes.

Researchers led by Philip Feng, the Theodore L. & Dana J. Schroeder Associate Professor of Electrical Engineering and Computer Science at Case Western Reserve, have made a big breakthrough in this small space: they’ve developed atomically thin drumhead transducers that are tens of trillions times smaller in volume than the human eardrum, but capable of sensing signals at ranges well beyond human hearing.

Big investment in small materials: Alp Sahinoglu

A trio of Case Western Reserve undergraduate students launched a three-year, NSF-funded research project in China studying electrostatic charging by creating sandstorms in a wind tunnel at Lanzhou University. A trio of Case Western Reserve undergraduate students launched a three-year, NSF-funded research project in China studying electrostatic charging by creating sandstorms in a wind tunnel at Lanzhou University.
GREAT LAKES ENERGY INSTITUTE celebrates 10 years

Climate change. An aging grid. Finite stores of fossil fuels. Increased energy needs of a growing population.

The world’s energy-related challenges are as numerous as they are serious. In response, the university launched the Great Lakes Energy Institute (GLEI) in 2008 with an initial $3M grant from the Cleveland Foundation to lead the creation of breakthroughs in advanced energy research. Since then, GLEI has brought together more than 100 faculty researchers, attracted nearly $100 million in research funding—including more than $10M in ARPA-E funding—and engaged more than 100 industry partners.

Helping solve the world’s most pressing energy challenges

- Total world energy consumption is expected to increase 28% by 2040.
- >80% of U.S. energy and 77% of the world’s energy comes from fossil fuels.
- 30% of energy used in commercial buildings is wasted.
- 16/17 warmest years on record have occurred since 2001.

We’re harnessing the changing energy landscape to create a more sustainable future.

SOLAR ENERGY
The cost of solar panels has dropped 80% since 2008.
A new solar energy device is installed in an American home every 3.2 minutes.

WIND POWER
A single wind turbine can create enough energy to power as many as 300 American homes.

STORAGE
The global energy storage market will increase 6X between now and 2030.
We received $10.75M from the DOE to establish a research center dedicated to identifying new battery chemistries for better storage.

GRID TECHNOLOGY
A smart grid can cut air pollution from the electric utility sector by as much as 30% by 2030.

AND EDUCATION INITIATIVES

- Our 900-site Global Sun Farm Network has the ability to put solar cell technologies through 25+ years of testing in a fraction of the time.
- Our campus-wide living lab with solar installations, wind turbine, sun farm and battery systems are all linked via a transactive control system to better optimize a smarter grid.
- Plus we’re helping refine the foundations for a $126M, 6-turbine wind farm on Lake Erie.

Learn more at energy.case.edu.
What makes a material ‘highly selective’ and what benefits does that selectivity bring?

Highly selective materials have a high preference for binding or permeating one type of analyte over other competing ions that may be in solution. For industry applications, these materials save money and time because they only concentrate the desired product. In our group, we design selective materials that perform separations as rapidly as possible. In medical isotope production, it is necessary to perform fast separations because the desired product is a radioisotope with a short half-life—the product is literally shortening in half every minute! Highly selective materials have a high preference for binding or permeating your desired radionuclide in a given set of conditions, so when you actually deploy it, it does the job quickly.

What got you interested in engineering in the first place and what led you to focus on separation materials?

I liked my high school chemistry classes, so my brother suggested I think about chemical engineering when I was applying to college. He’s an engineer himself—computer science—and a feminist, so he was happy to try and recruit a woman into the field. When I was an undergrad at the University of Connecticut, I was doing fuel cell research, specifically purifying hydrogen via gas separation with membranes. I got the research bug while I was there—I really liked working with membranes and I knew I wanted to stick with them in grad school. But when I arrived at Clemson University for graduate school, the lab I joined was in between active membrane projects. I ended up working on a radiation detection project, which was my introduction to nuclear forensics. As it turns out, I love nuclear forensics and radiation detection, so I ended up focusing on that topic.

You also worked in industry before grad school. Can you share some details about that experience?

When I was an undergrad, I got involved with an innovation accelerator program at the Connecticut Center for Entrepreneurship and Innovation, where I was part of a team that helped tech startups get up and running. I worked there for a few years and at the end of my third accelerator cycle, one of the companies I consulted for offered to hire me for a few months before I went to grad school. I did marketing for them—everything from making websites and brochures to digging up sales leads. How is your approach to separation materials different from what everyone else is doing?

The traditional approach to radiochemical separations is more one-size-fits-all. A lot of people take an off-the-shelf separation material and adjust the process variables to fit the characteristics of the material. Often times, that means adjusting the pH, adding oxidizing or reducing agents, or undergong buffer exchanges to get the analyte into the proper form for the resin—wasting time, money and resources. On top of that, for multicomponent mixtures, it may require several columns in series to purify the product. In the situations we’re thinking about, like post-detonation nuclear forensics, the radiochemistry has a limited timeline to test the air, water and soil before passing their findings to government officials. The timeline is crucial, so you can’t spend two days doing sample preparation. Our approach is to design custom separation materials that only bind the desired radionuclide. By doing this, we’re reducing consumables and processing steps in order to do the separation as fast as possible—we’re targeting minutes. If you want easy material synthesis you can buy the commercial resins, but you’ll spend all your time on workup. Or you can spend time developing a material that’s selective for your desired radionuclide in a given set of conditions, so when you actually deploy it, it does the job quickly.

What aspect of your research are you most excited about?

I’m a nuclear forensics ‘changer’ as it sounds! It is pretty flashy. The goal is basically the same as normal forensics, except the investigation is targeting someone who might be smuggling nuclear materials or who is working with them in a way they didn’t declare to international agencies. Let’s say you’re an IAEA inspector and you’re checking some nuclear site that claims it’s only enriching uranium for nuclear power and not making any weapons. Using radiation detection techniques to inform nuclear forensic analysis, we can show, with scientific evidence, whether or not a facility—or country—is in compliance with international law. My lab develops schemes to rapidly purify and separate actinides or fission products found in the environment. How did your time in industry impact your approach to research?

It helped me have a more practical approach. You can have a membrane that performs the world’s most elegant separation, but if it costs a million dollars per membrane, it’s never going to go anywhere and it’s never going to solve any problems outside of your lab. After working with startups and watching the commercialization process up close, I began to think of my separation schemes and materials in terms of a product that can be commercialized someday. In my lab, we aim to synthesize our separation materials from chemicals that are inexpensive and readily available on the market.

You mentioned the scarcity of women engineers as a factor when you started considering your career. Can you share some of your experiences as a women in STEM?

I hit a lot of the typical hurdles every woman in STEM has dealt with. I went to meetings, I brought up my opinion and, often, it wasn’t well accepted. Then my male colleague brought up the same opinion and suddenly, it was accepted. There was a strong trend with one of my friends who polished the same amount, we both won a lot of external awards, we were well-respected within our department, but a lot of times, my accomplishments would be downplayed compared to his. I realized I had to be my own advocate in graduate school because I started seeing these patterns of behavior and they started affecting me. I didn’t find my own support system, I wouldn’t have made it to where I am now.

What advice do you give upcoming female engineers about navigating their STEM careers?

As advisor of Case Western Reserve’s chapter of Phi Sigma Ro, a national sorority for women in engineering, I get a lot of opportunities to talk about these issues with our students. As a faculty member, when any students encounter inherent biases, it’s important to validate what they’re feeling. It’s easy for a student who may be encountering these things, these biases, in the form of silence or inaction to feel like they are even-reacting. I tell students that it’s important to acknowledge what’s happening—if you’re not aware of it, you’re not going to know how to respond. I encourage them to advocate for themselves, to stand up and to find supportive people in their classes. As a student, I made friends with other women who were pursuing their PhDs and realized they were having similar experiences—I wasn’t alone.

What is the focus of your research?

My lab develops advanced materials to perform chemical separations, and we design them to be highly selective. These materials, typically resins or membranes, can be used to selectively bind contaminants for environmental remediation and wastewater treatment, purification of medical isotopes for cancer radiotherapies and for nuclear forensic analysis.

What is your lab doing to recruit a woman into the field? When I was an undergrad at the University of Connecticut, I was the only woman in the lab that I joined. My male advisor—a computer scientist—and a feminist, so he was happy to try and recruit a woman into the field. When I was an undergrad, I realized I had to be my own advocate in graduate school because I started seeing these patterns of behavior and they started affecting me. I didn’t find my own support system, I wouldn’t have made it to where I am now.
Organismal engineering: post-doctoral researcher Vickie Webster-Wood and her team coined a new name for the emerging engineering field in bio-inspired robotics. Learn more at engineering.case.edu/news/mapping-out-biorobotic-future.

RAPID-FIRE SCREENING
Polymer researchers at Case Western Reserve developed a faster way to test flame retardants in plastics. Thanks to project lead Taneisha Deans, who began her career at Case Western Reserve as a high school student in the university's Polymer Envoys program, a dozen materials can be screened for flame retardancy in an afternoon—work that used to take an entire semester. Deans developed the technique as part of her PhD thesis while working in the lab of department chair David Schiraldi.

Kiju Lee, assistant professor of mechanical and aerospace engineering, has designed a robot with a gentler touch. Inspired by origami artwork, her 3-D printed flexible robot is soft—and safe—enough to work side-by-side with humans on the manufacturing floor or perform delicate surgical procedures. Its paper-esque properties also make it lighter than its traditional robot counterparts, making it ideal for work in outer space. Learn more at engineering.case.edu/origami-inspired-robot.

WALKING THE WALK
A research team including Roger Quinn, the Arthur P. Armington Professor of Engineering in the Department of Mechanical and Aerospace Engineering; Ronald Triolo, professor of biomedical engineering and executive director of the Advanced Platform Technology Center; and Musa Audu, research associate professor of biomedical engineering, received a $1-million NSF grant to develop a hybrid neuroprosthetic walking system for people paralyzed by spinal cord injuries.

MORE RESEARCH

Ya-Ting Liao, assistant professor of mechanical and aerospace engineering, received a grant from the NSF and the federal Center for the Advancement of Science in Space to study how fires behave in confined spaces in microgravity. Her team will conduct experiments on the International Space Station, examining how flame spreads within walls. They will also perform numerical simulations to complement the experimental data, aiming to help improve building designs and fire safety codes back home on Earth. Learn more at engineering.case.edu/flame-spread-space.

Mario Garcia-Sanz, professor of electrical engineering and computer science, published his third book: Robust Control Engineering: Practical QFT Solutions, with more than 600 pages about robust control theory and industrial and space applications he has developed during the last 25 years.

Civil engineering researchers put four highway berm materials and four pieces of compaction equipment to the test for a total field study of 16 different combinations. They discovered crushed limestone performed on par with recycled asphalt pavement and that a side-mounted roller has the edge when it comes to better compaction. The team's work was included in the Journal of Cold Regions Engineering. Learn more at engineering.case.edu/berming.

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Can you summarize your career up to this point?

I earned my undergraduate degree at the Indian Institute of Technology in Madras, then came to the United States and earned two master's degrees and a PhD in electrical engineering from Stanford. Afterward, I worked as a postdoctoral researcher at Stanford, the California Institute of Technology and the University of Maryland. I then joined the Purdue faculty in 1994 and, not long after receiving tenure, I became interested in serving the school. So I began volunteering and eventually was tasked with overseeing graduate admissions for the school, then strategic initiatives, and then education, before moving into a role at the College of Engineering as associate dean of research. I then served as the head of the School of Electrical and Computer Engineering for nine years before coming here. It's been a fun ride, and I've made many friends along the way. I've also learned that you can't please everybody all the time, so when making decisions with limited resources, it's essential to have a set of consistent principles and policies that guide such decisions. I try to make those principles persistent and communicate them consistently, so they inform the decisions you make. That's my style to be direct and transparent.

What has been the highlight of your career to date?

When I left my last position as head of ECE at Purdue, the faculty size was around 100, with about a third of them hired under my tenure. That means I've had substantial influence in shaping a very important component of an organization, which is the faculty, and I am particularly proud of the success of these more recent faculty members. Another highlight has been my continuing appreciation and support of experiential education. This is why I am very excited by all the activities surrounding Sears think[box].

What do you think the greatest challenges will be?

I believe the school's graduate program rankings underreport the quality that is here and my sense is there is much that can be done to remedy this. One of the first steps we need to take is to give the graduate student numbers. And that directly comes down to resources. I hope there are some creative ideas that I can implement to move resources around to bring more graduate students into the program. I think that translates not only into the rankings—which is not an end in itself—but also to bring even more great people into the fold.

What do you like most about Cleveland so far?

So far, I am most appreciative of how nice and friendly everyone has been. I am quite humbled by their welcome. It's been a pleasure coming here. Also the city of Cleveland, in contrast to the small town I came from, has more many options for entertainment. I have been pleasantly surprised by the variety of food and the quality of the cuisine in Cleveland. I also appreciate all the opportunities to be in nature. Overall, I'm very excited to be here.

What are your hopes for the next five years?

I would like to have a transformative, positive impact on the graduate program. I hope to focus on any of the steps we can make to improve the school, which is the most exciting opportunity. I'm also interested in exploring the integration of Sears think[box] with the experiential learning component of the curriculum. And I'm excited to see what we can do on the graduate student recruitment side to increase the number of students.
SCHOOL NEWS

ANANT MADABHUSHI

THINK BEYOND SPEAKER SERIES

In the fall of 2017, the school launched the Think Beyond Speaker Series, an opportunity for alumni and friends to hear from notable faculty members, alumni and other speakers on cutting-edge research and topics. The first event featured biomedical engineering faculty members Dustin Tyler and Mark Griswold exploring “Touch: Visualizing the Human Evolution of Technology.” The event was hosted at the home of Aarti (GRS ’88, computer science) and Asheem (CIT ’86, GRS ’88, computer engineering) Chandna in California.

In March 2018, appropriately on “Pi day,” the father of algorithm analysis, Don Knuth (CIT ’60), participated in an in-person “All Questions Answered” session to share and discuss moments from his life and career as a mathematician and pioneering computer scientist.

The most recent event, featuring Anant Madabhushi, faculty director of the Center for Computational Imaging and Personalized Diagnostics, explored the power of big data to create more personalized medical treatments. The event was hosted by Jay [GRS ’86, computer engineering] and Harita [GRS ’83, computer engineering] Patel, also in California.

NEW PEER ADVISING PROGRAM

The engineering school launched a new peer advising program this fall to complement the academic advising offered by faculty in the school’s seven departments. The 11 new peer advisors are all senior engineering students representing all engineering departments, and are available to undergraduate students on a drop-in basis Monday through Friday, 9 a.m. to 5 p.m. Peer advisors can assist their fellow students at all stages of their college careers—helping them review major and minor choices, declare majors, review academic requirements, and navigate dropping and adding courses, as well as offering recommendations and identification of other campus resources.

SCHOOL HIGHLIGHTS

Case Western Reserve University, in partnership with the National Academy of Engineering, hosted climate change experts Michael Mann, Stephen Palumbi and V. “Ram” Ramaswamy in the spring for a community event exploring the effects of climate change on Earth’s lands, seas and atmosphere.

TEACHING LAB RENOVATION SUPPORT

The engineering school is receiving a matching gift from the university for important teaching space renovations across campus, thanks to the generous support of alumni and friends who contributed $1 million to see upgrades done in the civil engineering, chemical engineering and materials science and engineering departments.

The new William M. (CIT ’94) and Mary Jane (CIT ’94) Lecture Hall in chemical engineering will come thanks to a lead $250,000 gift from the James family. A new concrete lab in civil engineering was made possible by the support of the Rollin M. Gerstacker Foundation and alumna Gina Beim (GRS ’97, systems and control engineering, MBA ’04). And James R. (CIT ’10) and Linda Vanier supported laboratory renovations at the dean’s discretion, allowing these projects to be undertaken, along with updates to the entrepy and teaching laboratory in materials science and engineering—a project initially supported by a gift from Robert Smirnov (CIT ’93, GRS ’97, ’79) and a pledge from Jenny Huang (GRS ’98).

NAMING BECKMAN SCHOLARS

One of only 12 institutions chosen nationally this year, Case Western Reserve University was selected by the Arnold and Mabel Beckman Foundation to offer research grants and mentorship to exceptional undergraduate students in chemistry and the biological sciences. The Beckman Scholars Awards will go to six students—two each over the next three years—who are majoring in biology, chemistry, biochemistry, nutrition, biomedical engineering or chemical and biomolecular engineering. The Arnold and Mabel Beckman Foundation provides grants to researchers and nonprofit research institutions to promote scientific discoveries—especially work that leads to new research methods, instruments and materials.

Alumnus Richard Mueller (CWRU ’95) donated $25,000 to the Case Alumni Association to establish the Joseph M. Prahl Scholarship Fund for undergraduate students. Mueller made the generous donation upon hearing the news of the death of mechanical and engineering beloved professor Joseph Prahl, who was his undergraduate advisor. Prahl passed away in April 2018.
A recent gift from university supporter Mark Gelfand allowed the school to develop a platform for introducing high-school students in ETHIOPIA to chemical engineering.

Co-leading the International Energy Agency’s Photovoltaic Power Systems Program on Performance and Reliability of Photovoltaic Systems

Developing and testing an iron-flow battery for long-lasting sustainable energy storage

Field-testing a point-of-care device for detecting hemoglobin disorders

Advancing image-guided surgery

Leveraging big data to create more personalized medicine solutions

Specialized academic exchange programs allowing students to study at Case School of Engineering and at their home institutions, often earning two degrees at once

Unique academic program with 4 academic institutions in BRAZIL, allowing students to study at Case School of Engineering and their home institutions, earning a PhD in macromolecular science and engineering from CWRU and a PhD from their home institution

Studying thermodynamics in BOTSWANA and SOUTH AFRICA

From study abroad options to unique dual-degree programs that span continents, from research collaborations that pull in partners from all time zones to field-testing translational technologies across hemispheres, the Case School of Engineering may be Cleveland-based, but it creates far-reaching connections that spark innovation all over the world.

OUR GLOBAL PARTNERSHIPS
THE ATLANTIC: “Mixed reality allows students to see where the professor is directing their attention and allows the professor to see how the students are approaching the body and get a sense of who might need a bit more guidance.”

NEW ATLAS: Soft origami tower robot keeps things light on the assembly line and in space

MEDGADGET: Carbon nanotubes spun into yarn work to stimulate neurons inside the brain.

CHEERS! Chemical and biomolecular engineering department chair Daniel Lacks comments on the chemistry behind mixing water and whiskey to improve flavor in THE WASHINGTON POST.

The U.S. DEPARTMENT OF ENERGY highlights the SDLE Research Center’s use of advanced imaging techniques and statistical analysis to improve the lifespan of solar photovoltaic cells as one of its Success Stories.

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NEW ATLAS: I don’t have any doubt,” [Vikas Prakash] says. “In a few years, you will be able to call an air taxi from Uber or someone else to travel maybe 100 miles in a vehicle with two other people. I’m very excited about this.”

Case Western Reserve mechanical and aerospace engineering professor Vikas Prakash tells the SMITHSONIAN’S AIR & SPACE MAGAZINE what it’ll take to get flying cars off the ground.

FORTUNE: “Augmented and mixed reality aren’t just for gaming. Case Western Reserve University and the Cleveland Clinic are designing programs that use Microsoft’s HoloLens to teach med students anatomy.”

CNET: “But that’s not their only potential benefit if Dustin Tyler’s research pans out. The professor of biomedical engineering at Case Western Reserve University is developing a technique that could trick the brain into thinking sensations are coming from the missing, flesh-and-blood hand.”

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On his blog, NIH DIRECTOR FRANCIS COLLINS highlighted red blood cell research by Case Western Reserve Assistant Professor Umut Gurkan and his team’s Bislet Competition-winning illustration of the effects of toxic mercury on blood cells.

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MEDIA MENTIONS

A deep-learning algorithm developed by biomedical engineering researchers at Case Western Reserve outperforms human doctors in making diagnoses and was named one of the “5 COOLEST THINGS ON EARTH THIS WEEK” BY GE REPORTS.

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Chris Yuan, associate professor of mechanical and aerospace engineering, won first place in the Reusable Abstractions of Manufacturing Processes national research competition.

David Sch Vad, chair of the Department of Macromolecular Science and Engineering and the Peter A. Asseff Professor, won the Polymeric Materials: Science and Engineering Division Distinguished Service Award, and was named editor-in-chief of the journal Polymer.

Umut Gurkan, assistant professor of mechanical and aerospace engineering, Birnur Akkaya, a visiting professor of mechanical and aerospace engineering, won the American Chemical Society’s Polymer Materials Science and Engineering Division Award in recognition of his contributions to nonlinear control systems.

Michael Hira, assistant professor of macromolecular science and engineering, received a Young Investigator Award from the American Chemical Society’s Polymer Materials Science and Engineering Division.

James Tian, the Leonard Case Jr. Professor of Engineering and chair of the Department of Mechanical and Aerospace Engineering, was elected to the inaugural class of fellows of the Combustion Institute.

Mario Garcia-Sanz, professor of electrical engineering and computer science, was appointed an associate editor for the IEEE Solid-State Circuits Society.

Anant Madabhushi, the F. Alice Nason Professor II of Biomedical Engineering, received the 2017 IEEE Institute of Electrical and Electronics Engineers’ Engineering in Medicine and Biology Society (EMBS) Technical Achievement Award for contributions in computer-aided diagnosis, pattern recognition, machine learning and image analysis tools for diagnosis, prognosis and treatment response—prediction of disease from digital pathology and radiographic images.

The Department of Mechanical and Aerospace Engineering’s Clare Binnor, the Willett’s Professor of Engineering, and Professor Emeritus Dwight Dax have been inducted into the inaugural class of fellows of the Orthopaedic Research Society.

Robert Gao, the Lady Staley Professor of Engineering and chair of the Department of Mechanical and Aerospace Engineering, received the American Society of Mechanical Engineers’ 2018 Blackall Machine Tool and Gage Award and was named co-recipient of the Richard Hansen Outstanding Investigator Award by the 2018 International Symposium on Flexible Automation.

Yeonghee Lee, assistant professor of civil engineering, was named an American Society of Civil Engineers (ASCE) ExCEED Fellow and was selected as the ASCE SEI (Structural Engineering Institute) Codes and Standards Activities Division committee’s Young Professional member.

James Basilion, professor of biomedical engineering and radiology, was elected president of the World Molecular Imaging Society.

Pedram Mohseni, professor of electrical engineering and computer science, was appointed an associate editor of the IEEE Solid-State Circuits Letters—the newest publication of the IEEE Solid-State Circuits Society.

Vikas Prakash, professor of mechanical and aerospace engineering, received the Society of Experimental Mechanics 2018 Peterson Award.

Rigberto Advincula, professor of macromolecular science and engineering, was elected to membership in the National Academy of Sciences and Technology, Philippines.

Andrew Rollins, professor of biomedical engineering, was appointed section editor for biomedical imaging for the new Elsevier journal, Current Opinion in Biomedical Engineering.

A. Bala Ajobye, assistant professor of biomedical engineering, and Robert Kim, the Allen H. and Constance T. Ford Professor and Chair of Biomedical Engineering, received first place in the 2018 International Annual Brain Computer Interface Research Award competition.

The University of Akron was named a partner in the Air Force’s University Affiliated Research Center (UARC) program, which supports university-led research projects.

Lisa Camp, associate dean for strategic initiatives, was named to the inaugural class of America Makes Ambassadors in recognition of dedication to the America Makes mission of advancing innovation in additive manufacturing.

Wei Lin, professor of electrical engineering and computer science, has been named a fellow of the Institute of Electrical and Electronics Engineers (IEEE) in recognition of his contributions to nonlinear control systems.

Daniel M. Sinke, Ph.D., was named the inaugural class of fellows of the Combustion Institute.

The Cleveland Institute of Art student, Courtney Fleming, a visiting scholar, and Courtney Fleming, a Cleveland Institute of Art student, were named among the winners of the Federation of American Societies for Experimental Biology’s sixth annual Bird Competition for their illustration depicting the impact of mercury exposure on red blood cells.

Gurkan and other researchers from Case Western Reserve also won the Vodafone Americas Foundation Wireless Innovation Project Competition with their Sickie and Malaria Accurate Remote Testing (SMART) system.

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STUDENT AWARDS AND ACCOLADES

CWRUbotix, Case Western Reserve’s robotics team, impressed on the national stage this year. The club sent three teams to the National Robotics Challenge, winning first in the combat competition and fourth for their mini-sumo robot. The team also placed fourth overall at NASA’s annual Robotic Mining Competition, securing a top spot out of 44 other collegiate teams.

The Case Western Reserve University Motorsports team and their baja off-road vehicle placed first in acceleration and overall dynamic at the Midnight Mayhem racing event in Louisville, Ky.

Case Western Reserve University student entrepreneurs won Infy Maker Awards from the Infosys Foundation: Matthew Campagna, an undergraduate computer engineering major and co-founder of Reflexion Interactive Technologies LLC; and Pavel Galchenko, an undergraduate studying biochemistry and applied data science, founder of RVS Rubber Solutions.

Mousa Younesi, a PhD student in the Department of Mechanical and Aerospace Engineering, won an Acta Student Award for his contribution to the manuscript, “Heparinized collagen sutures for sustained delivery of PDGF-BB: Delivery profile and effects on tendon derived cell In-Vitro,” which appeared in the journal Acta BioMaterialia.

Madeleine Harris, Aaron Mann, Nicholas Merchant-Wells and Jack Worsham, all civil engineering undergraduate students, won first prize in the Ohio Water Environment Association (OWEA) 2018 Student Design Competition.

A team of undergraduate students from Case Western Reserve won the American Society of Civil Engineers Sustainable Development Award at the EPA’s P3 National Sustainable Design Expo for developing an electrical incinerator for hazardous medical waste disposal designed for use in Uganda.

Madeleine Harris, Aaron Mann, Nicholas Merchant-Wells and Jack Worsham, all civil engineering undergraduate students, won first prize in the Ohio Water Environment Association (OWEA) 2018 Student Design Competition.

Case Western Reserve undergraduates took first place in the Cleveland Medical Hackathon for CrasBand—a wrist device that monitors a person’s cardiac health.

Case Western Reserve student-led startups Path Robotics and Boundary Robotics took the top two spots at the LaunchTown Entrepreneurship Awards.

Chemical engineering and chemistry major Zane Ostoin won the Ohio Co-op Education Association’s Cool Co-op Award.

Xinyou Ke, a PhD candidate in the Department of Mechanical and Aerospace Engineering, was awarded the 2018 ECS F.M. Becket Summer Fellowship by the Electrochemical Society.

Graduate students from the Department of Materials Science and Engineering earned accolades at conferences across the country:

• Zhe Ren and Aaron Washburn won first- and second-place poster awards at the 29th American Society for Metals (ASM)-Heat Treating Conference.

• Will Huddleston won a student poster contest at the American Ceramic Society’s Electronic Materials and Applications Conference in January with a poster titled, “Freeze casting of LAGF for 3D textured solid-state structural electrolytes.”

• PhD student Henry Nielson won a first-place award for his research at the Materials Science and Technology (MS&T) meeting in Pittsburgh.

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Graduate and professional-degree students 739
Declared undergraduate engineering students 1,484

*In addition, 718 undergraduate students expressed interest in engineering majors but are not expected to declare majors until the end of their sophomore year.

50th for engineering graduate schools*
43th for undergraduate engineering programs**
18th for graduate biomedical engineering programs*
14th for undergraduate biomedical engineering programs**

*published spring 2018
**published fall 2018

In FY2018, the Case Alumni Foundation/Association provided $2.8 million from annual and endowed gifts to the Case School of Engineering.

AT A GLANCE

1,484 Declared undergraduate engineering students
739 Graduate and professional-degree students

739

U.S. News & World Report rankings
50th for engineering graduate schools*
43th for undergraduate engineering programs**

212 invention disclosures 5.13 times the national per-dollar proficiency average*

202 deals with industry 3.64 times the national per-dollar proficiency average*

3 startup companies 2.02 times the national per-dollar proficiency average*

*AUTM U.S. Licensing Activity Survey FY16 (latest data available)

Technology Transfer

In FY2018 Case School of Engineering Faculty contributed to:

212 patent applications 9.88 times the national per-dollar proficiency average*

115 invention disclosures 5.13 times the national per-dollar proficiency average*

202 deals with industry 3.64 times the national per-dollar proficiency average*

3 startup companies 2.02 times the national per-dollar proficiency average*

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20 deals with industry 3.04 times the national per-dollar proficiency average*

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The Case School of Engineering has a proud 125-year history as one of America’s top engineering schools. We are innovators and educators—tackling the world’s most challenging engineering problems through groundbreaking research while balancing a rigorous academic curriculum with ample experiential learning opportunities that bring those lessons to life for tomorrow’s engineers. More than 100 full-time faculty represent the best minds in their fields, and our students are among the brightest and most ambitious in the nation. Learn more at engineering.case.edu.

Bachelor of Science in Engineering (BSE)
Available majors:
- Aerospace Engineering
- Biomedical Engineering
- Chemical Engineering
- Civil Engineering
- Computer Engineering
- Electrical Engineering
- Engineering Physics
- General Engineering
- Materials Science and Engineering
- Mechanical Engineering
- Polymer Science and Engineering
- Systems and Control Engineering

Bachelor of Science (BS)
Available majors:
- Computer Science
- Data Science and Analytics

Bachelor of Arts (BA)
Available majors:
- Computer Science

Majors

Master of Science (MS)
Available majors:
- Aerospace Engineering
- Biomedical Engineering, with optional specialization in Translational Health Technology or Wireless Health
- Chemical Engineering
- Civil Engineering
- Computer Engineering
- Computing and Information Science
- Electrical Engineering, with optional specialization in Wearable Computing or Wireless Health
- Macromolecular Science and Engineering, with optional specialization in Fire Science and Engineering
- Materials Science and Engineering, with optional specialization in Fire Science and Engineering
- Systems and Control Engineering, Undesignated

Master of Engineering (ME)
Master of Engineering and Management (MEM)

Doctor of Philosophy (PhD)
Available majors:
- Aerospace Engineering
- Biomedical Engineering
- Chemical Engineering
- Civil Engineering
- Computer Engineering
- Computing and Information Science
- Electrical Engineering
- Macromolecular Science
- Materials Science and Engineering
- Mechanical Engineering
- Systems and Control Engineering

Doctor of Medicine/Doctor of Philosophy (MD/PhD)
Available majors:
- Biomedical Engineering

Departments

Biomedical Engineering
Chemical and Biomedical Engineering
Civil Engineering
Electrical Engineering and Computer Science
Macromolecular Science and Engineering
Materials Science and Engineering
Mechanical and Aerospace Engineering

Centers and Institutes
Advanced Manufacturing and Mechanical Reliability Center
Advanced Platform Technology Center
Center for Advanced Polymer Processing
Center for Advanced Science and Engineering for Carbon Center for Breakthrough Energy Storage
Center for Computational Imaging and Personalized Diagnostics
Center for Control and Energy Systems
Center for Layered Polymeric Systems (CLIPS)
Center for the Evaluation of Implant Performance
Cleveland Functional Electrical Stimulation Center
Electro-Ceramics for Sustainable Energy Solutions
Electronics Design Center
Great Lakes Energy Institute
Institute for Advanced Materials
Institute for Smart, Secure and Connected Systems
Integrated Robotics Center
Materials for Optoelectronics Research and Education (MORE) Center
Microfabrication Laboratory
Neural Engineering Center
Richard ‘39 and Opal Vanderhoof Infrastructure Research and Education Facility
SDLE Research Center
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Swagelok Center for Surface Analysis of Materials
Wind Energy Research and Commercialization Center