SPRING 2025

MCKELVEY SCHOOL OF ENGINEERING
AT WASHINGTON UNIVERSITY IN ST. LOUIS

Momentum

Wonderland

Focused ultrasound making strides in diagnosis, potential treatment of brain disorders

page 10

Momentum
SPRING 2025

DEAN
Aaron Bobick

SENIOR ASSOCIATE DEAN & EXECUTIVE EDITOR
Nick Benassi

ENGINEERING NEWS & CONTENT DIRECTOR
Beth Miller

DIRECTOR OF MARKETING & COMMUNICATIONS
Virgil Tipton

MARKETING & COMMUNICATIONS WRITER
Channing Suhl

MARKETING & MULTIMEDIA MANAGER
Suzanne Bremehr

DIGITAL CONTENT SPECIALIST II
Catie Dandridge

COMMUNICATIONS SPECIALIST II
Caitlyn Spradley

SENIOR WEB DEVELOPER
Vince Ruppert

ENGINEERING VIDEOGRAPHER
Taylor Bevirt

CONTRIBUTORS
Shawn Ballard
Aimee Felter
Kurt Greenbaum
E. Brook Haley
Fadila Lateef
Leah Shaffer

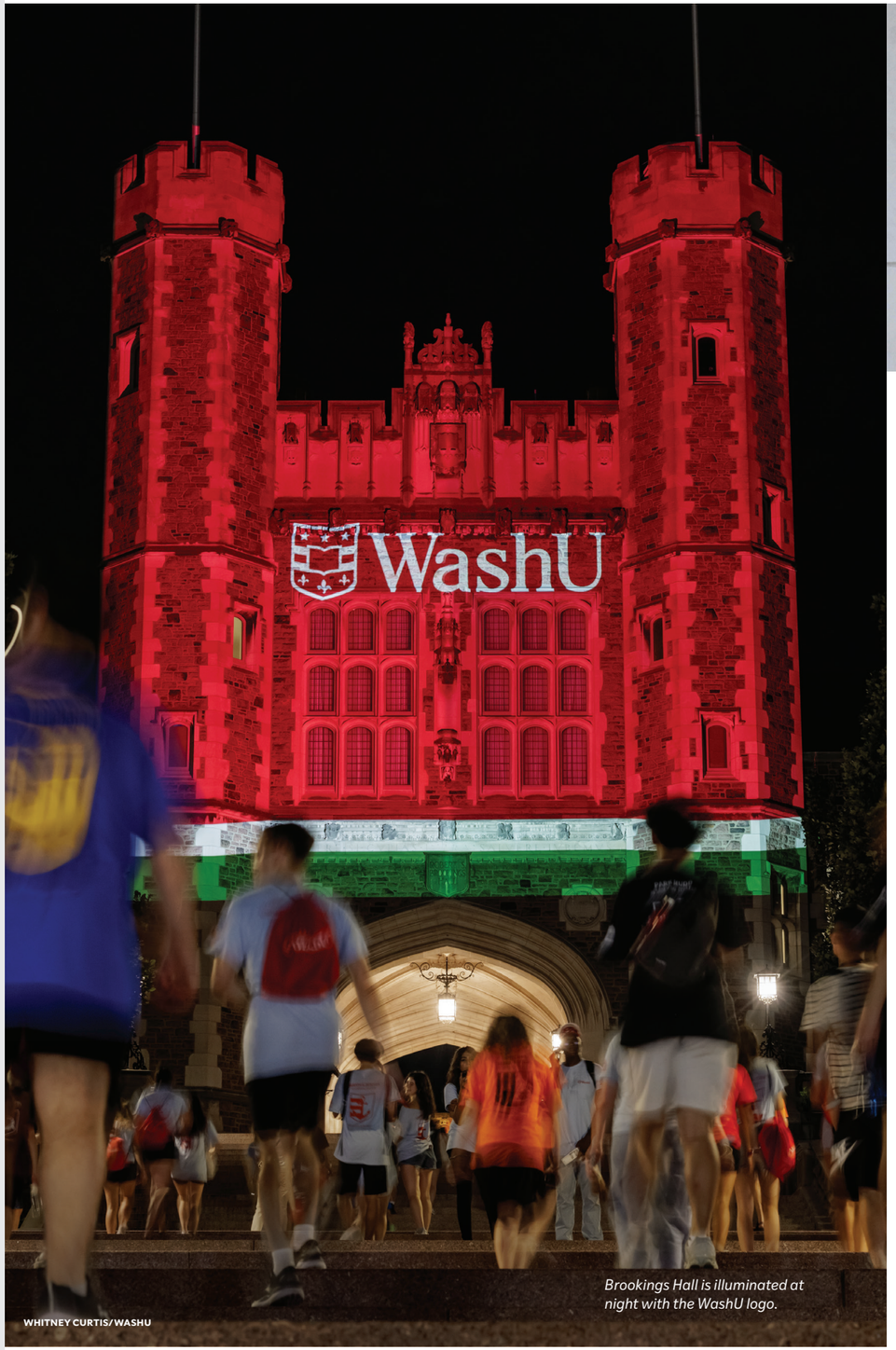
Engineering Momentum is published by the McKelvey School of Engineering at Washington University in St. Louis. Unless otherwise noted, articles may be reprinted without permission with appropriate credit to the publication, school and university.

CORRESPONDENCE
McKelvey School of Engineering
Washington University in St. Louis
MSC 1163-0206-01
One Brookings Drive
St. Louis, MO 63130-4899

EMAIL
engineering@wustl.edu

PHONE
314-935-6100

WEBSITE
engineering.washu.edu



Brookings Hall is illuminated at night with the WashU logo.

WHITNEY CURTIS/WASHU

WASHU PHOTO

“Administrations come and go, economic resources ebb and flow, but the time constants of all of these perturbations and contexts are significantly shorter than that of McKelvey.”

As I sit here writing this note, WashU finds itself in a potential perfect storm of legislation that may dramatically impact its financial position. The combination of proposed research funding cuts, reduction in overhead (which, despite the rhetoric around covering administrator salaries and bloat, includes funding PhD fellowships, building out faculty research laboratories and purchasing shared instrumentation), endowment tax and Medicaid cuts (we share a balance sheet with WashU Medicine) – all of these represent an unprecedented assault on America’s research universities. And if that storm wasn’t enough, just last week a tornado ravaged the neighborhoods around the Danforth Campus, upending many of our community members’ lives. (The campus came through relatively unscathed but many homes nearby have significant damage.)

And yet, when I look at this edition of *Engineering Momentum* magazine, even in the face of all the adversity mentioned above, I feel a deep sense of optimism. Whether it is the potential impact our research has on understanding the brain and possible interventions, or the ambition and ingenuity of our students (and the *chutzpah*: They decided to build a satellite!) or the academic leadership of our faculty and alumni, all these efforts are about the future. Administrations come and go, economic resources ebb and flow, but the time constants of all of these perturbations and contexts are significantly shorter than that of McKelvey. So I invite you, as you read through the articles and news, to imagine the future that these students and faculty portend: It is an exciting one with capabilities that were not even imaginable just a short time ago. The people who come through McKelvey help shape the world – and they will make a difference.

However, please do not mistake my optimism regarding the future as my not having dramatic concern about the state of the present. Higher education, especially at research universities, is no longer presented as the driver of economic strength and national security that it has been since the 1950s. Rather, it has become politically powerful — and in some cases expedient — to label these institutions as bastions of elitism instead of elite universities that improve the condition of our nation and of all humanity. While I suspect that most of you reading this magazine already deeply appreciate the contributions these universities make to our world, you might be surprised how many people in your orbit do not. Or at least are being swayed by rhetoric excoriating these institutions.

In response, I am asking that each of you engage your neighbors, co-workers, friends and family in dialogue about why you believe America’s great universities – including WashU – are critical to the future of our country and of our world. Most of you are alumni who have seen firsthand what a dynamic research university can do. Share those perspectives. Together we can change the narrative. In some sense, future generations are counting on us to do that.

Aaron F. Bobick
Dean & James M. McKelvey Professor

Table of Contents

ON THE COVER:
Focused ultrasound is an evolving noninvasive technology that is changing the way some diseases are diagnosed and treated. Hong Chen, associate professor of biomedical engineering and of neurosurgery at WashU Medicine, is breaking new ground in focused ultrasound.

Features

In every issue

This just in!

U.S. NEWS RANKING

#43

McKelvey Engineering continues its climb in the U.S. News & World Report rankings, moving up eight spots to No. 43 overall among engineering graduate schools.

Breaking down the citation measures considered in this ranking, McKelvey performed exceptionally well in citations per publications (No. 8) and field-weighted citation impact (No.9).

Congratulations to national champion Kyle Wolford, a BS/MS computer science student in McKelvey Engineering, who won the national title in the 200 backstroke with a time of 1:44.15.

He is the 27th student-athlete to win an individual national title. WashU Athletes now has 49 individual NCAA Champions.

This is the second-straight 200 backstroke national title for the men's swimming and diving program as Alex McCormick, who earned a bachelor's degree in mechanical engineering from McKelvey Engineering in 2024, won the title a season ago with Wolford coming in third. McCormick became the 11th national champion in men's swimming and diving program history and the first since 2019.

Alumna Losli seeks to improve the world through water

Rebecca Losli is president of Illinois American Water, the largest regulated water utility in Illinois, providing water and/or wastewater services to about 1.4 million people. It's a responsibility she doesn't take lightly.

"Water is personal," she said. "It is the only utility we ingest. There's a real underappreciation of the importance of water in our lives and the large amount of work utilities perform to provide clean water and wastewater services."

A student in the Dual Degree program, Losli earned a bachelor's degree in civil engineering in 2002 and master's degrees in environmental engineering and business administration in 2005 and 2010, respectively, from WashU, and a bachelor's degree in physics and mathematics from Samford University in 2002.

WE Day 2025

Nearly 200 students, faculty, staff, family and friends gathered for the Women & Engineering Center's annual WE Day, an event of inspiration, connection and celebration, to hear stories and insights offering guidance to attendees as they prepared for or reflected on their own engineering journeys. Lovingly known as "WE" because people come together to develop a sense of belonging for everyone — an equitable community where all are empowered to overcome challenges and thrive — WE Day's impact continues to inspire.

WashU Engineers Without Borders team with St. Francis Health Care staff. (Credit: Dan, St. Francis staff)

EWB mission expands health care in Uganda

The WashU Engineers Without Borders (EWB) St. Francis project team traveled to Uganda during winter break to assist St. Francis Health Care, a nonprofit that provides equitable, inclusive and affordable quality health care, economic empowerment and social services to the community. This trip marked a major milestone in a six-year project aimed at improving hospital infrastructure and the community's access to affordable health care.

The WashU EWB team's mission in Uganda was to implement engineering solutions that would have a lasting impact on St. Francis Hospital and the surrounding community. A significant portion of the team's work centered around the hospital's farm in a rural district of Jinja. This farm is a critical resource for food production, water supply and financial support for the hospital. The produce grown feeds the Omoana House, a facility for children suffering from HIV and malnutrition. The remaining is sold to help fund hospital operations, assisting with its goal to be self-sufficient. The surrounding community has some of the highest rates of typhoid due to limited access to clean water. Therefore, community members drink from stagnant pools shared by animals. The excess water not required for irrigation will be stored and made available to the community via a tap. The water is sourced from an underground aqueduct that passed all metrics required to be potable.

Farag, Mintz selected as Spencer T. and Ann W. Olin Fellows

Mina Farag and Rachel Mintz, MD/PhD students in the McKelvey School of Engineering and at WashU Medicine, have been selected as Spencer T. and Ann W. Olin Fellows by the Medical Scientist Training Program Committee at WashU. The prestigious fellowship, awarded annually, recognizes superior accomplishments in biomedical research by doctoral students.

As a doctoral student in the lab of Rohit Pappu, the Gene K. Beare Distinguished Professor of Biomedical Engineering, Farag worked to understand how proteins behave at the surface of biomolecular condensates and how this behavior can be connected to physiological and pathological functions of condensates.

Mintz, a doctoral student in the lab of Gwendalyn Randolph, Emil R. Unanue Professor in Pathology & Immunology, is working to better understand how ovarian cancer metastasizes to the omentum. Ultimately, the insight gained could result in the development of more specific therapeutic strategies to improve outcomes for ovarian cancer patients.

Stellar achievement

Estela Villacis, who earned a bachelor's in mechanical engineering in May from McKelvey Engineering, has been selected for the Brooke Owens Fellowship, a nationally acclaimed nonprofit program established to help address the gender imbalance in the aerospace field. The program recognizes exceptional undergraduate women and other gender minorities with space and aviation internships, senior mentorship and an expansive professional network.

Last summer, Villacis worked alongside Phil Bayly, the Lee Hunter Distinguished Professor and chair of the Department of Mechanical Engineering & Materials Science, through the Washington University Summer Engineering Fellowship (WUSEF). She also is president of WURocketry and is a peer mentor for other underrepresented students. After earning a bachelor's degree in May, Villacis will start a 12-week internship at Relativity Space, the commercial launch company with which she matched through the fellowship, in California.

Students (left to right) Michaela Sewall, Yvette Gerber, Daniel Ruskin and Emily Zeiberg work together on a redistricting exercise as Ben Wormleighton observes. (Credit: Sid Hastings)

Engineering students take on social choice

Ben Wormleighton's "ESE 3090 Modeling & Design in Social Choice Systems" class in the McKelvey School of Engineering addresses modeling and design challenges in social choice systems — from the way we split the check to the way we elect a president — by using math and software tools.

"It's pretty unique," said Wormleighton, a lecturer in the Preston M. Green Department of Electrical & Systems Engineering. "There's a real hunger at WashU for learning that's both quantitatively rigorous and socially relevant — and an eagerness to talk about ethical problems within the engineering context."

Wormleighton says systems engineering essentially allows engineers to look inside the "black boxes" that communal decision-making processes often become.

"For instance, we usually can't account for all possibilities in these decision-making spaces, so we might take a probabilistic approach," he said. "It's a systems analysis like you might do as an engineer, but you're applying it to problems of economics and political science. The tools and the philosophy are what make it engineering."

Mack was a Marshall finalist

Dylan Mack, a student at the McKelvey School of Engineering, was a finalist for the prestigious Marshall Scholarship, which funds graduate studies in the United Kingdom.

Mack, of Waterloo, Iowa, is earned a graduate degree in engineering data analytics and statistics in May. He earned a bachelor's degree in systems engineering in 2024. As an undergraduate, Mack was a Danforth Scholar and a Gephardt Institute Civic Scholar, where he used his technical skills to help the violence prevention program Cure Violence Global gain important insights about participants' needs.

CERV team members (from left) Sandy Montgomery, Annika Avula and Elizabeth Buzbee, master's students in biomedical engineering, received $3,000 in Innovator Funding through the Skandalaris Venture Competition.

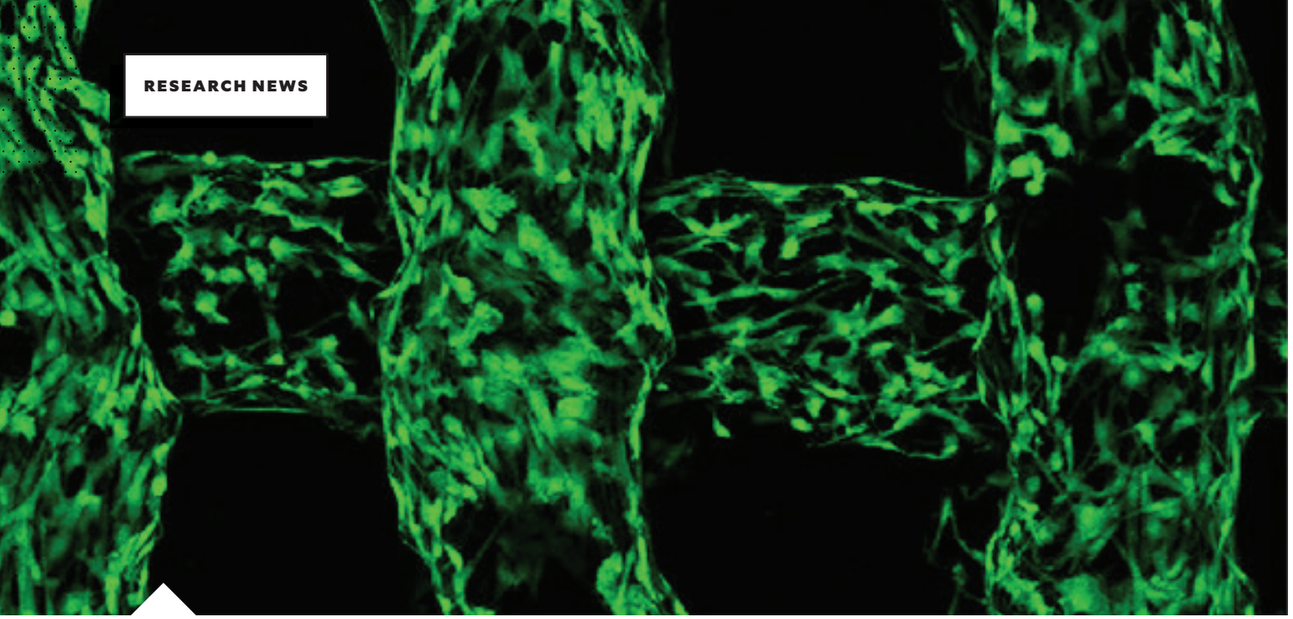
McKelvey Engineering students among Skandalaris Venture Competition winners

At the Washington University Skandalaris Venture Competition (SVC) Innovation and Entrepreneurship Awards ceremony Nov. 20, the CERV, WUWA Textiles and Connect teams were among the winners of a total of $50,000 in awards.

CERV is a FemTech startup that aims to enhance maternal health care by improving labor monitoring with a novel medical device that will ensure accurate, comfortable and continuous cervical dilation measurements. Members: Elizabeth Buzbee, Sandy Montgomery and Annika Avula, all recently graduated master's students in biomedical engineering.

WUWA Textiles is reimagining cardboard coffee sleeves with post-industrial textile waste. Members: Mac Barnes, a junior majoring in computer science with a second major in art; Lucia Umbreit, a junior majoring in chemical engineering; and Rachel Charendoff, a senior majoring in mechanical engineering.

Connect is a video chat/messaging platform for high schoolers to find college and career guidance from alumni and parents from their community. Members: Michael Lee, a junior majoring in computer science and mathematics with a second major in economics; Fortuna Kadima, a junior majoring in computer science with a second major in finance; and Ethan Ng, a sophomore majoring in computer science.



For success in bioelectronics, build with nature-inspired design

Alexandra Rutz, assistant professor of biomedical engineering in the McKelvey School of Engineering, and Somtochukwu Okafor, a doctoral student in Rutz's lab, have 3D printed bioelectronic scaffolds (shown above) that have the properties cells need to form new tissue.

The bioelectronic scaffolds that Rutz and Okafor print appear as dark-colored dots about 6 millimeters in diameter — about the size of a pencil eraser — and are floating in water. Okafor has carefully created these tiny scaffolds with a polymer known as PEDOT:PSS, which she has processed into a water-based gel used as an ink.

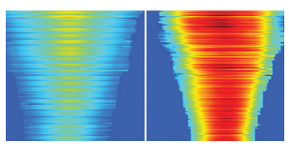
Rutz's lab created their scaffolds from a soft, conducting hydrogel and with pores that are about 150 microns to 300 microns in size that can influence how cells behave within the scaffold, such as how they attach to others, how they move through the scaffold and how they multiply. The pores help to form a lattice-like structure that grows upward to support the cells.

Researchers to develop energy efficient process to convert waste gases into biofuel

Engineers at Washington University in St. Louis will be working to improve energy efficiency in production of dimethyl ether thanks to a $2.1 million grant from the U.S. Department of Energy (DOE).

The work, headed up by Xinhua Liang, professor of energy, environmental & chemical engineering at WashU's McKelvey School of Engineering, is one of 66 projects selected by the DOE to support "transformational technologies" that reduce energy demand and improve American productivity. His task is to develop a more energy-efficient process to convert waste gases like CO_2 and methane into dimethyl ether.

May the force not be with you



McKelvey School of Engineering researchers found that cells can generate and use lower force yet move faster than cells generating and using high forces, turning the age-old assumption of force on its head.

The laboratory of Amit Pathak, professor of mechanical engineering & materials science, found that groups of cells moved faster with lower force when adhered to soft surfaces with aligned collagen fibers. Cells have been thought to continually generate forces as they must overcome friction and drag of their environment to move. However, this conventional need for forces can be reduced in favorable environmental conditions, such as aligned fibers. Their results, published in *PLOS Computational Biology*, are the first to show this activity in collective cell migration.

Traditional computer security principles can help develop secure agentic systems

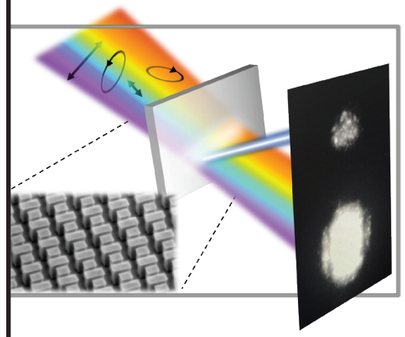
Large language models (LLMs) are becoming more and more useful, from booking appointments to summarizing large volumes of text. Some LLM-based agents can interact with external applications, such as calendars or airline booking apps, introducing privacy and security risks.

To mitigate this risk, Umar Iqbal, assistant professor of computer science & engineering in the McKelvey School of Engineering at Washington University in St. Louis, and Yuhao Wu, a doctoral student in Iqbal's lab, have developed IsolateGPT, a method that keeps the external tools isolated from each other while still running in the system, allowing the user to get the benefits from the apps without the risk of exposing user data. Ning Zhang, associate professor of computer science & engineering, was a collaborator.

WashU researchers map individual brain dynamics

A study from neuroscientists and engineers in the McKelvey School of Engineering describes a new method to create personalized brain models, which offer insights into individual neural dynamics. Led by ShiNung Ching, associate professor in the Preston M. Green Department of Electrical & Systems Engineering in the McKelvey School of Engineering, and Todd Braver, professor in the Department of Psychological & Brain Sciences in Arts & Sciences, the work, published in *PNAS*, introduces a novel framework that will allow the researchers to create individualized brain models based on detailed data from noninvasive, high-temporal resolution brain scans. Such personalized models have applications in research and clinical settings, where they could support advances in neuroscience and treatment of neurological conditions.

Todd Braver (left) and ShiNung Ching combine their expertise in brain science and systems engineering to gain insights into neural dynamics and behavior. (Credit: Jerry Naunheim)

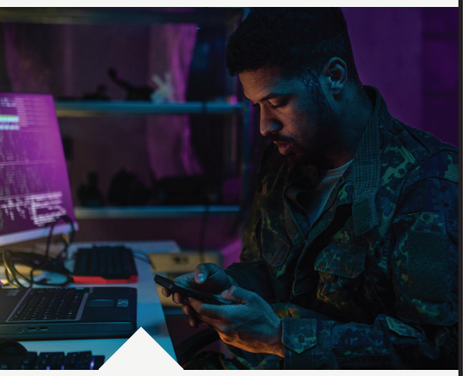


Collection of tiny antennas can amplify, control light polarized in any direction

Researchers in the McKelvey School of Engineering imagine a future where antennas reshape even more applications.

Their new metasurfaces, ultra-thin materials made of tiny nanoantennas that can both amplify and control light in very precise ways, could replace conventional refractive surfaces from eyeglasses to smartphone lenses and improve dynamic applications such as augmented reality/virtual reality and LiDAR.

To overcome this obstacle, a team led by Mark Lawrence, assistant professor in the Preston M. Green Department of Electrical & Systems Engineering, demonstrated polarization-independent and highly resonant metasurfaces that maintain high accuracy and efficiency. The results were published online in *Nano Letters*.



Novel learning method proposed for generative AI in challenging environments

Improving the performance of generative adversarial networks (GANs) in challenging environments is the focus of new research led by Yevgeniy Vorobeychik, professor, and co-investigators Ning Zhang and William Yeoh, associate professors, all in the Department of Computer Science & Engineering in the McKelvey School of Engineering. The team received a three-year, $1.5 million grant from the U.S. Department of Defense (DoD)'s Office of Naval Research to support their work on federated learning for generative AI.

Vorobeychik, Zhang and Yeoh propose a novel, comprehensive approach to federated generative AI. By integrating learning algorithms in their system design choices, the team aims to maximize learning efficiency and user participation, even in difficult conditions with unreliable communications and varied data streams.

Grant will fund development of vaccines to prevent dementia

McKelvey Engineering researchers are taking a new approach to Alzheimer's therapeutics targets , looking to design vaccines that will train a person's own immune system to take out accumulations of amyloid beta and tau proteins.

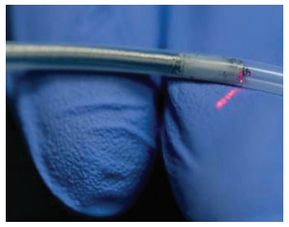
With a $2.9 million grant from the National Institute on Aging, part of the National Institutes of Health (NIH), researchers Jai Rudra, associate professor of biomedical engineering at the McKelvey School of Engineering, and Meredith Jackrel, associate professor of chemistry in Arts & Sciences, will design vaccines that generate anti-amyloid beta and anti-tau antibodies using Rudra's vaccine platform of peptide nanofibers.

Engineering better sleep

Jr-Shin Li, the Newton R. and Sarah Louisa Glasgow Wilson Professor in the Preston M. Green Department of Electrical & Systems Engineering, received a three-year, $1.2 million research grant from the National Institute of General Medical Sciences, a division of the National Institutes of Health, to support his work using advanced math to better understand and control biological systems, specifically our body's internal clock, or circadian rhythms.

In his new project, Li is developing a novel mathematical tool, the moment kernel machine (MKM), that will create accurate yet simple models to describe how complex systems, including dynamic biological networks, function. This tool can then be used to develop interpretable, data-driven techniques to control and learn from large-scale high-dimensional dynamical systems.

Colon polyps diagnosed more accurately by adding OCT to colonoscopy



Quing Zhu, the Edwin H. Murty Professor of Engineering, and Vladimir M. Kushnir, MD, professor of medicine in the Division of Gastroenterology at WashU Medicine, led a team of physicians and doctoral students that implemented high-resolution optical coherence tomography (OCT) into routine colonoscopy in a pilot study at WashU Medicine. Not only was the device safe, but it added only a few minutes to the colonoscopy procedure. In addition, their deep learning model predicted whether a polyp was benign or malignant with excellent accuracy. Results of the pilot study were published online in *Scientific Reports*.

Just keep flying

In response to a splashy but mathematically dubious paper that suggested long-established theories of lift were fundamentally incomplete, David Peters, the McDonnell Douglas Professor of Engineering in the McKelvey School of Engineering, developed a fresh approach to reaffirm classical airfoil theory.

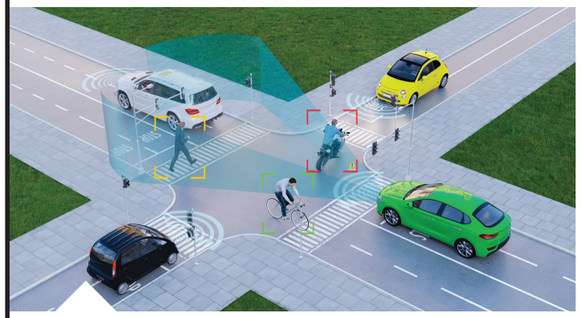
Peters and longtime collaborator Robert Ormiston, emeritus scientist at the U.S. Army Combat Capabilities Development Command, Aviation & Missile Center, employed Gauss' principle of least constraint to address fundamental questions about the lift of a two-dimensional airfoil in ideal, incompressible fluid flow, a core concept in aerodynamics. Their results align with the classical, Newtonian derivation of aerodynamic theory for ideal fluid flow and reaffirm the longtime practices of aerospace engineers.

The findings of Peters and Ormiston, both fellows of the American Institute of Aeronautics and Astronautics (AIAA), were published in the *AIAA Journal*.

Scientists collect 'microbial fingerprints' found in household plumbing

Fangqiong Ling, an assistant professor of energy, environmental & chemical engineering in the McKelvey School of Engineering, and her colleagues shared results from sampling the bathroom faucets of eight households in the St. Louis metro area. They sampled the homes for seven days to see the flow and change of different bacteria populations. They found that, though houses generally shared major categories of bacteria, down to the species level, there was wide variation from house to house.

The research aims to be able to monitor, anticipate and prevent outbreaks of opportunistic pathogens and bacteria that spread disease. This kind of monitoring is under development for large buildings and institutions such as hospitals, but it's scarce for individual households.



Clark to enhance safety of autonomous systems, even when under attack

Andrew Clark, associate professor in the Preston M. Green Department of Electrical & Systems Engineering, received a $454,202 grant from the National Science Foundation (NSF) to support his research on safe control of autonomous systems in adverse conditions. Whether malfunctions result from naturally occurring faults or deliberate attacks, Clark aims to combine techniques from control theory, machine learning and system security to guarantee system functionality across a wide range of autonomous systems and fault or attack scenarios.

Wonderland

Focused ultrasound making strides in diagnosis, unlocking potential treatment of brain disorders

by Beth Miller

Our brains are designed for survival: They regulate metabolism, body temperature and myriad other functions that keep us alive. What if the brain could safely be put into a hibernation-like state to extend survival, for instance, for astronauts on an extended mission into space?

Such an idea has been bandied about since the 1960s, yet no safe and effective solution exists. Washington University in St. Louis researchers are the first to safely induce a hypothermic and hypometabolic state — the hibernation-like state — in small mammals by targeting the central nervous system using focused ultrasound.

Hong Chen, associate professor of biomedical engineering in the McKelvey School of Engineering and of neurosurgery at WashU Medicine, is leading the way in focused ultrasound

> **“We can push the limits of what’s possible, especially if we can reach deep into the brain without surgery. That opens up a new wonderland when we can interface with the brain without any incision.”**
>
> **– HONG CHEN**

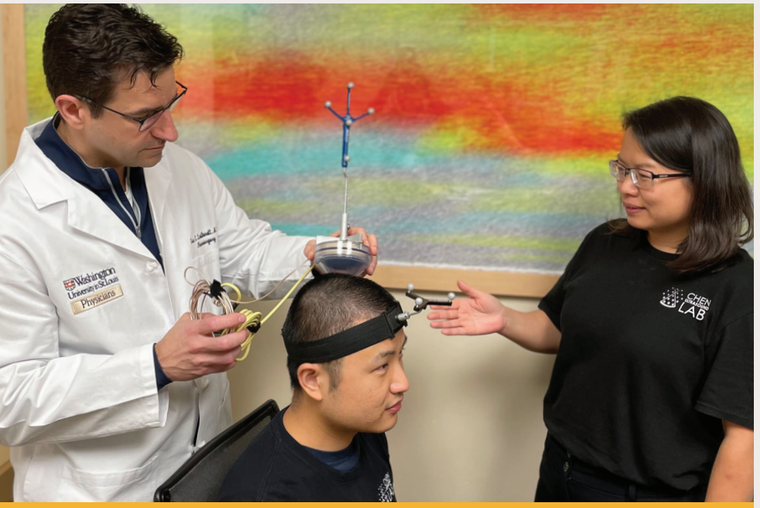
Hong Chen, her collaborators and her lab members have been using focused ultrasound to deliver drugs to the brain, to treat brain diseases and to aid in noninvasive brain liquid biopsy for the molecular diagnosis of brain diseases.

PHOTO BY DOUGLAS GARFIELD

“There wasn’t a scientific term that fully captured the breadth of our work, so I coined the term ‘Neurosonics,’ which aims to turn discovery in neuroscience into health through ultrasound.”

— HONG CHEN

(From left) Eric Leuthardt, the Shi Hui Huang Professor of Neurological Surgery at WashU Medicine and of biomedical engineering and of mechanical engineering & materials science in McKelvey Engineering; graduate student Lu Xu; and Chen demonstrate the focused ultrasound device that has been granted U.S. Food and Drug Administration "Breakthrough Device" designation. (Credit: Hong Chen)



research, technology and clinical application in collaboration with colleagues in McKelvey Engineering and at WashU Medicine. Her growing research portfolio, most recently establishing the induction of the hibernation-like state, earned her a highly competitive National Institutes of Health Director’s Pioneer Award, which provides $5.4 million over five years to continue the work to develop a safe solution that may offer significant advancements in understanding metabolism regulation pathways and make extended space flights a reality.

Chen and her collaborators have used focused ultrasound to deliver drugs to the brain to treat brain diseases and to aid in noninvasive brain liquid biopsy for the molecular diagnosis of brain diseases.

“There wasn’t a scientific term that fully captured the breadth of our work, so I coined the term ‘Neurosonics,’ which aims to turn discovery in neuroscience into health through ultrasound,” she said. “Neurosonics integrates advances in neuroscience and ultrasonics to develop noninvasive and precise ultrasound technology to advance our understanding of brain function and transform the diagnosis and treatment of neurological disorders.”

How it works

Focused ultrasound seems extremely complicated: It uses a special type of device to deliver ultrasound waves through the skull to precisely target a specific brain area, often deep in the brain. But the basic idea is as simple as using a magnifying glass to focus sunlight into a focal point. Focused ultrasound works in a similar way, but instead of sunlight, it uses sound waves. Ultrasound devices, which look like a shallow bowl or a helmet, send out multiple sound waves that are directed to meet at a specific point inside the brain. When these waves meet, they concentrate their energy in that tiny area. This focused energy can heat up or stimulate the brain tissue without needing to make an incision, which makes it a noninvasive way to interface with the brain.

“We can push the limits of what’s possible, especially if we can reach deep into the brain without surgery,” Chen said. “That opens up a new wonderland when we can interface with the brain without any incision.”

Among all forms of energy — such as light, electricity, magnetic fields and ionizing radiation — ultrasound is the only one that can safely and noninvasively penetrate the skull to target both shallow and deep brain regions in humans.

What it can do

In the groundbreaking torpor research, published in May 2023 in *Nature Metabolism*, Chen and a multidisciplinary team induced a hibernation-like state in mice by using focused ultrasound to stimulate the hypothalamus preoptic area in the brain, which helps to regulate body temperature and metabolism. In addition to the mouse, which naturally goes into torpor, Chen and her team induced torpor in a rat, which does not.

For this work, she and her team, including Yaoheng (Mack) Yang, who earned a doctorate in biomedical engineering from McKelvey Engineering in 2022 and is now an assistant professor of biomedical engineering at the University of Southern California, created a wearable ultrasound transducer — the shallow bowl — to stimulate the neurons in the hypothalamus preoptic area. When stimulated, the mice showed a drop in body temperature of about 3 degrees C for about one hour. The mice’s metabolism showed a change from using both carbohydrates and fat for energy to only fat — a key feature of torpor — and their heart rates fell by about 47%, all while at room temperature.

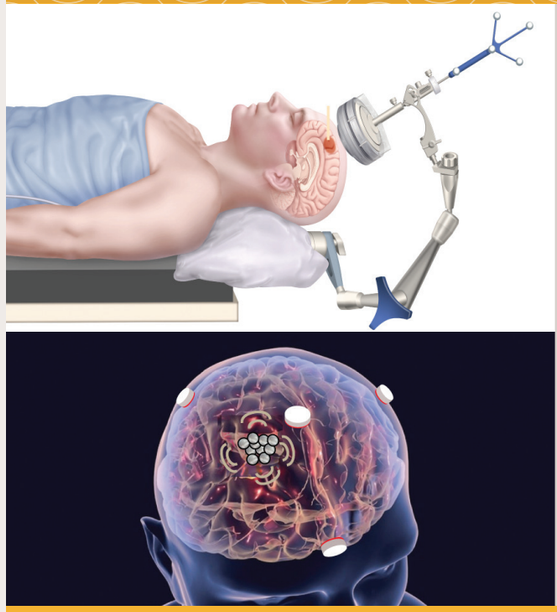
In the rat, the team delivered ultrasound to the hypothalamus preoptic area and found a decrease in skin temperature, particularly in the brown adipose tissue region, as well as about a 1 degree C drop in core body temperature in their preliminary study.

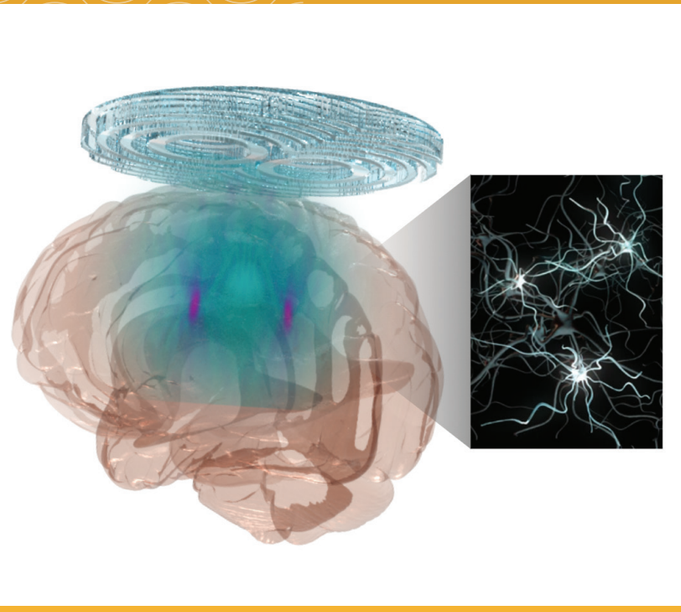
Jonathan R. Brestoff, MD, PhD, associate professor of pathology & immunology at WashU Medicine, was a collaborator on the research. He and his lab worked with Chen’s team to take the measurements in the mice and provided insights, resources and experimental help to test the role of brown fat in focused ultrasound-induced torpor. Brestoff said the results have widespread implications and raise thoughtful questions.

“Can focused ultrasound technology be used to treat any diseases for patients or pets?” he asks. “If adapted for humans, could it enable long-term space flight? What are the implications of this technology for national defense and international affairs?”

Since joining WashU in 2015, Chen has established collaboration with more than 20 faculty members at WashU across 12 departments on projects funded by the NIH and other agencies.

Before the torpor research, Chen and her collaborators made other groundbreaking findings using focused ultrasound. Early in her tenure at WashU, Chen met Eric Leuthardt, MD, the Shi Hui Huang Professor of Neurological Surgery and professor of neuroscience at WashU Medicine





Clockwise from top left: Chen and her team, including doctoral student Chih-Yen Chien, developed a quality assurance protocol to ensure their guided focused ultrasound device and treatment is safe and functions consistently; AhSonogenetics, or Airy-beam holographic sonogenetics, is a technique that uses a noninvasive wearable ultrasound device to alter genetically selected neurons in the brains of mice (Credit: Yaoheng Yang); Chen and her team are developing tiny sensors to detect blast-induced traumatic brain injury with funding from the Office of Naval Research.

WATCH:
An illustrative view of the ultrasound-induced artificial torpor.

When Chen joined WashU, Lihong Wang was assigned as her faculty mentor whom she met with regularly before he moved to CalTech.

“Those meetings with Lihong were incredibly beneficial in the early phase of my career,” she said. “I still reach out to him for career advice. He is a true role model to me.”

— HONG CHEN

and of biomedical engineering and of mechanical engineering & materials science in McKelvey Engineering, and the team has been innovating together ever since on what Leuthardt calls “an amazing progression.

“Hong and I have worked closely to develop sonobiopsy, which we have brought from a rodent demonstration to preclinical model to first in human trials, to now receiving an FDA Breakthrough Designation,” said Leuthardt, who also is vice chair of innovation in the Department of Neurosurgery, chief of the Division of Neurotechnology, and director of the Center for Innovation in Neuroscience and Technology and of the Brain Laser Center. “I love working with Hong because we make science fiction real. We have done that with touchless brain biopsies, and she has done that in several other domains, including ultrasound-induced hibernation. The implications for that are protean.”

Sonobiopsy uses focused ultrasound to target a precise location in the brain. Once located, the researchers inject microbubbles into the blood that travel to the ultrasound-targeted tissue and pulsate, which safely opens the blood-brain barrier. The temporary openings allow biomarkers, such as tau proteins, which are indicative of neurodegenerative disorders, to pass through the blood-brain barrier and release into the blood. The biomarkers can then be identified through a simple blood test. Conversely, the technique could also be used to facilitate drug delivery to the brain.

Chen and collaborators, including Leuthardt, published results in 2023 that were the first to open the door for noninvasive and targeted diagnosis and monitoring of neurodegenerative disorders with focused ultrasound-mediated liquid biopsy. In 2023, the team reported promising findings from the first-in-human prospective trial of sonobiopsy in patients with glioblastoma, a form of aggressive brain tumor that is commonly diagnosed through a risky and invasive surgical biopsy.

Chen credits the rapid progress of sonobiopsy to the collaborative research environment at WashU.

“WashU is a place where the barriers between engineering and medicine have been removed,” she said. “Here, I can forge long-term collaborations with exceptional physician-scientists like Eric Leuthardt, which accelerates the clinical translation of our engineering innovations.”

Leuthardt said he believes sonobiopsy has the potential to fundamentally change how researchers interrogate the human brain, moving away from MRI and functional MRI.

“To understand the human brain on a molecular level currently requires me to insert a needle in the brain,” Leuthardt said. “With sonobiopsy, we now molecularly interrogate the brain. That will be a sea change in the questions we can answer about human brain function.”

Chen and her collaborators have been working on another focused ultrasound technology she calls sonogenetics, which integrates ultrasound with genetics to precisely modify neurons in the brain. In 2021, she published the first research that provided direct evidence showing noninvasive, cell-type-specific activation of neurons in the brain of a mammal by combining ultrasound-induced heating effect and genetics. It was also the first work to show that the ultrasound-genetics combination can control mouse behavior by stimulating a specific target deep in the brain. Their second-generation method, Sonogenetics 2.0, has the potential to combine the advantage of ultrasound and genetic engineering to modulate defined neurons noninvasively and precisely in the brains of humans and animals.

PHOTO BY DOUGLAS GARFIELD

(From left) Jinyun Yuan, research scientist, and Chen look at a PCR machine in Chen's lab.

Looking ahead

Ever the planner, Chen develops five-year vision plans for her research. Now in Vision 3.0, she is focusing on expanding the field of Neurosonics through developing three research pillars that include sono-neuroengineering, sono-neuroscience and sono-neuromedicine.

Through Vision 3.0, Chen and her team’s mission is to innovate, impact and inspire. They are committed to innovating in Neurosonics to impact patient care and inspire new thinking in the scientific community.

“Our vision is to build on a lab culture that centers on three core values,” she said. “These include pioneering, integrity and teamwork.”

While Chen and her collaborators are not the only researchers working on focused ultrasound, they are making remarkable waves in the field, which Leuthardt attributes to Chen.

“Hong is unstoppable in turning a vision into reality,” Leuthardt said. “She is tenacious in moving her creative ideas forward and validating them with vigor.”

Next steps

With the funding from the NIH Director’s Pioneer Award, Chen aims to test a bold hypothesis that the neural pathways governing the hibernation-like state are conserved across mammals, including humans.

“Throughout my career, I have continuously broken new ground in research and opened up new frontiers,” Chen said, “This award offers me, an ultrasound engineer, an exciting opportunity to venture into uncharted realms of neuroscience and pioneer innovative solutions in medicine.”

“I love working with Hong because we make science fiction real.”

— ERIC LEUTHARDT, MD

SPECIAL FEATURE

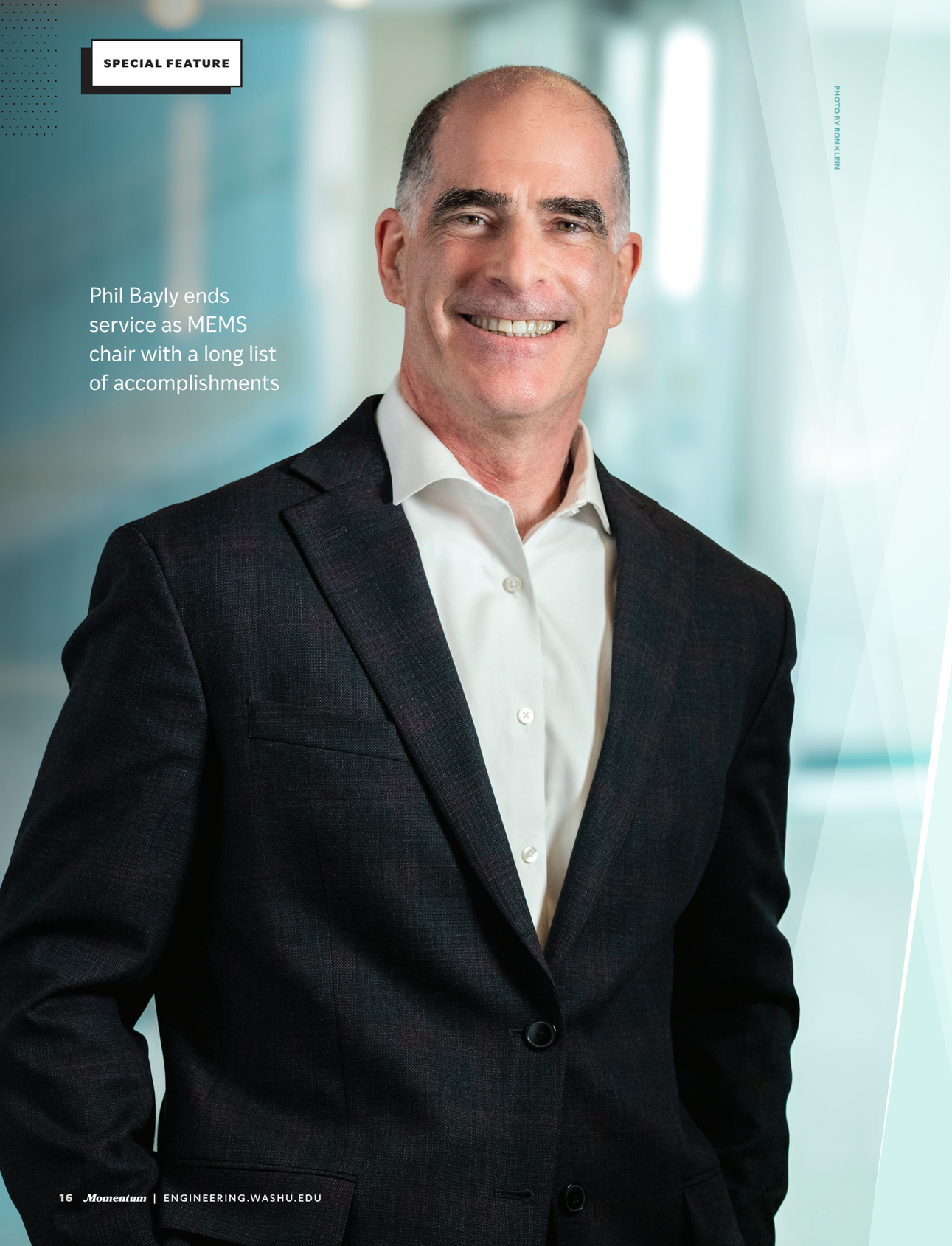


PHOTO BY RON KLEIN

Phil Bayly ends service as MEMS chair with a long list of accomplishments

Leadership at the intersection

by Beth Miller

When Philip V. Bayly became chair of what is now the Department of Mechanical Engineering & Materials Science (MEMS) in 2008, the Engineering School was experiencing a tremendous amount of change. A controversial dean had made some unpopular changes to academic programs, including in what was then known as Mechanical, Aerospace and Structural Engineering (MASE), and tensions were high. In addition, the nation was in economic crisis from the Great Recession.

"It was a time of turmoil and reorganization and change," recalls Bayly, the Lee Hunter Distinguished Professor. "We had to decide not to offer civil engineering and aerospace engineering as majors. I think it was a necessary change, and it was an opportunity to reset the direction of the department."

That reset launched what became MEMS in 2010 on an upward trajectory. Under Bayly's steady leadership and calm demeanor, MEMS has not only rebounded from its changes but has thrived. Undergraduate student enrollment has increased by 85%, while master's degree enrollment has increased by 295%, and PhD student enrollment has increased by 80%.

"Those challenges required us to focus on what we could do on a world-class level," said Bayly, who will step down as chair at the end of the 2024-25 academic year. "We decided to focus on what WashU is really good at, what our faculty are really good at, what our students are really looking for, and make sure we focus on doing those really well."

One of the things the department does well, Bayly said, is finding connections between mechanical engineering and materials science and other disciplines.

"I think we're one of the best places in the world to do mechanical engineering as applied to medicine and biology and a really good place to advance materials for applications in medicine and biology," said Bayly, who joined the WashU faculty in 1993 after earning a doctorate in mechanical engineering from Duke University. "It's also turning into a really interesting place to do research at the intersection of mechanical engineering and energy, environmental and chemical engineering."

"Phil Bayly has done a wonderful job building and growing the Mechanical Engineering & Materials Science department over the past 17 years," said Aaron F. Bobick, dean and the James M. McKelvey Professor. "Under his leadership, the department has grown significantly in the number of students, in research awards, in outstanding faculty and in reputation.

> **"Phil Bayly has done a wonderful job building and growing the Mechanical Engineering & Materials Science department over the past 17 years."**
>
> **– AARON BOBICK**

85%
increase in undergraduate enrollment

295%
increase in master's degree enrollment

80%
increase in PhD student enrollment

587%
increase in faculty research awards

377%
increase in research expenditures

> **Dr. Bayly has been a fantastic mentor to me since I came to WashU in 2012. His genuine interest in people and sincere desire to see them succeed have enabled him to lead our department with kindness and encouragement."**
>
> — SPENCER LAKE

He did all this while maintaining an active research lab and teaching load."

Not only has the department grown in student enrollment, but in research awards and faculty numbers as well. Faculty research awards increased 587% to $11.8 million in 2024, and research expenditures increased 377% to $9.2 million. Department faculty increased from 10 tenured/tenure-track faculty and one teaching faculty member in 2008 to 19 tenured/tenure-track faculty and 12 non-tenure track teaching or research faculty in the current academic year. The number of women faculty in MEMS increased from two to eight.

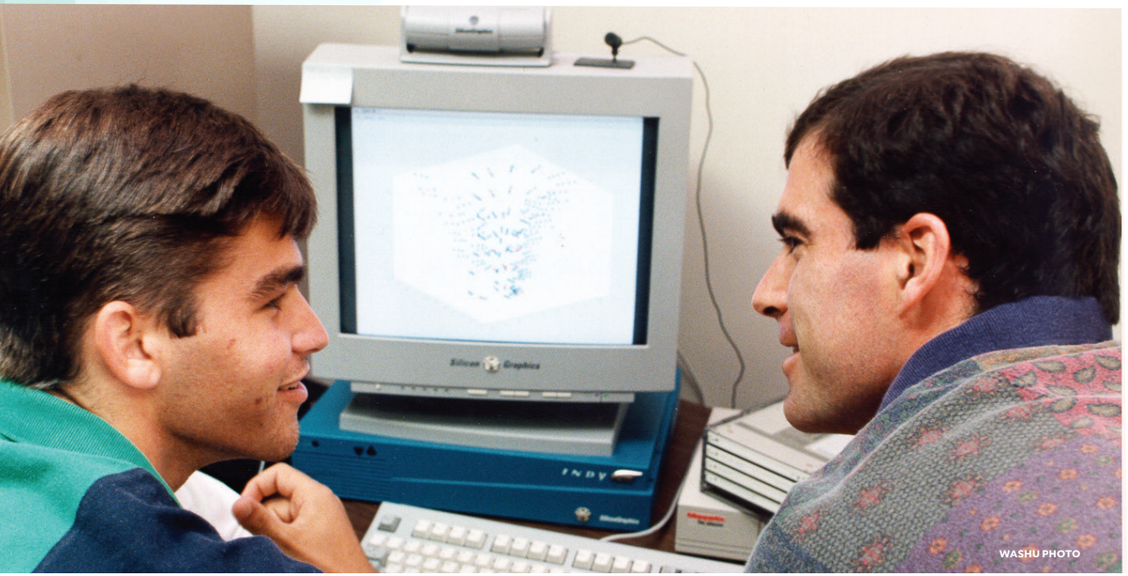
"It's really been a pleasure and privilege to help MEMS grow," Bayly said. "The three deans I've worked with — Sal Sutera, Ralph Quatrano and Aaron Bobick — have been generous in their support and encouragement. Most importantly, we have a group of faculty that truly cares about our students and helps them to succeed."

One of the faculty who came to the Engineering school under Bayly's leadership is Spencer Lake, associate professor of mechanical engineering & materials science.

"Dr. Bayly has been a fantastic mentor to me since I came to WashU in 2012," Lake said. "His genuine interest in people and sincere desire to see them succeed have enabled him to lead our department with kindness and encouragement."

Bayly is one of those faculty members who cares about his students. A frequent spectator at WashU athletic events, Bayly has been WashU's NCAA Faculty Athletics Representative since 2020, serving as a liaison between the university and the athletics department. It is a fitting role, since McKelvey Engineering students — particularly mechanical engineering students — make up a large percentage of student athletes at WashU.

Bayly has been a true champion for the WashU Summer Engineering Fellowship (WUSEF) program that provides research opportunities for students from groups in the minority in engineering. Many of those students have conducted research in Bayly's lab, including Jordan Escarcega, who earned a doctorate in mechanical engineering in 2024 and is now a postdoctoral research associate in the lab of Sara Roccabiana, associate professor of mechanical engineering & materials science.



(From left) Alan R. Barnette, MD, with Bayly when Barnette was an undergraduate researcher in Bayly's lab. (WashU photo)

Clockwise from left: Kate Wilson, who was a graduate student in Bayly's lab; Bayly in a classroom; Bayly with Ralph Quatrano, emeritus dean and the Spencer T. Olin Professor Emeritus of Biology.

Susan Dutcher, professor of genetics and of cell biology and physiology at WashU Medicine, has been a frequent collaborator with Bayly on cilia research and said Engineering students from Bayly's lab have brought a unique perspective to the biology of cilia.

"Phil is always willing to help teach us about the principles of engineering, promote interactions with members of the Department of Mechanical Engineering & Materials Science, and show how these ideas can be applied to the cell biology of these cellular organelles," Dutcher said. "Phil is a person who loves teaching and bringing people together to interact."

In addition to his academic leadership, Bayly provided input on the design of Henry A. and Elvira H. Jubel Hall, which became the department's home in summer 2019, its location serving as a symbolic bridge between engineering and medicine. The building, which contains classrooms, laboratories, faculty offices, study areas and the Spartan Light Metal Products Makerspace, allows mechanical engineers to work closely with scientists and engineers to promote the convergence of mechanics, materials science and nanotechnology.

Don Jubel, a member of the McKelvey Engineering National Council and an emeritus member of the university's Board of Trustees, recalled a trip to Duke and Yale universities with Bayly and Bobick to visit their makerspaces.

"The time we spent together at meals and on planes is where I learned of Phil's dedication to McKelvey Engineering, and more importantly, his kind disposition," Jubel said. "He was instrumental in making Jubel Hall a success, for which I am very grateful."

After he concludes his time as department chair, Bayly will remain on the faculty and continue his research on biomechanics from cell motility to traumatic brain injury. His active research lab focuses on impact, vibration, waves, oscillations and instability in mechanical and biomedical systems, using magnetic resonance imaging (MRI) to investigate the mechanics of brain injury and brain development.

PHOTOS BY JERRY NAUNHEIM

On a mission

WashU Satellite has big plans for its spaceflight technologies

by Channing Suhl

It started with a conversation between Ben Cook, a junior majoring in electrical engineering at the McKelvey School of Engineering at Washington University in St. Louis, and Aaron Bobick, dean and James M. McKelvey Professor. Cook had been thinking of starting a satellite team since high school, and Bobick encouraged him to "come back with a plan." It was the push he needed.

Now in its second year, the WashU Satellite team is taking off. Its mission: Train future engineers, inspire interdisciplinary collaboration and provide consistent space access to advance WashU research.

"Traditionally, missions take many years and millions of dollars," said Cook, the team's president. "We're trying to say, 'Hey, let us Engineering students do it, we'll save you a lot of money.' It's a great experience for WashU Engineering students and a new opportunity for WashU research."

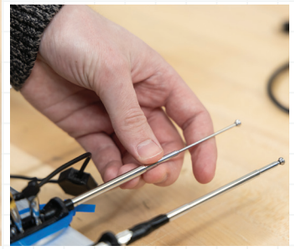
Clockwise from left: Avery Cohen, Geoffrey Goffman, Sophie Fendler and Jack Galloway assemble the ground station frame.

The team designs, builds and tests CubeSats, which are miniature, lightweight satellites used for space exploration, scientific research and testing spaceflight technologies. Made from standard, stackable 10 cm cubic units that vary in quantity, CubeSats are a cost-effective way to get payload into space with greater speed. They can be launched into Earth's lower orbit using rockets or deployed from the International Space Station.

In April 2024, WashU Satellite launched a small weather balloon with help from James Buckley, a professor of physics in Arts & Sciences at WashU who specializes in astrophysical research in high-energy phenomena.

"This is an incredibly hardworking, motivated team," Buckley said. "I was impressed with the speed with which they completed their first project, which led to the weather balloon flight by the end of the last academic year."

Project manager Geoffrey Goffman, a sophomore majoring in mechanical engineering, said that although the balloon mission only flew 400 feet, it "provided an immediate project for the team to work on and allowed us to test out ideas for organizational structure, management and task delegation."

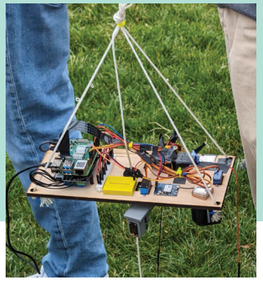


Left: The ground station's rotator will enable its antenna to move once mounted. Right: A team member tunes one of the antenna components.

In 2025, the team expects to continue gaining valuable experience with multiple in-progress projects. Its first ground station, a 12-foot antenna in the build-and-test phase, will help the team contact satellites in orbit and collect and analyze data. It will provide critical infrastructure that should be easily adaptable for future deployments, thanks to the use of software-defined radios which can be reprogrammed without the need for hardware modifications.

WATCH: Watch two members of WashU Satellite talk about the group's work over the past year.

Balloon launch



WashU Satellite launched a small weather balloon to build experience with flying missions. (Credit: Aaron Beagle)

PHOTOS BY JERRY NAUNHEIM

Nathaniel Bowman, a dual degree student, tunes the ground station antenna by adjusting the lengths of each element.

(From left) Siri Rodin sets up a soldering station to work on electrical components while mechanical team members Sam Kendall, Eduardo Teixeira and Peter Essa discuss project tasks for the AIRIS mission.

OWEN NIEUWENHUIZEN

Chief systems engineer

The team's approach to its work is different from other student design teams.

"We start by considering our constraints and use them to brainstorm a list of requirements our system must fulfill," said chief systems engineer Owen Nieuwenhuizen, a junior majoring in computer engineering. "Then we use Model-Based Systems Engineering to visually describe the integration of all our parts before we design, review, manufacture and test to ensure that all system requirements are met."

Leveraging innovative WashU research remains a top priority. The team is collaborating with Buckley on ADAPT, a first-of-its-kind high altitude balloon mission over Antarctica designed to detect gamma ray bursts (GRBs).

"WashU is at the forefront of this NASA-funded effort led by Professor Buckley," said Sophie Fendler, a junior majoring in physics in Arts & Sciences at WashU and the team's chief physicist. "Our team has secured a 20-kilogram ride-share slot, allowing us to further advance research in characterizing GRBs and their origins."

The team's contribution is AIRIS, a rapidly moving optical telescope mounted on the same platform as ADAPT that will image GRB afterglows in the optical spectrum.

"We'll send back images that will be fed into NASA's general coordinates network so other telescopes can also view these afterglows," Fendler said. "Multi-messenger astronomy is an emerging field in astrophysics."

WashU Satellite's plans to build a portfolio for sustainable space access at WashU also include SCALAR, a single-unit CubeSat designed to demonstrate satellite design and build techniques, as well as mission operations.

In addition, the team has just developed VECTOR, a three-unit CubeSat that will build off the mission of AIRIS. Group members completed a 60-page proposal to submit VECTOR to the NASA CubeSat Launch Initiative, Goffman said.

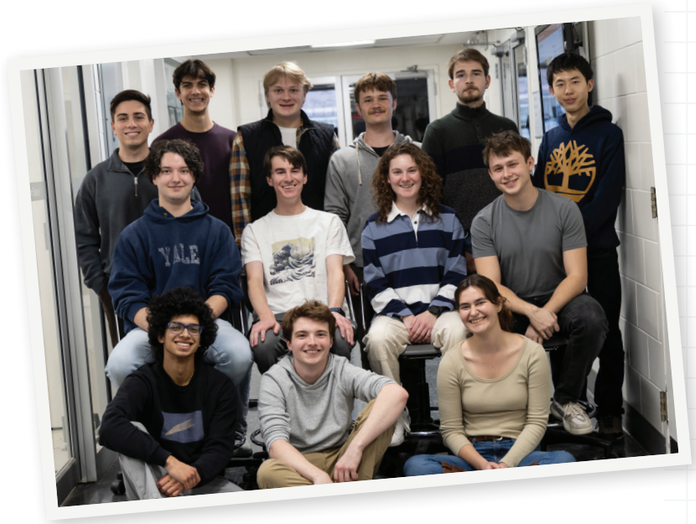
"The VECTOR mission will demonstrate key research, imaging and control algorithms – very important things to all of engineering but also really important for this rapid follow-on problem for optical astronomy," Cook said.

In March, WashU Satellite was selected to collaborate with NASA, the Air Force Research Laboratory, the U.S. Space Force and the Space Dynamics Laboratory to advance small-spacecraft technology through the University Nanosatellite Program (UNP) Mission Concept 2025, which includes a $50,000 grant. As part of this program, several team members will have the opportunity to spend the summer working on the VECTOR mission.

The team continues to welcome interest from the WashU community. Its membership has already grown from 15 to nearly 50, including students from four of the five Engineering departments, as well as those from Arts & Sciences, Sam Fox School of Design & Visual Arts and Olin School of Business. Goffman said the team has also "been approached by a significant number of physics and computer science professors about future missions."

The appeal is clear, Cook says.

"We're a student-led, project-based team with research implications. We're attracting the best people and doing something that hasn't been done previously at WashU." *M*



(From left) Back row: Eduardo Teixeira, Peter Essa, Sam Kendall, Owen Cromly, Nathaniel Bowman, Victor Huang. Middle row: Joe Billips, Avery Cohen, Sophie Fendler, Geoffery Goffman. Bottom row: Aavik Wadivkar, Jack Galloway, Siri Rodin.

"The VECTOR mission will demonstrate key research, imaging and control algorithms – very important things to all of engineering but also really important for this rapid follow-on problem for optical astronomy."

– BEN COOK

EDITOR'S NOTE:
Alumni interested in supporting WashU Satellite may contact Jessica Reinheimer at jreinheimer@wustl.edu.

YOUNG ALUMNI

How fashion could heal the planet

by Kurt Greenbaum

How do the runways of Paris help restore biodiversity in the Florida Everglades? McKelvey School of Engineering alumnus Kahan Chavda may have a surprising answer.

Chavda, who earned a bachelor's degree in biomedical engineering with a minor in mechanical engineering in 2016, is now a co-founder — along with his brother, Aarav, and friend Roland Salatino — and the chief commercial officer of Inversa, an ecosystem restoration company that has grabbed global headlines in the fashion industry.

About five years ago, the brothers, both avid scuba divers, noticed lionfish infesting the coral reefs of their favorite Florida diving spot. Their divemaster shared how these invasive species feed upon native fish and other organisms, destroying not only the Caribbean reef systems, but also the livelihoods that depend on them.

After the partners began researching ways to manage the invasive fish, they tried turning lionfish skins into leather.

"After we'd done a lot of work to create our first iteration of lionfish leather, we realized we weren't just holding a material," Chavda said. "We realized we were holding a platform on how to heal our planet."

PHOTO BY LISA BETH ANDERSON

Kahan Chavda, who earned a bachelor's degree in biomedical engineering in 2016, is a co-founder and chief commercial officer of Inversa, which is working to manage invasive species in a unique way.

That platform, Inversa, addresses the need to manage invasive species that threaten ecosystems by providing the fashion industry with an ethical and more responsible alternative to traditional exotics. In addition to helping restore the Caribbean reefs, Inversa manages other invasive species to restore more ecosystems, including Burmese pythons from the Florida Everglades and silverfin in the Mississippi River Basin.

Inversa has garnered the attention of high-end designers such as Gabriela Hearst, highlighted in November's British Vogue for her spring/summer 2025 collection. The designer, known for her commitment to sustainable fashion, has showcased her products made with Inversa leathers on the

PHOTO BY LISA BETH ANDERSON

Samples of the lionfish and python leathers that Inversa makes from the invasive species.

Image A: *Python swatches, courtesy photo*

Image B: *Gabriela Hearst Edwina high heel stiletto made from Python. Photo credit: Launchmetrics Spotlight for The Impression*

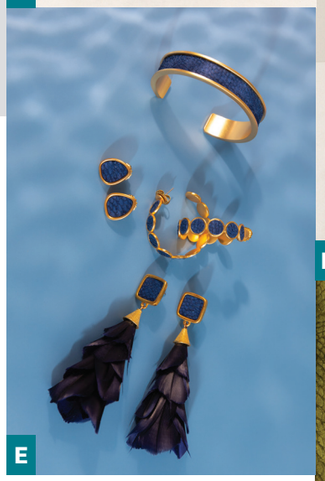
Images C & D: *Khaite python bags. Photo credit: Hanna Tveite, courtesy of KHAITE, for Vogue Runway*


A


B


C

D


E


F

“After we’d done a lot of work to create our first iteration of lionfish leather, we realized we weren’t just holding a material. We realized we were holding a platform on how to heal our planet.”

— KAHAN CHAVDA

Image E: *Brackish x INVERSA lionfish jewelry and accessories, courtesy photo*

Image F: *Lionfish swatches, courtesy photo*

runways of Paris and New York. Other partnerships include designer Andrea Marron in Florida, Brackish in South Carolina and Teton Leather Co. in Idaho.

Chavda credits a few WashU instructors for their roles in mentoring and driving him forward in his career: Patricia Widder, teaching professor of biomedical engineering and director of undergraduate studies; Glenn MacDonald, the John M. Olin Distinguished Professor of Economics and Strategy at WashU’s Olin Business School; and Mary Ruppert-Stroescu, associate professor of fashion design at WashU’s Sam Fox School of Design & Visual Arts.

“They have been great mentors, great sources of insights and so supportive,” Chavda said. “If I’m ever struggling with something, I know I can always call and ask for their opinion on any question.”

Their encouragement moved Chavda into business consulting for nearly seven years, gaining experience solving business problems and managing clients. The experience has helped him push Inversa forward as the company seeks ways to use other invasive species.

Based on the company’s progress, Chavda is optimistic about its future.

“We’re seeing a really cool cascade between the partnerships we’ve started, the ecosystems we’re helping, and seeing how much INVERSA has grown,” Chavda said. “We’re in an amazing growth phase, and we’re showing the world how fashion can heal the planet.” *M*

“They [Chavda’s former WashU instructors] have been great mentors, great sources of insights and so supportive. If I’m ever struggling with something, I know I can always call and ask for their opinion on any question.”

— KAHAN CHAVDA


PHOTO BY LISA BETH ANDERSON

ALUMNI FEATURE

From sensors to society

For Jamie Payton, the more challenging parts of computer science problems are sometimes the 'people parts'

by Shawn Ballard

FIREFLY

Jamie Payton, who earned a master's in computer science in 2004 and a doctorate in 2006 from WashU, is dean of the Ying Wu College of Computing at the New Jersey Institute of Technology. Previously, she was chair of the Computer and Information Sciences Department at Temple University. Payton also is director of the STARS Computing Corps and co-principal investigator and director of broadening participation in computing and outreach for the INVITE Institute.

How did you get interested in computer science and engineering?

I grew up in a very small, rural area, and there weren't a lot of opportunities in my hometown. I thought I wanted to be a lawyer because I liked solving problems, finding evidence and presenting a case to people, so I enrolled in a paralegal program. I hated it. I was so bored! But across the hall there was a computer programming class. That sounded interesting to me, so I enrolled in a digital design program the next semester.

After that initial exposure, what drew you to computer science research?

I studied computer science at the University of Tulsa, where I got involved in undergraduate research. My faculty mentor, Rose Gamble, who is also a WashU alumna, introduced me to the world of academic research, and it combined all the things I loved — solving problems, looking for evidence, communicating with others, being part of a team and working on things that could potentially make a difference in the world.

What problems caught your interest?

I started working on protocols for mobile ad hoc networks. The idea was that you could drop small, battery-powered sensors with wireless communication capabilities anywhere in the world, they could form a mesh network to exchange information. That would be useful for things like disaster recovery, where connections may not be available, or wildlife monitoring, where you lack infrastructure.

How has your focus shifted?

Over time, I realized the more challenging parts of problems are sometimes the people parts. As mobile phones and smart watches have become widely used and accessible, they have replaced the sensors I originally started working on. But, unlike sensors that we could drop into an environment, now it's people who move the sensors.

If you want to solve a problem, you could deploy your question across a network of volunteers and ask them to use sensors on their phones to contribute information. This field is called participatory sensing or crowd sensing, and that's what my work evolved into. The challenge is coordinating people and making sure they're giving quality data at the location and time you need it.

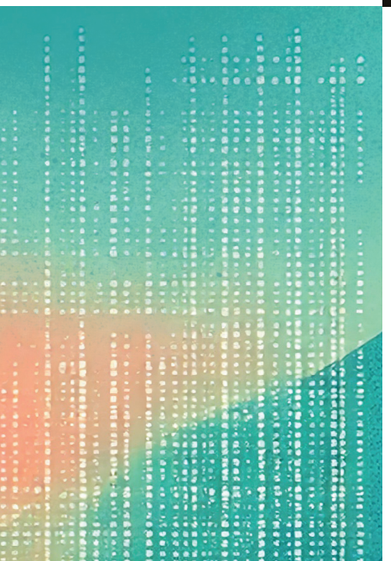
Your role as dean is also very people-focused. How does your administrative work dovetail with your work as a researcher?

As I've grown in my career, I've thought a lot about the people involved in solving problems. Research has shown more diverse teams have improved outcomes, so it's important that

> **"Unlike sensors that we could drop into an environment, now it's people who move the sensors."**
>
> **– JAMIE PAYTON**

> **It's about understanding what the core problem is and why it's important, evaluating approaches that we can use to solve it, collecting data and reflecting back on our solution and refining it."**
>
> — JAMIE PAYTON

COURTESY PHOTO



we have people from different backgrounds and experiences developing computing solutions.

For the past eight to 10 years, my research has primarily focused on broadening participation in computing, with research on creating more inclusive approaches to computer science education, and developing ways to increase representation of women, Black and Hispanic students. The STARS Computing Corps and INVITE AI Institute, where I have leadership roles, are aligned with this need to broaden participation in computing so that everyone has an opportunity to participate in the tech workforce.

As dean, I'm implementing best practices for computer science education. An important part of my job is to look for creative and innovative ways to prepare all students to meet the challenges of society and the workforce in the future.

COURTESY PHOTO

Jamie Payton (right) with doctoral adviser Catalin Roman (center), former chair of computer science & engineering, and lab mate Christine Julien, who is now chair of the Department of Computer Science at Virginia Tech and remains a close friend and collaborator of Payton's.

Was it hard to make the transition from research to administrative work?

Moving into administration did not feel like a big jump because a lot of it overlaps with what I love about research. One of my favorite parts about collaborative research has been connecting people across disciplines with complementary skills and expertise who can come together to solve an even bigger problem. A large part of what I do as a dean is exactly that – bringing people together, connecting people with different problems to the resources they need to solve them.

We can and should be applying the skills we've honed as researchers to administrative positions. Part of what we want to do is to achieve an ambitious goal. That's true in research and in administration. It's about understanding what the core problem is and why it's important, evaluating approaches that we can use to solve it, collecting data and reflecting back on our solution and refining it. All those things I loved about research are integrated in the dean position.

What advice do you have for students interested in computer science?

Computer science is not just one thing. If you love solving problems, if you love having an impact, you can find a way to do that through computer science.

Richard Souvenir (center), professor in the Department of Computer and Information Sciences and vice provost for strategic initiatives at Temple University and Payton's husband, who earned bachelor's, master's and doctoral degrees from the Engineering school in 2001, 2003 and 2006, respectively; with his father (right), and Robert Pless (left), former WashU professor of computer science & engineering now at George Washington University, at Souvenir's graduation. (Courtesy photo)

Biography

- **Hometown:** Liberty Mounds, Oklahoma
- **Degrees:** Computer Science & Engineering, MS 2004, PhD 2006
- **Adviser:** Catalin Roman, the Harold B. and Adelaide G. Welge Professor of Computer Science and chair of the Department of Computer Science & Engineering from 1997-2010

SPECIAL FEATURE

Steady leadership

Ralph S. Quatrano's portrait to hang in Preston M. Green Hall

by Beth Miller


WASHU PHOTO

Ralph S. Quatrano, an internationally renowned plant scientist, former dean of the Engineering school at WashU and former chair of the Department of Biology, was the center of attention Nov. 22 as his portrait, honoring his leadership of the Engineering school, was unveiled in Uncas A. Whitaker Hall.

Colleagues, friends and family gathered to give a handshake, a pat on the back or a warm hug to the man who became dean of the Engineering school July 1, 2010, and served until 2015, when he was succeeded by Aaron F. Bobick, dean of the McKelvey School of Engineering and the James M. McKelvey Professor. Quatrano is now Emeritus Dean and the Spencer T. Olin Professor Emeritus of Biology.

Jamie Adams, associate professor, area coordinator — painting at the Sam Fox School of Design & Visual Arts at WashU, was commissioned to paint the portrait, which portrays Quatrano sitting at the window in the dean's office in Stephen F. and Camilla T. Brauer Hall. A potted orchid to his left signifies his wife, Lee Anne Quatrano, who was by Quatrano's side at many activities during his five years as dean. Behind him is a small replica of the double helix sculpture on display in the Whitaker Hall Atrium, signifying the convergence of engineering and biology during Quatrano's tenure as dean, and a framed photo of his children. The portrait will hang in Preston M. Green Hall.

"These portraits tell the story of who the school has been over the past 167 years, from the first dean, Calvin Woodward in the 1800s, to Alexander Langsdorf and Jim McKelvey in the 1900s, and more recently, Ralph Quatrano," Bobick said at the unveiling. "Perhaps Ralph's single biggest contribution was to provide steady leadership and to get everyone rowing in the same direction, because it is fundamental for the school to have a North Star that we can pursue."

As dean of Engineering, Quatrano designed and implemented the school's ambitious Convergence strategic plan. He hired one-third of the tenured and tenure-track faculty in place in 2015, including two department chairs, and built a sustainable research infrastructure. Recognizing the university's priority for a diverse faculty, Quatrano increased the number of women faculty by 40 percent and hired faculty members from groups traditionally underrepresented in the STEM fields. During his final year as dean, research awards increased by more than 25 percent.

> **"Perhaps Ralph's single biggest contribution was to provide steady leadership and to get everyone rowing in the same direction, because it is fundamental for the school to have a North Star that we can pursue."**
>
> — AARON BOBICK

Under his leadership, student enrollment increased by 20 percent, creating the school's largest-ever undergraduate and graduate classes at the time. He also revitalized the Dual Degree Program, which reached its highest enrollment in 20 years.

Chancellor Andrew D. Martin first worked with Quatrano when Martin was a department chair and later when Quatrano became dean of Arts & Sciences.

"As I think about individuals who have had such profound effects on Washington University, I can think of very few who have had the impact that Ralph has had on this place," Martin said. "An incredibly distinguished scholar who contributed through his research and through the students that he taught and mentored." As Chancellor Emeritus Mark Wrighton mentioned, "Ralph is also an entrepreneur who thought deeply and carefully about how to take his science into the marketplace to help serve others. And as you've heard, Ralph has been an academic leader, first of our biology department and then Arts & Sciences for a year, and then the leadership that he provided to this school at a very complicated time."

WATCH: The WashU community celebrated the career of Ralph S. Quatrano and the unveiling of his portrait.

Quatrano's fingerprint is also on Engineering facilities. Preston M. Green Hall, the third building of the East End Engineering complex, was built during his tenure, and plans began for Henry A. & Elvira H. Jubel Hall, which was completed in 2019. During Quatrano's time as dean, nearly $60 million was raised as part of *Leading Together: The Campaign for Washington University.*

> **"As I think about individuals who have had such profound effects on Washington University, I can think of very few who have had the impact that Ralph has had on this place."**
>
> — ANDREW D. MARTIN

Quatrano joined Washington University in 1998 as chair of the nationally regarded Department of Biology and the Spencer T. Olin Professor of Biology in Arts & Sciences. From 2005-07 he was director of the Division of Biology & Biomedical Sciences, a university-wide interdisciplinary doctoral program including medical, engineering and basic science disciplines. He also was interim dean of Arts & Sciences from 2008-09.

Quatrano earned a bachelor's degree in plant science with honors from Colgate University in 1962; a master's in plant science from Ohio University, Athens, in 1964; and a doctorate in biology from Yale University in 1968. He was a faculty member at Oregon State University, Corvallis, then moved to DuPont in Wilmington, Del., where he was research manager in molecular biology for the next three years. He left DuPont in 1989 to become the first John N. Couch Professor of Biology at the University of North Carolina at Chapel Hill. He served as chair of the Department of Biology at UNC from 1992-97 before joining WashU as chair of the Department of Biology and the Spencer T. Olin Professor of Biology.

Ralph S. Quatrano, former dean of the Engineering school, and his wife, Lee Anne, smile as Quatrano's portrait is unveiled in Whitaker Atrium Nov. 22.

Ling named 'Rising Star' in environmental research for 2024

Fangqiong Ling, assistant professor of energy, environmental & chemical engineering in the McKelvey School of Engineering, has been named among *ACS Environmental Au*'s 2024 Rising Stars in Environmental Research.

The journal named an international group of 18 early-career environmental researchers to its annual list of those working to improve the understanding of complex environmental issues and offering new technologies to solve or mitigate pollution.

Ling's research group explores the principles behind the assembly of microbial communities in urban environments, combining fieldwork, experiments and computational methods to understand how microbes interact with urban environmental conditions.

Bai honored by Academy of Science-St. Louis

Peng Bai, an associate professor of energy, environmental & chemical engineering at the McKelvey School of Engineering, was recently honored by the Academy of Science – St. Louis for his contributions to science.

Bai, who is developing next-generation batteries, was chosen for the Innovation Award, which recognizes a scientist or engineer, age 40 or under, who has demonstrated exceptional potential for future accomplishments in science, engineering or technology.

Bai's research group combines theoretical and experimental approaches to developing new materials, electrodes and batteries. The physics-based mathematical modeling and analytical electrochemistry research findings and tools developed in his lab also apply to and benefit the design of other electrochemical energy systems including supercapacitors and fuel cells.

Jacobs appointed for digital transformation

Nathan Jacobs, a professor of computer science & engineering in the McKelvey School of Engineering and co-director of the Geospatial Research Initiative, will serve as an assistant vice provost for digital transformation at WashU.

Digital transformation is integral to the research pillar of the university's "Here and Next" strategic plan. The DI2 Accelerator was founded in 2023 as the institutional home of digital transformation at WashU.

Jacobs has spent his career developing computational tools at the forefront of what's possible in computer vision and artificial intelligence, with a particular focus on geospatial and medical applications.

Jun receives Distinguished Women in Chemistry or Chemical Engineering award

Young-Shin Jun, professor of energy, environmental & chemical engineering in the McKelvey School of Engineering, has been chosen to receive a 2025 Distinguished Women in Chemistry or Chemical Engineering award from the International Union of Pure and Applied Chemistry (IUPAC).

The awards program acknowledges and promotes the work of women chemists and chemical engineers worldwide. Awardees are chosen based on excellence in basic or applied research, distinguished accomplishments in teaching or education, or demonstrated leadership or managerial excellence in the chemical sciences.

.

Chen receives St. Louis Innovator Award from St. Louis Bar Association

Yixin Chen, professor of computer science & engineering in the McKelvey School of Engineering, was given the St. Louis Innovator Award by the Bar Association of Metropolitan St. Louis at its inaugural Spirit of Innovation Awards.

Chen was selected for his contributions and dedication to fostering innovation and entrepreneurship in our region, specifically, in AI and large-language models and their applications in health care and legal practices.

In addition, Chen was elected a Fellow of the Association for the Advancement of Artificial Intelligence (AAAI). He is the first from WashU to be elected as an AAAI fellow, one of the highest honors in the AI community.

Kamilov receives Pierre-Simon Laplace Early Career Technical Achievement Award

Ulugbek Kamilov, an associate professor of electrical & systems engineering and of computer science & engineering at the McKelvey School of Engineering, won the 2024 IEEE Signal Processing Society Pierre-Simon Laplace Early Career Technical Achievement Award for major contributions to theory and practice in computational imaging.

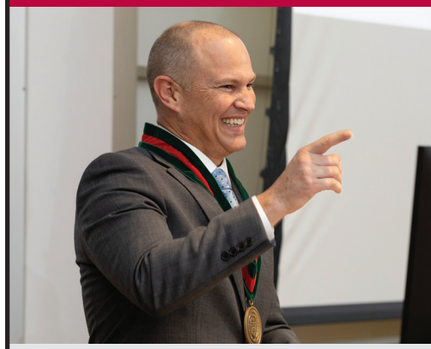
The honor recognizes Kamilov's research focused on developing new algorithms and mathematical insights for biomedical and scientific imaging applications including magnetic resonance imaging (MRI), computed tomography (CT), optical microscopy, computational photography and remote sensing.

Hu elected Fellow of Optica

Song Hu, professor of biomedical engineering in the McKelvey School of Engineering, has been elected a Fellow of Optica.

Optica, formerly known as the Optical Society of America or OSA, is an international organization at the forefront of the optics and photonics field. The title of Fellow recognizes individuals who have made significant and lasting contributions to the advancement of optics and photonics in areas including research, education, engineering, business and society. Fewer than 10% of the total membership can be elected a Fellow.

The honor recognizes Hu's outstanding achievements that help shape the future of optics and photonics. One of 121 newly elected members from 27 countries in the 2025 class, Hu was specifically selected for pioneering contributions to the development of photoacoustic microscopy for high-resolution functional and metabolic imaging in vivo.



Berkland named inaugural Mark and Becky Ruhmann Levin Professor

Cory Berkland, a respected innovator and developer of immune system therapeutics, has been named the inaugural Mark and Becky Ruhmann Levin Professor in the McKelvey School of Engineering at Washington University in St. Louis. He was installed Nov. 18, 2024.

Berkland joined WashU's Department of Biomedical Engineering from the University of Kansas. Berkland also will serve a portion of his time as a professor in the Department of Chemistry in Art & Sciences.

In addition to Berkland's continuing work developing immune system therapeutics to fight cancer, he will be working on research connected to his two-year, $2.6 million grant from The Leona M. and Harry B. Helmsley Charitable Trust to develop a new treatment for Type 1 diabetes.

Berkland's lab studies pharmaceuticals and biomaterials, emphasizing molecular design to enable transport into the human body. He investigates ways to use antigen-specific immunotherapy, developing treatments to keep immune cells from attacking proinsulin, which is the main factor in developing Type 1 diabetes.

Martin among highly ranked scientists by ScholarGPS, Research.com

Randall Martin, the Raymond R. Tucker Distinguished Professor in the McKelvey School of Engineering at Washington University in St. Louis, has been named an inaugural Highly Ranked Scholar in 2024 by ScholarGPS. In addition, he was named one of the top environmental scientists in the world in 2024 by Research.com.

Highly ranked scholars are authors whose ranking places them in the top 0.05% of all scholars due to their lifetime scholarly contributions in the following four categories: overall (all fields); in their specific field; in their specific discipline; and in all specialties with which they are associated.

Martin was ranked No. 15 on the list of highly ranked scholars – lifetime in the satellite specialty.

Research.com ranked Martin as one of the top environmental scientists in the world, coming in at No. 52 in the world and No. 28 in the United States.

Martin is a leading expert on atmospheric composition. His research focuses on characterizing atmospheric composition to inform effective policies surrounding major environmental and public health challenges.

Six McKelvey Engineering faculty among world's highly cited researchers

The Institute for Scientific Information has named six faculty members in the McKelvey School of Engineering at Washington University in St. Louis among the most highly cited researchers in the sciences in 2024.

The McKelvey Engineering faculty were among 49 faculty with primary affiliations at WashU named to the list, which recognizes researchers worldwide who have demonstrated significant and broad influence reflected in their publication of multiple papers that have been highly cited by their peers over the course of the past decade.

Those named include:

- Peng Bai, associate professor of energy, environmental & chemical engineering
- Feng Jiao, Lauren and Lee Fixel Distinguished Professor in the Department of Energy, Environmental & Chemical Engineering
- Randall Martin, the Raymond R. Tucker Distinguished Professor in the Department of Energy, Environmental & Chemical Engineering
- Rohit V. Pappu, the Gene K. Beare Distinguished Professor in the Department of Biomedical Engineering
- Gang Wu, professor of energy, environmental & chemical engineering
- Lan Yang, the Edwin H. & Florence G. Skinner Professor in the Preston M. Green Department of Electrical & Systems Engineering

Li named IEEE Fellow

Jr-Shin Li, the Newton R. and Sarah Louisa Glasgow Wilson Professor of Electrical & Systems Engineering in the McKelvey School of Engineering, has been named an IEEE Fellow in the Class of 2025.

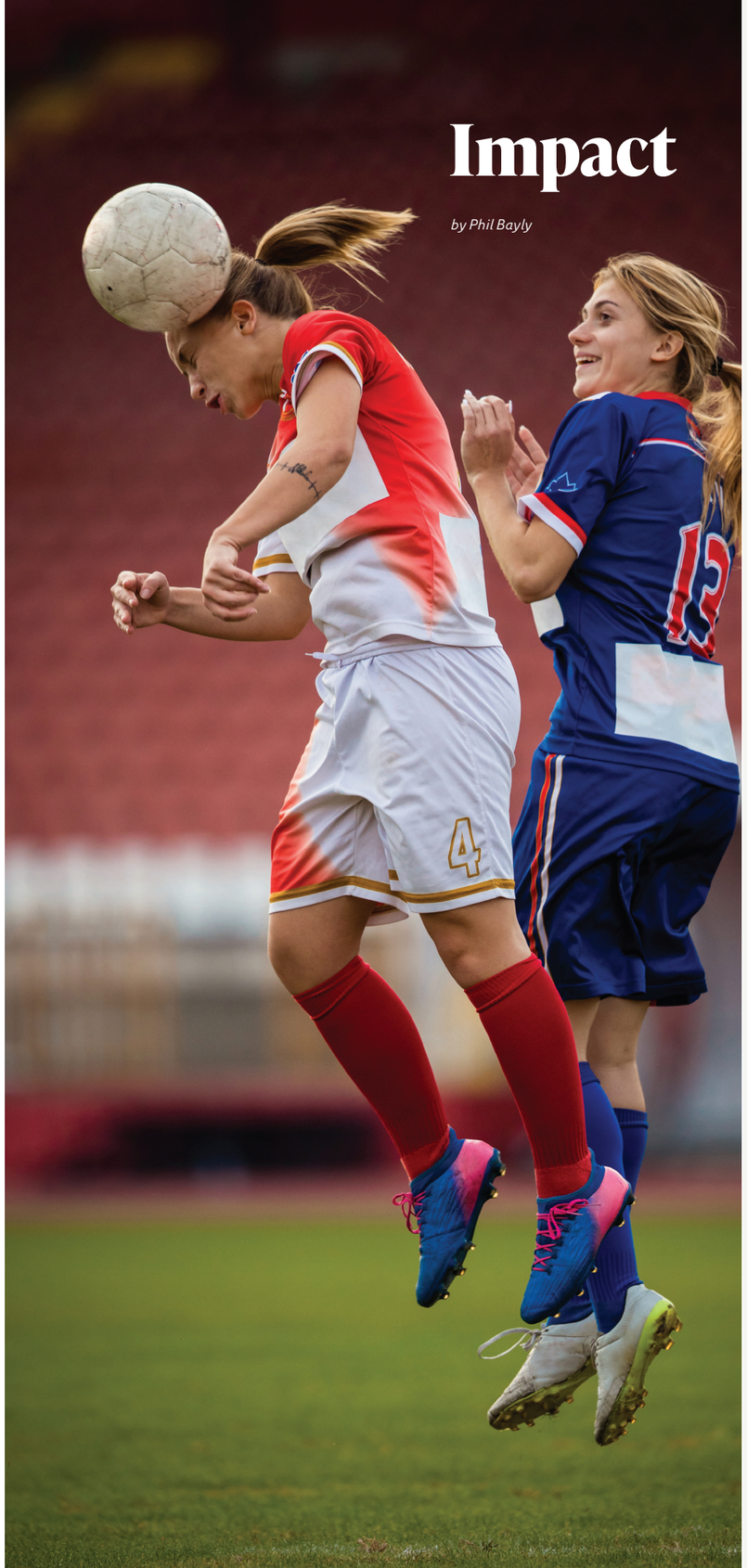
The IEEE Fellow is one of the most prestigious honors of the IEEE, a technical professional organization dedicated to advancing technology, and is bestowed upon a very limited number of senior members who have contributed to advancing or applying engineering, science and technology that brings value to society.

Li was selected for his contributions to ensemble control systems theory and applications to quantum and biological systems.

Agarwal publishes four textbooks in 2024

Ramesh Agarwal, the William Palm Professor of Engineering, was an author of four books published in 2024:

- Modeling and Simulation of Fluidized Bed Reactors for Chemical Looping Combustion, Springer, February 2024.
- Mixed Flow Pump: Modeling, Simulations and Measurements, Wiley, May 2024.
- Introduction to Modeling, Simulation and Optimization of CO2 Sequestration in Various Types of Reservoirs, Elsevier, June 2024.
- Discrete Element Method for Multiphase Flows with Biogenic Particles: Agriculture Applications, Springer, September 2024.



Impact

by Phil Bayly

Impact gets a bad rap. Of course, impacts can cause great harm; blows to the head lead to concussions and traumatic brain injuries. Even mild head impacts can generate cumulative brain damage if repeated many times.

But coordinated impacts on strings and membranes create piano concertos and drum solos. You tap on a melon to tell if it's ripe, and your doctor taps your back to check your lungs. Impacts excite all frequencies of a system, so engineers tap on aircraft wings to predict when they will flutter and on machine tools to find out if they will chatter. We have learned about brain trauma by using MRI to watch the brain respond to light, safe head impacts.

Impact is not just mechanical. We have impact when we uncover knowledge, invent a new tool or affect the course of someone's career. Such changes in momentum can occur in a single dramatic event or by the accumulation of many small nudges, as long as those nudges are well-timed and consistent. Over the past 17 years my job has been to help MEMS faculty and students achieve impact in their careers. But as Newton said, the forces of impact go both ways, and I revel in the reverberations.

Phil Bayly is the Lee Hunter Distinguished Professor and chair of the Department of Mechanical Engineering & Materials Science.

Washington University in St. Louis
McKelvey Engineering
MSC 1163-0206-01
One Brookings Drive
St. Louis, MO 63130-4899

CHANGE SERVICE REQUESTED

NON-PROFIT ORG.
U.S. POSTAGE
PAID
ST. LOUIS, MO
PERMIT NO. 2535

#WashUengineers

$$p = mv$$

Spring rain brings the trees and blooms in the WashU Arboretum to life. Around campus, you'll see blooming serviceberries, plums, cherries and dogwoods, the state tree of Missouri. (Credit: Virgil Tipton)

WashU McKelvey Engineering