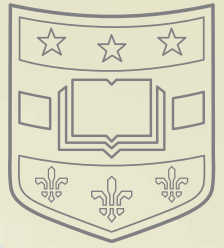


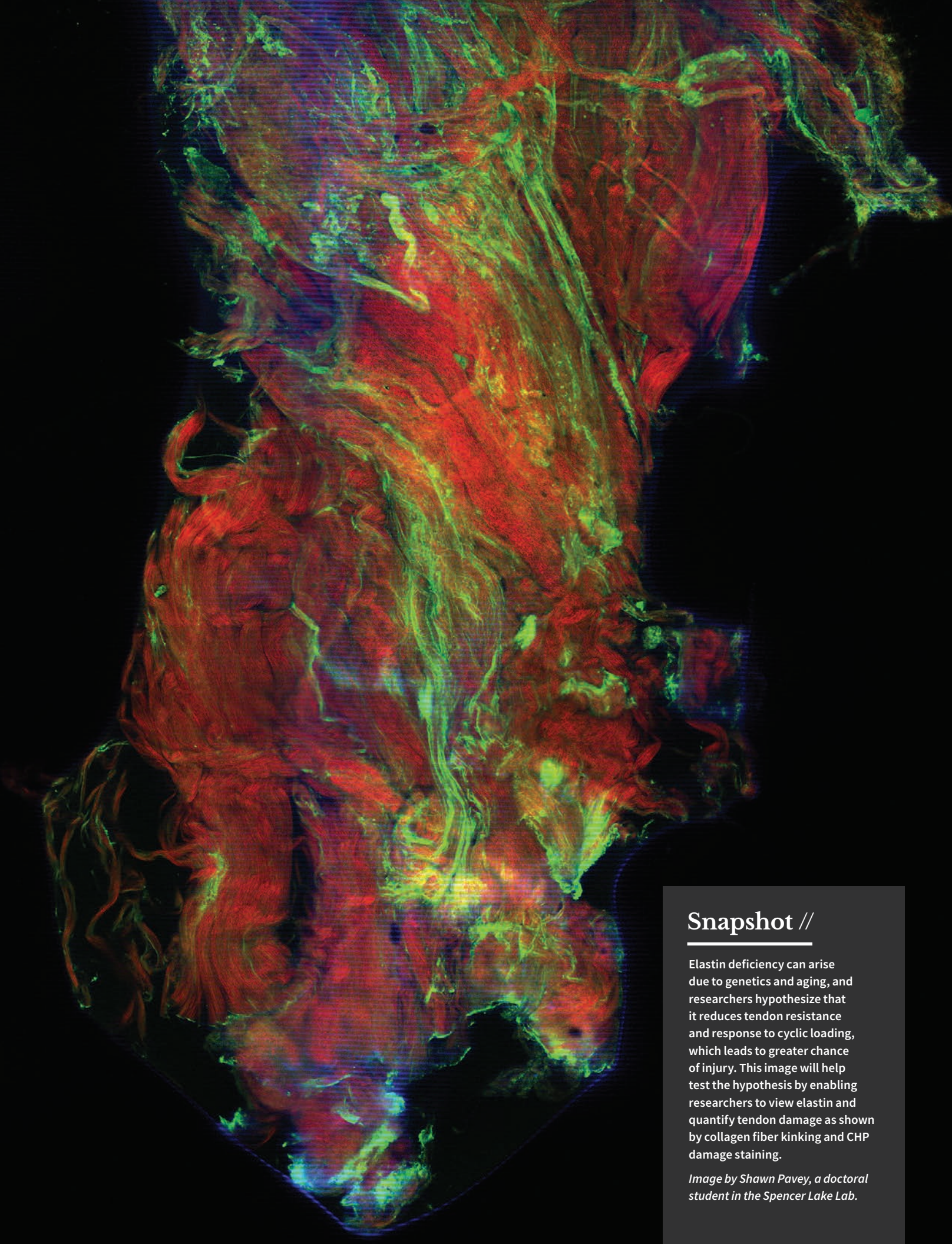
# MCKELVEY ENGINEERING Momentum

Across Disciplines. Across the World® // WINTER 2023



## ENGINEERING WOMEN'S HEALTH





## Snapshot //

Elastin deficiency can arise due to genetics and aging, and researchers hypothesize that it reduces tendon resistance and response to cyclic loading, which leads to greater chance of injury. This image will help test the hypothesis by enabling researchers to view elastin and quantify tendon damage as shown by collagen fiber kinking and CHP damage staining.

Image by Shawn Pavey, a doctoral student in the Spencer Lake Lab.

## From the dean //



From left: Aaron Bobick and Jerome Cox in 2016

### Every now and then, you get the timing just right.

In this issue of *Momentum*, you will see the story of McKelvey Engineering launching a new Center for Women's Health Engineering. When I tell individuals who are not part of an engineering/medical school ecosystem about this new endeavor, I get puzzled looks. How is women's health an engineering problem? If the person is a parent — especially a woman parent — I mention that as they recall, pregnancy entails a remarkable set of mechanical and materials phenomena. Tissues develop and stretch, absorbing mechanical load. Entire organs form that permit the transmission of certain elements from the mother's circulatory system to the fetus. And at time of labor, the forces that are produced in a synchronized manner, coupled with the controlled rupture of membranes and the dilation of other structures, result in birth of a child, and yet the mother's system is left intact so the mother can move from caring for a baby internally to being a mother externally.

Except when it doesn't.

As reports mentioned in the article attest, maternal mortality in the U.S. is actually increasing — the only developed country for which that is true. Outcomes among women of color are even more disturbing: Black women are three times more likely to die in childbirth than white women. The situation is so extreme that in the summer of 2022, the White House and Congress began developing roadmaps and passing legislation to address these challenges. When you dig into the various possible causes and challenges, one learns quickly that many women's health issues — and in particular maternal health — is woefully understudied and thus poorly understood.

Enter the Center of Women's Health Engineering. As you will read, establishing the Center was an outcome of process started in 2020 when several faculty members from both McKelvey Engineering and the School of Medicine began a women's health initiative. The effort quickly gained momentum (pardon the pun) as other faculty and supporting alumni saw the immediate need and opportunity. The medical school faculty recognize that many of the scientific challenges require an engineering approach not only because of the structural issues involved but also because it is quite challenging (for obvious reasons) to do any experimental work with pregnant women, and thus simulation and modeling was key to much initial understanding. Because of increased awareness of this challenge, there will be significant funding available to support these interdisciplinary lines of research. The timing was perfect. And the Center is a quintessential example of the type of interdisciplinary research that is championed at McKelvey Engineering. As dean, I am thrilled to be able to support such a Center that addresses such a critical societal problem, and I know you will enjoy learning more about it.

Before I close, I want to acknowledge the end of two eras. First, you will read of the passing of Jerome Cox. Jerry was a fundamental force behind the development of computer science at WashU. His impact is seen not only in the work he did but also by the remarkable number of students, now our alumni, whose lives he touched. Second, after years of leadership in biomedical engineering through his work in cardiac arrhythmia, Yoram Rudy is retiring. At a symposium held a few years ago, the academic influence that Yoram has had was clear as speaker after speaker could trace their scientific roots to Yoram's research and laboratory. McKelvey Engineering research is stronger now than it ever has been, and much of that is because of the type of foundation laid by Jerry and Yoram.

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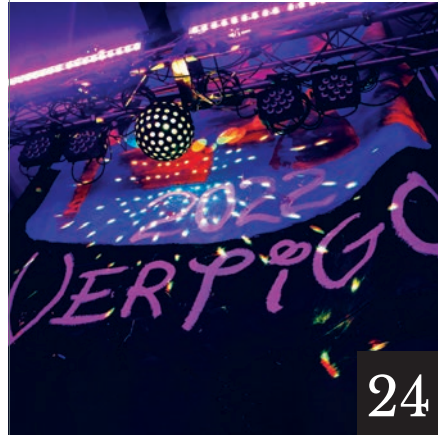
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# THE BUZZ

**We are McKelvey!**



**Study Abroad**

McKelvey Engineering offers students the opportunity to travel and study at more than 20 institutions around the world.

Esther Faronbi, a senior majoring in chemical engineering, spent a semester studying at University College Dublin.

"My two favorite things about studying abroad in Ireland were the people and the scenery. I never got tired of seeing rolling green hills and quaint little fishing towns along the Irish coastlines." — ESTHER FARONBI



**New video series**

**Chatting with Engineers**

View the entire series here:



SCAN ME

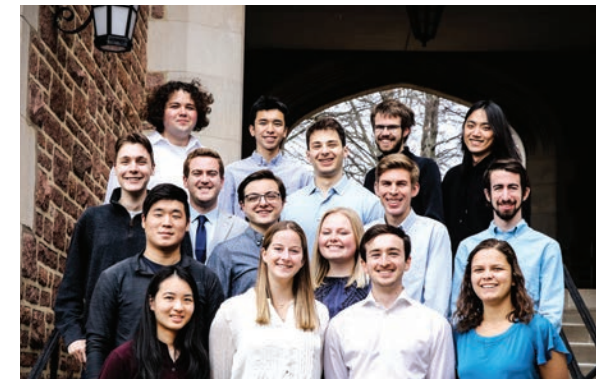
**New students Fall 2022:**

**28%**  
ARE PELL-GRANT ELIGIBLE

**20%**  
ARE FIRST-GENERATION COLLEGE STUDENTS



**2022 Commencement**



**2022 Valedictorians:** Left to right, First row: Kathleen Cheng, Katie Stender-Moore, Michael Casey, Kaitlyn Moran; Second row: Michael Qiu, Sam McGarey, Katie Lund, Grayson Derossi, Josh Pullen; Third row: Isaac Bock, Leo Karp, Aaron Stein; Fourth row: Cameron Bleem, Zach Young, Aidan Kelley, David Shen

**Did you know?!**



**#13**  
**2023 Best Colleges for Engineering**  
NICHE



**#13**  
**Biomedical Engineering graduate program**  
U.S. NEWS & WORLD REPORT



## New advising team to strengthen student support systems

Undergraduate Student Services in the McKelvey School of Engineering has experienced a major reorganization of its staff and services in the past two years.

While some changes were necessary due to departing personnel, the office took the opportunity to make intentional adjustments to their services. Lisa Gillis-Davis, senior assistant dean, joined Undergraduate Student Services in 2022 and is leading a new team focused on developing student support initiatives.

“Chris Kroeger looked strategically at the student body profile and where the needs are,” Gillis-Davis said. Kroeger is the associate dean for Undergraduate Student Services. “He created our arm of student support, and underrepresented student groups and first-year students are our focus.”

The new team consists of Gillis-Davis and three other staff members, each focusing on specific strategies to improve student support: Jessica Allen, academic adviser; LaVeasey Carter, assistant dean; and Ashleigh Goedereis, assistant dean.

“One of the areas I’ll be focusing on is the early alert process and establishing a better way of communicating with faculty,” Allen said. “That’ll give us an opportunity to look at the populations that may be part of that alert process.”

Allen said the team was especially interested in non-academic warning signs, such as frequent absences, that faculty may observe in students at risk for academic probation.

Carter is assisting with the early alert process, as well as examining how the office works with students on academic probation and developing the school’s first-year bridge program.

Goedereis works closely with first-generation students and has established a formal group where students can find support and community. She’s also taken over organizing a mentorship program that partners



From left: LaVeasey Carter, Ashleigh Goedereis, Jessica Allen and Lisa Gillis-Davis

first-generation undergraduate students with first-generation doctoral students.

As they continue to adapt to student needs, Gillis-Davis said the team will pull enrollment and academic data to ensure they’re meeting students where they are.

“We have a lot of first-generation, limited-income and students of different ethnic backgrounds,” Gillis-Davis said. “Knowing what majors they pursue and their retention rate may drive more specific actions and support in the future.”

Written by Danielle Lacey

## Executive Cybersecurity Leadership Program launched in 2022

Companies continue to face cybersecurity threats and data breaches daily, despite all efforts to prevent them. In fact, cyber risks were the top business concerns worldwide in 2022, according to the Allianz Risk Barometer.



Senior-level executives in cybersecurity will develop the tools and knowledge needed to develop cybersecurity policies as well as their own leadership approach through the Executive Cybersecurity Leadership Program offered by the Technology & Leadership Center in the McKelvey School of Engineering. The six-month certificate program, which began with its first cohort in 2022, includes two on-campus residencies and weekly virtual classes and culminates in a capstone project that will be evaluated by several members of McKelvey Engineering’s National Council.

## Industry Connect highlights engineering career opportunities, resources, for students, alumni

McKelvey School of Engineering students and alumni are highly sought after for opportunities in industry, academia and research. While many pursue engineering because they enjoy math and science, they are not always informed about the plethora of opportunities that exist with an engineering degree. In partnership with the WashU Career Center, the school launched McKelvey Industry Connect, an online industry-based platform designed to better inform and prepare students and alumni for careers in industry.

Through McKelvey Industry Connect, students and alumni can access career content aligned to numerous industries, such as biotechnology and health care, energy and sustainability, or cybersecurity and seek advice on how to find leading companies and prepare for a career in a select field. The platform features high-quality jobs and internships that align with the school’s programs; and



WHITNEY CURTIS

generates awareness about companies, career paths and industries that students and alumni can pursue.

“Whether it’s an internship with a local startup, a national hackathon, a professional conference, we want our students and alumni to have access to as many resources and connections as possible through their WashU network,” says Kelli Delfosse, director of industry relations and career engagement.

For more information, visit [mckelveyconnect.wustl.edu](http://mckelveyconnect.wustl.edu).

## McKelvey Engineering joins Argonne, others, to study urban climate change



The U.S. Department of Energy (DOE) has awarded Argonne National Laboratory and a team of academic and community leaders, including faculty from the McKelvey School of Engineering, \$25 million over five years to advance urban climate science by studying climate change effects at local and regional scales.

The results of this new research will inform communities to build resilience to future effects of climate change.

Argonne and partners will establish an Urban Integrated Field Laboratory called Community Research on Climate and Urban Science (CROCUS) focusing on the Chicago region. CROCUS will use community input to identify questions and specific areas of urban climate change to study, ensuring that research results directly benefit local residents. CROCUS researchers will also work with organizations and students to collect on-the-ground data and develop climate models.

Jian Wang, professor and director of the Center for Aerosol Science and Engineering, and Brent Williams, associate professor, both in McKelvey Engineering’s Department of Energy, Environmental & Chemical Engineering, will work with CROCUS to help advance a scientific understanding of urban climate issues in Chicago and hopefully make discoveries with wider significance.

“Findings in Chicago might yield insights that are useful in cities across the country for working with residents on citizen science and for better understanding of both the impact on and feedback from urban environment to regional and global scale climates,” Wang said.

## Dearmont to lead newly launched Women & Engineering Center

Christine Dearmont has been appointed the inaugural director of the Women & Engineering Center in the McKelvey School of Engineering.

The Women & Engineering Center (WEC) is designed to create a community that supports women Engineering students and engages efforts to recruit and retain women in the school’s undergraduate and graduate programs. As director, Dearmont will collaborate with alumnae and faculty to develop and oversee programming that promotes academic and professional development and retention of women in engineering. In addition, she will advise the Women & Engineering Leadership Society, assist with various student organizations that support women in STEM and work to develop industry partnerships to support the center.

“The appointment of Christine Dearmont as the first formal director of the Women & Engineering Center represents the culmination of an effort to institutionalize the support for our women students,” said Aaron Bobick, dean and the James M. McKelvey Professor. “The passion and dedication Christine shows for advancing the agenda of our women students is nothing short of inspiring and will drive the Center as it establishes its role within the school.”

The WEC evolved from the success of various women-focused initiatives over the past decade, including the Women & Engineering Initiative for alumnae, students, faculty and staff. The effort was previously headed by Emily Boyd, teaching professor

of mechanical engineering & materials science, to attract more women into engineering programs and strengthen connections to promote the the success and advancement of female engineers. In addition, the Women & Engineering Challenge, spearheaded by Engineering alumnae Jan Holloway and Michele Liebman, established a fund to enhance the experience of women students and broaden their opportunities.

“I appreciate Christine’s strategic approach, her broad experiences and her passion for positive student outcomes,” said Holloway, who chaired the search committee. “Her existing relationships across the WashU community and in industry also will enhance the Women & Engineering Center.”

Dearmont joined McKelvey Engineering from Olin Business School, where she was corporate relations and business development manager and industry relations lead for entrepreneurship in the Weston Career Center.

Dearmont earned bachelor’s degrees in management and Spanish from Missouri State University and an MBA from the University of Missouri.

Written by Beth Miller



## New robotics club creates opportunity for students

In 2022, electrical engineering major Liana Tilton set out to start WashU Robotics Club, the first club of its kind currently at Washington University in St. Louis.

Tilton set up an initial group of 12 executive board members and recruited a group of academic advisers.

Tilton said she believes that the sky is the limit when it comes to WashU Robotics. “I don’t know how we got so lucky,” she said. “It feels like there are endless possibilities for growth, especially in this environment of support where our ideas are welcomed and encouraged. I urge anyone who’s interested in learning more to reach out.”

Written by Catie Dandridge





IN MEMORIAM

# Jerome R. Cox Jr., prolific inventor and computer science professor, 97



WASHU PHOTOS

His work pioneered personal computing in biomedical research

Written by BETH MILLER

Jerome R. Cox Jr., senior professor emeritus in computer science & engineering at the McKelvey School of Engineering in Washington University in St. Louis, died Jan. 17, 2023, in St. Louis. He was 97.

Cox joined Washington University's faculty in 1955 and contributed significantly to the areas of biomedical computing, multimedia communications and computer networking. He and a graduate student, A. Maynard Engrebretson, created a computer to measure hearing in infants. Their work paved the way for early detection of deafness and for mandated screening tests for newborns in the United States.

Cox's work made a significant impact on biomedical research both at Washington University and worldwide. In 1964, he brought the Laboratory Instrument Computer, which became known as LINC, and its development team to WashU from Massachusetts Institute of Technology (MIT). LINC transformed biomedical research by integrating computer science with medicine, allowing researchers to program data analysis on the fly, and is considered to be one of the first personal computers. That same year, he founded the Biomedical Computing Laboratory, which introduced small computers to biomedical research.

His pioneering work in radiation treatment planning paved the way for systems in worldwide operation. Computer methods his research team developed for reconstructing images from CT and PET scanners aid in the diagnosis of cancers and cardiovascular disease. His innovations were instrumental in developing early monitors for heart rhythm disturbances. He also worked on computer applications in mapping the human genome and in electronic radiology. He holds 12 U.S. patents and published more than 150 journal publications.

"A year or so before COVID, I had lunch with Jerry," said Aaron Bobick, dean and the James M. McKelvey Professor in the McKelvey School of Engineering. "At age 94, he was telling me about the two startups he was currently working with and how one of them had just achieved some significant

**"... Jerry was a remarkable combination of excellence, passion and humility. Both his life and his legacy are inspirations to us all."**

— AARON BOBICK

traction with the Department of Defense. Jerry was a remarkable combination of excellence, passion and humility. Both his life and his legacy are inspirations to us all."

R. Martin Arthur, the Newton R. & Sarah Louisa Glasgow Wilson Emeritus Professor in the Preston M. Green Department of Electrical & Systems Engineering, worked with Cox in the early 1970s.

"I only worked with him in my early days as a new faculty member, but he changed the course of my career," Arthur said. "He asked me to join him and Floyd Nolle on a paper on digital analysis of the EEG that was published in *Proceedings of IEEE* and was republished and cited many times. On top of that, I had been doing electromagnetics in my doctoral work, and that paper with Jerry and Floyd channeled my career into image and signal processing."

Cox recently sent Arthur a copy of Cox's memoir, "Work Hard, Be Kind."

"He was true to that," Arthur said. "His influence was worldwide. He worked with people all over the world and did it in such a kind, gracious way."

Cox, the Harold B. and Adelaide G. Welge Professor of Computer Science at Washington University from 1989-1998, was the first chair of the Department of Computer Science & Engineering from 1975-1991. He was instrumental in building a department that has an international reputation for biomedical computing applications and computer networking. With then-

department colleagues Jonathan Turner and Guru Parulkar, he founded Growth Networks, a company acquired by Cisco Systems in 2000 that produced an advanced networking chip set and became a model for technology transfer initiatives at the university. In 2007, he started Blendics (Blended Integrated Circuit Systems), to provide system-on-chip design tools and services to companies seeking to develop complex, proprietary, low-power integrated circuits.

"While we think of people like Jerry as being exceptional in technology, many people don't understand or appreciate what kind of a human being he was," said Ron Indeck, CEO of Q-Net Security, a cybersecurity firm that Cox founded. "His license plate read, 'Work hard, be kind.' If we all followed what he lived, the world would be a better place."

Indeck, who worked with Cox for 35 years, said cybersecurity is a challenge, but Cox addressed it directly.

"His vision for the company, which we still have today, is to protect critical infrastructure," he said. "That was so important to Jerry, and he saw that as having the biggest impact on society, humans and life."

Cox earned bachelor's, master's and doctoral degrees in electrical engineering from MIT. He was a member of the National Academy of Science's Institute of Medicine and a fellow of the Acoustical Society of America and the IEEE. He was awarded an honorary doctor of science from Washington University in 2001. His honors also include the 2011 Chancellor's Award for Innovation and Entrepreneurship, which he received with former professor Jonathan Turner, who was the inaugural Barbara J. and Jerome R. Cox Jr. Professor of Computer Science. That same year, he was recognized with the Engineering School's Dean's Award.

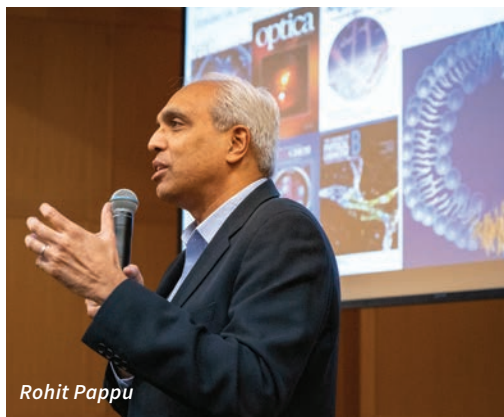
Cox is survived by three children: Nancy (Craig) Battersby, Jerry (Margaret) Cox and Randy (Patty) Cox; a sister, Anita Hunt; eight grandchildren and four great-grandchildren. He was preceded in death by his wife, Barbara (Bobby), in 2006.



## Center for Biomolecular Condensates launches

The Center for Biomolecular Condensates kicked off with an inaugural symposium Oct. 14, highlighted by the Condensates Colloquium Series. Rohit Pappu, the Gene K. Beare Distinguished Professor of Engineering and director of the Center, said the Center, housed within the McKelvey School of Engineering, is the first of its kind, with biomolecular condensates being crucial to future breakthroughs.

The molecules of life — DNA, RNA and proteins — are organized into distinct molecular communities known as biomolecular condensates. As the name implies, the organization arises from physical processes that involve the condensing of the right type of molecules at the right locations. This condensation reaction separates the key molecules into distinct condensates through a process known as phase separation. Biomolecular condensates are everywhere in cells, and they are distinct from one another. Appreciation of the importance of the physics of phase separation has transformed how we think about cellular organization, cellular mechanics, cellular responses and cell physiology. The dysregulation of condensates



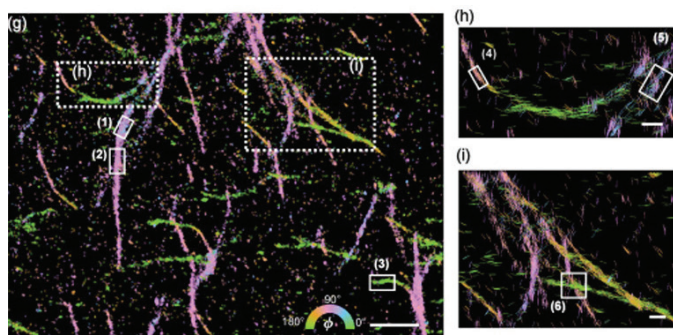
Rohit Pappu

through aberrant phase separation underlies proliferative diseases such as cancers and degenerative illnesses such as ALS, Parkinson's, Alzheimer's and Huntington's diseases.

"A key mission of the Center for Biomolecular Condensates is to develop technologies, uncover the relevant physical principles and apply these to study and understand how condensates function in live cells," Pappu said. "This is one of the more important topics in cell biology today and one that is attracting attention across disciplines."

*Written by Eric Buttermann*

## Machine learning generates pictures of proteins in 5D



orientation of a molecule in 3D space as well as its position in 2D, five parameters from a single, noisy, pixelated image.

Humans, however, have already learned how signals from the molecules of interest and this noise are combined together within microscope

images. Instead of asking the algorithm to re-learn the laws of physics, the team added a second, "post-processing" algorithm — a straightforward computation that applied these physical laws to the results from the first algorithm.

Their research was published Sept. 26, 2022, in the journal *Optics Express*.

*Written by Brandie Jefferson*

By combining machine learning with the laws of physics, researchers in the lab of Matthew Lew, associate professor in the Preston M. Green Department of Electrical & Systems Engineering, have been able to sort out the orientation and position of overlapping single molecules in 5D from a single image.

A team headed by Tingting Wu, a PhD student in the imaging sciences program, was able to design a system that could tell her the



## Before test results, signs of COVID-19 are in water systems

A new research paper from the lab of Fangqiong Ling, assistant professor of energy, environmental & chemical engineering, has shown the viability of wastewater as an accurate tool when it comes to describing COVID-19 outbreaks in a community. Beyond proving the usefulness of COVID-19 detection, the breadth of the paper's analysis also makes it a resource for other researchers in the fast-growing field of wastewater epidemiology.

The research was published as the cover story of the July 22, 2022 issue of the journal *Environmental Science, Water Research & Technology*.

Since the beginning of the COVID-19 pandemic, researchers across the world have begun or ramped up existing water monitoring programs. Working collaboratively with the Washington University School of Medicine and researchers from two other universities, Ling and David Mantilla-Calderon, a postdoctoral associate in her lab, took advantage of the data to determine what, if any, relationship they could find between the number of COVID-19 cases reported in an area and the amount of genetic material from SARS-CoV-2 in municipal wastewater.

*Written by Brandie Jefferson*

## Aligning computer science research with real-world applications



There are more smartphones in the world than people, yet little to no networking research by computer scientists includes them.

Patrick Crowley, a renowned expert in computer and network systems architecture, plans to develop a new software infrastructure that would allow computer science researchers to develop networking systems and protocols on smartphones and similar devices with a three-year, \$1.8 million grant from the National Science Foundation (NSF). Such an infrastructure would allow for better translation between research innovation and real-world use and commercialization.

Crowley, professor of computer science & engineering, said while most networking research projects are designed to improve how users, devices and servers connect and communicate, most academic systems researchers only use the Linux operating system, while the most-used user platforms are the iOS and Android operating systems. A new infrastructure would create software that could operate over several types of devices and make it simpler for researchers to evaluate their work in these common devices.

*Written by Beth Miller*

## Study shows hazardous herbicide chemical goes airborne

"Dicamba drift" — the movement of the herbicide dicamba off crops through the atmosphere — can result in unintentional damage to neighboring plants. To prevent dicamba drift, other chemicals, typically amines, are mixed with dicamba to "lock" it in place and prevent it from volatilizing, or turning into a vapor that more easily moves in the atmosphere.

Now, new research from the lab of Kimberly Parker, assistant professor of energy, environmental & chemical engineering, has shed new light on this story by demonstrating for the first time that these amines themselves volatilize, often more than dicamba itself.

If amines themselves are released into the atmosphere, they can have a negative impact



on human health as they can form cancer-promoting substances. They also affect the climate and atmospheric chemistry. Because of their potential danger and prevalence, the scientific literature is full of research looking at the ways they are released into the atmosphere — except when it comes to their use in herbicide-amine formulations.

Their findings were published Sept. 23, 2022 in the journal *Environmental Science & Technology*.

*Written by Brandie Jefferson*

## Chakrabarty works to make AI more energy efficient



In 2019, the energy required to train a top-of-the-line artificial intelligence system was more than the energy required to operate five U.S. cars over their entire lifetimes. The situation

has only gotten worse.

To curb this unsustainable amount of energy use, Shantanu Chakrabarty, the Clifford W. Murphy Professor in electrical engineering, will lead a project funded by a three-year \$1.14 million grant from the National Science Foundation.

Working with Gert Cauwenberghs at the University of California, San Diego, Chakrabarty plans to develop new hardware to be used in machine learning. The algorithms that will be developed as part of the research will be made available to the research community.

*Written by Brandie Jefferson*

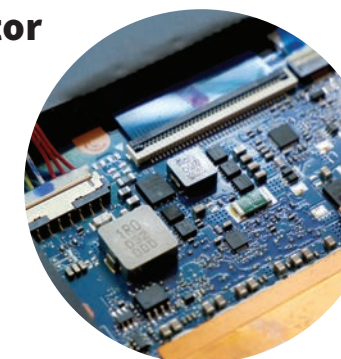
## An alternate route to semiconductor production

Semiconductors are essential components in many modern technologies, including computers, digital cameras, LEDs, automobiles and solar panels. Despite their prevalence, current methods to produce semiconductors are energy-intensive and costly.

Researchers working with Bryce Sadtler, associate professor of chemistry in Arts & Sciences, and Rohan Mishra, associate professor of mechanical engineering & materials science, recently developed an alternative method for producing semiconductors. The team's novel approach uses electrodeposition to create a thin layer of material without the need for an expensive and difficult-to-produce subsurface. The method could reduce the cost of growing semiconductors and improve the accessibility and scalability of the process.

The results were published Sept. 29, 2022 in the *Journal of the American Chemical Society*.

*Written by Shawn Ballard*





## McKelvey Engineering faculty awarded \$10.7 million in federal clean energy grants

Four professors in the Department of Energy, Environmental & Chemical Engineering in the McKelvey School of Engineering at Washington University in St. Louis are working toward a goal of a net-zero emissions economy by 2050 with a combined \$10.7 million in newly awarded grants from the U.S. Department of Energy (DOE).

Young-Shin Jun will lead a team from Washington University and the Pacific Northwest National Laboratory in developing new clean energy technologies and achieving low-carbon manufacturing with a three-year grant for \$4.1 million.



A project led by Zhen (Jason) He was among seven projects awarded a total of \$16.5 million to use waste carbon and reduce greenhouse gas. He received \$2.52 million over three years.



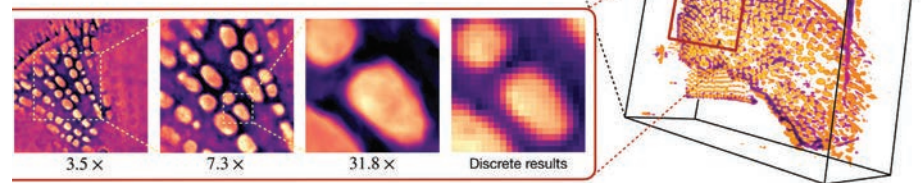
As part of a \$29.5 million initiative by the DOE to more effectively use waste streams, often located in underserved communities, Fuzhong Zhang received \$2.5 million over three years for his team's project to convert waste to energy.



Vijay Ramani, the Roma B. & Raymond H. Wittcoff Distinguished University Professor, was awarded \$1.6 million to develop a technology that will enable process intensification at scale in hydrogen production from natural gas.

*Written by Beth Miller*

## Machine learning generates 3D model from 2D pictures



Researchers from the McKelvey School of Engineering have developed a machine learning algorithm that can create a continuous 3D model of cells from a partial set of 2D images that were taken using the same standard microscopy tools found in many labs today.

"We train the model on the set of digital images to obtain a continuous representation," said Ulugbek Kamilov, assistant professor of electrical & systems engineering and of computer science & engineering. "Now, I can show it any way

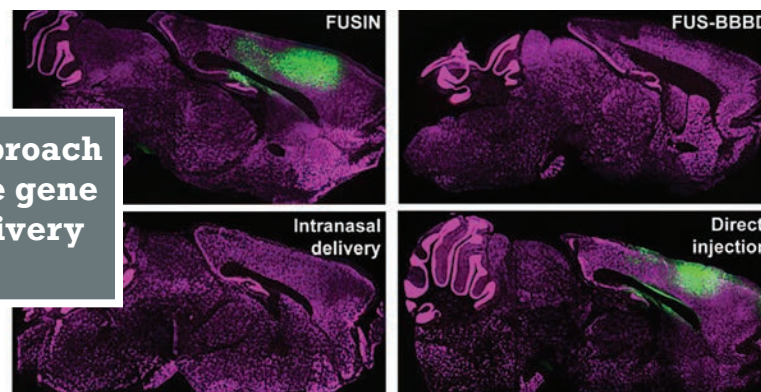
I want. I can zoom in smoothly and there is no pixelation."

The key to this work was the use of a neural field network, a particular kind of machine learning system that learns a mapping from spatial coordinates to the corresponding physical quantities. When the training is complete, researchers can point to any coordinate and the model can provide the image value at that location.

Their findings were published Sept. 16, 2022 in the journal *Nature Machine Intelligence*.

*Written by Brandie Jefferson*

## A sound approach for effective gene therapy delivery to brain



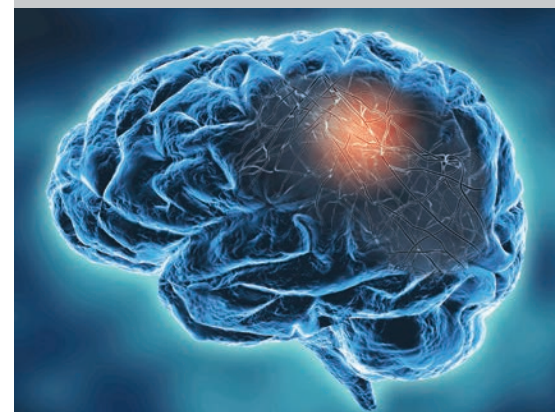
Researchers have been experimenting with different ways to deliver genes to the brain to treat central nervous system diseases and tumors. One of the obstacles, however, is the ability to penetrate the blood-brain barrier while having minimal effect on the other organs in the body.

Hong Chen, associate professor of biomedical engineering in the McKelvey School of Engineering and of radiation oncology in the School of Medicine, and her team found an effective method to overcome that obstacle using focused ultrasound intranasal delivery (FUSIN).

In new research, they found that the intranasally delivered gene therapy had comparable or better outcomes than existing methods while having minimal effect on the body's other organs.

Results of the research, led by Chen and Dezhuang Ye, a postdoctoral research associate, and collaborators, were published online in *eBioMedicine* Sept. 21. It is the first study to evaluate the potential of FUSIN to deliver adeno-associated viral vectors, small viruses used to deliver gene therapy, in a mouse model.

*Written by Beth Miller*



## Biomarkers for Parkinson's disease sought through imaging

More than 10 million people worldwide live with Parkinson's disease, a progressive neurodegenerative disorder that affects movement, balance and thinking. Severity of the disease is measured through external symptoms, as there are no effective biomarkers that indicate the phase of the illness.

A team of engineers, physicians and researchers at Washington University in St. Louis, led by Abhinav K. Jha in the McKelvey School of Engineering, has collaborated to create an imaging method that allows them to get an accurate measurement of dopamine transporter, a protein important in movement, in three regions in the brain associated with Parkinson's disease.

Jha, assistant professor of biomedical engineering and of radiology at the School of Medicine's Mallinckrodt Institute of Radiology (MIR), and Ziping Liu, a doctoral student in Jha's lab, in collaboration with Joel Perlmutter, MD, the Elliot Stein Family Professor of Neurology and professor of radiology, of neuroscience, of physical therapy and of occupational therapy; Scott Norris, MD, associate professor of neurology and of radiology; and Richard Laforest, professor of radiology, all in the School of Medicine; developed a way to calculate the uptake of dopamine transporter using single photon emission computed tomography (SPECT) in the caudate, putamen and globus pallidus regions in the brain in simulation studies.

Results of their research appeared in *Medical Physics*, published in August 2022.

*Written by Beth Miller*

## New system creates bioplastics, consumes CO<sub>2</sub>

A team of researchers has developed a system that uses carbon dioxide, CO<sub>2</sub>, to produce biodegradable plastics, or bioplastics, that could replace the nondegradable plastics used today. The research addresses two challenges: the accumulation of nondegradable plastics and the remediation of greenhouse gas emissions.

The research was a collaboration of Texas A&M AgriLife researcher Susie Dai, associate professor in the Texas A&M University Department of Plant Pathology and Microbiology, and Joshua Yuan, the Lucy & Stanley Lopata Professor and chair of energy, environmental and chemical engineering in the McKelvey School of Engineering. Yuan was formerly with the Texas A&M Department of Plant Pathology and Microbiology.



The researchers and their laboratory scientists worked for almost two years to develop an integrated system that uses CO<sub>2</sub> as a feedstock for bacteria to grow in a nutrient chamber solution and produce bioplastics. The work was published in the Sept. 28, 2022 edition of the journal *Chem*.

*Written by Brandie Jefferson*

## NSF CAREER Award New approaches to context-aware visualization systems target of new research



Alvitta Ottley, assistant professor of computer science & engineering in the McKelvey School of Engineering, plans to take a closer look at individual differences on tasks and visualization designs with a five-year, \$528,223 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.

One aspect of Ottley's research involves identifying personality traits that impact strategy during data exploration. She and members of her lab also apply machine learning to predict individual characteristics, such as personality traits and cognitive abilities, from user interaction logs. They use machine learning and artificial intelligence algorithms to learn from those interactions then develop new visual analytics systems that predict intentions and provide support for the user during analytical tasks.

In the new research, she and members of her lab will study the impact of these individual characteristics by using behavioral data, such as the user's interactions with the mouse, to model a user's cognitive profile, attention and workflow. With the data and models, she and her team will assess and predict cognitive traits that affect an analyst's strategies and visualization effectiveness, then develop new visual analytics tools that provide personalized guidance and suggestions based on the user's characteristics and profile.

*Written by Beth Miller*



NSF CAREER Award

## Mishra to develop novel ferroelectric semiconductors with NSF CAREER Award



Rohan Mishra, associate professor of mechanical engineering & materials science in the McKelvey School of Engineering, aims to avoid these interfaces by discovering and developing a new class of semiconductor materials with a five-year, \$588,795 CAREER Award from the National Science Foundation. The NSF 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.

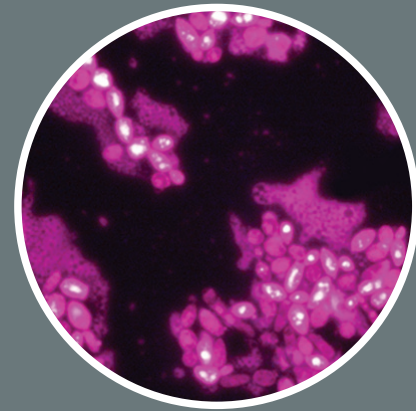
Mishra, a materials scientist, plans to use theory, computations and machine learning to predict novel ferroelectric semiconductors exhibiting the best properties of each, such as band gap, carrier mobility and polarization. These semiconductors would have a built-in electric field that will allow the selective movement of electrons and holes across them. Moreover, the direction of this built-in electric field or polarization, can be reversed with an external potential, thus giving control over the movement of the charge carriers. By eliminating the interfaces, these new semiconductors would allow for more effective and efficient electronic devices that could be used to generate and store energy as well as in storing and processing information.

Written by Beth Miller

## EECE and CSE collaborate in a fusion of synthetic biology, AI

Partly through a three-year National Science Foundation (NSF) grant of \$940,000, a collaborative effort is taking place between the Department of Energy, Environmental & Chemical Engineering (EECE) and the Department of Computer Science & Engineering in the McKelvey School of Engineering to focus on three yeasts for a result of low-cost, effective AI-enhanced biomanufacturing. The group aims to use machine learning and modeling for the development of the yeasts.

Yixin Chen, professor of computer science & engineering, is helping EECE faculty develop the machine learning strain design; and McKelvey Engineering alumni Jeff Czajka, who earned a doctorate in 2021, and Di Liu, who earned a doctorate in 2017 and was a student in Professor Fuzhong Zhang's lab, are co-investigators on the grant, along with Keesoo Lee, a professor of microbiology at Lincoln University, a

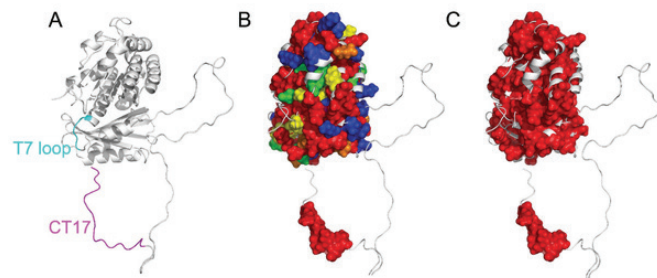


historically Black college and university (HBCU). The Department of Energy is providing \$200,000 to support collaboration with Liu, now a staff scientist at Sandia National Labs.

With a focus on oleaginous, or oily, yeasts, which allow for biosynthesis of pharmaceuticals and biofuels from substrates, the hope is to move the biomanufacturing process away from long and expensive test cycling.

Written by Eric Butterman

## A disordered domain plays a key role in cell division



Antibiotics prevent bacteria from growing and multiplying, making cell division a particularly appealing target for drug development. To illuminate the mechanisms responsible for cell division in bacteria and facilitate the design of precision drugs, biophysicists in the McKelvey School of Engineering collaborated with microbiologists in the Department of Biology to discover how a small part of a key bacterial division protein functions at the molecular level.

The lead author of the study, Min Kyung Shinn, a postdoctoral fellow, and her colleagues, Megan C. Cohan, who earned a

doctorate in biomedical engineering in 2020 in the laboratory of Rohit V. Pappu, the Gene K. Beare Distinguished Professor of Engineering, and Kiersten Ruff, a senior scientist in the Pappu lab, collaborated

with Jessie L. Bullock, a graduate student in the laboratory of Petra A. Levin, the George William and Irene Koechig Freiberg Professor of Biology, to investigate how the intrinsically disordered region (IDR) of the essential cell division protein FtsZ actually functions. FtsZ is found in nearly all bacteria. This IDR was previously shown by Levin's lab to be essential for cell division in the soil bacterium *Bacillus subtilis*.

The research, which was published Oct. 10, 2022 in *PNAS*, builds on several key findings made over the past decade in the Pappu and Levin labs.

Written by Carla Beecher

## A design of experiments approach to precision vaccine adjuvants



Adjuvants are added to vaccines to improve protection, extend the duration of protection and reduce the dose or number of boosters required. As vaccines are increasingly in demand for a growing variety of diseases and populations, vaccine developers are turning to combination adjuvants, which often work together to stimulate and activate a variety of cells and immune mechanisms, to meet clinical needs.

Jai Rudra, associate professor of biomedical engineering, won a four-year, \$2 million award from the National Institute of Allergy and Infectious Diseases, part of the National Institutes of Health (NIH), to support his lab's research on mechanisms of nanomaterials-based combination adjuvants.

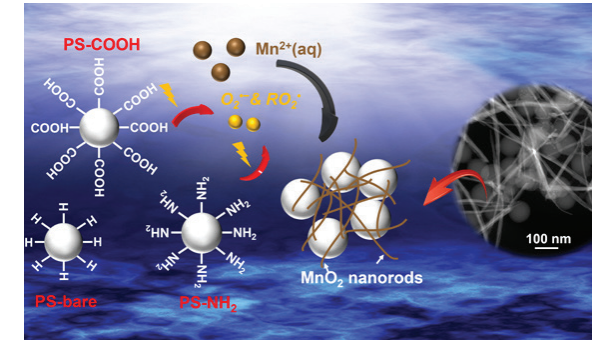
Rudra's lab specializes in designing biomaterials for vaccine development and immunotherapy and has previously developed adjuvants based on synthetic nanomaterials, which act via mechanisms distinct from adjuvants extracted from microbes. With NIH support, Rudra plans to develop new combination adjuvants by combining engineered nanomaterials and immune adjuvants approved for human use or under development in the vaccine pipeline.

Written by Shawn Ballard

## Nanoplastics unexpectedly produce reactive oxidizing species when exposed to light

Plastics are ubiquitous in our society, found in packaging and bottles as well as making up more than 18% of solid waste in landfills. Many of these plastics also make their way into the oceans, where they take up to hundreds of years to break down into pieces that can harm wildlife and the aquatic ecosystem.

A team of researchers, led by Young-Shin Jun, professor of energy, environmental & chemical engineering, analyzed how light breaks down polystyrene, a nonbiodegradable plastic from which packing peanuts, DVD cases and disposable utensils are made. In addition, they found that nanoplastic particles can play active roles in environmental systems. In particular, when exposed to light, the nanoplastics derived from polystyrene unexpectedly facilitated the oxidation of aqueous manganese ions and formation of manganese oxide solids that can affect the



fate and transport of organic contaminants in natural and engineering water systems.

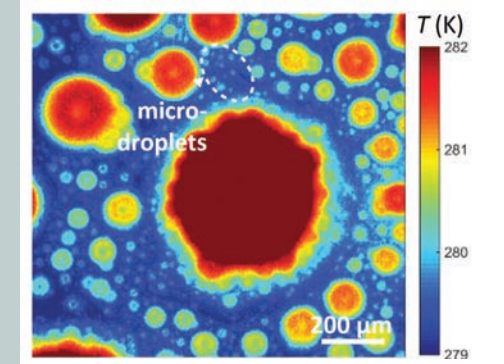
The research, published in *ACS Nano* Dec. 27, 2022, showed how the photochemical reaction of nanoplastics through light absorption generates peroxy and superoxide radicals on nanoplastic surfaces, and initiates oxidation of manganese into manganese oxide solids.

Written by Beth Miller

## Condensation key to climate-friendly power generation

To combat climate change, Patricia Weisensee, assistant professor of mechanical engineering & materials science, is working to increase energy efficiency, particularly in power generation, air conditioning and refrigeration systems.

Weisensee won a \$351,971 grant from the National Science Foundation to support a new study of condensation in fluid refrigerants. By determining the conditions necessary for these fluids to condense into droplets, rather than films, Weisensee aims to increase heat transfer rates in refrigerant mixtures. Better heat transfer leads to increased efficiencies in applications such as power plants and savings in energy normally lost as waste heat.



"I'm interested in low-temperature waste heat recovery, where you actually produce electricity from low-temperature heat sources around 150 degrees Celsius or lower," Weisensee said. "You can't really use water for that. Its thermodynamic properties aren't very good in that temperature range."

Written by Shawn Ballard

Stay updated on the latest research news from McKelvey Engineering



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Tools and techniques of engineering can be applied to diagnosis, treatment and prevention in women's health

# Improving women's health with engineering

Written by BETH MILLER



ILLUSTRATIONS BY ROBERT ARMBRISTER



**F**or decades, women's health has been an afterthought. As recent as 1993, most testing in clinical trials was conducted on men, and female animals and cells were not required to be included in federally funded testing until 2016. This lack of research focused solely on women's issues has trickle-down effects on women of all ages, from puberty through post-menopause. Maternal mortality rates are increasing in the U.S., particularly in Black and Native American women, who are three times more likely to die from a pregnancy-related cause than white women. This is in contrast to the decreasing rates of maternal mortality in other developed countries.

Recently, the Centers for Disease Control & Prevention's Maternal Mortality Review Committees reported that pregnancy-related deaths occurred during pregnancy, delivery and up to a year postpartum. More than 80% were determined to be preventable, and their causes varied by race and ethnicity. More than 80% of the women who died lived in urban areas, and more than half of all pregnancy-related deaths occurred within seven days to one year after delivery.

At Washington University in St. Louis, the McKelvey School of Engineering and the School of Medicine have made women's health a focus area by adding new faculty whose research is in the field and establishing new interdisciplinary collaborations. Together, they will focus on some of the more

**“He took me to the NICU and showed me the tiny premature babies and said, ‘I think we can do something about this, but I think it involves engineering.’”**

— Michelle Oyen

understudied and underfunded areas of women's health, including maternal health and cancers of the reproductive system, from both the engineering and medical research perspectives.

As part of the new focus, McKelvey Engineering launched the Center for Women's Health Engineering, composed of faculty and researchers from McKelvey Engineering and the School of Medicine, in September 2022, naming Michelle Oyen, associate professor of biomedical engineering, director of the Center. When she joined the McKelvey Engineering faculty in January 2022, she worked to unite existing women's health initiatives at the university and added a unique twist: engineering.

“What we bring to the picture are the tools of engineering, such as in vitro models, benchtop models of biomaterials for tissue engineering, microfluidic devices, microphysiological systems and computational models,” said Oyen, whose research focuses on the placenta, the organ that provides



nutrients to a developing fetus. “This goes across all the different areas of engineering, such as sensors, computer science, biomaterials, biomechanics, tissue engineering, medical imaging, artificial intelligence and machine learning. We have all these tools and techniques from our own engineering fields, all of which could be relevant in different problems in women’s health.”

Oyen, whose doctoral research began in bone and cartilage orthopedic biomechanics, came to the intersection of engineering and women’s health after meeting an obstetrician interested in premature birth.

“He took me to the NICU and showed me the tiny premature babies and said, ‘I think we can do something about this, but I think it involves engineering,’” Oyen recalls. “He was a very forward-thinking man. We started collaborating, and by the time I finished my PhD, I was working full-time in the ob-gyn department and doing my PhD on the side.”

While the leading cause of death in women nationally is heart disease, the new Center for Women’s Health Engineering will sharpen its focus on areas including maternal health, preterm birth, pelvic floor disorders and cancers of the reproductive system, which are already areas of strength at WashU and are new areas of focus by the White House.

In June 2022, President Joe Biden and Vice President Kamala Harris released a Blueprint for Addressing the Maternal Health Crisis, which is committed to lowering the rates of maternal death and disease, reducing the disparities in maternal health outcomes and improving the experience during and after pregnancy for women nationwide. The blueprint calls for various federal agencies to focus on this initiative, and several have women’s-health focused research offices.



PHOTOS BY WHITNEY CURTIS

“Engineering is pregnant with possibilities,” published in *Science Advances* Jan. 25

SCAN ME



- » The U.S. is the only industrialized country with a rising maternal mortality rate.
- » The six weeks following birth are very important to the mother’s health.
- » The postpartum period extends to 1 year after birth.
- » Endometriosis is found in 10% of women and is a leading cause of infertility.
- » Missouri ranks 12th in the nation for the worst rate of maternal mortality.
- » There are significant sex differences in many diseases and conditions, including autoimmune diseases, cancer, cardiovascular diseases, depression and brain disorders, diabetes, infectious diseases, obesity and substance abuse disorders.

From left: Adrienne Scott, Madison Landeros, Samantha Zambuto, all members of Michelle Oyen’s lab, work on research on the placenta.

In addition, members of Congress are working to draw attention to maternal health care. The Black Maternal Health Momnibus Act of 2021 is 12 individual bills that include such actions as extending eligibility for the Women, Infants and Children nutrition program; increasing access to maternity care; and establishing programs to improve maternity care for the incarcerated population. The Tech to Save Moms Act of 2021 promotes telehealth and digital tools that would close racial and ethnic gaps in maternal health outcomes to reduce maternal mortality.

### The beginnings

With support from Aaron F. Bobick, dean and the James M. McKelvey Professor, and Lori Setton, the Lucy & Stanley Lopata Distinguished Professor and chair of Biomedical Engineering, one of the first steps toward a unified effort in women’s health began in 2020 when Quing Zhu, the Edwin H. Murty Professor at McKelvey Engineering; Yong Wang, associate professor of obstetrics & gynecology in the School of Medicine and of electrical & systems engineering in the McKelvey School of Engineering; Tracy Spitznagle, professor of physical therapy and of obstetrics & gynecology; and Whitney Ross, MD, assistant professor of obstetrics & gynecology, held a symposium for researchers to present their work in fertility, monitoring cervical health, progression of labor and postpartum outcomes.

In March 2020, the Department of Biomedical Engineering and the Department of Obstetrics & Gynecology funded a Women’s Health Technologies Collaboration Initiation Grant pilot program that provided seed grants of up to \$30,000 to generate sustaining collaboration between engineering and medical school partners that will be competitive for future external funding. Inaugural recipients of the grant were Christine O’Brien, assistant professor of biomedical engineering, with Antonina Frolova, MD, assistant professor of obstetrics & gynecology; and Philip Bayly, the Lee Hunter Distinguished Professor and chair of the Department of Mechanical Engineering & Materials Science, with Jerry Lowder, MD, associate professor of obstetrics & gynecology.

O’Brien and Frolova collaborated to develop a wearable light-based sensor that would provide an early alert for postpartum



Key leaders in women’s health at Washington University. From left: Lori Setton, Sarah England, Quing Zhu, Michelle Oyen, and Yong Wang

“... Other fields, such as, cardiovascular science and neuroscience, have benefited from collaborating with engineers. I think it’s really a great time for women’s health to do the same.”

— Sarah England

hemorrhage, and Bayly and Lowder collaborated to devise a new prediction model to guide surgical decision making in female pelvic organ prolapse surgery based on anatomic measurements. The work of O’Brien and Frolova’s team was recognized as an Honorable Mention Awardee in the National Institutes of Health Technology Accelerator Challenge (NTAC) for Maternal Health.

In the second year of the program, grants were awarded to Alexandra Rutz, assistant professor of biomedical engineering, and Mary M. Mullen, MD, assistant professor of obstetrics & gynecology, for their work titled “In Vitro Bioelectronic Monitoring of Therapy Response in 3D, Patient-Derived Ovarian Cancer Models”; and to Oyen and Anthony Odibo, MD, the Virginia S. Lang Professor of Obstetrics & Gynecology, for their work comparing clinical ultrasound with quantitative multiphysics models

of placental function. In September 2022, the Oyen research team, which now includes Ulugbek Kamilov, assistant professor of computer science & engineering and of electrical & systems engineering, won funding from Wellcome Leap to support their work.

In late 2021, researchers in McKelvey Engineering and the School of Medicine partnered to launch the Women’s Health Technologies Initiative, which aims to apply engineering technology to develop new strategies to improve the detection, diagnosis and treatment of conditions affecting the female reproductive system.

### Building a center

While the early efforts created momentum, the new Center for Women’s Health Engineering brings these into the fold to ensure that the area is covered from both the engineering and medical research angles. Its four main focus areas of research, education and training, entrepreneurship and community will allow the work accomplished through the center to go beyond the labs and clinics at WashU through innovation and technology transfer.

Sarah England, the Alan A. and Edith L. Wolff Professor of Medicine, professor of obstetrics & gynecology and interim director of the Center for Reproductive Health Sciences, is one of the key faculty in the Center for Women’s Health Engineering and a leader in getting support for a wider university focus on women’s health. Her research focuses on the molecular mechanisms underlying uterine

### FemTech

Students from McKelvey Engineering, Olin Business School and the School of Medicine are organizing a FemTech Society that will promote education, innovation and research in technology that addresses these unmet needs in women’s health. Annabella Mascot, a senior majoring in mechanical engineering, is the inaugural president of the society, which will begin holding events this spring.

The FemTech movement, which began in the past five years, arose from research published in *Science* in June 2021 that found that only 13% of U.S. Patent inventors are women; patents with all-women inventor teams are 35% more likely than all-men teams to focus on women’s health; and that women researchers are more likely to discover women-focused ideas.

“The only way you get more companies in this space is to have women venture capitalists looking at inventions by women inventors and starting companies that are women-led to get the pipeline going,” Oyen said.





Tiger Nie, a doctoral student in Quing Zhu's lab, works with photoacoustic images of ovarian lesions.



From left: Doctoral student Josephine Lau and Zichao Wen, MD, instructor of obstetrics & gynecology. Using 3D imaging, Yong Wang can see where a contraction starts and finishes and how it is activated, which could revolutionize the obstetrics practice by helping to determine if a patient is likely to have preterm labor.



**Christine O'Brien**  
Assistant Professor of Biomedical Engineering



From left: Sitai Kou and Tiger Nie, both doctoral students, work in Quing Zhu's lab developing imaging methods for the early detection of cancer.

function during pregnancy. She has collaborated with biomedical engineers in McKelvey Engineering to understand how naturally occurring oxytocin receptor variants affect uterine activity.

England said as more women enter the fields of engineering, research and medicine, they start asking questions, such as, "why are one in 10 births preterm?" and "why is there not a diagnostic tool to predict it?"

"It's the perfect time to open a center," she said. "When we get more diversity in these fields, we start broadening what questions we study. Other fields, such as cardiovascular science and neuroscience, have benefited from collaborating with engineers. I think it's really a great time for women's health to do the same."

England said her previous collaborations with Engineering faculty have been beneficial for her research.

"I look at things differently when I talk to engineers," she said. "What's important is that they think about design, structure and mechanics, which is highly complementary to what we do, and now it has me thinking along those lines also. It's a great collaboration, and I love that we're doing this in the women's health space."

### Solving problems

Yong Wang, another faculty leader in the center and women's health initiative, has a unique role in the center with faculty appointments in both medicine and engineering. Wang brings his engineering research

and technology development skills developed while earning a doctorate in biomedical engineering from the engineering school in 2009. Before he joined the faculty of the Department of Obstetrics & Gynecology, he said he didn't know that preterm birth was so common and sees many ways engineering can contribute, including through fetal monitoring and participation in clinical trials.

"By working together with physicians, we can optimize patient outcome — it's a win-win solution," he said. "Physicians have wishes, and we satisfy their wishes by making them customized tools. We have a question raised by the physician, and we look for the tool or invent tools to answer it."

Wang's research builds on what he learned working in the lab of Yoram Rudy, the Fred Saigh Distinguished Professor of Engineering, as a doctoral student developing devices to measure electrical activity in the heart. He has implemented new ways to use imaging methods that are safe for pregnancy, such as ultrasound, electrophysiology and MRI, to monitor electrical and muscle function to determine why some patients get preterm contractions. Using his 3D imaging, Wang can see where a contraction starts and finishes and how it is activated, which could revolutionize the obstetrics practice by helping to determine if a patient is likely to have preterm labor.

An often-overlooked aspect of women's health is how the body responds to changes during and after

pregnancy and in peri- and post-menopause. Such changes can result in incontinence, pelvic pain and injuries that occur during birth that can result in long-term issues.

Tracy Spitznagle has focused much of her career helping women with these issues. As a professor of physical therapy and of obstetrics & gynecology at the School of Medicine and a board-certified specialist in women's health physical therapy, she leads a women's health clinical residency in the Program in Physical Therapy that offers specialized training for physical therapists to treat pelvic pain,



incontinence and pelvic floor disorders, which affect more than one-third of women by age 60.

"All birthing individuals could benefit from physical therapy because of the profound changes that happen from giving birth," she said. "From a population health perspective, we ask how we can keep our women more active and healthier and contributing to society at a better level. With healthy women, you have a healthy community."

Spitznagle sees more collaboration with engineers as a way to increase research in this area.

"It's exciting to head down a path that isn't clear because there is a lot of potential for change," she said. "What we do is an art, not a science, and at times there are some common mechanisms that we still don't understand. So having engineers help us understand the mechanisms for how some things work or don't work can really help us, especially if it improves the quality of life for women."

Yong Wang's imaging technology can help to improve clinical diagnosis and treatment of various gynecological conditions.

O'Brien's research focuses on developing translational optical technologies that can improve women's health care. Her lab develops optical tools that tackle challenges spanning maternal health, reproductive cancers and women's global health, using optical spectroscopy, optical imaging and simulation techniques that can be translated to impact patient care.

O'Brien and her team are gaining recognition for their work on a light-based, wrist-worn device to monitor and detect hemorrhage after birth. Most recently, she and her team received a \$20,000 prize from the National Institutes of Health's Rapid Acceleration of Diagnostics Technology (RADx Tech) for Maternal Health Challenge, and in July 2022, she and her team were recognized as Honorable Mention Awardees in the National Institutes of Health Technology Accelerator Challenge for Maternal Health.



# ENVIRONMENTAL champion

Jay Turner renews focus  
on environmental exposures  
'in St. Louis, for St. Louis'

Written by SASHA NYARY



COURTESY PHOTOS



Morning haze over Bayankhongor, Mongolia, photo taken February 2022. Bayankhongor's population of about 30,000 is about 2% of Ulaanbaatar's (UB) population, yet in the winter, the particulate matter air pollution is about two-thirds of UB's levels.

← From left: Rufus Edwards and Jay Turner at Lake Issyk-Kul, Kyrgyzstan, in November 2022. Edwards is a professor of epidemiology and public health at University of California, Irvine. Turner and Edwards have collaborated for nearly 10 years, first in Mongolia now also in Kyrgyzstan.

Environmental hazards such as living near roadways, air-polluting industries and dumping sites disproportionately affect nearby communities, where residents may show excessive levels of illnesses such as asthma, cancer and cardiovascular disease. After many years of air quality research in Asia, Jay Turner, an internationally respected environmental researcher at Washington University in St. Louis, is making such environmental justice issues in local communities a renewed focus in his lab.

"It's really exciting to be looking at air pollution exposures and health effects where so much has been done, but there's still so much more to learn," said Turner, the James McKelvey Professor of Engineering Education and vice dean for education in the McKelvey School of Engineering. "Now we might be looking at neurological effects instead of solely respiratory and cardiovascular effects. I've intentionally swung in the environmental exposures direction, both because I feel my skill sets can contribute to working with the health scientists, and I find that it's a fruitful landscape for my students."

## THE ST. LOUIS PROJECT

Part of his latest motivation came from WashU connections. In 2019, the Washington University School of Law's Interdisciplinary Environmental Clinic found that most of the top pollutant sources in St. Louis are concentrated in neighborhoods of color and that Black residents of St. Louis are at a greater environmental risk than white residents. That same year, in his inaugural address, Chancellor Andrew D. Martin spoke movingly about the university's commitment to its home city.

"WashU being 'in St. Louis and for St. Louis' resonated with me," said Turner, who in recent years has largely focused overseas. "It felt like the right time to reengage locally. And certainly, the right way to do it now is through an environmental justice lens. Also, this is transformational work for my students. Yes, they should get their research into peer-reviewed publications, but at the same time, they should be working with people in the community."

That balance is what drew doctoral student Tyler Cargill to Turner's lab. Cargill wanted to work with Turner because Cargill knew he would





**“We inhale the particles. If they’re small enough, they can spread to anywhere in your body, and that can lead to an increased risk of inflammation and cause cardiovascular effects. They’re thinking it’s likely to cause neurological effects, and potentially cancer as well. That’s why we do air quality research.”**

— TYLER CARGILL

receive both community-oriented field experiences and strong training in the technology and instrumentation necessary to the research.

In late 2021, Turner, Cargill, and doctoral student Zhiyao Li placed mid-cost QuantaAQ Modulair sensors at 14 member churches around St. Louis in partnership with Metropolitan Congregations United and with funding from the Missouri Foundation for Health. Five of the churches also have additional sensors loaned by the EPA and measure levels of gaseous pollutants including ozone and carbon monoxide.

“You can see the particulate matter if it’s in a high enough concentration, or if the atmospheric conditions are right, like when there are forest fires in the west,” Cargill said. “We inhale the particles. If they’re small enough, they can spread to anywhere in your body, and that can lead to an increased risk of inflammation and cause cardiovascular effects. They’re thinking it’s likely to cause neurological effects, and potentially cancer as well. That’s why we do air quality research.”

Cargill has been meeting with the church community to listen to their concerns.

“A lot of my preparation for this comes in conversations with Dr. Turner,” Cargill said. “You don’t want to go too in-depth, as you might lose the audience, but you also don’t want to skim the

surface. You could miss the chance to teach people something about air quality so they can advocate for change. You also want to hear what they think is important.”

### **BUILDING ON INTERNATIONAL RESEARCH**

Turner’s local research into how environmental pollutants may affect human health comes on the heels of several projects in Asia, where he has been an air quality fellow supporting U.S. Embassy Tashkent in Uzbekistan since 2020. He visited the country in May 2022 to meet with scientists, government officials, students and civil society leaders across the country to discuss its environmental concerns.

U.S. embassies help connect experts such as Turner with their international counterparts, which in turn strengthens technical cooperation and the relationship between countries.

“Dr. Turner in particular has proven irreplaceable to Embassy Tashkent,” said William P. Langley, Environmental, Science, Technology, and Health Officer at the embassy. “He answers our questions, provides technical guidance and advises our partners in the government of Uzbekistan. In short, he contributes not just to our understanding of the country’s air quality



COURTESY PHOTOS

Jay Turner with kindergarten teachers and school administrators at a teacher training program on air quality, Bayankhongor, Mongolia, February 2022. Teachers were trained on using and maintaining low-cost air quality sensors and how they could use the data to take measures to improve indoor air quality.



**“The work raised awareness and provided capacity building and interest to start looking at this problem more carefully across the whole country.”**

— JAY TURNER

environment, but to the United States’ bilateral relationship with Uzbekistan.”

Turner also has worked in Mongolia for nearly a decade. His latest project, in partnership with United Nations Children’s Fund (UNICEF), measured children’s exposure to air pollution in 30 kindergartens and a few health care facilities inside and outside of Ulaanbaatar, the country’s capital. Poor indoor air quality arises in part from a combination of severely overcrowded classrooms and infiltration of smoke from the coal stoves many Mongolians use to heat their yurts, called gers, and small homes, he noted.

“There’s a very strong coupling between socioeconomic status and air pollution exposures,” Turner said. “The people living in gers tend to be the ones with lower socioeconomic status. And indeed, we’re finding it’s the kindergartens in and near the gers communities that have the worst indoor air quality.”

His team’s research has smoothed the way for UNICEF to have helpful conversations with the Mongolian government about ways to improve the indoor environment in kindergartens. Building upon this work, UNICEF recently expanded the indoor air quality network to include about 100 kindergartens and funded the Mongolian government to place low-cost air quality sensors outdoors nationwide.

“That kind of scale-up is what we love to see happen,” Turner said. “The work raised awareness and provided capacity building and interest to start

looking at this problem more carefully across the whole country. The key is that in the country, the people will do that themselves.”

To further empower the people of Central Asia, he proposed the creation of an air quality knowledge hub between universities in Uzbekistan, Kyrgyzstan and Tajikistan that will expose students to careers in air quality. With funding from the U.S. Department of State, Turner and his colleagues at the three universities are offering a short course on different aspects of air pollution, health and sustainable development, to raise awareness about possible professional opportunities.

### **RETURNING TO HIS ROOTS**

As he adds the local community back into his research focus, Turner is aware that he’s continuing a long WashU tradition of serving St. Louis. Raymond Tucker, who was a professor and chair of mechanical engineering at WashU for 30 years, also was the smoke commissioner for the City of St. Louis in the 1930s and established a national reputation as a leader in the anti-pollution field. Tucker also served three terms as mayor.

“Raymond Tucker is a role model of how an academic can also engage in very practical aspects of environmental management,” Turner said. “Here’s a person who, while he was a professor at WashU, engaged in the issues in his town, and was a big part of solving the problem. I see that as an inspiration — really helping people.”

From left: Zhiyao, a 5th year PhD student in the Turner Lab, Tyler Cargill and a member of First Unitarian after installing sensors at First Unitarian.



METROPOLITAN CONGREGATIONS UNITED PHOTOS



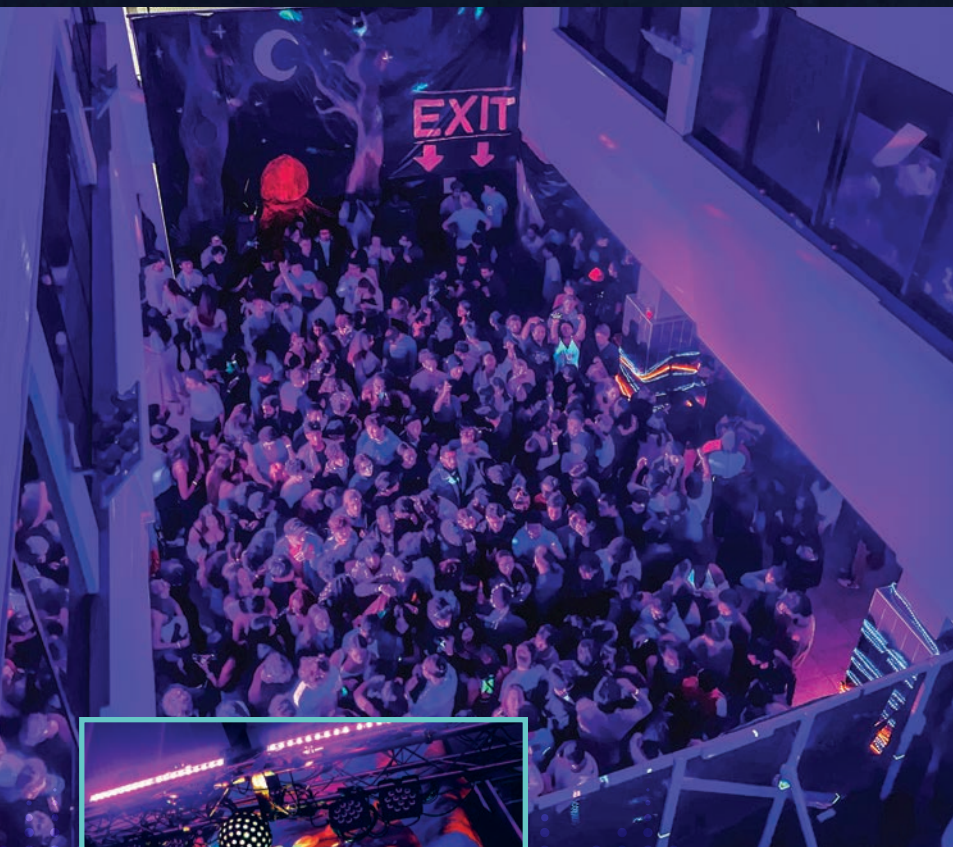


## Student feature //

EnCouncil brought the popular dance party back to campus after being cancelled for three years due to COVID-19.

# VERTIGO

RETURNS TO *McKelvey Engineering*



▶ SCAN ME

Check out a video of the 2022 event.

Written by DANIELLE LACEY

## After a three-year hiatus, Vertigo is back.

EnCouncil, the undergraduate student government for the McKelvey School of Engineering at Washington University in St. Louis, hosted nearly 1,000 students at the annual dance party Nov. 19, 2022.

The event, themed “Fairy Tale,” offered students a chance to relax with music, food and drink before finals. It also marked the return of a wireless computer-controlled dance floor designed and installed in the Lopata Gallery by members of the WashU chapter of Institute of Electrical and Electronics Engineers (IEEE).

Kayleigh Crow, a junior majoring in systems science & engineering and Vertigo committee chair, said EnCouncil had the confidence to host Vertigo this year thanks to the strong support system within McKelvey Engineering.

“The work done by my predecessor, Caitlind Walker, in providing thorough documentation of her time as Vertigo chair has been invaluable,” Crow said. “Caitlind remained at WashU as a master’s student, and it has been extremely comforting having her here to support us.”

▼ Vertigo Committee Chair Kayleigh Crow (far right) gives pep talk to volunteers before the event.



▲ From left: Committee members Guinter Vogt and Shua Jeon set up for Vertigo.

Planning an event that large is a lot of work for any organization, but this year’s Vertigo committee faced the unique challenge of bringing back a popular tradition that its members never had the opportunity to attend. Not only did they not know what Vertigo was, neither did many of the students they were advertising to.

“Although we had been circulating beautiful flyers designed by Shua Jeon, our publicity subchair, most first-years, sophomores and juniors didn’t fully understand what Vertigo was,” Crow said. “We had to adjust the messaging a bit and get more aggressive when it came to publicity.”

The team’s plans also had to incorporate new university event policies that had been put in place since the start of the pandemic.

“One significant policy change is that alcohol is no longer allowed to be distributed for free at events or purchased with Student Union or club money, so we had to work with our vendor to sell on a per-drink basis,” Crow said. “We didn’t know about this change until a few weeks before the event, so it’s fortunate that this problem was resolved in time.”

The day of the event, it took Crow and her team more than 20 hours to transform the Lopata Gallery.

“When I became Vertigo chair, I was aware of the workload and time commitment, but didn’t expect to grow as attached to the event and the planning process as I did,” Crow said. “I initially felt bad asking volunteers to give so much of their time, but I was floored by their hard work and support. I could not have asked for a better team of people to work with.”

Crow said she enjoyed her first-ever Vertigo and she’s grateful for all who helped make it work, including Student Union, Campus Life, Undergraduate Student Services and EnCouncil members.

“My first two years at WashU had normalized a minimal level of campus involvement, even though I made sure to take part in many student groups,” Crow said. “Chairing Vertigo pulled me into the community in a way I wish I could have experienced as a first year. I feel closer to my fellow EnCouncil members and the WashU Engineering community, and I’m immensely honored to contribute to this beloved tradition.”



## Why “Fairy Tale”?

“After begrudgingly admitting to myself that a Taylor Swift-themed Vertigo (‘I don’t know about you, but I’m feeling Vertigo 2022!’) was perhaps not the best idea, I googled and was inspired by the search results. I was a huge fan of fairy tales as a kid, so seeing this theme come together has made my inner child very happy.”

— KAYLEIGH CROW,  
Vertigo Committee Chair

“ I was busy managing things most of the time, but every once in a while, I took a moment to absorb my surroundings and realize how my hard work had paid off. A lot of people don’t know how much work goes into Vertigo, and seeing it unfold was definitely an emotional experience for me.” — KAYLEIGH CROW, Vertigo Committee Chair





Meet Joshua Yuan, who joined the McKelvey School of Engineering in May as chair of the Department of Energy, Environmental & Chemical Engineering. Yuan brings his robust research in energy and environmental sustainability, as well as experience in entrepreneurship, to the growing department.

RON KLEIN

# Q&A with Joshua Yuan

As the new chair of Energy, Environmental & Chemical Engineering, Joshua Yuan brings considerable research and entrepreneurial experience.

*Yuan has been awarded more than \$22 million in funding as a principal investigator or as co-investigator from the Department of Energy, the National Institutes of Health, the National Science Foundation and others.*

Written by **BETH MILLER**

## You've been here several months now. What have you learned about the department you didn't know before?

I'm really proud of its inherent excellence and its aspirations for greatness. The department enjoys a very collegial environment and very strong support from Dean Aaron Bobick to achieve our goals. I'm really proud to be part of this department.

One thing I really like about the department is the aspiration for a better and bigger perspective for something higher than ourselves. I want to work together with the faculty to build up that aspiration to impact society and bring in sustainability for our future.

## Why WashU and McKelvey Engineering? What brought you here?

First is the outstanding intellectual environment of the department. In 2016 I was a seminar speaker here. I was impressed with our faculty. I also have a grant with Young-Shin Jun and Yinjie Tang (professors of energy, environmental & chemical engineering) and have submitted grants with Richard Axelbaum (the Stifel & Quinette Jens Professor of Environmental Engineering Science), and several proposals with other faculty. My background fits into the department very well to work with different faculty and build collective excellence.

**“We believe that this department is about the student, but not only about the students, it is about the future of our society as we play an important role in and building a sustainable future. This degree is not just for themselves; it's also for something bigger and for the future of our society.”**

Second is the excellence of the department. It is a very young department that has a high expectation and aspiration

for itself. The faculty support the need to improve our rankings and funding, to build a robust program and recruit excellent graduate students. I have heard the same consistent message for the pursuit of excellence from almost every faculty member, and you can't find that everywhere.

Also, I'm at a career stage where I'm looking for a bigger impact and empowering more success beyond myself. That's why I see this as a unique opportunity.

## What are your priorities for the first year?

The first thing I need to do is listen. We spent the summer listening to the faculty, and that synergized with a faculty retreat where we identified 12 points that we are going to work on. Some of those points are revisiting the PhD program to make it more efficient and productive; enhancing the master's program; revisiting the class design and building a departmental structure that reflects the National Academy of Engineering's Grand Challenges; enhancing equity, diversity and inclusion through recruiting and Historically Black Colleges and Universities (HBCU) partnership; and building a new teaching lab for the undergraduate program. This 12-point action plan is the roadmap that the faculty identified at the retreat, and I will work with the faculty, the committees and the program directors to advance the roadmap so that it can be implemented effectively.

## What are the strengths of the department, and where do you see opportunities for growth?

If we want to analyze the growth, we need to analyze two dimensions. One is the future need of society, which is so often reflected in the federal funding trend and industry need. The other is to analyze where our strength is and how the two align with one another.

Congress recently passed the Bipartisan Infrastructure Law, which is the largest investment in U.S. infrastructure and technology in recent years. I started my career in 2008 during the Obama administration when American Recovery and Reinvestment Act (ARRA) was passed, which was a huge influx of funding for a junior professor. I started my career too late to take advantage of it. The current

legislative initiative is an even bigger opportunity, because besides the Bipartisan Infrastructure Law, Congress recently passed the CHIPS and Science Act and the Inflation Reduction Act, which have a significant investment in climate change. We are seeing a huge influx of investment in carbon capture and use, renewable hydrogen, renewable energy and carbon sequestration.

Since July 1, 2022, our faculty have brought in more than \$20 million in new grants and contracts, and we are on a trajectory of tripling last year's total grants and contracts and doubling the historical high of the department.

We see the growth in addressing the needs in climate change, in renewable energy, infrastructure and environmental sustainability. Our department also is trying to engage local industry as partners to build translational programs. Our time has come, and we need to capture this opportunity within the department.

## How do you plan to connect with the other departments and with outside collaborators?

WashU has one of the best medical schools in the world. Our department has strengths in environmental microbiology and environmental technology, and we can provide a lot of empowerment for medical technologies in different ways. We see a lot of opportunity for EECE to contribute to health initiatives, including environmental health, global health and different types of medical therapeutics and devices. Having a closer collaboration with the medical school is another way to grow our department.

We also are collaborating with other departments in the school, including Computer Science & Engineering (CSE). Artificial intelligence has transformed everything. We recently launched seed grants with CSE to promote collaborations across the departments. I am very impressed with the collegial environment in McKelvey Engineering and how Dean Bobick supports interdisciplinary collaborations. We also are talking about building collaboration with the Department of Chemistry, the Brown School and other units, as well as building international interdisciplinary collaboration.



# McKelvey Engineering Awards 2022



From left: Marcia Brown-Rayford, Rajesh Bhat, Mary Jane King, Verneta Simon and Randy Bateman

## Alumni Achievement Award

### Randall J. Bateman, MD

Randall Bateman, MD, is the Charles F. and Joanne Knight Distinguished Professor of Neurology, director of the Dominantly Inherited Alzheimer Network (DIAN) and director of the Knight Family DIAN Trials Unit. His research focuses on the pathophysiology and development of improved diagnostics and treatments of Alzheimer's disease.

Bateman has 47 active or pending patents and is co-founder of C2N Diagnostics, which provides the first high-accuracy blood test for Alzheimer's disease. Bateman has established multiple research consortiums, including the DIAN-TU Pharma Consortium, Tau SILK Consortium and the NFL Consortium. He is an elected member of the National Academy of Medicine and the National Academy of Inventors.

Bateman earned bachelor's degrees in electrical engineering and biology from Washington University in St. Louis in 1996. He earned a doctor of medicine from Case Western Reserve University School of Medicine in 2000 and completed a residency in neurology with Barnes-Jewish Hospital and a clinical fellowship in dementia with the Washington University School of Medicine.

### Marcia Brown-Rayford

Marcia Brown-Rayford is the vice president of the Global Life Sciences R&D practice at RGP, a global consulting firm. She supports clinical research phases, scale-up, technology transfer and commercial launch of drugs, medical devices and diagnostics.

Prior to RGP, during a 13-year tenure at Merck, she led clinical drug development efforts in various roles, including co-inventing Singulair for asthma and Heartgard and Ivermectin for animals. She also brings experience from PricewaterhouseCoopers' Life Sciences practice, where she was an executive management consultant for Fortune 100 global pharmaceutical, biotechnology and medical device companies.

In 2019, Brown-Rayford launched BrightPath STEAM Academy, a nonprofit organization designed to bridge the gap for marginalized Black youth and expose them to possibilities in science, technology, engineering, arts and math. The academy partners with highly skilled STEAM educators, corporations, universities and the faith-based community.

Brown-Rayford earned a bachelor's degree in chemical engineering from Washington University in 1991. She also earned three MBA degrees in strategic management, entrepreneurial management and finance from The Wharton School at the University of Pennsylvania.

### Verneta Simon

Verneta Simon has been an on-scene coordinator for the U.S. Environmental Protection Agency for almost 35 years. In this role, she coordinates all federal efforts with and provides support and information to local, state, and regional response communities. Simon provides expert leadership to teams responding to environmental emergencies in Illinois, Indiana, Michigan, Ohio, Wisconsin and Minnesota. She has primary responsibility for spills and releases to inland areas and waters. Once a release or spill has been identified, she determines whether federal assistance will be necessary to help control and contain it and coordinates all aspects of the emergency response.

Simon's career has included work on significant environmental incidents, including Hurricane Katrina, Deepwater Horizon and the Columbia Space Shuttle disaster.

Since 1985, she has served on Washington University's Black Alumni Council. She supports the annual Verneta H. and William D. Simon Jr. Scholarship named in honor and memory of her parents.

She earned a bachelor's degree in chemical engineering from Washington University in 1982, and a master's degree in environmental health engineering and a certificate in executive management for design and construction from Northwestern University.

## Engineering Entrepreneurship Award

### Rajesh Bhat

Rajesh Bhat co-founded Roostify to provide consumers with an accelerated and streamlined home-lending process. The single, intuitive point-of-sale platform helps lending teams close loans faster, improve margins and deliver a personalized borrower experience. As the CEO of Roostify, Bhat is responsible to establish and execute the vision and deliver on the brand promise of "Reinvent Lending. Realize Dreams."

Bhat has scaled the company from three employees to more than 150 and has crossed major industry milestones. Roostify is one of the top digital lending platforms in the home lending industry and processes more than \$50 billion a month in loan volume across 200 financial institutions.

Bhat has been recognized twice as a Goldman Sachs 100 Most Intriguing Entrepreneur, a HousingWire Vanguard Award winner and a Mortgage Bankers Association Tech All-Star. Prior to starting Roostify, Bhat spent 14 years in management consulting, most recently at Pace Harmon, and began his career at Ernst & Young LLP.

Bhat earned a bachelor's degree in computer science from Washington University in 1998.

## Dean's Award

### Herman T. & Phenie R. Pott Foundation

In 1963, Herman T. Pott (1895-1982) and his wife, Phenie R. Pott (1898-1993), established The Pott Foundation. Beginning in 1933, Herman Pott developed the St. Louis Shipbuilding & Steel Co. into a thriving enterprise. During World War II, his company constructed ships for the United States and Russia, and by the 1950s, the company was the world's largest designer and builder of inland river towboats. In 1953, Herman purchased the Federal Barge Lines from the government and built the M.V. America and the M.V. United States, the two most powerful towboats in the world. Herman steadily expanded the company and changed its name to Pott Industries Inc. in 1967.

Phenie Hope Ryals Pott was born in Fort Deposit, Alabama. She moved to St. Louis in 1923 where she met and married Herman Pott. Phenie was a long-time volunteer and philanthropist.

The Pott Foundation is dedicated to supporting children, education and health and human services in the St. Louis region. Mary Jane King, a niece of the Potts who earned a master's degree in social work from Washington University in 1983, is the executive director. The Pott Foundation has funded annual engineering scholarships since 1994, which have benefited 111 Pott Foundation Scholars to date.

# McKelvey Emerging Leader Awards



From left: Christine Hansen; John Schupbach, MD; Melissa Holtmeyer Terlaje; and Jennifer Pangborn-Dolde

### Christine Hansen

US Equity Options Trading Lead, Partner, IMC-Financial Markets

As a partner, Christine Hansen manages a team of derivative traders at IMC Financial Markets, a global market maker that uses algorithmic trading and advanced technology to buy and sell securities.

Since 2014, Hansen has led the U.S. Equity Options desk, which manages responsibilities for daily trading operations, business development and company alignment with a strategic vision.

Hansen earned a bachelor's degree in chemical engineering with a minor in computer science from Washington University in 2010. She also is a graduate student-at-large at the University of Chicago.

### Melissa Holtmeyer Terlaje

Strategy & Technology Development, Air & Missile Defense Sector, Johns Hopkins University Applied Physics Laboratory

As an American Association for the Advancement of Science fellow, Melissa Holtmeyer Terlaje used her engineering background to shape science and technology policy at the national level.

In Holtmeyer Terlaje's role of strategy and technology development at the Johns Hopkins University Applied Physics Laboratory, she develops strategic visions and identifies technologies and policies needed to make the visions real.

Holtmeyer Terlaje earned bachelor's and master's degrees in mechanical engineering from Washington University in 2006 and 2007, respectively. She also earned a doctorate in energy, environmental & chemical engineering from WashU in 2012.

### Jennifer Pangborn-Dolde

Assistant vice president, Midwest & Plains Traffic & ITS Manager, WSP USA

Jennifer Pangborn-Dolde is a transportation planner and engineer who oversees mobility, complete streets, multimodal planning and last-mile connectivity projects across the country.

As the assistant vice president, Midwest & Plains Traffic and ITS manager at WSP, she connects people to places through innovative, safe and sustainable multi-modal transportation solutions. Her portfolio includes the award-winning Armour Road Complete Streets in North Kansas City and the rebuilding of Interstate 270 North in St. Louis to enhance community connectivity.

Pangborn-Dolde earned a bachelor's degree in civil engineering and a master's degree in construction management from Washington University in 2006.

### John Schupbach, MD

Founder & CEO, Squalor to Scholar; Emergency Medicine Resident Physician, Mayo Clinic

In 2011, John Schupbach founded Squalor to Scholar, a nonprofit that enables bright and talented children in India to attend high-quality private schools. Squalor to Scholar has provided more than 1,000 annual scholarships over the past 10 years as well as life-changing support, social and health care services to hundreds of families. As the CEO, Schupbach empowers and inspires children to become leaders who improve the world.

He earned a bachelor's degree in mechanical engineering with minors in aerospace engineering and architecture from Washington University in 2010. He also earned an MBA from Harvard Business School and a doctor of medicine from Mayo Clinic Alix School of Medicine.





# For biomedical engineer Yoram Rudy, a new chapter awaits

RON KLEIN

Written by CARLA BEECHER

It's no wonder that after such a long, accomplished and productive career, **Yoram Rudy** is not quite ready to retire from his life's work. Yes, he stepped down at the end of 2022 from his role as director of the Cardiac Bioelectricity and Arrhythmia Center — which he founded in 2004 — to become emeritus professor, but he sees this next step as yet another opportunity to begin anew. With a life defined by an inquisitiveness that has furthered the field of biomedicine, Rudy has trained and inspired a new generation of bioengineers as they make their own discoveries in service to humanity.

"It's not just my work, it's my passion," said Rudy, the Fred Saigh Distinguished Professor of Engineering in the Washington University McKelvey School of Engineering. He also is professor of medicine, of cell biology and physiology, of radiology and of pediatrics in the School of Medicine. Rudy and his team have labored to develop computational biologic tools and imaging methods to study arrhythmia mechanisms at all levels of the cardiac system, from molecule to the whole heart. With a mission to train graduate students and conduct research in cardiac electrophysiology and electrocardiology, his lab has produced innovative approaches for the diagnosis, prevention and treatment of cardiac arrhythmias that can lead to sudden death. As well, 30 doctoral students have graduated under his tutelage and continue the work by pursuing careers in academic research and in the biomedical industry.

Born and raised in Tel Aviv, Rudy comes from a family that highly values education.

"Both parents also were very passionate about art and music," Rudy said, "and I am a classical music and jazz enthusiast. To me, science and art are very intimately connected through the imaginative creative process. I agree with Albert Einstein — whom I greatly admire — who once said, 'Logic can get you from A to Z, but imagination will take you everywhere.'"

After high school, Rudy spent a mandatory three years of service as an officer

in Israel's military. The commander of the officers academy, renowned Col. Meir Pa'il, taught Rudy the importance of planning, tactics and strategies.

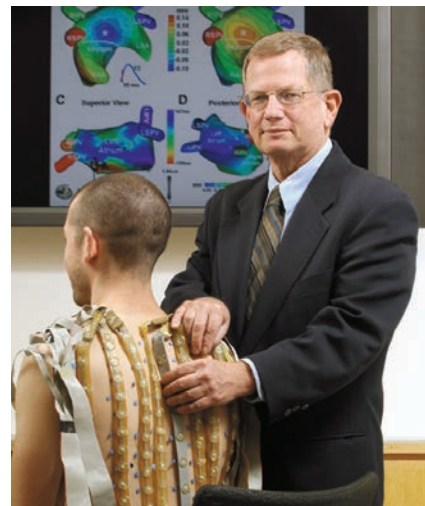
"He told us to always remember that every plan is subject to change," he said. "In retrospect, from a life and a science perspective, it's good advice. Rigidity is counterproductive."

Rudy earned undergraduate and graduate degrees in physics from Technion, Haifa, Israel, in 1971 and 1973, respectively, focusing his graduate work on the quantum theory of superconductivity.

"It was all very abstract and very elegant work," he said. "But I found that the human dimension was missing for me; I wanted a more human-related application for my work."

Gravitating toward the life sciences, he moved to Cleveland and began a doctorate in biomedical engineering at Case Western Reserve University. He studied under Robert Plonsey, an expert in electromagnetic waves and a founding father of the new science of biomedical engineering. The two collaborated on calculating the relationship between body surface and cardiac electrical potentials.

After earning a doctorate in 1978, he began teaching at Case Western, eventually becoming professor of biomedical engineering, physiology and biophysics, and medicine as well as director of its Cardiac Bioelectricity Research and Training Center.



WASHU PHOTO

*Rudy's curriculum vitae summarizes the numerous discoveries, inventions, presentations, lectures, fellowships, visiting professorships, committee and board work, publications, awards and honors that have framed his career. Of all his accolades, the most meaningful include his 2003 membership in the National Academy of Engineering; becoming a fellow in the National Academy of Inventors in 2018; and his induction as a lifetime fellow of the Institute of Electrical and Electronics Engineers. He also is grateful for receiving a National Institutes of Health Merit Award in September 1998, which provided 10 years of support for his development of electrocardiographic imaging (ECGI).*





Current and past members of Rudy's lab gathered in 2018 to celebrate his research and contributions to the field of bioengineering.

WHITNEY CURTIS

In 2004, Washington University offered him the directorship of the Cardiac Bioelectricity and Arrhythmia Center.

Named the Fred Saigh Distinguished Professor of Engineering, Rudy took it upon himself to learn a bit about baseball and Fred Saigh, the former owner of the St. Louis Cardinals. He also learned about baseball legend and St. Louis native Yogi Berra. "I enjoy his adages, especially, 'When you see a fork in the road, take it.'"

That thought has come to Rudy again and again over the years as he counseled his doctoral students to take risks.

"It's important to sometimes go sideways at a problem and explore the back roads that you really didn't plan on taking," he said of nurturing creativity.

According to Rudy, many of his aha! moments usually happened during the interpretation of data in the effort to extract principles from the results of an experiment or theoretical modeling. He recalled a car trip he took with a graduate student between Cleveland and Penn State. The two had been working on computer modeling of the conduction of electricity in the heart.

"Electricity travels in waves through the heart muscle," he explained. "We were trying to

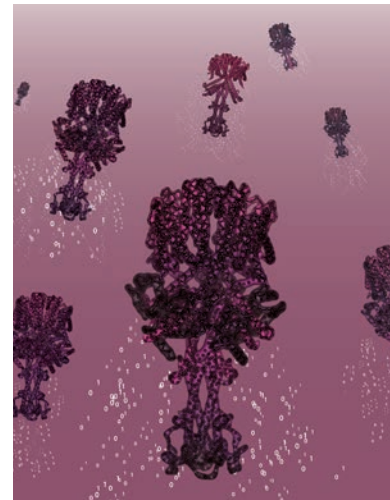
formulate this process with equations to devise a measure of the safety of the conduction processes. We struggled and struggled. During the drive we were listening to the radio, and it came to us. We were not talking about it or discussing it, but all of a sudden it came.

And the safety of discontinuous conduction is now recognized as one of the principles of cardiac electricity. It's a fantastic moment — all of a sudden you see the idea crystalize. To extract a core principle, a model should be as economical as possible. One should make the model simple, but not too simple. It should contain all the important elements that are needed to answer a specific question, yet be simple enough so the concept could be described to a child."

As Rudy winds down his work at Washington University — passing the torch to the next generation of biomedical engineers — he still intends to keep his hand in the work as emeritus professor. He and his wife, Hadas, will be moving back to Tel Aviv.

"It's a new beginning for us," he said.

"Life is like riding a bicycle," Rudy said, quoting again from his favorite theoretical physicist Albert Einstein. "To keep your balance, you must keep moving."



Computer-generated molecular structure of a cardiac ion channel.

Rudy also credits the five years he spent traveling back and forth to Oxford University as a Royal Academy of Engineering Distinguished Visiting Fellow, which broadened his perspective on science, research and education.

For more information about Rudy's research and center: [cbac.wustl.edu](http://cbac.wustl.edu)



View Rudy's CV

## Lu paper wins 'test of time' award



For the second time in 2022, Chenyang Lu, an internationally recognized leader in cyber-physical systems, received recognition for a trailblazing paper that has been influential in the field for more than a decade.

Lu, the Fullgraf Professor in the McKelvey School of Engineering, has received the Test of Time Award from the ACM Conference on Embedded Networked Sensor Systems (SenSys), the flagship conference on the Internet

of Things (IoT). This award recognizes papers that are at least 10 years old and have had a longstanding impact on the field.

The paper, titled "Reliable clinical monitoring using wireless sensor networks: experiences in a step-down hospital unit," was presented at SenSys in November 2010. Co-authors were Octav Chipara, who earned a doctorate in computer science from the engineering school in 2010 and is now an associate professor at the University of Iowa; Thomas Bailey, MD, professor of medicine at the School of Medicine; and Gruiua-Catalin Roman, former professor and chair of the Department of Computer Science & Engineering, now a professor at the University of New Mexico.

## Genin, Guilak named to National Academy of Inventors



The National Academy of Inventors (NAI) has elected two Washington University in St. Louis faculty members to its 2022 cohort of fellows: Guy Genin, the Harold and Kathleen Faught Professor of Mechanical Engineering at the McKelvey School of Engineering, and Farshid Guilak, the Mildred B. Simon Research Professor of Orthopaedic Surgery at the School of Medicine.

## Boyd elected a Fellow of ASME



Emily Boyd, a teaching professor of mechanical engineering & materials science, was elected a Fellow of the American Society of Mechanical Engineers. Boyd joins an elite group of fewer than 3,500 Fellows out of more than 79,000 society members.

Fellows are elected to be the essential resource for mechanical engineers and other professionals worldwide for solutions that benefit humankind and are selected for their engineering achievements and experience in the field.

Boyd specializes in thermofluids sciences, teaching courses in fluid dynamics and heat transfer. She also coordinates the Washington University Summer Engineering Fellowship program, which provides research experience for undergraduate students.

## Guilak among faculty elected to National Academy of Medicine



Farshid Guilak, an affiliate faculty member in the Department of Biomedical Engineering, has been elected to the National Academy of Medicine, a part of the National Academy of Sciences. He is one of four faculty with primary appointments at the School of Medicine whose election was announced Oct. 17, 2022.

Guilak is the Mildred B. Simon Research Professor of Orthopaedic Surgery and co-director of the Washington University Center of Regenerative Medicine. He specializes in the study of arthritis, working to uncover factors that contribute to the onset and progression of the disorder, with an eye toward developing new drugs and stem cell therapies that may be used as treatments. He also is a professor of developmental biology and of biomedical engineering and mechanical engineering & materials science in the School of Medicine.

### Professorships

## Chakrabartty named Clifford W. Murphy Professor



Shantanu Chakrabartty, who uses novel techniques to design self-powered computing devices, analog processors and instrumentation with applications in biomedical and structural engineering, has been named the Clifford W. Murphy Professor in the McKelvey School of Engineering. Although he received the professorship title in fall 2019, his installation ceremony was delayed due to the COVID-19 pandemic and took place Sept. 29, 2022.

Chakrabartty is a professor of electrical & systems engineering, of computer science & engineering and of biomedical engineering. His research pushes new engineering frontiers in analog computing and in the design of self-powered systems and instrumentation. He has published more than 180 refereed journal and conference articles in prestigious venues such as *Nature*, *Frontiers*, *IEEE Transactions* and *NeurIPS*.



Professorships

## Flores named Christopher I. Byrnes Professor of Engineering

Katharine Flores, a renowned materials scientist who develops new complex metallic alloys and advanced manufacturing techniques, was installed as the Christopher I. Byrnes Professor of Engineering Oct. 25, 2022.

Flores is professor and associate chair for materials science in the Department of Mechanical Engineering & Materials Science and director of the interdisciplinary Institute of Materials Science & Engineering. From November 2020 to May 2022, she was interim chair of the Department of Energy, Environmental & Chemical Engineering.

Flores' research includes fundamental studies of structure-property relationships in structurally and compositionally complex materials, as well as more applied work to develop new metallic alloys



for load-bearing applications in high-temperature environments. She leads research projects focused on quantitatively describing the inherently disordered atomic structure of metallic glasses and has pioneered high-throughput synthesis methods to rapidly explore the vast design space of "multi-principal element" alloys. She also is interested in developing new advanced manufacturing methods that use energy and raw materials more efficiently and sustainably.

## In memoriam: Donald Snyder



Donald Snyder, a senior professor in the Preston M. Green Department of Electrical & Systems Engineering, died Monday, Nov. 21, 2022, of complications of gastrointestinal cancer. He was 87.

Snyder joined the Washington University faculty in 1969 in the Department of Electrical Engineering and in the Biomedical Computer Laboratory at the School of Medicine, where he participated in research with Jerome R. Cox Jr., a leader in applying advanced technology for introducing new treatments in biomedical engineering; Michel Ter-Pogossian, the founder of positron emission tomography (PET); and others to develop PET systems. He was the Samuel C. Sachs Professor of Electrical Engineering and chair of the department from 1976 to 1986, as well as a professor of radiology at the School of Medicine. He became senior professor in 2003.

Snyder was the founding director of the Electronic Systems and Signals Research Laboratory in the Department of Electrical Engineering from 1986 to 1998. During this period, the lab grew to seven faculty, 25 graduate students and several undergraduate students working on fundamental aspects of imaging applied to biomedical, astronomical and remote-sensing problems. Snyder was a Fellow of the Institute of Electrical and Electronic Engineers (IEEE), cited for "contributions to estimation theory and applications to communications and medicine." He was the 1982 President of that Institute's Information Theory Society.

After the initial launch of the Hubble space telescope, an aberration in the mirror was identified resulting in blurring of all images. Snyder proposed a novel image reconstruction approach that removed the blur; a version of this algorithm has been used on all subsequent images.

# New faculty join McKelvey Engineering

### Computer Science & Engineering

#### Nathan Jacobs, professor

- » PhD, computer science, Washington University in St. Louis
- » BS, computer science, University of Missouri



Nathan Jacobs joins McKelvey School of Engineering from the University of Kentucky, where he has been on the faculty since 2010. Jacobs' research focus is developing learning-based algorithms and systems

for processing large-scale image collections. He is developing techniques for mining information about people and the natural world from geotagged imagery, including images from social networks, publicly available outdoor webcams and satellites. He is a Taylor Institute Fellow of the Taylor Geospatial Institute.

#### Cynthia Ma, lecturer

- » PhD, computer science, Washington University in St. Louis
- » BA, computer science and biology, Swarthmore College



Cynthia Ma, who was a doctoral student in the lab of Michael Brent, professor of computer science & engineering, began teaching data mining in the Department of Computer Science &

Engineering in fall 2021. Her research interest lies in the study of gene regulatory systems, specifically on using mathematical modeling to infer the activity of transcription factors in cell signaling pathways from large datasets of gene expression measurements.

#### Hussein Sibai, assistant professor

- » PhD, MS, electrical and computer engineering, University of Illinois Urbana-Champaign



» BE, computer and communication engineering, American University of Beirut  
Hussein Sibai joins the faculty from the University of California, Berkeley, where he was a postdoctoral

scholar in the electrical engineering and computer sciences department. His research is on trustworthy autonomy, spanning the areas of cyber-physical systems (CPS), formal methods, control theory and machine learning. He develops theory and builds tools to efficiently design, evaluate and deploy assured autonomous systems.

#### Chenguang Wang, assistant professor

- » PhD, computer science, Peking University
- » BS, computer science, Beijing Institute of Technology



Chenguang Wang joined the faculty from the University of California, Berkeley, where he had a postdoctoral appointment with the Berkeley Artificial Intelligence Research Lab.

and security labs. In his research, Wang focuses on techniques and systems for making natural language processing (NLP) trustworthy in real-world settings ranging from science to industry. His research has influenced real-world scenarios and is deployed in a wide range of applications including voice assistants, biomedicine, math, finance, cognitive science, search engines and e-commerce platforms.

### Division of Engineering Education

#### Peizhen Zhu, lecturer

- » PhD, MS, applied mathematics, University of Colorado Denver



Peizhen Zhu joined the faculty from Missouri University of Science & Technology. Zhu's research interests include matrix computations, including numerical linear algebra,

numerical analysis, optimization, graph algorithms, data mining, eigenvalue and model predictive control.

### Energy, Environmental & Chemical Engineering

#### Jenna Ditto, assistant professor

- » PhD, MS, chemical and environmental engineering, Yale University
- » ScB, chemical engineering, Brown University



Jenna Ditto joined the faculty from the University of Toronto, where she was a postdoctoral researcher in the Department of Chemical Engineering and Applied Chemistry. Her research

interests lie at the interface between indoor and outdoor air quality. She seeks to answer

questions about the impacts of poor outdoor air quality and variable building quality on indoor chemical exposures the ultimate health impacts of our indoor activities and exposures.

#### Xinhua Liang, professor

- » PhD, chemical engineering, University of Colorado, Boulder
- » BS, MS, chemical engineering, Tianjin University, China



Xinhua Liang joined the faculty from Missouri University of Science & Technology. Liang's research interests are in the synthesis, functionalization and applications of

nanoparticles. Liang is internationally recognized for gas-phase atomic/molecular layer deposition in scalable fluidized bed reactors to synthesize or functionalize nanomaterials for various applications, such as catalysis and energy storage.

#### Kristen Wyckoff, lecturer

- » PhD, civil engineering, University of Tennessee, Knoxville
- » BSE, MSE, environmental engineering, Mercer University, Macon, Georgia

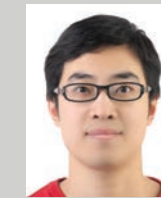


Wyckoff joined McKelvey Engineering as a lecturer after working as a lecturer at the University of Tennessee, Knoxville, for four years. Their research interests

relate to the integration of active learning and outreach into classroom and laboratory settings. In addition to engineering topics, they also have a history of and interest in improving diversity and inclusion in university settings, with a special interest in the LGBTQIA+ community.

#### Lu Xu, assistant professor

- » PhD, chemical engineering, Georgia Institute of Technology
- » BEng, chemical engineering, Zhejiang University



Lu Xu joins McKelvey Engineering from the University of Colorado, Boulder, where he is a research scientist for National Oceanic and Atmospheric Administration (NOAA). Xu's

research interests are in air quality and climate change. He has investigated the atmospheric chemistry of organic compounds from diverse sources such as wildfires, vegetation and power plants, and the subsequent impacts on air quality, human health and climate.

#### Joshua Yuan, professor and chair

- » PhD, University of Tennessee
- » MS, University of Arizona
- » BS, Fudan University



Joshua Yuan joined the faculty as professor and chair of the Department of Energy, Environmental & Chemical Engineering from Texas A&M University.

His research encompasses renewable biomaterials, carbon capture and utilization, integrated biorefining, and systems and synthetic biology. He also focuses on designing biorefinery and biomaterial from biomass as well as innovative technologies for environmental remediation, carbon capture and utilization.

### Electrical & Systems Engineering

#### Andrew Clark, associate professor

- » PhD, electrical engineering, University of Washington
- » MS, mathematics, University of Michigan
- » BSE, electrical engineering, University of Michigan



Andrew Clark joined the McKelvey Engineering faculty from Worcester Polytechnic Institute. Clark's research is in the areas of control and security of autonomous cyber-physical systems

(CPS); complex networks; resilience; control- and game-theoretic security modeling, combinatorial optimization, and network security.

### Mechanical Engineering & Materials Science

#### Xianglin Li, associate professor

- » PhD, mechanical engineering, University of Connecticut
- » BS, MS, mechanical engineering, Xi'an Jiaotong University, China



Xianglin Li joined McKelvey Engineering from the University of Kansas. Li's research interests are in batteries and fuel cells, including lithium-oxygen batteries and battery thermal

management; greenhouse gas emissions and full fuel cycle analysis of fossil fuels; and life cycle assessment and economic analysis of advanced energy techniques, among others.



Holly Rockweiler, who earned a bachelor's and master's degree in biomedical engineering, is using her role as CEO of Madorra to improve women's health.

# Rockweiler uses her passion to improve the world

Written by DANIELLE LACEY

A mentor once described Holly Rockweiler as "an activist in a lab coat."

Rockweiler, who earned bachelor's and master's degrees in biomedical engineering from the School of Engineering at Washington University in St. Louis in 2007, is passionate about women's health and is now working to improve the lives of women as co-founder and CEO of Madorra, a medical device company.

"I'm not someone who is going to have a megaphone and lead a march," Rockweiler said. "But this is a way I can use my engineering, R&D and startup experience to promote what I want to see in the world, which is equal treatment for women."

Rockweiler and her team founded Madorra while she was enrolled in the Biodesign Innovation Fellowship at Stanford University. The company is developing an at-home, external device that aims to treat genitourinary syndrome of menopause.

Formally known as vaginal atrophy, the condition causes itching, dryness and discomfort during urination. Madorra's new device will use ultrasound to reactivate the body's own natural lubricating mechanisms.

Rockweiler acknowledges the awkwardness that can sometimes arise when discussing her work.

"I would say we're working on quality of life and be vague about what we were doing," she said. "Then someone said to me, 'Holly, if you're not saying vagina, who is going to say it?' That helped me step into the space of just speaking about it. Now when I pitch, I get compliments on how I made it approachable and easy to understand. I talk about it like heart disease or diabetes."

It's a lesson that's helped her in her mission to bring equity to women's health.

"Two percent of each dollar goes to female entrepreneurs," Rockweiler said.

"Imagine being a female entrepreneur talking

about women's vaginas. We cannot ignore that women's health has been overlooked for so long and funding has not been given to this."

Rockweiler never planned to become an entrepreneur, but she said she felt her engineering education more than prepared her to take on the challenge.

"Engineering taught me how to problem solve and to understand what I know and don't know," Rockweiler said. "I then know how to go about structuring the process to develop the understanding I need."

Rockweiler encourages WashU engineers to keep their minds open when following their own passions.

"I didn't set out as a first grader saying I wanted to be a startup CEO or even a biomedical engineer," she said. "I've learned along the way you don't have to have a plan. I'm very excited about where I am. I got to know myself more along the way."

JAY FRAM

# birth

Written by MICHELLE OYEN



Michelle Oyen is the director of the Center for Women's Health Engineering and an associate professor of biomedical engineering.

Birth (noun) is the emergence of a new individual from the body of its parent (Merriam-Webster). It is a process that is more challenging and suffers many more failures than people generally realize.

One in every 10 births — both in the U.S. and globally — takes place before full-term gestation. The costs associated with prematurity can be extremely high, increasing for each week of earliness.

Stillbirth late in pregnancy can be devastating for expectant parents. Many stillbirths are classified as "preventable," which is no consolation to a family experiencing grief.

Although decreasing worldwide, maternal mortality is increasing in the U.S., where racial disparities are much of what drives that increase. Black and Native American women are three times more likely than white women to die due to pregnancy.

Poor outcomes for mothers and babies are expensive for the medical system and carry other societal costs, including enduring mental health challenges.

In fall 2022, we launched our new Center for Women's Health Engineering with maternal and fetal health research as part of its core. Historically, the intersection of engineering and medicine has been stronger in some clinical specialties than in others. We aim to build strong ties with fields underrepresented in engineering collaboration, such as obstetrics and gynecology.

Engineering brings novel tools and techniques to intractable problems in society. In biomedical engineering, those tend to be challenging clinical issues. Saving lives and improving the quality of life for mothers and babies are fundamental goals of this new Center.



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#WashUengineers

$$p = mv$$



## Snapshot //

Philip Bayly, chair of the Department of Mechanical Engineering & Materials Science, interacts with students at the MEMS 411 Senior Design Prototype Expo held in Jubel Hall on Nov. 30, 2022.