MCKELVEY ENGINEERING
Momentum
Across Disciplines. Across the World® // SPRING 2021

Racial justice in Engineering

The road ahead for McKelvey Engineering

Washington University in St. Louis

Snapshot //

Research in Amit Pathak's lab focuses on understanding how normal and cancerous cells sense and remember varying biomechanical cues present in the tissue microenvironment. The image represents a merge of vimentin (green) expression in MCF10A breast epithelial cells monolayer after 72H of cell culture on collagen coated soft polyacrylamide gel, actin cytoskeleton (red) and cell nuclei (blue).

Image by Florence Flick Jaecker, a postdoctoral associate in the Pathak Lab.

From the dean //

Aaron F. Bobick
Dean & James M. McKelvey Professor
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The Long Road Ahead

I write this letter as we are wrapping up what will be remembered as the most unusual academic year in living memory. The COVID-19 pandemic, which last spring was a crisis requiring an immediate response to launch online learning, grew into an ever-present constraint that impacted teaching, research and all aspects of operations across the university. For the Fall 2020 and Spring 2021 semesters, McKelvey Engineering needed to embrace new paradigms of teaching and learning, to develop new modes of managing and sharing research spaces, and to conduct business operations almost exclusively through remote interactions. In the pages of this issue of *Engineering Momentum*, you will read about some of the efforts it took to rise to the occasion. Given the enormity of the task, one might expect responding to COVID-19 to be the cover story of this issue of the magazine.

It is not.

Instead, the summer of last year saw the emergence of an awareness of a challenge that has been with us for centuries and whose destructive power is not amenable to being controlled by a vaccine. While the most visible event of the summer was the video-captured death of George Floyd at the hands of police officers, there was a litany of such tragedies and travesties. These incidents energized a Black Lives Matter movement that is supported by persons of all backgrounds. Fundamental to the conversation is the declaration that these occurrences are neither new nor particularly more severe than those experienced by Black members of our community in every corner of society. There arose a demand that the time for true action has arrived.

That demand for action has made its way to McKelvey. As I mentioned in a short message released last summer, I was hesitant to simply offer words of sympathy and understanding. I was concerned that words could ring hollow and believed the school would need deliberate and sustained action that could, over time, make a difference: actions that would begin by uncovering some very uncomfortable truths and then seeking common ground to address them; actions that would identify sources of toxic climate and eliminate them; actions to inform and education all members of the McKelvey Engineering community.

This is hard work. It is not work that will be finished this semester, this year or this decade. Rather, it is work that will be ongoing. In our cover story, you will read about some initial efforts along with individuals who are stepping up to help McKelvey establish a sustainable plan to combat systemic racism within our School, our university, and our profession. We have tried to be as forthright as possible in our coverage. You may dispute some of the observations made in the story — that's ok. One of the things I have learned in the short time since we have begun this effort in earnest is the deep variation in perspectives among members of our community. In fact, one of the first important steps in this process is to learn about other people's perspectives. I hope this story at least accomplishes that goal.

As always, I welcome your thoughts. And in this matter, maybe more than ever.

In this issue //

SPRING 2021

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SPECIAL FEATURE

YOUNG ALUMNI FEATURE

THE BUZZ

We are McKelvey!

McKelvey Engineering alumni and admitted graduate students gathered for lunch Friday, Dec. 4 in Beijing.

Alumna Ilic elected to National Academy of Engineering

Marjia Ilic is a senior research scientist at LIDS at MIT and professor emerita of Electrical & Computer Engineering and Engineering & Public Policy at Carnegie Mellon University.

Alumna Patterson addresses Women & Engineering

Engineering alumna Anna Patterson gave the keynote address at the Women & Engineering Leadership Society Summit held March 6. Patterson is the founder and managing partner at Gradient Ventures and oversees the fund's global activities.

Inspiring Black Scientists

McKelvey Engineering faculty members Princess Imoukhuede (left) and Alvitta Ottley have been named among the 1,000 inspiring Black scientists in America by Cell Mentor.

Engineering alumnus Bateman elected to National Academy of Medicine

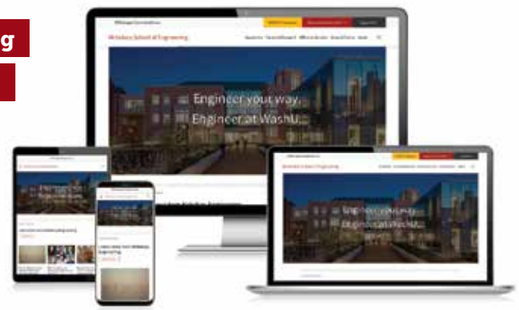
The National Academy of Medicine selected Randall Bateman, MD, for his work in discovering the causes of Alzheimer's disease, developing the first highly specific blood test for Alzheimer's and initiating the first Alzheimer's prevention trial.

New seminar series

The "Education, Engineering & Race" seminar series, which began July 30, featured faculty experts in various aspects of racism and education who presented their research so that participants could better understand practices and policies in STEM education and engineering that support systemic racism.

McKelvey Engineering launches new website

McKelvey Engineering launched a redesigned website that offers a cleaner reading experience and more flexibility for users and keeps up with the latest technological standards.



"I wanted to develop medicines and vaccines. I thought being at Pfizer might give me that opportunity".
— TATENDA SHOPERA

The most important work: Creating a vaccine for COVID-19

Alumnus Tatenda Shopera went to work as a senior scientist at Pfizer in June 2019. The first case of the novel coronavirus was reported six months later. Three months after that, he was pulled into a COVID project.

As a process scientist, he worked to fine-tune the conditions in the environment to ensure the quality and consistency of the final product, a medicine or a vaccine.

Project Covid aims to spread facts about novel coronavirus

During the early days of the COVID-19 pandemic, Will Hunter, a junior in the McKelvey School of Engineering, knew he wanted to do something to help.

Hunter understood that misinformation about the virus could spread just as easily as the disease, so when he learned about an opportunity to build an app to educate users about the novel coronavirus, he took action.

"There were a lot of rumors spreading, and we wanted to make sure that we could answer questions, as well as track the spread," said Hunter, who is majoring in computer science with a second major in entrepreneurship.

Hunter, along with co-founder Satvik Sethi, a recent alumnus of Binghamton University, developed Project Covid, a mobile app that gathers information about the virus and disease from a select list of credible sources, including the Centers for Disease Control and Prevention, the Associated Press and the World Health Organization. The app aggregates information, including real-time statistics, testing center information and news, and localizes the content to the user's state.

Serving as the lead product manager, Hunter managed the team of 12 developers and 10 researchers, many of whom had backgrounds in public health, medicine or health literacy. Hunter also brought additional engineering students from WashU onto the project.

For example, Michael Ginn, a junior computer science major, served as the project's lead engineer and worked closely with Katie Lund, a junior computer science major, to develop the app's front end. Giorgio Guttilla, a senior computer engineering major, served as the lead mobile app developer, overseeing its user experience and interface.

Written by Danielle Lacey

Nine McKelvey Engineering students named inaugural Chancellor's Career Fellows

Nine first- and second-year students in the McKelvey School of Engineering are among the inaugural members of Chancellor Andrew D. Martin's Career Fellows Program to increase career access for WashU students. The program is part of the university's overall effort to increase and support the number of first-generation college students and those from families with lower incomes.

The McKelvey Engineering students are among the 61 students selected for the inaugural class of the Chancellor's Career Fellows Program, designed to provide low-income and first-generation students with career planning and coaching and funding to cover a summer professional development experience. The program is designed to get students more focused on the pathways and social networks leading to the world of work and graduate school and to provide similar coaching for post-university life that students with more resources have.

Student-led nonprofit wins international road safety prize

Eisner

LFR International, a nonprofit organization co-founded by a McKelvey School of Engineering student, was recently awarded the Prince Michael International Road Safety Award by Prince Michael of Kent.

Co-founders Zach Eisner, who earned a bachelor's in biomedical engineering in 2020, and Peter Delaney, who earned a bachelor's in anthropology from the College of Arts & Sciences in 2018, were recognized for their work improving emergency response, treatment and transfer of people injured in traffic accidents. Eisner and Delaney are among the youngest recipients of the award in its 33-year history.

New student organization aims to build community among LGBTQIA students in STEM

From left, Keya Nagula, oSTEM secretary, and Dean Oken, oSTEM president, plant flowers during an event that will later be given to students during oSTEM's May social event.

Dean Oken, a master's student studying data analytics & statistics, decided to bring a chapter of oSTEM, which stands for Out in Science, Technology, Engineering, and Mathematics, to the McKelvey School of Engineering, a move that was made even more vital thanks to the COVID-19 pandemic. He currently serves as the president of the WashU chapter.

"I had an idea to build a community around STEM and LGBT+ representation," Oken said. "I saw other groups such as SHPE, NSBE and SWE, and, one year prior, Proud Network came to campus and increased LGBT+ representation at Olin. I thought it was the perfect time to start something."

Groups such as the Society of Hispanic Engineers (SHPE), the National Society of Black Engineers (NSBE) and the Society of Women Engineers (SWE) help members of groups traditionally underrepresented in STEM to network and find support among others with similar experiences. oSTEM is a national organization with more than 100 chapters throughout the country that offers similar opportunities to LGBT students and their allies who are interested in STEM.

"When like-minded individuals are put together in a space where they're more comfortable, they can achieve more because they can focus more on the task at hand and not have to worry about feeling judged," Oken said. "oSTEM provides that community for like-minded people to come together for professional, activist and social events."

"I knew that I felt passionate about this idea, and if I was passionate about this idea, there were certainly others who would be passionate about it," Oken said. "I would have been happy with four or five interested people, but once I took that step, the interest was overwhelming."

The group now claims more than 90 members since it began in August 2020.

Written by Danielle Lacey

Student athlete Andrew Whitaker juggles life in pandemic while giving back

Andrew Whitaker has spent his undergraduate career at Washington University in St. Louis giving back.

A biomedical engineering major in the McKelvey School of Engineering, he has danced and played with kids who have cerebral palsy so they can put on a dance recital through Dance CPSR (Cerebral Palsy Sports Rehabilitation).

A two-sport athlete in football and track, he has spent weekends with kids on the autism spectrum, guiding them through exercises to improve coordination and social skills through the Bear Cubs running program.

An Annika Rodriguez Scholar, he has traveled to Honduras for a week helping doctors assist patients with basic medical needs through a program called Global Brigades. He also has been involved in the McKelvey Takes Responsibility Campaign and WU BLAC.

Yet when Whitaker — who recently was selected as one of 22 college football players from all three NCAA divisions for the prestigious Allstate American Football Coaches Association (AFCA) Good Works Team — is asked what, if any, of these experiences had the most meaning for him, he responds, "Whatever I'm doing now."

What began as an internship last year has turned into a project near and dear to this defensive back's heart. With the help of the Gephardt Institute for Civic & Community Engagement, for which he also serves as a Bob and Gerry Virgil Civic Scholar, Whitaker spearheaded a project to send medical supplies to every school district in the St. Louis area.

"And as a senior on the football team, as a captain on the track team, I now feel like if I can inspire someone, I should. If I can share my experiences about being Black and get my teammates to look at things through a different lens in terms of the social injustices going on, I will."

— ANDREW WHITAKER

Written by Leslie Gibson McCarthy

COVID-19

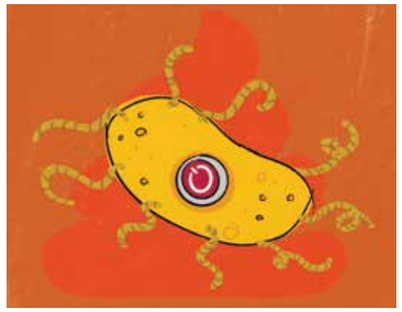
Modeling can help balance economy, health during pandemic

Using mathematical modeling, new interdisciplinary research from the lab of Arye Nehorai, the Eugene & Martha Lohman Professor of Electrical Engineering, determines the best course of action when it comes to walking the line between economic stability and the best possible health outcomes.

The group — which also includes David Schwartzman, a business economics doctoral student at Olin Business School, and Uri Goldsztejn, a doctoral student in biomedical engineering — published their findings Dec. 22, 2020, in *PLOS ONE*.

The model indicates that of the scenarios they consider, communities could maximize economic productivity and minimize disease transmission if, until a vaccine were readily available, seniors mostly remained at home while younger people gradually returned to the workforce.

Kill switch could keep genetically engineered bacteria at bay



The USDA has recently awarded Tae Seok Moon, associate professor in the Department of Energy, Environmental & Chemical Engineering a $498,771 grant in an effort to develop a "kill-switch" for genetically engineered bacteria.

For this project, Moon will be working on a self-destruct mechanism for bacteria that will be genetically engineered to destroy pathogens in the gut of livestock. Once the bacteria have completed that task in the gut, the switches will turn on and they will kill themselves.

Written by Brandie Jefferson

Researchers devise new method to get lead out of filters, better measure amount in tap water

Researchers in the McKelvey School of Engineering have devised a new method that allows them to extract the lead from these "point-of-use" filters, providing a clearer picture of what's coming out of the faucet.

And they can do it in less than an hour.

Their research was published this past summer in the journal *Environmental Science: Water Research & Technology*.

The problem with just collecting a one-liter sample is that "We don't know how long it was in contact with that lead pipe or if it just flowed through quickly. Everyone's water use patterns are different," said Daniel Giammar, the Walter E. Browne Professor of Environmental Engineering in the Department of Energy, Environmental & Chemical Engineering.

A better method would be to collect the lead from a filter that had been in use long enough to provide an accurate picture of household water use.

Written by Brandie Jefferson

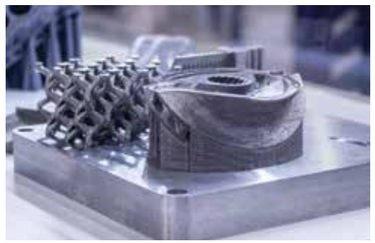
NSF CAREER Award

Additive manufacturing, high-speed imaging focus of Weisensee's CAREER Award

Patricia Weisensee, assistant professor of mechanical engineering & materials science, will look at the effects of additive manufacturing process on the material properties of the printed medals with a five-year, $557,000 CAREER Award from the National Science Foundation. CAREER awards support junior faculty who model the role of teacher-scholar through outstanding research, excellence in education and the integration of education and research within the context of the mission of their organization.

Weisensee, whose research focuses on understanding the interplay of fluid dynamics, heat transfer and liquid-solid interactions of droplets and other multi-phase systems, said additive manufacturing is frequently used to build complex structures without having to use screws or welding or to make repairs without having to case new pieces. The process uses fewer parts, is generally lighter in weight and lower in cost and requires less human labor to construct. However, the quality of the products is inconsistent, which has limited its more widespread use.

"Because metals are not transparent, we don't have ways of being able to tell



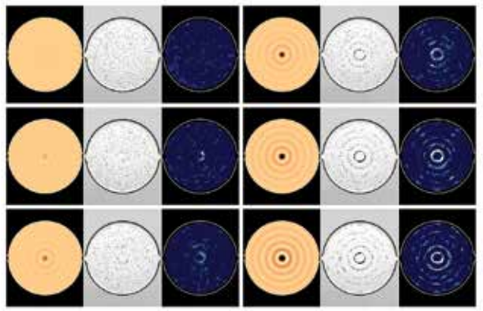
whether the outcome will be a good quality or not while it's printing," she said. "Because additive manufacturing is a fairly complex process that requires frequent reheating of the materials, the reheating changes the microstructure, and that influences the mechanical properties. We want to learn how these influence each other."

Imoukhuede named AIMBE Fellow

Princess Imoukhuede, associate professor of biomedical engineering has been named a fellow of the American Institute for Medical and Biological Engineering (AIMBE). According to AIMBE, its College of Fellows is limited to the top 2% of medical and biological engineers. She uses computational models and quantitative measurements to better understand several aspects of vascular signaling.

She is one of 174 engineers to receive this honor in 2021. She was inducted during a virtual ceremony March 26.

Fine-tuning device performance with swarms of swimming cells



Mark Meacham, assistant professor of mechanical engineering & materials science, used *Chlamydomonas reinhardtii*, a single-cell green alga that swims with two cilia, or whip-like structures, to test the efficacy of bulk acoustic wave devices created in his lab. These devices use piezoelectric materials to translate an electrical signal to mechanical vibrations, which then generate ultrasonic standing waves in the fluid-filled channel of a device. Meacham and Minji Kim, a doctoral student in his lab, design these devices to operate at multiple resonant frequencies to generate strong acoustic waves with maximum energy transfer. Efficient operation is critical because inefficient devices generate heat that can kill biological cells.

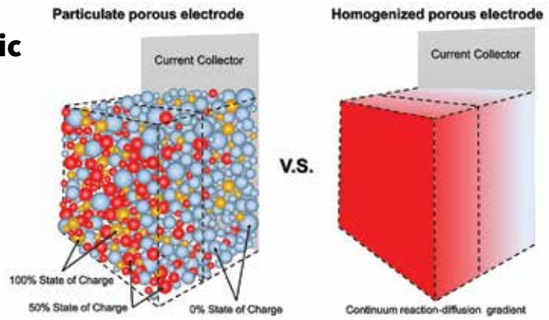
It is the first reported work to provide this functionality in real time and for a variety of device geometries. Results of the work are published in *Lab on a Chip* Feb. 9 and are featured on the back cover of the print journal.

"The goal of this work is to use these cells to characterize the acoustic field, to find resonances and to assess field strength, and eventually to calibrate device performance using the cells as our measurement tool," Meacham said. "We know how much power is put in. The cells give us a way to evaluate how much of that power is useful."

Written by Beth Miller

NSF CAREER Award

Bai to study dynamic heterogeneities in lithium-ion battery electrodes



Lithium-ion batteries (LIBs) have revolutionized the way people live, by enabling transformative electronic devices, portable power tools and electric vehicles. They are popular choices of energy storage technologies, wherever high energy density, high power density and system simplicity are required. However, elusive safety accidents, especially life-threatening fires and explosions, have become a major and urgent concern. Failures of LIBs and other high-energy batteries always originate from microscopic heterogeneities, which, however, are difficult to be monitored, analyzed and predicted by existing electroanalytical methods.

Peng Bai, assistant professor of energy, environmental & chemical engineering, has been preparing to better understand the dynamic heterogeneities in the electrodes of lithium-ion and other high-energy batteries, and now received a five-year, $503,025 CAREER Award from the National Science Foundation.

"We have been focusing on reaction heterogeneities in batteries because they are the birthplace of safety hazards," Bai said. Here, the reaction heterogeneity refers to a local hot spot that has a much higher reaction current than the neighboring regions. The difference between the local current density over the hot spots and the apparent current density can become huge, potentially leading to everything from inefficiency to deadly accidents, depending on the nature of the electrode and the operating condition of the battery.

Written by Brandie Jefferson

Zhang seeks ways to stop sneaky attacks on computer hardware

Malicious attacks on computer hardware and embedded systems, such as cloud servers, smartphones and Internet-of-Things devices, are a constant threat. Xuan 'Silvia' Zhang, assistant professor of electrical & systems engineering, plans to conduct fundamental research on building a detection framework that would spot these attacks with a nine-month, $300,000 grant from the Air Force Research Laboratory and the Defense Advanced Research Projects Agency (DARPA).

Zhang and Huifeng Zhu, a doctoral student in her lab, recently received the Best Paper Award from the IEEE Asian Hardware Oriented Security and Trust Symposium (AsianHOST) for their paper titled "PowerScout: A Security-Oriented Power Delivery Network Modeling Framework for Cross-Domain Side-Channel Analysis."

NSF CAREER Award

Lee seeks to boost speed on cloud platform apps with CAREER Award

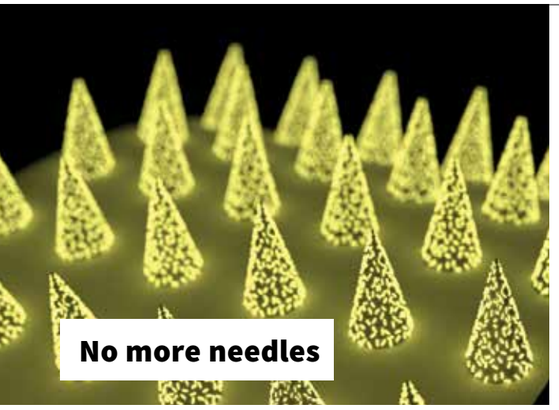
I-Ting Angelina Lee, assistant professor of computer science & engineering, plans to develop software infrastructure that can improve programmer productivity and increase the speed of interactive applications running on cloud platforms with a five-year, $500,000 CAREER Award from the National Science Foundation. CAREER awards support junior faculty who model the role of teacher-scholar through outstanding research, excellence in education and the integration of education and research within the context of the mission of their organization. One-third of current McKelvey Engineering faculty have received the award.

Lee studies task parallelism, a parallel programming paradigm designed to program shared-memory multicore machines.

"Task parallelism can improve programmer productivity because it provides high-level language abstractions to allow the programmer to express the logical parallelism of the computation and let an underlying runtime system to perform load balancing and synchronization automatically," Lee said. "Existing task-parallel platforms have been demonstrated to work efficiently for high-performance scientific applications in practice."

Lee said task parallelism falls short in supporting modern interactive parallel applications commonly run on cloud platforms, however, because it is mainly designed to target high-performance scientific applications that use specific parallel patterns and has throughput as the main performance criterion.

Written by Beth Miller



No more needles

Engineers at the McKelvey School of Engineering have developed a microneedle patch that can be applied to the skin, capture a biomarker of interest and, thanks to its unprecedented sensitivity, allow clinicians to detect its presence.

The technology is low cost, easy for a clinician or patients themselves to use, and it could eliminate the need for a trip to the hospital just for a blood draw.

The research, from the lab of Srikanth Singamaneni, the Lilyan & E. Lisle Hughes Professor in the Department of Mechanical Engineering & Materials Sciences, was published online Jan. 22 in the journal *Nature Biomedical Engineering.*

In addition to the low cost and ease of use, these microneedle patches have another advantage over blood draws, perhaps the most important feature for some: "They are entirely pain-free," Singamaneni said.

Finding a biomarker using these microneedle patches is similar to blood testing. But instead of using a solution to find and quantify the biomarker in blood, the microneedles directly capture it from the liquid that surrounds our cells in skin. Once the biomarkers have been captured, they're detected in the same way — using fluorescence to indicate their presence and quantity.

Written by Brandie Jefferson

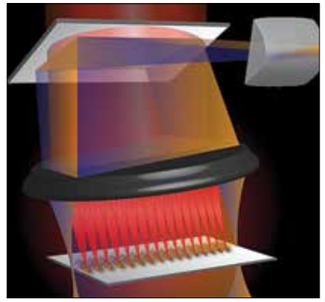
Center for Water Innovation to showcase, connect WashU water research

Washington University in St. Louis has long been a leader in water research with world-class faculty in both the McKelvey School of Engineering and in the College of Arts & Sciences. To bring this research together and to promote additional collaboration, Zhen (Jason) He, an internationally recognized water researcher, will head the newly launched Center for Water Innovation (CWI).

The CWI will facilitate collaboration among the university's water resources from various departments to address major water quality and water technology research questions. In addition, its member faculty will perform educational outreach to K-12 schools, promote water sustainability to the public, and assist area governmental and nonprofit organizations in making policies related to water and wastewater management.

"We expect that this will be a bridge to connect WashU water resources with industry, government agencies and investment companies," said He, professor of energy, environmental & chemical engineering and a fellow of the International Water Association.

Initially, research at CWI will focus on sustainable wastewater management, safe drinking water and the nexus of agriculture and water, all critical needs in research and practice, and strengths of WashU faculty. The center aims to demonstrate the strength of the university's researchers, create opportunities for collaborative proposals to federal funding agencies and to attract attention from potential industrial members.



Colored light investigated to control irregular heartbeat noninvasively

With a four-year, $2.08 million grant from the National Institutes of Health, Chao Zhou, associate professor of biomedical engineering, will lead a multi-institutional team that will apply optogenetics, a technique that uses light to control the opening and closing of ion channels, to help the heart achieve regular beating. Zhou will collaborate with Abhinav Diwan, MD, professor of medicine, of cell biology and physiology and of obstetrics and gynecology; Jeanne Nerbonne, professor of medicine and of developmental biology and director of the Center for Cardiovascular Research; and Kenneth Schechtman, professor of biostatistics and of medicine, all at Washington University School of Medicine. He also will work with Airong Li, MD, PhD, assistant professor of neurology at Harvard Medical School, and Rudolph Tanzi, the Joseph P. and Rose F. Kennedy Professor of Child Neurology and Mental Retardation at Harvard University and Massachusetts General Hospital, both experts in human and fruit fly genetics.

The team will use the light beams on the fruit flies at different developmental stages, from larvae to adult. The motivation behind the work is to investigate an option for pacemakers, which control the heart rate in patients with rhythm irregularities, but also affect surrounding tissues and require periodic invasive surgery to replace the batteries.

Written by Beth Miller

New tech can get oxygen, fuel from Mars' salty water

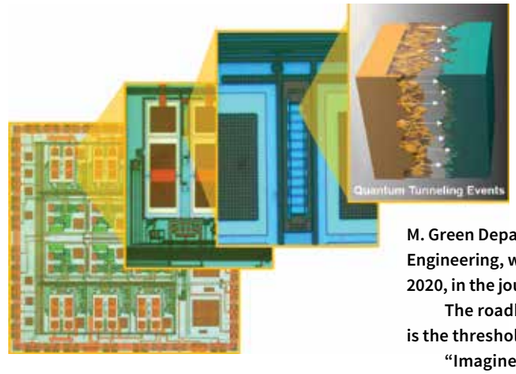
If oxygen and hydrogen could be directly coerced out of briny water, that brine electrolysis process would be much less complicated — and less expensive.

Engineers at the McKelvey School of Engineering have developed a system that does just that. Their research was published in the *Proceedings of the National Academy of Sciences* (PNAS).

The research team, led by Vijay Ramani, the Roma B. and Raymond H. Wittcoff Distinguished University Professor in the Department of Energy, Environmental & Chemical Engineering, didn't simply validate its brine electrolysis system under typical terrestrial conditions; the system was examined in a simulated Martian atmosphere at -33 °F (-36 °C).

"Our Martian brine electrolyzer radically changes the logistical calculus of missions to Mars and beyond," said Ramani. "This technology is equally useful on Earth where it opens up the oceans as a viable oxygen and fuel source."

"Our novel brine electrolyzer incorporates a lead ruthenate pyrochlore anode developed by our team in conjunction with a platinum on carbon cathode," Ramani said. "These carefully designed components coupled with the optimal use of traditional electrochemical engineering principles has yielded this high performance."



Quantum tunneling pushes the limits of self-powered sensors

Shantanu Chakrabartty's laboratory has been working to create sensors that can run on the least amount of energy. His lab has been so successful at building smaller and more efficient sensors that they've run into a roadblock in the form of a fundamental law of physics.

Sometimes, however, when you hit what appears to be an impenetrable roadblock, you just have to turn to quantum physics and tunnel through it. That's what Chakrabartty and other researchers at the McKelvey School of Engineering did.

The development of these self-powered quantum sensors from the lab of Chakrabartty, the Clifford W. Murphy Professor in the Preston M. Green Department of Electrical & Systems Engineering, was published online Oct. 28, 2020, in the journal *Nature Communications*.

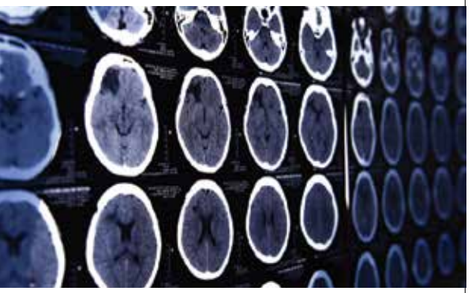
The roadblock that inspired this research is the threshold effect.

"Imagine there is an apple hanging from a tree," Chakrabartty said. "You can shake the tree a little bit, but the apple doesn't fall. You have to give it enough of a tug to shake the apple loose." That tug is akin to a threshold energy. "It's the minimal amount of energy needed to move an electron over a barrier." If you cannot move the electron over the barrier, you cannot create current.

But naturally occurring quantum mechanical phenomenon move electrons across barriers all the time. The research team took advantage of this to build a self-powered device that, with a small initial energy input, can run on its own for more than a year.

Written by Brandie Jefferson

Chan Zuckerberg Initiative names two WashU groups Frontiers of Imaging grantees



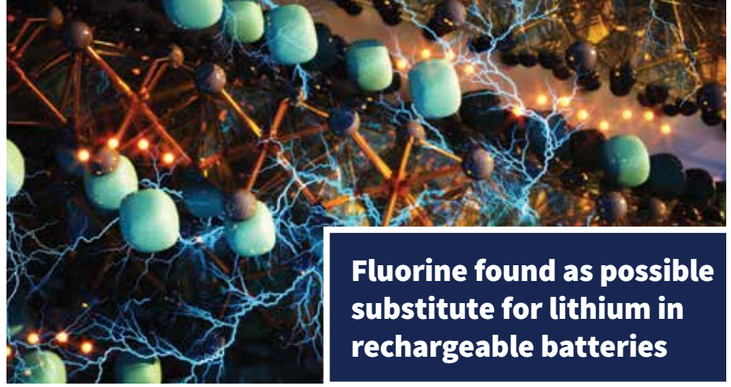
Imaging of proteins, cells and tissues is critical to understanding health and disease. In December 2020, the Chan Zuckerberg Initiative (CZI) announced $2 million in funding for research led by faculty at Washington University in St. Louis. The support is part of nearly $32 million in funding from CZI to support biomedical imaging researchers.

Two multidisciplinary groups headed by faculty from the McKelvey School of Engineering will be homing in on the brain, where currently, imaging techniques can penetrate about the depth of a couple of human hairs.

Jung-Tsung Shen, associate professor in the Preston M. Green Department of Electrical & Systems Engineering, is principal investigator of a research team with co-PIs Lihong Wang from California Institute of Technology and Junichiro Kono from Rice University. The team is developing a quantum photonic-dimer laser, a light source that produces a special class of entangled pairs of photons known as photonic dimers.

Song Hu, associate professor of biomedical engineering, will be working with co-PIs Lan Yang, the Edwin H. & Florence G. Skinner Professor in the Preston M. Green Department of Electrical & Systems Engineering, and Adam Kepecs, BJC investigator and professor of neuroscience and psychiatry in the School of Medicine. The team is developing a new photoacoustic technology that will enable cellular-resolution molecular imaging deep inside live tissue.

Written by Brandie Jefferson



Fluorine found as possible substitute for lithium in rechargeable batteries

Materials scientists have found a potential alternative for lithium in fluorine, a relatively abundant and light element. Interestingly, fluoride ion is the mirror opposite of lithium ion, having the strongest attraction for electrons, which allows it to easily carry out electrochemical reactions. Researchers in Japan also are testing fluoride-ion batteries as possible replacements for lithium-ion batteries in vehicles. They say these batteries could allow electric vehicles to run 1,000 kilometers on a single charge. However, current fluoride-ion batteries have poor cyclability — that is they tend to degrade rapidly with charge-discharge cycles.

Washington University researchers Steven Hartman and Rohan Mishra have adopted a new approach to fluoride-ion battery design, identifying two materials which easily gain or lose fluoride ions while undergoing small structural changes to enable good cyclability. Mishra, assistant professor of mechanical engineering & materials science, said that the new battery materials are both layered electrides.

Written by Beth Miller

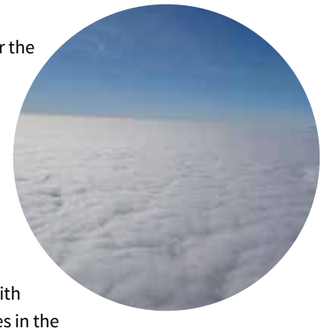
Pappu, collaborators, awarded $7.5 million MURI award

Rohit Pappu, the Edwin H. Murty Professor of Engineering, is part of a multi-institution team to receive a highly competitive 2020 Multidisciplinary University Research Initiative (MURI) award from the Department of Defense.

The five-year $7.5 million grant is shared with three other universities and is aimed at uncovering the fundamental design principles that will enable researchers to design and engineer novel, synthetic and membraneless organelles.

This research will lead to the ability to control biochemical pathways and synthesize high-value compounds in yeast cells.

Aerosol particles naturally form over the open sea



New results from an atmospheric study over the eastern North Atlantic reveal that tiny aerosol particles that seed clouds can form out of next-to-nothingness over the open ocean.

This "new particle formation" occurs when sunlight reacts with molecules of trace gases in the marine boundary layer, the atmosphere within about the first mile above Earth's surface. The findings will improve how aerosols and clouds are represented in models that describe Earth's climate so scientists can understand how the particles — and the processes that control them — might have impacted the planet's past and present and better predict the future.

The research, a collaboration led by principal investigator Jian Wang, professor of energy, environmental & chemical engineering and director of the Center for Aerosol Science and Engineering, was published Jan. 22 in the journal *Nature Communications*.

Written by Brandie Jefferson

NSF CAREER Award

Deep learning investigated to improve imaging techniques

When getting an MRI scan, a patient is told to lie as still as possible because any movement will create errors in the scans. An engineer at Washington University in St. Louis is proposing a novel way to correct errors in MRIs and other types of images using deep learning.

Ulugbek Kamilov, assistant professor of computer science & engineering and of electrical & systems engineering, plans to develop a framework that ultimately would lead to algorithms to correct these errors and enhance imaging capabilities with a five-year, $486,000 CAREER Award from the National Science Foundation. CAREER awards support junior faculty who model the role of teacher-scholar through outstanding research, excellence in education and the integration of education and research within the context of the mission of their organization.

Kamilov, whose research is in computational imaging, said the demand for more advanced imaging technology is increasing, leading to the need to remove artifacts, noise or other errors, which cannot be done by hand. That's where deep learning, which simulates human brain functionality by using a neural network, comes in.

"In MRI scans, you scan patients then feed their images to a neural network to learn the patterns we want to eliminate," he said. "We then use those trained neural networks to fix the errors in subsequent scans."

Written by Beth Miller

Solved: The mystery of toxic fracking byproducts

Research from the lab of Kimberly Parker, assistant professor in the Department of Energy, Environmental & Chemical Engineering, shows that underground presence of halogen radicals is a key to the formation of these halogenated organic compounds, which are dangerous for human health and damaging to the environment.

The research was published Jan. 15 in the journal *Environmental Science & Technology*.

"For a long time, we didn't really know where they were coming from," Parker said. "We knew that they weren't being put down into the system on purpose. It seemed clear that they were being generated under the ground."

In addition to knowing where they were coming from, researchers had a pretty good reason to suspect halogen radicals — molecules with an unpaired electron — were driving the generation of these compounds.

Written by Brandie Jefferson

Yang named 2020 AAAS fellow

Lan Yang is the Edwin H. & Florence G. Skinner Professor in the Preston M. Green Department of Electrical & Systems Engineering. AAAS is honoring her for groundbreaking contributions to the fields of photonics, particularly her pioneering experimental studies on non-Heritian photonics, optical sensing and light-matter interactions in optical resonators.

Many of the high-tech devices we use in our day-to-day lives are electronic devices — they rely on the movement of electrons to transmit information. Yang's research focuses on silicon-chip-based, ultra-high-quality micro-resonators and their applications for sensing, lasing, nonlinear optics, environmental monitoring, biomedical research and communication.

NSF CAREER Award

Artificial intelligence, algorithms focus of Juba's NSF CAREER Award

Brendan Juba, assistant professor of computer science & engineering, will take a closer look at the relationships and generalization in artificial intelligence and develop new algorithms with a five-year, $543,000 CAREER Award from the National Science Foundation. Juba, who studies algorithms for integrated learning and reasoning in artificial intelligence, said researchers have recognized for a long time that relational generalization is necessary for artificial intelligence, but it has been difficult to solve. So far, there have been two types of approaches.

"On one hand, you might have a solution that would do the right thing, but you don't know how long it will take," Juba said. "Or you may produce something quickly, but it doesn't necessarily have the quality. It's not known how to do both, so our focus is to try to get both and to find a feasible method that gives good answers in a reasonable time."

"I will take both the learning and planning problems together — both the data that I would have used for learning and questions I want to answer with that data," he said. "We've seen in the past that by not having to hand off something that is learned to this second problem of producing a plan or an answer, you can do much better and guarantee that it's going to work in some cases."

Written by Beth Miller

Racial justice in Engineering

The road ahead for McKelvey Engineering

Written by **BETH MILLER**

Editor's note: In Engineering Momentum, we frequently tell you about the strengths and opportunities in McKelvey School of Engineering and the progress toward new goals. We do this because we are proud of what we do, and we want you to be proud as well. However, this story takes a different tack: Here we address the challenges we face as a school in addressing diversity, equity and inclusion, as well as where we have fallen short and how we plan to improve.

Amid the weight of the global pandemic in 2020 came a renewed and intensified focus on racial justice in the United States after numerous unjustified killings of Black Americans at the hands of white law enforcement officers, including George Floyd and Breonna Taylor — six years after Michael Brown was killed in Ferguson, Missouri — as well as others who did not become household names. After Floyd's death in May, as thousands of Americans took to the streets to express their outrage about the killings, Washington University in St. Louis Chancellor Andrew D. Martin reaffirmed the university's commitment to support all members of the university's community and to redouble efforts for equity.

In the McKelvey School of Engineering, Dean Aaron F. Bobick also has committed to involving the McKelvey Engineering community in efforts to achieve racial equity within the school, as well as supporting racial justice efforts on campus, in St. Louis and around the world. In the latter half of 2020, Bobick, with support from school leadership, faculty, staff and students, implemented several new initiatives to address diversity, equity and inclusion within the school.

"Our 2018 strategic plan wove racial equity goals throughout the various objectives," Bobick said, "but it did not explicitly call out racial equity as a fundamental objective in and of itself. This is one of the reasons that we have been talking about changing things and addressing diversity, equity and inclusion for a long time, but little has changed. This lack of progress gives rise to frustration and anger on the part of our Black and people of color members of our community. It is telling that it took the violent events of the past summer, and in particular, a video of a Black man being killed by a policeman kneeling on his neck for us to decide that we have fallen short. Our challenge is to harness that dissatisfaction and anger into steps that might actually make a difference. Frankly, this is very hard work, and we should only undertake these efforts if we have the will to establish sustainable approaches to increasing racial equity within our School."

As one of the first steps, in Fall 2020, Bobick appointed the McKelvey Committee on Diversity, Equity and Inclusion (DEI) to provide structure and oversight to the school's efforts to address these issues. The committee is chaired by Princess Imoukhuede, associate professor of biomedical engineering, with associate chair Jessica Wagenseil, professor of mechanical engineering & materials science. Coupled with forming the committee, Bobick appointed Imoukhuede the school's inaugural director of diversity initiatives and Wagenseil the inaugural vice dean for faculty advancement.

"It's not enough to just generally be supportive: we have to be active. Passive support is not the same as active consideration and active efforts. Engineering has always been a participant in what other parts of the university are leading, but we've never organized what we're going to do until now."

— Dean Aaron Bobick

As the school's first director of diversity initiatives, Imoukhuede will chair the 16-member committee and ensure that it engages with the entire McKelvey community to identify and address DEI issues. The committee's mission is to exemplify, encourage, facilitate and nurture a culture of inclusive excellence at the McKelvey School of Engineering through the identification and implementation of best practices in recruitment, retention and climate for students, postdoctoral researchers, faculty and staff of Black, Indigenous and Latinx populations. In addition, Imoukhuede will serve as the school's liaison to the university's various organizations focused on diversity, equity and inclusion, including the Center for the Study of Race, Ethnicity & Equity; the Academy for Diversity, Equity & Inclusion; and the Center for Diversity and Inclusion, as well as connect with the Office of the Provost.

As vice dean, Wagenseil will work with the department chairs to assess and monitor faculty mentoring and career development, to develop faculty leadership training opportunities, and to coordinate nominations for faculty awards in support of the full range of faculty career progression. She also will work with Bobick to coordinate the tenure and promotion process.

Wagenseil and Imoukhuede were part of a precursor faculty committee that organized a new virtual seminar series, titled Education, Engineering & Race, that features academic speakers from around the country sharing how their research applies to racial justice in engineering education. Three seminars were held in summer 2020, each followed by moderated breakout discussion groups in which participants

shared ideas and concerns, many of which were recorded on shared documents for future reference. Three additional seminars are being held in the spring 2021 semester.

"We've always had a modest effort on diversity, but very little on equity and inclusion," Bobick said. "It's not enough to just generally be supportive: we have to be active. Passive support is not the same as active consideration and active efforts. Engineering has always been a participant in what other parts of the university are leading, but we've never organized what we're going to do until now."

Bobick acknowledges that the challenges of 2020 have slowed efforts.

"Because of the pandemic, faculty and students are working under extreme circumstances, and quite frankly, are exhausted," he said. "Because I am adamant that any DEI efforts we launch be sustainable, we are purposely being quite deliberate in developing our strategies and practices. The amount of new work faculty, staff and students can take on right now is limited, and we want to ensure that all efforts receive the investment of time and energy required. Much of what the committee is doing now is preparing us to do the work we need to do."

"I think it's important for society that we don't want to create elite universities that cater only to elite students. I think we want to have as much diversity in thought and age and everything as possible."

— Jim McKelvey Jr.

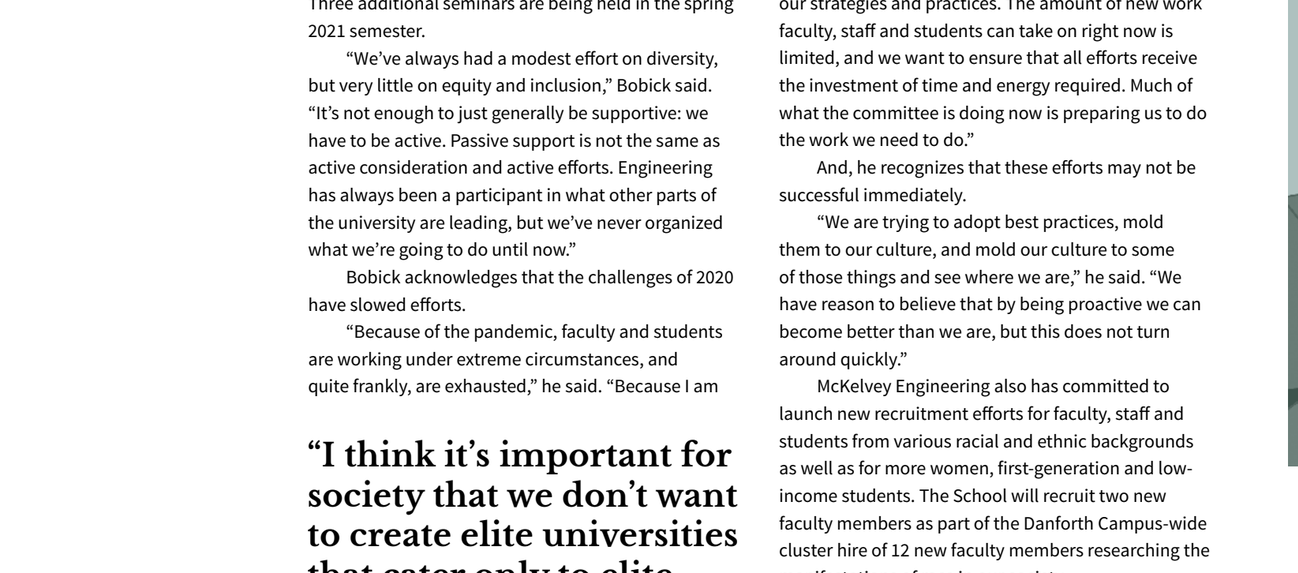
And, he recognizes that these efforts may not be successful immediately.

"We are trying to adopt best practices, mold them to our culture, and mold our culture to some of those things and see where we are," he said. "We have reason to believe that by being proactive we can become better than we are, but this does not turn around quickly."

McKelvey Engineering also has committed to launch new recruitment efforts for faculty, staff and students from various racial and ethnic backgrounds as well as for more women, first-generation and low-income students. The School will recruit two new faculty members as part of the Danforth Campus-wide cluster hire of 12 new faculty members researching the manifestations of race in our society.

This follows with the desire of James McKelvey Jr., who provided the gift to name the school, to open McKelvey's doors to a wider audience.

"I want to see WashU, engineering in particular, but the institution in general, as a talent magnet and talent creator for St. Louis and the world," McKelvey said in a 2019 interview. "One of the things that motivated me to give the gift was the potential to open the doors of WashU to people who would probably never consider coming to our school. I want them to feel welcome and for them to be part of a larger community."



WHITNEY CURTIS

"Give it the recognition it deserves, don't marginalize racial justice in STEM, and allow faculty to use STEM as a tool for decreasing racism and anti-blackness in STEM."

— Ebony O. McGee

In conjunction with opening the doors wider, McKelvey also said he is committed to increasing diversity in the school.

"I think it's important for society that we don't want to create elite universities that cater only to elite students. I think we want to have as much diversity in thought and age and everything as possible."

In Fall 2020, 21% of first-year students in McKelvey Engineering were Black, Indigenous, or from other racial or ethnic backgrounds, and 37% are women. More than 60% of graduate students are international students. Among full-time faculty, 25% are women, and 50% have international roots.

"I'm often asked why we are not hiring more Black faculty," Bobick said. "Along with every other Engineering dean, I am desperately trying to hire more Black and Brown faculty, as well as more women – a challenge more pronounced in Engineering than other parts of the academy. To do so requires looking beyond the traditional sources of graduating doctoral candidates and to surface as many applicants of color as possible."

But Ebony O. McGee, an associate professor of diversity and STEM education at Peabody College at Vanderbilt University and author of "Black, Brown, Bruised: How Racialized STEM Education Stifles Innovation," says the pipeline is a broken and simplistic metaphor when it comes to groups of color.

"There are enough black faculty for each of the 350 engineering institutions to hire one black faculty member, but 37% of engineering institutions have no black faculty," she said. "Why don't they hire one of those thousands of black doctoral grads? It's because they didn't go to top universities like University of Chicago, MIT or Georgia Tech. If you keep looking at the same 35 institutions, you're going to get the same results."

McGee says the STEM retention messages and marketing need a makeover.

"STEM will have to find a greater appreciation for racial justice that goes beyond considering racial justice in STEM a service project," she said. "It is part of people's core research and professional and personal identities. Give it the recognition it deserves, don't marginalize racial justice in STEM, and allow faculty to use STEM as a tool for decreasing racism and anti-blackness in STEM."

McGee's work promotes an equity ethic, the concept that people in the STEM fields from diverse groups gravitate toward empathic social causes and racial justice efforts to eliminate disparities both within their STEM field and beyond.

"Black, LatinX and Indigenous folks come to their engineering faculty positions with an embedded equity ethic as part of their own racialization and experience," she said. "Maybe it's because those who are seen as smart in STEM in their younger years are volunteering, speaking and are really engaged in community, but those things aren't valued or appreciated in STEM. They have to cut off part of their professional identities — the part that cares about social, environmental and racial justice, and just do STEM because that's what's valued."

Leading up to 2020:

- Targeted student recruitment activities and communications
- Supported student organizations such as NSBE, SHPE and others
- Building the pipeline through programs including WUSEF, CS4All and Studio: Tesla
- Research, such as bias in artificial intelligence

Students call to action

McKelvey Engineering students say there aren't structures within the school that support students of color and are seeking change. In summer 2020, two student groups — one comprised of graduate student groups and one of undergraduate student groups — presented call-to-action statements to the School leadership calling for change. Partly inspired by social media movements #Blackinthelvory and #ShutdownSTEM, these student groups seek to improve the environment in McKelvey Engineering for students from groups traditionally underrepresented in the STEM fields.

Dinal Jayasekera, a fourth-year doctoral student in biomedical engineering, was one of the leaders of the graduate student group that drafted a 12-page document outlining actions it wants to see within the school.

Jayasekera said the George Floyd protests last summer opened his eyes to pervasive systemic racism in the United States, but as an international student, he didn't feel it was his place to bring it up. After a group of students wrote a call to action to Chancellor Andrew D. Martin in the spring, McKelvey graduate students decided to present goals they wanted the school to address in a school-specific call to action, he said.

In all, 10 graduate students wrote the call to action, and 110 additional graduate students and 12 engineering graduate student groups signed on in support.

"The school's strategic plan wasn't very transparent about the goals they had met and what was in progress," Jayasekera said. "These initiatives weren't given the attention they deserved because the pandemic took up a lot of their time. We want to use the attention that was brought to DEI as a result of the Floyd protests to enact the changes that we, the students, want to see."

Jayasekera said more than half of graduate students who answered a survey said they were not comfortable publicly acknowledging support of DEI initiatives because they feared backlash.

"This drives our point that the dean and the chairs need to be transparent that they are supportive of this cause," he said. "If they come out in support of these initiatives, there will be more students willing to help out and voice their concerns and point out issues that need to be addressed."

High-level goals from graduate students:

- Adopting a zero-tolerance policy toward harassment, discrimination and unprofessional behavior;
- Reforming personnel practices to support Black and others from diverse groups traditionally underrepresented in engineering;
- Cultivating an inclusive culture that respects individuals for their unique contributions and expertise;
- Diversifying and innovating the curriculum.

The call to action written by undergraduate students, led by students in the National Association of Black Engineers (NSBE), calls for changes that would improve the McKelvey Engineering environment for current and future Black students to feel included, wanted and safe among professors and peers. The document, titled #McKelveyTakesResponsibility, calls for six high-level initiatives.

#McKelveyTakesResponsibility:

- Increase Black and Brown faculty
- Develop an Engineering course to address racial inequity and intersectionality
- Accountability in faculty
- Diversify study abroad options
- Develop civic engagement courses and programs
- Implementation and initiatives toward the future

Hannah Smith, the 2020-21 president of McKelvey Engineering's NSBE chapter, said the students have other requests, including having school administration publicly denounce all hate and racism proactively, rather than reactively to a particular incident.

"They are willing to meet with us, have a conversation with us and listen to what we want, but they won't always implement what we request even if it does seem simple," said Smith, a senior majoring in applied science in electrical engineering. "I do realize it is a process. Administrative actions are behind closed doors, and every day students don't see the results of those negotiations because they are navigating classes and homework."

Smith and Jayasekera, along with two other students are members of the DEI Committee which should provide greater transparency to the student body.

In addition, the group requested a McKelvey Engineering-specific hate and bias reporting system.

"When we say something is wrong, we rarely hear back, and we don't hear anything about the process," Smith said. "Survivors welcome information about these things, and when we don't learn about the discipline or punishment that faculty received, it makes us feel like we aren't heard."

When Smith meets with potential students or speaks on panels for prospective Engineering students, she is often asked about the climate for Black students at WashU.

"I feel like I am sometimes put in a position of being an expert on diversity, equity and inclusion," she said. "My experience being a woman and Black in Engineering is an isolating experience — you won't see a lot of people like me," she said. "I'm candid about my experiences, but I tell them that college is what you make of it, and it's hard no matter where you go."

Both Jayasekera and Smith said the appointment of Imoukhuede is a step in the right direction, but they want to see more. Smith said undergraduate students would like a full-time staff member who has experience within critical race theory and DEI in general to be dedicated to racial bias, as well as mandatory diversity and inclusion training for faculty and staff.

WHITNEY CURTIS

Dean Bobick meets regularly with students from NSBE, SHPE and other student groups.

> **"If [the dean and chairs] come out in support of these initiatives, there will be more students willing to help out and voice their concerns and point out issues that need to be addressed."**
>
> — Dinal Jayasekera

In response to the two student-led call-to-action statements, McKelvey Engineering launched a page on its website dedicated to its diversity, equity and inclusion efforts. The page, engineering.wustl.edu/diversity, includes 11 action items for change, many of which are well underway, including appointing the committee headed by Imoukhuede and Wagenseil; increasing recruitment efforts for faculty, staff and students from groups underrepresented in STEM; and continuing the Education, Engineering & Race seminar series. Additional action items include improving the bias reporting system; improving retention of women and faculty members from groups underrepresented in the STEM fields; and working with the Brown School to develop new community partnerships.

"We are all very delighted with the progress we've seen so far," Jayasekera said. "Many students have come forward to voice concerns, and there have been committees created that hopefully will do what they were created to do. We hope that we've inspired more people to speak out about these topics and move forward, and we realize there shouldn't be any backlash for speaking about these topics that not just affect them, but the entire WashU and St. Louis community as a whole."

New for 2020-2021:

- Appointments of Princess Imoukhuede and Jessica Wagenseil and forming the McKelvey Committee on Diversity, Equity and Inclusion (DEI)
- Launching the Engineering, Education & Race seminar series
- Recruiting faculty from diverse groups
- Enhancing the bias reporting system
- Resources: engineering.wustl.edu/diversity

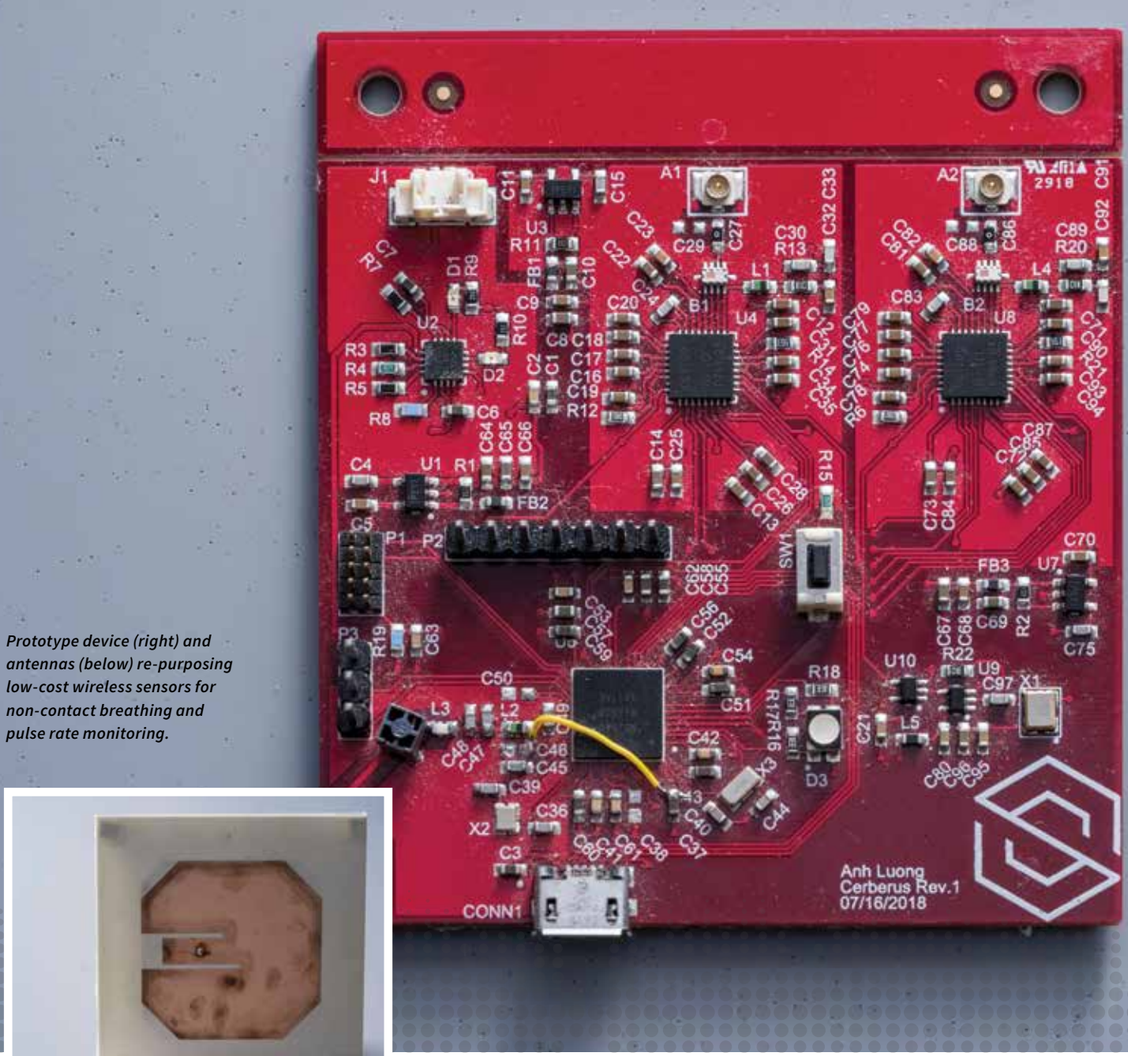
Neal Patwari

Sensors, sensors everywhere

While some engineers work to develop new technologies, others work to find applications of existing technology. That is what has brought Neal Patwari success in his work, both in academia and in industry.

Written by **BETH MILLER**

Photos by **WHITNEY CURTIS**



Prototype device (right) and antennas (below) re-purposing low-cost wireless sensors for non-contact breathing and pulse rate monitoring.

Patwari, who holds a dual appointment as a professor of electrical & systems engineering and of computer science & engineering, is an expert in using radio waves, the signals used by wireless devices, to develop sensors that can be used in applications including medical devices or to detect motion in a home. He and his lab, the Sensing and Processing Across Networks (SPAN) lab, use the same range of frequencies used in cell phones and other wireless devices to create these sensors.

Nearly eight years ago, Patwari, who joined the McKelvey School of Engineering at Washington University in St. Louis in January 2019 after 12 years at the University of Utah, and his team were working on a project using radio waves to determine which rooms were occupied in a home so that lights could turn on and off automatically in response to motion. A student alone in the lab saw changes in the measurements of radio waves although there was no movement in the lab. On a hunch, he held his breath, and the measurements stayed constant — the device was detecting the radio waves from his breathing.

"We just happened on to it," said Patwari, a native of Cleveland, Ohio. "It was rare to observe that on lab equipment, so we had to take some time to figure out how to make a commercial device that would reliably record breathing no matter what your position was or what else was going on."

Aarti Singh runs tests using wireless sensors like this UWB prototype to predict and avoid collisions between autonomous robots.

Neal Patwari

Highlights

- **Number of patents: 14**
- **Peer-reviewed publications: 131**
- **NSF CAREER Award received: 2008**
- **Current number of PhD students: 2**
- **PhD students who have graduated: 12**

Education & training

- **PhD and postdoctoral research, electrical engineering: University of Michigan**
- **BS and MS, electrical engineering: Virginia Tech**

Based on this, Patwari's lab has developed sensors to measure breathing and pulse rate that do not need to be connected to the body. Their sensors can be placed on opposite sides of a bed to determine changes in the radio waves due to breathing changes and determine a pattern over time. Now, he and his lab are working on wireless protocols for a router that would secure that breathing and pulse rate data.

"The encryption and security technologies that have emerged for Wi-Fi and cell phones don't help at all because they encrypt the data being sent," he said. "Vital sign sensing doesn't require the data because it observes changes occurring to the radio waves. We think that by having an access point insert random changes into its transmitted signal we can allow people near that access point to keep information about their vibrations and health private."

Patwari also is working to get his sensors into the market through his association with startup Vita Sensors, which has made a prototype medical breathing monitor. He also was director of research for Xandem Technology from 2010-2019. Before earning a doctorate from the University of Michigan, he also spent two years as a research engineer at Motorola Labs, which obtained several patents for his work. In all, he has a hand in 14 patents, some of which have been licensed by Vita Sensors, Xandem Technology and Texas Instruments.

Patwari and students in his lab also are developing sensors for football and other sporting helmets that might warn the wearer of an impending collision. He and his team are working with mechanical engineers and biologists to test it out.

"The idea is if someone is going to get hit from behind, they should get a warning," he said. "Maybe it's not long enough to change the game, but enough that they would tense up their muscles and reduce the angular acceleration to the head. If we can achieve that goal, it could reduce traumatic brain injury."

Over the course of his career, Patwari has been awarded, together with his collaborators, more than $24 million in research grants from such agencies as the National Science Foundation (NSF), including a CAREER Award given to promising early-career investigators; the National Institutes of Health; the Army Research Office; and the University of Utah Research Foundation. The largest grant he and his team are working on is one for the NSF- and PAWR-Industry-Consortium-funded Platform for Open Wireless Data-driven Experimental Research (POWDER), a testbed for experimenting on the future of wireless networking in a living laboratory composing 10 square kilometers in Salt Lake City. There are fixed stations as well as buses and utility vehicles that carry programmable wireless devices around the city.

Patwari and students in his lab also are developing sensors for football and other sporting helmets that might warn the wearer of an impending collision.

Equipment being deployed as part of the Powder Wireless testbed in Utah

> **The idea is that when people are making the next-generation developments for 5G or 6G, they can test their idea in the real world rather than in a lab.**
>
> — NEAL PATWARI

"This testbed allows users to log on to a base station and user device from home, write code to program them and have them operate as their code describes," Patwari said. "The idea is that when people are making the next-generation developments for 5G or 6G, they can test their idea in the real world rather than in a lab."

At WashU, Patwari designed a graduate-level course for the Fall 2020 semester titled "Equity and Fairness in Estimation and Classification," about fairness in machine learning. The course has given Patwari the opportunity to have meaningful discussions with students about issues of race, gender, class and disability, and how algorithms have undesirable and unfair effects on society.

"We are looking at how machine learning algorithms learn from society's inequities," he said. "They might be trained using a set of data that includes only the dominant group or has labels generated by a biased world, and these biased algorithms then contribute to further inequities in policing, criminal justice and real estate. All of these inequities are visible in St. Louis, so it is the perfect place to teach this material."

Patwari also is chairing a faculty recruiting committee for the university's race and ethnicity cluster hire initiative, which seeks to hire 12 new faculty members engaged in research on the manifestations of race in society. Patwari's committee is seeking a faculty member engaged in data science and racial equity who will have an appointment in the Division of Computational & Data Sciences and in McKelvey Engineering's Computer Science & Engineering department.

Patwari's new course has been developed with consultation from his spouse, Cassie Power, associate director for faculty & academic engagement with the Gephardt Institute for Civic & Community Engagement, who earned a doctorate in women's studies and social psychology and has 12 years of experience in teaching with a critical framework. Her contribution has ensured that the course provides the necessary critical race and feminist theory to be able to see algorithms in the larger societal context in which they operate.

"I'm really fascinated by all of these topics and to learn the kinds of tools I can use in engineering to make some contribution," he said.

Patwari Lab members

Caleb Martin
Doctoral student

Allison Todd
Undergraduate student in Electrical Engineering

Jie (Jemma) Wang
Doctoral student

Aarti Singh
Doctoral student

Virtual becomes reality

Written by **BETH MILLER**

On March 11, 2020, while Washington University in St. Louis students were on spring break, Chancellor Andrew D. Martin told the WashU community that the remainder of the spring semester would be conducted remotely due to the COVID-19 pandemic. McKelvey School of Engineering students had to quickly adjust their learning styles from in-person to online, and faculty had to convert their courses to a virtual format without causing too much disruption or losing momentum.

During the extended two-week spring break, 239 McKelvey Engineering instructors and staff members prepared 203 unique courses to be taught remotely. They also trained 16 staff members to serve as moderators for classes taught on Zoom. Thanks to some foresight by school administration, there had been some preparation that made the transition smoother.

Jason Crandall, who joined the school in 2016 as director of learning design and innovation to incorporate technology that would enhance the student learning experience, co-chaired a university search committee that selected Zoom and Kaltura for video conferencing and learning management systems, respectively.

> "We had been encouraging faculty to include more technology in how they taught, and because we already had a policy in place that required every course to be on Canvas, we were far more ready. It was very prescient of Dean Bobick to have that focus in place and to provide the supply before the demand was there."
>
> — JASON CRANDALL

"If those tools hadn't been available before the pandemic, I'm not sure we could have weathered it the way we did," said Crandall, director of learning design and innovation. "We had been encouraging faculty to include more technology in how they taught, and because we already had a policy in place that required every course to be on Canvas, we were far more ready. It was very prescient of Dean (Aaron) Bobick to have that focus in place and to provide the supply before the demand was there."

While the school was executing emergency remote instruction during the Spring 2020 semester, a planning committee, which included Crandall; Ben Geers, senior director of computing & IT services; Joe Scherrer, executive director of professional education & program director; and Jay Turner, professor of energy, environmental & chemical engineering and vice dean of education, focused on the Fall 2020 semester.

"We laid out numerous scenarios and looked at our strengths and vulnerabilities under these scenarios so that if the university pivoted in a certain direction, we wouldn't be caught blindsided," Turner said.

As a result, Crandall and Meghann Pytka, one of two instructional specialists hired to help with the transition to virtual learning, created an online summer course for faculty to help them convert their courses from in-person to a hybrid or all-remote course.

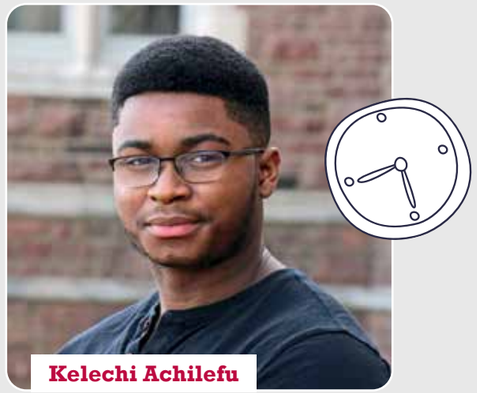
"That course was the cornerstone of our support to instructors," Turner said. "It gave instructors interesting insight into what it's like to be an online student. There were a lot of aha moments, discovering the opportunities and challenges the new teaching modalities provided."

In a survey at the end of the spring 2020 semester, students reported being mostly to very satisfied with quality of teaching both before and after the transition to emergency remote instruction, with only a 2% decline in satisfaction after the transition. In Fall 2020, students reported difficulties with the lack of personal interaction with classmates and faculty, time management and an increased workload. In many cases, Turner said, many exams were replaced with more frequent quizzes or projects, keeping students in test-mode all semester.

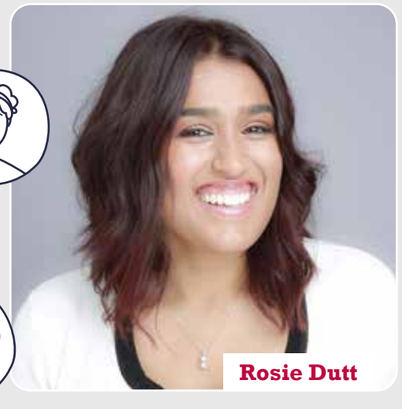
For the Fall 2020 semester, final exams were held after the New Year and were fully remote. Some were conducted synchronously with video conferencing to simulate the classroom environment, while others were "take-home" exams. Some instructors took advantage of online testing applications, such as Respondus, to assist with exam proctoring.

Students have mostly taken the change to remote learning in stride while acknowledging its opportunities and challenges.

"Logging into an online lecture has been very convenient, especially when the weather is poor," said Kelechi Achilefu, a junior majoring in mechanical engineering and president of EnCouncil for 2020-2021. "However, with hybrid learning, a common problem I hear about is establishing boundaries for when to work. Oftentimes, I find myself working for much longer than I need to simply because the work always appears to be there. For people like me, it is much easier to experience things like burnout when approaching school without taking time to separate from work, so it is something I focus on every week."



Kelechi Achilefu



Rosie Dutt

Logan Press

Alanna Bader

COURTESY PHOTOS

As EnCouncil president, Achilefu said the Executive Board decided to keep all of its programming remote for this academic year to keep members safe, which led them to be more creative.

"Although I personally miss the programs we typically hold, like Vertigo and Cheap Lunch, having time to focus on getting to know the members of EnCouncil is invaluable moving forward," he said.

Rosie Dutt, a doctoral student in imaging science, said she preferred the remote format because it allowed her to work on her own schedule and to get involved with a variety of groups, including joining the national leadership team for 500 Women Scientists and *The Journal of Science Policy and Governance.*

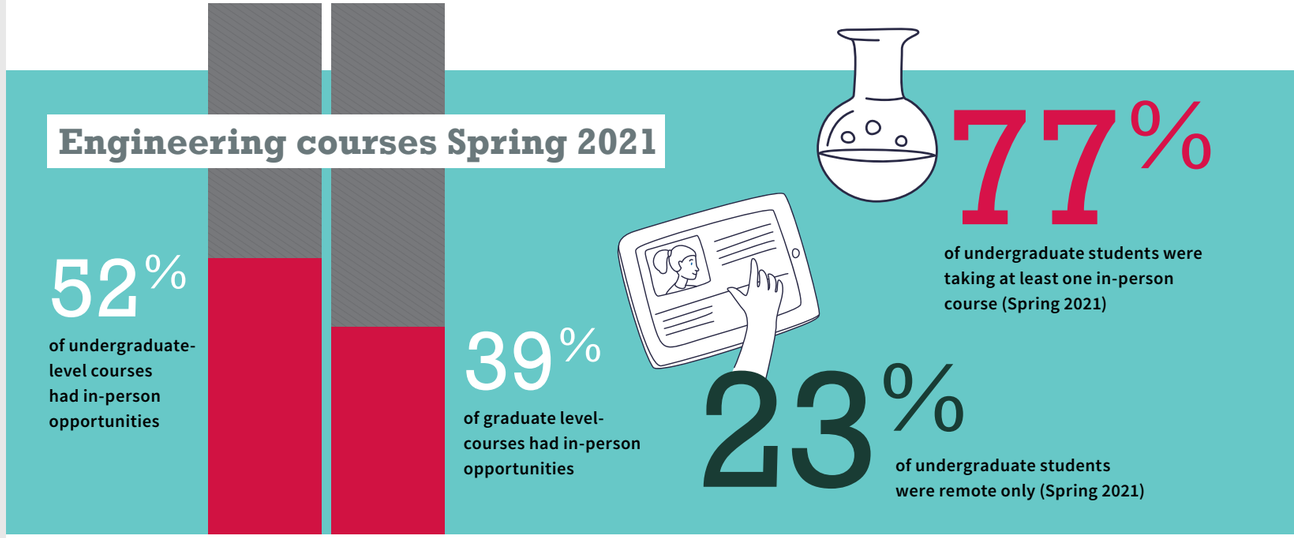
Logan Press, a senior majoring in computer science, described his virtual learning experience as rigorous. "I'd have to be inventive in how I went about learning, which then empowered me to excel.

"Nearly all my classes are online, so it's very taxing being inside the majority of the time," he said. "I make sure to give myself time get out and bike through Forest Park or take a walk on campus to de-stress."

Sophomore mechanical engineering student Alanna Bader described her fall semester as "challenging, peaceful and collaborative.

"I enjoy the flexibility of my class schedules with Zoom," she said. "Often times, mornings are the worst for me due to my disability, so I am glad to have time dedicated to physical therapy and relieving pain before I start my schoolwork. Being able to stay home instead of traveling to campus has been beneficial for my health, as well, since I struggle with permanent spine issues from an injury."

Of the 254 courses offered in Fall 2020, seven were in-classroom instruction; 102 were hybrid, offering both in-person and online options; and 145 were remote only. Of the 271 courses offered in Spring 2021, eight were in-classroom instruction; 105 were hybrid; 155 were



"I had to restructure my whole curriculum in technical writing to only meet once a week, with half in class and half on Zoom. It made me think through why we teach what we teach."

— SANDRA MATTEUCCI

remote only; one was online hybrid; and two were online. Teaching assistants served as Zoom moderators.

Some departments, such as mechanical engineering & materials science, had to change the way they presented lab experiments. Shaun Sellers and Sharniece Holland, both lecturers, teach MEMS 205, Mechanics and Materials Science Laboratory, a normally hands-on course that was fully online this fall through Canvas. Students were required to watch a video with Sellers and Holland performing the experiments, answer questions about the video, then attend a group meeting to discuss results and finish their lab report.

"We still wanted it to be an involved learning experience," said Chiamaka Asinugo, lab & design course specialist in mechanical engineering & materials science and an alumna of the Dual Degree Program who earned a bachelor's and a master's in mechanical engineering from WashU in 2016. "We had them watch the video and gave them incomplete data. They had to request the rest of the data, then do the data analysis themselves."

Sandra Matteucci, director of the Engineering Communications Center and senior lecturer, said her interactive and discussion-based courses had to change a lot.

"I had to restructure my whole curriculum in technical writing to only meet once a week, with half in class and half on Zoom," she said. "It made me think through why we teach what we teach."

Despite the separation and masks in class, the new class structure has sparked more creativity, Matteucci said.

"From my perspective, the presentations during the fall semester in leadership and ethics were among the best we've ever had," she said. "The students said their barriers for collaboration are lower because they can meet anytime. We've tried hard, but the students have, too."

Danielle Lacey contributed to this story.

Remote or online only: *No in-person component to the course.*

Online hybrid: *Same as hybrid (in-person/online), except that it was offered this way pre-COVID.*

MEMS 205 Canvas video

JENNIFER MARTIN

Libby Allman oversees manufacturing and global procurement for Hallmark Card Inc. which has faced new challenges since the COVID-19 outbreak.

In the cards

Libby Allman makes sure you find the perfect Hallmark card

Written by **BETH MILLER**

By the time that the novel coronavirus was declared a national emergency in mid-March 2020, Libby Allman had already been dealing with its effects on her job for a few months.

Allman is vice president of manufacturing and global procurement at Hallmark Cards Inc., a $4.1 billion Kansas City, Missouri-based company with 30,000 employees worldwide, where she has worked for 20 years and where she is responsible for knowing when, where and how many cards and other products are made. She oversees manufacturing facilities in Lawrence and Leavenworth, Kansas, that make cards and wrapping paper, and partner suppliers in Asia that make other items, such as Keepsake Ornaments and gifts. Together with her peers on Hallmark's distribution and logistics teams, she plans ahead to ensure that cards for everyday occasions and the three biggest card seasons — Valentine's Day, Mother's Day and Christmas — are ready and in stores in plenty of time. Hallmark sells its everyday and seasonal cards and products online and at retailers, chain drug and grocers, as well as at Hallmark Gold Crown stores, which carry exclusive cards and a larger selection of specialty items.

In early 2020, many companies with operations in China, including Hallmark, extended their employees' time off for Chinese New Year as a result of the spread of coronavirus. Allman's February trip to China was canceled, and about a month later, Hallmark closed its two Kansas plants for six weeks to comply with stay-at-home orders. For a company that makes seasonal and everyday products, the plant closures both in China and in Kansas ground its supply chain to a screeching halt.

"If you look at a graph of our volume output, we were going along, then there was a big dip, then gradually it goes back up again as we slowly brought employees back to work," Allman said. "We sorted through the seasonal products we had in stages of production, and in time, completed all of it because we know we'll need it next year, then worked to get through our everyday products. The Care & Concern and Sympathy categories were hard to keep up with, so we had to increase our units of those. We weren't planning on that, so trying to get that through a plant that has an enormous amount of WIP (work in process) is really challenging."

Hallmark brought its employees back to the plants in stages while screening, wearing face coverings and maintaining physical distancing, and is now working to catch up with its supply chain. In the meantime, the company donated nearly 6 million greeting cards worldwide to help people express their sentiments for others during the pandemic and manufactured and donated 10,000 face shields to the State of Missouri to distribute to health care organizations and schools.

WHITNEY CURTIS

Clockwise from left: Libby Allman (second from left) with colleagues from Hallmark; Allman speaking at the Women & Engineering Leadership Summit, Allman with her family.

COMMUNITY INVOLVEMENT

- **Urban Neighborhood Initiative – Kansas City**
- **Girl Scouts of Northeast Kansas and Northwest Missouri**
- **Hallmark Cards' political action committee (HallPAC)**
- **Society of Women Engineers**
- **Women & Engineering – McKelvey School of Engineering**
- **William Jewell College President's Advisory Board**
- **Greater Missouri Leadership Foundation**

Allman has had several roles at Hallmark, including vice president of product integrity and technical resources for which she was responsible for brand protection; vice president of supply chain planning & product integrity; general manager of the Hallmark Distribution Center; and director of process and program management in information technology. She also co-founded the Hallmark Women's Network.

Prior to joining Hallmark, she was a management consultant for Grant Thornton LLP and a process improvement manager for Fike Corp., where she worked while earning an MBA from Rockhurst University.

Allman credits WashU's Dual Degree program, from which she earned a bachelor's in mechanical engineering in 1991 and a bachelor's degree in physics from William Jewell College in 1990, for preparing her for all of these challenges.

"I still love the fact that I did that program — I talk it up all the time," she said. "The liberal arts part of it was deep on communication, critical thinking and problem solving. For someone like me — I've never thought of myself as an engineer's engineer — it was wonderful because I could take subjects like Spanish for four years or a religion or literature class.

"All of that plus the engineering really broadened my mind and introduced me to things that I didn't necessarily know about. For me, that was really important to making me a whole-brain thinker."

The role of women in engineering also is important to Allman. She is a mentor in the McKelvey School of Engineering's Women & Engineering program, on the board of directors of the Society of Women Engineers, and an advocate for recruiting more women into the areas of engineering in which they are underrepresented — and keeping them there.

"These young women are extraordinary in high school and are the best in their class," she said. "But when they get to college and take their first engineering class, they may get their first D or F in their lives and think they aren't smart enough to handle engineering and change to something else. We have to make sure these women understand that you don't have to make straight As in engineering to be a good engineer."

Second, she says, women want to be involved in other activities, such as sports, sororities or volunteer work.

"WashU has always been open to a new way of thinking about that, and that's one of the keys to getting more women in engineering," she said. "That, plus having more women professors and being part of women's engineering organizations so they can see other women who have developed the tenacity to stick with engineering and see that women can have families and work in engineering fields, and also so they have a place to talk about issues that impact them as women that maybe don't impact men."

> All of that plus the engineering really broadened my mind and introduced me to things that I didn't necessarily know about. For me, that was really important to making me a whole-brain thinker.
>
> — LIBBY ALLMAN

She advocates for those in Kansas City as well, where she is on the board of directo of the Urban Neighborhood Initiative, an organization that works with neighborhoo to break the cycle of poverty and build healthy neighborhoods. She also leads Hallmark Cards' political action committ known as HallPAC, which works with loc politicians to advocate for issues that impact Hallmark, such as continuing six day postal service, and she is a longtim board member of and volunteer with the Girl Scouts of Northeast Kansas an Northwest Missouri.

In addition to her community involvement, she remains involved with the McKelvey School of Engineering as well. Allman received an Alumni Achievement Award from the school in 2017 and joined the school's National Council the same year. She is co-chair of the WashU-Kansas City Regional Cabinet. Allman and Scott Ruland also support the Allman & Ruland Scholarship in Engineering

"I am so incredibly honored and humbled by the people in that room," she said. "I am a phenomenal advocate for WashU, so the more information I have about what's happening on campus and in engineering, the more I can advocate for it."

EDITOR'S NOTE

After this story went into production, Libby Allman left Hallmark for another opportunity.

NEW BUILDING

James M. McKelvey, Sr. Hall

McKelvey Hall, located south of Preston M. Green Hall, will house the Department of Computer Science & Engineering and support Washington University's data science efforts.

WASHU PHOTO

A view of McKelvey Hall from the west. An aluminum and glass curtain wall is used to flood the building with natural light.

"The open concept that permeates the design of McKelvey Hall is intended to foster greater interactions and collaborations. It will help our faculty and students create connections both within and outside of engineering and contribute to broadening the impact that data and computing are having on science and society."

— Roch Guérin, Harold B. and Adelaide G. Welge Professor of Computer Science and Department Chair

PHOTOS BY PATTERHN IVES

1 The collaboration area on the first floor near the main entry. On the south wall are white decorative metal panels, and a portion of the video display wall can be seen. Past the seating is the communicating stair that connects all five floors.

2 A view of McKelvey Hall from the east, along Skinker Boulevard.

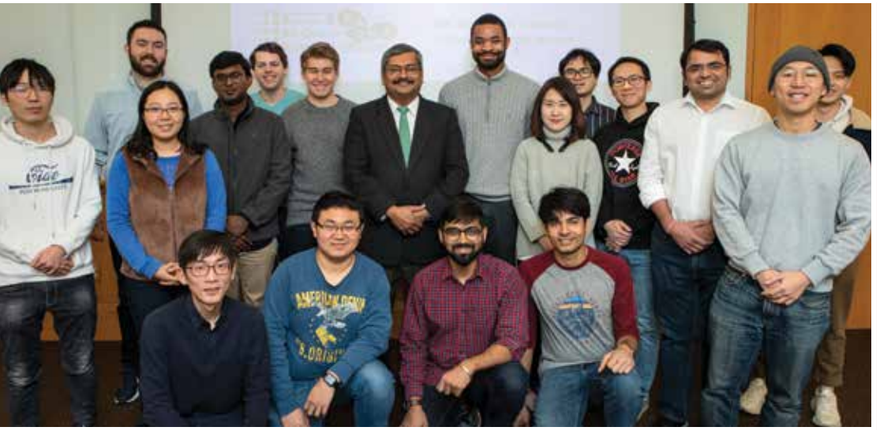
3 Bytes, the café on the first floor, will serve Starbucks products, among other items. The café has views of the Engineering Quad and Tisch Park to the west.

4 The second-floor collaboration area known as the Judith Hood McKelvey Commons. Polished concrete floors and extensive glass boards for spontaneous collaboration are part of the design. This area is meant to be flexible to also accommodate various types of presentations.

5 One of the student office areas known as neighborhoods, which were designed to accommodate a number of various research groups to facilitate collaborative exchanges.

McKelvey Hall is the newest building on the East End of the Danforth Campus. It connects directly with Green Hall and is only steps away from the Skinker Metrolink station.

DEVON HILL



By the numbers

260%
Growth in research awards from 2007-2020 in the department

108%
Growth in research expenditures from 2008-2020 in the department

331%
Overall enrollment increase from 2006-2020 in the department

50%
Tenured/tenure-track faculty growth from 2007-2020 in the department

A new chapter

Written by **BETH MILLER**

After 20 years of and leading environmental engineering in the McKelvey School of Engineering into an international powerhouse for aerosols, air quality and environmental research, **Pratim Biswas** left Washington University in St. Louis to become the dean of the University of Miami College of Engineering in January 2021.

Biswas, who was the Lucy & Stanley Lopata Professor and assistant vice chancellor of international programs, is an internationally renowned aerosol scientist who is a member of the National Academy of Engineering, considered one of the highest honors in the field of engineering. The founding chair of the Department of Energy, Environmental & Chemical Engineering since 2006, he is renowned worldwide for his pioneering work in aerosol science and engineering in his Aerosol and Air Quality Research Laboratory. While at the McKelvey School of Engineering, Biswas orchestrated numerous national and international collaborations to advance the common good, particularly in developing countries. He was the university's ambassador to the Indian Institute of Technology Bombay and directed the McDonnell Academy Global Energy and Environmental Partnership (MAGEEP), a consortium of 35 universities worldwide where scholars collaborate on research and new initiatives.

In addition to his leadership, he was prolific in his research. He holds 10 patents and has spun off two startup companies based on his inventions. His work applying aerosol science to energy and environmental nanotechnology, solar energy use, air pollution control, medicine and other areas of science and engineering brought him numerous awards and honors, including the Fuchs Award, the highest honor given to an aerosol scientist. He was elected as a fellow of the Academy of Science, St. Louis in 2003 and a fellow of the American Association for Aerosol Research in 2009. In 2014, he was selected as a fellow of the International Aerosol Research Assembly; and in 2017 was elected fellow of the Association of Environmental Engineering Science Professors. He won numerous awards from national societies such as AIChE, ASCE and others.

RON KLEIN

> "If there were a recipe for a great leader and academic, Pratim would have all the necessary ingredients: keen intellect and memory, contagious enthusiasm for his field, vision, excellent managerial skills and a passion for motivating others to reach their potential."
>
> — RICHARD AXELBAUM

"Pratim is a rare breed," said Richard Axelbaum, the Jens Professor of Environmental Engineering Science and longtime colleague. "If there were a recipe for a great leader and academic, Pratim would have all the necessary ingredients: keen intellect and memory, contagious enthusiasm for his field, vision, excellent managerial skills and a passion for motivating others to reach their potential. Add to this a relentless work habit and endurance, and you have created, well, Pratim — someone who has transformed the EECE department at Washington University and has had a major impact internationally, someone who I find it an honor to be able call a collaborator, mentor and friend."

Biswas also was instrumental in the development of the Stephen F. and Camilla T. Brauer Hall, which houses the Department of Energy, Environmental & Chemical Engineering.

"I was honored to work with my colleagues at creating an impactful department at WashU," Biswas said. "Working with my colleagues, I recruited more than 20 of the faculty members in the department, and each one of them is doing extremely well. I enjoyed working with them and will miss them immensely. I hope to continue to collaborate with them as I start my new stint at the University of Miami. I am also proud of the students that we trained and graduated from our department. I cherish their accomplishments and will continue to do so in the years ahead. Washington University will always have a special place in my heart — both my sons graduated from here. "

The McKelvey Challenge *continues*

“We are grateful to Jim and Anna McKelvey for their generosity and continued support of our school through the McKelvey Challenge, as well as to all of those who have participated in the Challenge so far. McKelvey Engineering is working hard to focus on education, fundamental research and innovation. With these and future gifts made through the McKelvey Challenge, we are strengthening those areas and providing new opportunities through scholarships, faculty investment and hands-on experiences.”

— DEAN AARON BOBICK

The McKelvey Engineering Challenge will match all gifts, pledges, estate gifts, and bequest commitments for the McKelvey School of Engineering made through June 30, 2022 — or until the challenge funds are exhausted.

On a cold, snowy day in January 2019, the Washington University School of Engineering & Applied Science became the James M. McKelvey School of Engineering thanks to a generous gift from alumnus and tech entrepreneur Jim McKelvey Jr. and his family.

In the more than two years since the name change took place, many alumni and friends have participated in the $30 million McKelvey Challenge. Jim McKelvey Jr., who earned degrees in computer science and economics at WashU in 1987, established the challenge with his wife, Anna, to expand opportunities for students, bolster cutting-edge research and provide modern facilities for Engineering. The multi-year challenge was designed to provide matching funds to support endowed scholarships, endowed professorships, the school’s annual fund, the recently opened James M. McKelvey, Sr. Hall and the Henry A. and Elvira H. Jubel Hall, and for other engineering projects.

The McKelvey Engineering Challenge will match all gifts, pledges, estate gifts and bequest commitments for the McKelvey School of Engineering made through June 30, 2022 — or until the challenge funds are exhausted. Additional contributions during the remaining time period will trigger matching funds that will combine with the gifts into a powerful investment in Engineering at Washington University.

One of the most innovative programs included in the McKelvey Challenge is the support of multidisciplinary Computing + X professorships, an initiative to connect computational thinking with other fields across the university. Through Computing + Music, Computing + Political Science or Computing + other disciplines, McKelvey Engineering is breaking down barriers between academic disciplines, transforming how research is conducted and pioneering new ways to integrate computer education across campus.

Challenge accepted

STEVE LOWY

Among the donors who have already participated in the McKelvey Challenge is Steve Lowy, who earned a bachelor’s degree in 1968 and a master’s degree in 1970 in chemical engineering from Washington University. Lowy, with his wife, Susie, gave a gift in 2020 that will provide 31 additional scholarships to the Washington University Scholars in Engineering Program. Previously, Lowy had established three endowed scholarships and four annual scholarships, and this new donation will bring the total number of Lowy scholarships to an unprecedented 38 scholarships each year.

“It’s a great program that dramatically changes lives by making it possible for students from low-to-moderate income families to get an outstanding education at Washington University McKelvey School of Engineering that they could not afford without a Lowy scholarship,” he said. “I enjoy giving to this so much more than any other charity where you don’t really know what your money goes to. I get much more satisfaction out of this program.”

Lowy, who is chairman of Envision LLC, a St. Louis-based IT firm that provides staffing to Fortune 500 companies, began contributing to the scholarship program in the 1970s, when he worked for his family’s wholesale carpet business. Since then, 79 students have benefited from his generosity.

Lowy remains very involved with the university through the Eliot Society and serving as chairman of its Patron Committee for the past three years. He also served on the executive committee of his undergraduate class’s 50th reunion in 2018. He received the McKelvey Engineering Alumni Achievement Award in 2018.

LAURIE BOWEN

Laurie Bowen’s participation in the McKelvey Challenge focuses on scholarships, particularly for women in Engineering.

“I appreciate the opportunity to help talented people who can’t quite afford to make it to WashU but have the drive and capability to succeed,” Bowen said. “I especially want to support women in engineering because there just aren’t enough in the workplace!”

Bowen spent more than 30 years in telecommunications and wireless communications around the globe with companies including Tata Communications, British Telecommunications and IBM. Most recently, she was CEO for the Americas companies of Telecom Italia Sparkle. She now sits on the boards of directors for Ricardo plc and Chemring Group plc, which often faces the challenge of recruiting women engineers.

Bowen, who earned bachelor’s degrees from WashU Engineering in computer science and in electrical engineering in 1983 and an MBA from Olin Business School in 1989, said her experience at WashU helped her learn about herself and where she was headed in life. “I am so grateful for the foundation that WashU provided for me,” she said. “If possible, I want to help provide that opportunity for other students.”

She said she has enjoyed seeing the changes and impact that WashU has been making over the years and really appreciates the heightened profile the McKelvey name and challenge bring.

“This massive investment that has come from Jim McKelvey puts the Engineering school on a different level,” she said.

Bowen also serves on the school’s National Council.

MICHAEL LEFENFELD

Michael Lefenfeld, who earned a bachelor’s degree in chemical engineering from WashU in 2002 and master’s degrees from Columbia University in 2005 and 2007, is president and CEO of Houston-based Cyanco, the world’s largest producer of sodium cyanide, used in the gold and silver mining industry to extract metal from rock. Previously, he co-founded SiGNa Chemistry, which manufactures highly active, environmentally friendly chemicals used to improve production processes in the energy recovery, petrochemical refining and chemical manufacturing industries. He holds more than 100 patents and has received numerous awards and recognitions for his professional and charity work, including the Engineering Entrepreneurship Award from McKelvey Engineering in 2017. He also serves on the school’s National Council.

Lefenfeld participated in the McKelvey Challenge by investing in scholarships and making a major contribution to help construct a hands-on learning lab for chemical and environmental engineering.

“Any way to support the Engineering school with shared support is always an important factor,” Lefenfeld said. “The McKelvey family is contributing a lot to engineering, and to be a part of this challenge is a great way to add to that.”

As an entrepreneur, Lefenfeld wants to promote that spirit among Engineering students.

“The school and the Energy, Environmental & Chemical Engineering Department have given so much to me, so I have tried to give back to ensure that students will have interactive, hands-on tools, entrepreneurial experience and interdisciplinary collaborations that make up a well-rounded education.”

For more information: mckelveychallenge.wustl.edu

Professorship

Bayly named inaugural Lee Hunter Distinguished Professor

Philip V. Bayly, an innovative researcher of waves and oscillations in the mechanics of cells and biological tissues, has been named the inaugural Lee Hunter Distinguished Professor in the McKelvey School of Engineering.

Bayly, who has been chair of the Department of Mechanical Engineering & Materials Science since 2008, was installed Oct. 28, 2020.

"It is fitting that Phil Bayly will be taking on the Hunter professorship. Like Lee Hunter, Professor Bayly's work showcases the importance of creativity in engineering," Chancellor Andrew D. Martin said. "This creativity will certainly revolutionize the way society understands and treats head trauma.

"Lee Hunter's work revolutionized the automotive industry, and his legacy persists, thanks to his stepson, Stephen Brauer," Martin said. "We are grateful for the Brauers' continued, generous support of Washington University in St. Louis, and honored to help keep Hunter's legacy alive with the Lee Hunter Distinguished Professorship."

In memoriam: Palghat Ramachandran

Palghat (P.A.) Ramachandran, professor of energy, environmental & chemical engineering, died Thursday, March 18, 2021, of natural causes in his sleep. He was 75.

Ramachandran joined the faculty at Washington University in 1982 as an associate professor. He taught many graduate courses in transport phenomena, reaction engineering, multiphase reactor analysis, computational engineering, engineering mathematics, environmental reaction engineering, semi-conductor material processing analysis, and pollution prevention in chemical processes.

Ramachandran's research interests were in chemical reaction engineering, three-phase catalytic reactors, mathematical modeling, semiconductor material processing, boundary element and integral equations, and reactor design for pollution prevention. He worked extensively on modeling and analysis of multiphase reactors as applied to chemical and pharmaceutical industry. He published more than 200 papers in refereed journals, as well as four books and several monographs.

He received numerous awards, including the Moulton Medal from the Institution of Chemical Engineering (England) in 1971; the Institute of Chemical Technology Distinguished Alumni Award; NASA Certificate of Recognition; National Environmental Engineering Research Institute Medal; Indian Institute of Chemical Engineers; and the Big Fish Award from the Engineering School for graduate student mentoring and education.

NEW LEADERSHIP

Imoukhuede named director of diversity initiatives

Princess Imoukhuede, associate professor of biomedical engineering, has been named director of diversity initiatives for the McKelvey School of Engineering.

As the school's first director of diversity initiatives, Imoukhuede will engage students, faculty and staff to more precisely identify and define diversity, equity and inclusion concerns, develop approaches to address those concerns and partner with school leadership to implement appropriate solutions. She also will examine curricular and programmatic opportunities to enhance the success of Black, Indigenous and people of color (BIPOC) students as well as students with intersectional, marginalized identities. She is chair of the McKelvey Committee on Diversity, Equity and Inclusion.

Wagenseil named vice dean for faculty advancement

Jessica Wagenseil, associate professor of mechanical engineering & materials science, has been appointed vice dean for faculty advancement in the McKelvey School of Engineering.

In the newly created position, Wagenseil will work with the department chairs to assess and monitor faculty mentoring and career development, to develop faculty leadership training opportunities and to coordinate nominations for faculty awards in support of the full range of faculty career progression. She also will work with Dean Aaron F. Bobick to coordinate the tenure and promotion process and serve as associate chair of the McKelvey Committee on Diversity, Equity and Inclusion.

New faculty join McKelvey Engineering

Biomedical Engineering

Alexandra L. Rutz, assistant professor

» PhD, MS, biomedical engineering, Northwestern University

» BS, chemistry and molecular and cellular biology, University of Illinois Urbana-Champaign

Alexandra L. Rutz joins McKelvey Engineering from the University of Cambridge, where she is the Marie Skłodowska-Curie Individual Research Fellow in the bioelectronics lab of George Malliaras, the Prince Philip Professor of Technology.

Rutz's research focuses on improving the biocompatibility and long-term function of implantable bioelectronics, especially neural probes. Her doctoral thesis focused on engineering hydrogel bioinks for 3D printing tissues and organs. Rutz joins the department in Spring 2021.

Ismael Seáñez, assistant professor

» PhD, MS, biomedical engineering, Northwestern University

» BS, mechanical engineering, University of Texas, San Antonio

Ismael "Mayo" Seáñez joins McKelvey Engineering from the Swiss Federal Institute of Technology Lausanne (EFPL), where he is a postdoctoral fellow working with Grégoire Courtine as head of the translational division at the NeuroRestore Defitech Center for Interventional Neurotherapies. Seáñez focuses on developing brain-spine interfaces where real-time brain recordings are used to reinforce leg movements with spinal cord stimulation.

Seáñez joins the department in Spring 2021. He also will have a secondary appointment at the School of Medicine as assistant professor of neurosurgery.

Electrical & Systems Engineering

Mark Lawrence, assistant professor

» PhD, physics, University of Birmingham

» MS, theoretical physics, University of Birmingham (England)

Mark Lawrence joins WashU from Stanford University, where he was a postdoctoral researcher and physicist with interests in optics, nanophotonics and condensed matter physics. Lawrence's specific research focuses on the use of dielectric metasurfaces, plasmonic nanoantennas and photonic crystals to build novel systems and devices for applications in telecommunications, computing and quantum information.

While at Stanford, Lawrence proposed and experimentally demonstrated the first high-quality factor phase gradient metasurfaces and theoretically demonstrated power independent subwavelength nonreciprocity using Raman amplification; subwavelength Kerr-nonlinear nonreciprocal beam-steering; and dielectric metasurface enhanced enantiomeric detection and separation of chiral molecules.

Yong Wang, assistant professor

» PhD, biomedical engineering, Washington University in St. Louis

» MS, BS, electrical engineering, Xi'an Jiaotong University, Shannxi, China

Yong Wang joined McKelvey Engineering as a joint appointment with the Department of Obstetrics & Gynecology at the School of Medicine. His current research on developing a novel hybrid noninvasive imaging system for the study of electrical maturation and microstructural changes of pregnant uterus builds logically on his prior doctoral and postdoctoral training. He will adapt and combine his expertise in ECGI and MRI/DBSI to creatively develop and validate the novel hybrid imaging system and use it to study the mechanism underlying preterm and normal term labor.

His invention of meshless ECGI technique has eliminated conventional ECGI's imaging artifacts and enhanced the imaging speed by a factor of 100, which greatly facilitated the successful application of ECGI system to study the basic mechanisms of cardiac disorders.

Mechanical Engineering & Materials Science

Sang-Hoon Bae, assistant professor

» PhD, materials science and engineering, University of California, Los Angeles

» MS, BS, materials science and engineering, Sungkyunkwan University (South Korea)

Sang-Hoon Bae will join WashU in August 2021 from Massachusetts Institute of Technology, where he is a postdoctoral research associate. His research interests include new material building blocks, including freestanding single-crystalline 3D thin films and 2D atomic layers; highly efficient, cost-effective advanced photovoltaics; and heterogeneous integration with artificial intelligence toward ubiquitous electronics.

He is an author on 47 published papers and has won numerous awards. Bae completed research internships at IBM T.J. Watson Research Center and Samsung Display.

Matthew Bersi, assistant professor

» PhD, MS, MPhil, biomedical engineering, Yale University

» BS, biomedical engineering, Texas A&M University

Bersi joins McKelvey Engineering from Vanderbilt University, where he was a postdoctoral research scholar in biomedical engineering and a member of the cardiovascular research training program in the division of cardiovascular medicine at Vanderbilt University Medical Center.

Bersi's research interests are focused on using experimental and computational approaches to better understand the relationship between biomechanics and inflammation in soft tissues. To date, he has investigated the role of the immune system in hypertension, cardiac fibrosis and vascular injury and has developed tools to assess the mechanical properties of single cells using micropipette aspiration and mathematical modeling. While focused primarily on cardiovascular disease, this multiscale approach has applicability to understanding injury and disease processes in multiple tissues and organ systems.

Megan Flake

Our essential staff member

Written by **BETH MILLER**

WHITNEY CURTIS

As McKelvey Engineering's laboratory safety & protocol manager, Megan Flake, who has seemingly limitless energy and passion for her job, is responsible to ensure everything runs smoothly and safely in the school's labs. But what happens when all research shuts down due to a global pandemic?

"Our buildings are living beings," Flake said. "We have cells that are alive and equipment that needs to be maintained. There were a lot of things that needed to continue to happen."

For the first few months of the shutdown, Flake was part of a skeleton crew with Gena Reed, payroll coordinator & finance/facilities assistant, and Barbara Semar, who had recently been hired as lab manager for the Department of Mechanical Engineering & Materials Science. Flake and Semar took turns walking through every Engineering lab daily, following a checklist of things specific to each lab they needed to keep their eyes on, including incubators, freezers, refrigerators and chemical supplies. Their goal was to keep each lab in a state that it could restart without significant delay.

McKelvey Engineering labs run around the clock, which means they are in constant need of replenishing supplies. With most of the labs closed, Flake set up a central receiving site at the Brauer Hall loading dock where all supplies would be delivered, sorted and either stored or picked up by the labs still open. Several faculty in the departments of Biomedical Engineering and of Energy, Environmental & Chemical Engineering were in their labs working directly on COVID-19-based research. Ruth Okamoto, teaching professor, and Charlotte Guertler, associate director, were in the Spartan Light Metal Products Makerspace in the Henry A. and Elvira G. Jubel Hall making face shields for health care providers at Washington University Medical Center. Flake also drove materials to the School of Medicine and back.

"We had to add all of this to the things we do for normal lab safety," Flake said. "In early summer, we started to help all of the faculty develop ramp-up plans for when the labs reopened. We were trying to determine how to keep people safe in an environment in which we needed to have a widespread expectation of compliance, so we wanted to have as much standardization as we could."

While Flake has been managing labs in the school since 2007, previously managing labs of two former faculty members is biomedical engineering, she never expected to be managing labs during a global pandemic.

"I think this mostly fell to my position because of my background in research and the existing relationships I have with our research faculty and graduate students," said Flake, who earned a bachelor's degree in biology with a minor in chemistry from Fontbonne University. "Safety is already an overarching part of my job, and I have an intimate knowledge of what happens in our labs on a daily basis, so that put this in my wheelhouse."

Flake said faculty have been very patient and understanding about the changes.

"I feel very fortunate to be working in Engineering in particular — I don't have to sell the science," Flake said. "Everyone gets it, and we've made a conscious decision to make science-based decisions. With the support of the infectious disease specialists at the medical school and the Environmental Health and Safety department, we have been able to respond unbelievably quickly to changing conditions because of the team we have here at the university."

"As we restarted our research activities in earnest last summer, the McKelvey COVID response team was discussing the new laboratory protocols and how we would manage them," said Aaron Bobick, dean and James M. McKelvey Professor. "As we considered everything we were doing, I think one of our department chairs summed it up the best: 'Thank god for Megan Flake.'" Bobick added: "Amen to that."

YEAR IN REVIEW | 2020

A year like no other

1,018 *degrees awarded*
graduates in FY20

$41M
Research awards (FY20)

82%
increase in research awards during the past seven years

STUDENTS | FALL 2020

highest enrollment *in the history of* WashU Engineering **2,809**

1,428	519	338	524
Undergraduate	Full-time master's	Part-time master's	PhD students

32.8%
of undergraduate students are women

$45K
Average need-based undergraduate scholarship awarded in Engineering

Forty percent
of Engineering undergraduate students receive financial aid

100
tenured/tenure-track faculty members

63%
of McKelvey Engineering undergraduate students engaged with the Career Center in the 2019-2020 academic year

$13.5M
in gifts and commitments

FINANCIAL REPORT | FY20

$164,901,000	TOTAL GROSS REVENUE
$153,688,000	TOTAL EXPENSES
$10,412,000	FUNDS RESERVED
$801,000	NET RESULTS

AWARDS

three
faculty members received NSF CAREER Awards

RANKING

#1
Embedded & real-time systems (CSRankings.org)

86,500
square feet in the newly opened McKelvey Hall

254
Engineering courses offered in Fall 2020

102	hybrid
145	remote only

Frank Bergh

COURTESY PHOTO

Written by **BETH MILLER**

Frank Bergh

The writer Isaac Asimov is quoted as saying "Science can amuse and fascinate us all, but it is engineering that changes the world." Washington University in St. Louis Engineering alumnus Frank Bergh has taken that to heart, using his education to take electricity to remote regions of the world and changing the lives of those getting electricity for the first time.

Bergh, who earned a bachelor's degree in electrical engineering with a minor in Spanish in 2008, has spent much of the past several years working to set up microgrids and off-grid solar energy systems in sub-Saharan Africa. After several jobs working in wind and solar energy, Bergh is now a senior electrical engineer with the National Rural Electric Cooperative Association International (NRECA), a nonprofit cooperative whose rural electrification initiatives have reached 160 million people in 65 developing countries since 1962. As NRECA's first specialist on microgrids and renewable energy, Bergh is working on off-grid systems for rural communities and national electrification strategies for several countries in Africa, as well as consulting with U.S. Agency for International Development (USAID) and other international organizations.

"My work is focused on isolated systems in which communities can provide and maintain their own electric service with solar energy, batteries and newly emerging technologies with the right support systems in place," he said.

Bergh started with NRECA in early 2020 after spending about three years of freelance work for two consulting firms, JustDesign Cooperative and Beyond the Grid PLLC, focused on technical assistance and consulting work primarily in sub-Saharan Africa and Latin America. From 2017 to 2018, Bergh was working primarily in northwest Haiti with Sigora International designing and building rural microgrids that now serve about 20,000 people. From 2018 to 2020, he served as the principal engineer for Nuru Energy and managed the design and construction of the largest solar hybrid mini-grid in Central Africa, a 1.3-megawatt solar array with 2 megawatt hours of lithium-ion batteries, in the city of Goma in the Democratic Republic of the Congo. He traveled to Goma five times over 15 months — all during the Ebola epidemic.

Despite the rigorous travel and sometimes rugged conditions he works and lives in while on an international project, Bergh said he finds the work very motivating.

"My life is forever shaped by the relationships and the people who have been part of the journey with me," he said. "I don't live in those places for long, but I have a responsibility if I'm going to work there to be a good neighbor and participate in those communities with integrity."

Bergh ended his freelance work for a good reason: he and former WashU classmate December Kinney, who earned a bachelor's in French in 2008, married in August 2020. Since COVID-19 is preventing a traditional honeymoon, the couple decided to spend their first year of marriage in Oakland, California, Bergh said.

While living in Chicago, Bergh was a founding member of Organizing White Men for Collective Liberation (OWMCL) in Chicago, which is part of a national movement focusing on white men taking action against white supremacy and patriarchy, and Showing Up for Racial Justice (SURJ) Chicago, a national racial justice organizing collective. In 2016, he was part of the 41-day #FreedomSquare encampment in Chicago.

Even though his upcoming microgrid projects with NRECA in Africa remain on hold for now, Bergh stays in contact with those he's worked with around the world.

"I'm excited about what we've learned together, and in many cases, what I've been taught by these experiences," he said. "Over the course of my career, I think about not only how much can I get done, but how I can reallocate power and privilege in solidarity with those who have been disadvantaged and disempowered. I'm leveraging the tremendous gifts and blessings of my WashU education to share power with the rising global leaders of a brighter future."

interminable

def. endless, long, never-ending

Written by **HANNAH SMITH**

COURTESY PHOTO

Hannah Smith is a senior majoring in applied science in electrical engineering and the president of the WashU chapter of the National Society of Black Engineers.

This pandemic feels interminable. It didn't always. In March of 2020, one full year ago, we were under the impression that with the termination of a two-week quarantine, the world would resume as planned. As students, faculty and administrators adjusted along with the rest of the world to a new reality containing virtual learning, masks and social distancing, that impression faded fast. With no end, no solution in sight, days began to meld together, and as such, the world of isolation and Zoom meetings seems permanent. But just because things appear to be absolute doesn't mean they are.

Our way of being has changed, in a seemingly interminable manner, and as we stretch and mold ourselves to fit into our new roles in the world, our community's perseverance and resilience are tested.

Underrepresented minorities in McKelvey, the greater WashU population and the world are accustomed to the uncomfortable process that is fitting yourself into a new world. And as we all experience the pains of isolation, Zoom fatigue and general discontent due to COVID-19, we recognize the parallels in adjustment many students face when entering an unknown schooling environment. This is a new type of resilience, but perseverance is not new. Communities of color have dealt with seemingly endless structures of oppression, and now as a greater community, we will persevere through this endless pandemic. As engineers, we are tasked with solving problems. We don't accept things as they are, we make them better.

As our vaccine rollout reaches more in our community and the systematic racism that is interwoven into our school's bylaws are being publicly challenged, the permanent is proven to be temporary. As we keep hope for the future, we must remember that even the most ever-fixed mark is amenable.

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James McKelvey School of Engineering

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CHANGE SERVICE REQUESTED

#WashUengineers

$p = mv$

Snapshot //

Air Quality Engineering is an undergraduate class that explores air quality principles, atmospheric chemistry and movement of pollutants in the atmosphere. Students utilized sensors to measure particulate matter (PM) to better understand indoor air quality with applications to COVID-19 transport.

DEVON HILL