SPRING 2024

Momentum

MCKELVEY SCHOOL OF ENGINEERING
AT WASHINGTON UNIVERSITY IN ST. LOUIS

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Momentum

SPRING 2024

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Students in the Introduction to Zymurgy class learn how beer is made at various scales, from troubleshooting their home-brew setups in the lab; to tours of a small craft brewer in Florissant; the visit to medium-scale producer Urban Chestnut; and, finally, a tour of Anheuser-Busch InBev to see a much larger scale of production.

WASHU PHOTO/JOE ANGELES

JERRY NAUNHEIM

“A potential solution to mitigating the harm caused by the prodigious use of these materials is to design alternatives that are as useful to society as traditional plastics but are also biologically safe and can be produced using nonpetroleum-based methods. Our cover story focuses on several efforts within McKelvey Engineering to create exactly these materials.”

There was a time — not that long ago on the scale of human history — when we viewed the planet as a limitless resource. It was assumed that no amount of human activity would be on a scale that could perturb the planetary state. Indeed, natural disasters such as massive volcanic eruptions and asteroid collisions were studied as events that could have global consequences. As the electrical engineers among you might attest, we can ground an arbitrary number of electrons into the earth — we never question its ability to absorb them.

This assumption of a limitless planet is, of course, false. Unlike electrons that can be absorbed by the entire volume of the earth, most of the physical process output of humanity interacts with a remarkably thin and biologically precious outer shell of the globe. Because of recently observed changes in climate, there is now a great emphasis on understanding the shift in atmospheric chemistry and heat cycles caused by the release of various gases and particles into the air. In fact, several McKelvey Engineering researchers study exactly the impact of particles on global atmospheric conditions.

But another emerging process concern is the release of plastics and other long-lasting materials into the environment. In many ways, these effects are likely to have a much more direct impact on humanity because these particles and chemicals find their way directly into our bodies through various pathways. We are only now beginning to assess the biological implications of this persistent exposure. Furthermore, these materials are almost exclusively derived from petroleum and produced by processes that themselves have environmental impact.

A potential solution to mitigating the harm caused by the prodigious use of these materials is to design alternatives that are as useful to society as traditional plastics but are also biologically safe and can be produced using nonpetroleum-based methods. Our cover story focuses on several efforts within McKelvey Engineering to create exactly these materials. This research in the school aligns well with the environmental thrust of the university’s Here and Next strategic plan. As you will also read, that effort is led by McKelvey Engineering Professor Dan Giammar; the Engineering school’s leadership of this universitywide initiative speaks to our strength in this area. You will hear much more about this aspect of McKelvey Engineering research in the years to come.

Finally, in these pages is an In Memoriam section about the passing of former Professor, Chair and Dean Salvatore Sutera. Beyond being a highly respected researcher, Sal was a passionate administrator. I am fairly certain that many of you find that phrase to be an oxymoron, but I assure you it is not. As you will read, Sal not only served two stints as chair of the Department of Mechanical Engineering, totaling more than a quarter century of leadership, but he also helped to launch the Department of Biomedical Engineering, created numerous programs and came out of retirement to help guide the school when it needed calm, stable leadership. His passion was the Engineering school, and he gave selflessly to advance our mission.

Aaron F. Bobick
Dean & James M. McKelvey Professor

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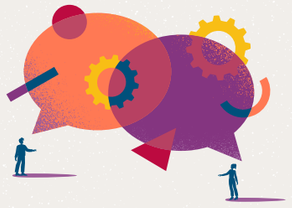

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In every issue

POINT OF VIEW **Feb. 16, 2023**

Quiet, snowy Friday on campus

5 YEARS AGO

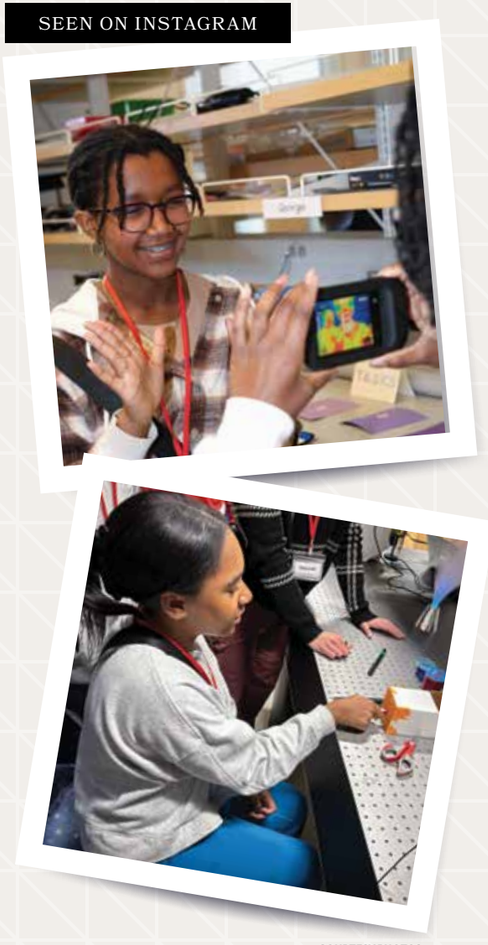
We are McKelvey! Jan. 31, 2019

January 31, 2024, marks five years since we changed our name to the McKelvey School of Engineering!

STRATEGIC PLAN

McKelvey's new strategic plan is available to read and download.

SEEN ON INSTAGRAM



COURTESY PHOTOS

Black Girls do STEM
Nov. 7, 2023

The Center for Women's Health Engineering hosted Black Girls Do STEM for a day of fun and learning.

OT students Rebecca Linnemann (left) and Nana Boateng with their device for baby Henry, who needs his tummy supported as he learns to crawl. The device has wheels that lock and a suspension hammock for his torso.

Ruth Okamoto, director of the Spartan Light Metal Products Makerspace, helped students use the Makerspace's high-tech equipment, such as 3D printers and laser cutters, as well as low-tech materials, such as fabric and PVC pipe.

Engineering, OT students work with patients to design assistive tech

by Diane Keaggy

Team Rainbow Butterfly Rangers was on a mission — to create an assistive technology device that would help Berlin, a bubbly 6-year-old with cerebral palsy, carry her plates and toys. Per Berlin's instructions, the device should be stable, easy to wear and — oh yeah — super cute.

The Rainbow Butterfly Rangers were one of eight teams of Washington University in St. Louis students who participated in the inaugural Assistive Tech Make-A-Thon, a collaboration between the Department of Biomedical Engineering and the Spartan Light Metals Product Makerspace in the McKelvey School of Engineering and the WashU Medicine Program in Occupational Therapy (OT). The teams had one week to design and build an assistive device in the Spartan Light Metal Products Makerspace that met the specific needs of current WashU OT patients and community members who served as co-designers. Other co-designers included a man with a spinal cord injury who wanted a modified dressing stick; a baby with motor delays who needs his tummy supported as he learns to crawl; a man with severe facial pain who wanted a hood that protects him from cold but does not touch his skin; and a WashU OT student and Make-A-Thon participant who is visually impaired and needs a goniometer, which measures range of motion, that is easy to read.

The teams presented their final prototypes to their co-designers Feb. 7 on the Medical Campus. Cecropia Strong, a national nonprofit that assists disabled individuals, served as a co-sponsor.

Inaugural WE Day celebrates Women & Engineering

The inaugural WE Day, held Feb. 23, offered the opportunity for women, engineering and community to take center stage and connect through storytelling and networking.

KATHERINE YU

Students in the McKelvey School of Engineering designed prototypes for a device that could help environmental engineers monitor the air quality impact of factory farms in Missouri. The students built their prototypes in the Spartan Light Metal Products Makerspace in Jubel Hall.

Left: Celine Vuong (right), shown here working with Patrick Kirby and Nic Sprague, developed early versions of her prototype in the Spartan Light Materials Makerspace in September. Right: Over the semester, students in the "Multidisciplinary Design & Prototyping" course grappled with many decisions related to their prototypes.

WASHU PHOTOS/JOE ANGELES

'Elegance in simplicity:' A prototype is born

by Talia Ogliore

Students in the McKelvey School of Engineering designed prototypes for a device that could help environmental engineers monitor the air quality impact of factory farms in Missouri. The students built their prototypes in the Spartan Light Metal Products Makerspace in Jubel Hall over the course. Working with lecturer Jackson Potter, undergraduate students in the upper-level "Multidisciplinary Design & Prototyping" class (MEMS 312) developed their prototypes to meet a need described by environmental engineers in Jay Turner's research group. Turner is the James McKelvey Professor of Engineering Education.

While much of the nation's animal agriculture production once occurred in open fields, today most animals raised for human consumption live in concentrated animal feeding operations, or CAFOs. If not designed or managed properly, these intensive farming operations can pollute local air and water. People who live or work near CAFOs, especially those who spend a lot of time downwind of them, experience the brunt of the negative impacts.

"Basically it stinks — in one direction," said Celine Vuong, an undergraduate student who developed one of the prototypes, along with her class partner, Jaimie Lin.

Parker wins design contest

Congratulations to Tristan Parker, a senior double-majoring in mechanical engineering and entrepreneurship! Parker won the Altair Engineering monthly design contest for December 2023 for the Americas!

"This project provided a valuable learning experience that allowed me to integrate my interest in boating with practical engineering insights," he said.

Tristan used the power of Altair Inspire to create an optimized dock cleat, which is vital to tying a boat to a dock.

Hodges receives geospatial diversity fellowship, Dean's Select Fellowship

Nia Hodges, a second-year master's student studying data analytics and statistics in the Preston M. Green Department of Electrical & Systems Engineering, received a Diversity Fellowship Award from the Taylor Geospatial Institute (TGI). The award will provide $35,000 a year for up to four years to fund Hodges' study and research.

After earning a bachelor's degree in computer science in 2022 from Jackson State University, Hodges came to McKelvey Engineering on a Department Chair's Master's Research Fellowship, a pipeline program designed to encourage students to continue to doctoral programs. She began a doctoral program in systems science & mathematics in spring 2024 under the Dean's Select Fellowship Program.

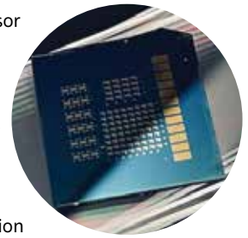
WashU awarded up to $20 million to develop high-tech imaging technology

Chao Zhou, a professor of biomedical engineering in the McKelvey School of Engineering, has been working to improve optical coherence tomography (OCT) systems that can conduct high-resolution imaging of the eyes. Now, with a contract of up to $20 million from the Advanced Research Projects Agency for Health (ARPA-H), he plans to create a portable OCT system based on photonic integrated circuits (PIC) and custom-designed electronic integrated circuits that could offer advanced eye screening to many more patients and at a lower cost. The technology also could be used in other applications, such as cardiology, dermatology, dentistry, endoscopy and urology.

The contract is part of ARPA-H's first call for proposals for unconventional approaches to improving health outcomes across patient populations, communities, diseases and health conditions via breakthrough research and technological advancements. It is the first ARPA-H contract awarded to Washington University in St. Louis.

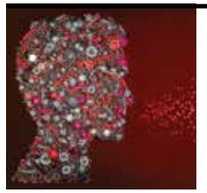
Traditional OCT systems are expensive, complex, bulky and labor-intensive to assemble and calibrate. The proposed system would weigh a few pounds, take high-resolution 3D scans of the retina in less than a second and be a fraction of the cost of the traditional systems.

NSF invests in semiconductor research in McKelvey School of Engineering



Sang-Hoon Bae, assistant professor of mechanical engineering & materials science, and Mark Lawrence, assistant professor of electrical & systems engineering, both in the McKelvey School of Engineering, are undertaking projects to transform computing through developing next-generation technologies. Bae's work focuses on integrating 2D elements into advanced 3D microelectronics. Lawrence will enhance AI-driven machine vision systems to achieve real-time adaptivity and high energy efficiency in a range of applications.

Bae and Lawrence each received a grant from the National Science Foundation (NSF) as part of a $45.6 million investment into 24 research and education projects. The projects are supported by funding from the CHIPS and Science Act of 2022 and by the NSF's Future of Semiconductors (FuSe) program. The FuSe program aims to accelerate the growth of a U.S.-based workforce and knowledge that will enable innovative semiconductor and microelectronics development.



Team to develop breathalyzer test for COVID-19, RSV, influenza A

Rajan Chakrabarty, the Harold D. Jolley Career Development associate professor of energy, environmental & chemical engineering, and John Cirrito, professor of neurology at the School of Medicine, will adapt their COVID-19-detecting breathalyzer to one that can also screen for influenza A and RSV with a two-year, $3.6 million grant from Flu Lab, an organization that funds efforts to defeat influenza. With the funding, they plan to take the technology from bench into clinical trials at Washington University's Infectious Disease Clinical Research Unit with the goals of design and specifications for commercial application and preparing the breath test for FDA registration.

The mission of the Synthetic Biology Manufacturing of Advanced Materials Research Center is to push the frontiers of knowledge through convergent research; develop pathways to train a manufacturing workforce; leverage an environment of diversity; and enhance innovation in the manufacturing of synthetic biological materials.

Synthetic Biology Manufacturing of Advanced Materials Research Center launches

Despite efforts to reduce the use of plastic or recycle it, most plastic produced in the world ends up in landfills, the oceans or dumped, bringing with it catastrophic effects on the environment, the ecosystem and the economy.

To address this, a team of researchers in the McKelvey School of Engineering at Washington University in St. Louis has established the Synthetic Biology Manufacturing of Advanced Materials Research Center (SMARC) to create an integrated education, research and innovation ecosystem enabled by the convergence across multiple disciplines and research areas. Marcus Foston, associate professor of energy, environmental & chemical engineering, will co-lead the center with Fuzhong Zhang, professor of energy, environmental & chemical engineering and co-director of the center, which is funded in part by a five-year, $3.6 million Growing Convergence Research (GCR) grant from the National Science Foundation (NSF). With this funding, the team plans to develop a new class of biologically synthesized, protein-based and biodegradable materials that harness themes from nature to replace traditional petroleum-derived plastics.

Also on the WashU leadership team are Guy Genin, the Harold and Kathleen Faught Professor of Mechanical Engineering, and Roman Garnett, associate professor of computer science & engineering.

NSF CAREER AWARDS

Rupture of aorta to get closer look with specialized testing, imaging

Matthew Bersi, assistant professor of mechanical engineering & materials science, will use pioneering optics-based mechanical testing and imaging techniques to study the aorta with a five-year, $575,000 CAREER Award from the National Science Foundation. CAREER awards support junior faculty who model the role of teacher-scholar through outstanding research, excellence in education and the integration of education and research within the context of the mission of their organization. One-third of current McKelvey Engineering faculty have received the award.

"The heart beats every second and is part of a system that is well designed for resistance against fatigue," Bersi said. "In cases where there is damage to the aorta, changes in blood pressure with each beat of the heart can make the vessel vulnerable to failure, but this process is difficult to study and hard to predict, since it is dependent upon the local mechanical environment of the tissue."

At the heart of drug development for cardiovascular disease

With a five-year, $695,746 CAREER Award from the National Science Foundation, Nathaniel Huebsch, assistant professor of biomedical engineering, will grow heart muscle in the lab that is more representative of adult heart tissue and use that muscle to predict how drugs will affect patients' hearts. 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.

"This is going to be especially useful for developing cures for genetically inherited diseases. It will also help us understand how to avoid cardiac side effects of drugs that are used to treat diseases like cancer, provide guidance on whether emerging therapies will work on certain diseases, such as arrhythmias, and determine if there are more effective times for the application of therapies," Huebsch said.

For the birds

Cactus Wren

As birdwatchers, birders and fans of the popular board game Wingspan know, feathered friends are found worldwide in a variety of different habitats, from frosty Antarctic penguins to desert-dwelling cactus wrens to Midwest favorite cardinals. BirdSAT, a new tool for classification and ecological mapping of bird species, enables the creation of species distribution maps across any geographic region to provide important information to assist ecologists who monitor and protect endangered species.

Nathan Jacobs, professor of computer science & engineering in the McKelvey School of Engineering, leads the research team that developed BirdSAT. The framework combines ground-level imagery of birds, location and time metadata, and corresponding satellite imagery to classify different species of birds and map their habitation anywhere in the world. First author Srikumar Sastry, a doctoral student in Jacobs' lab, presented BirdSAT Jan. 6 at the Winter Conference on Applications of Computer Vision in Waikoloa, Hawaii.

Water quality monitor, electronic nose under development

Two teams of engineers led by faculty in the McKelvey School of Engineering will work toward developing products to monitor drinking water quality and to detect explosives with an electronic nose, thanks to one-year, $650,000 Convergence Accelerator Phase 1 grants from the National Science Foundation (NSF).

Barani Raman, professor of biomedical engineering, and Daniel Giammar, the Walter E. Browne Professor of Environmental Engineering, will lead teams of researchers from Washington University and other institutions and entities funded under the NSF's Convergence Accelerator program, designed to address national-scale societal challenges through convergence research and to transition basic research and discovery into practice to solve these challenges aligned with specific research themes. Among the themes are real-world chemical sensing applications, bio-inspired design innovations and equitable water solutions.

AI for Health Institute launches to promote growing intersection of artificial intelligence, health

Advanced artificial intelligence (AI) tools and techniques allow researchers to use the vast amounts of data now available from electronic health records and wearables to help solve complex health problems and improve population health.

To further integrate the power of AI into health care, the McKelvey School of Engineering has launched the AI for Health Institute to design data-driven tools to characterize complex diseases, support clinical decisions and drive precision health. The institute was introduced Oct. 18–19, 2023, at the AI & Digital Health Summit at Washington University.

Chenyang Lu, the Fullgraf Professor of Computer Science & Engineering in the McKelvey School of Engineering and director of the institute, said the AI for Health Institute intends to establish Washington University as a leader in AI for health in a very competitive field.

Brain-machine interfaces for insects to study principles of odor-guided navigation

Barani Raman, professor of biomedical engineering in the McKelvey School of Engineering, is leading a multidisciplinary team to study how the locust brain transforms sensory input into behavior with a four-year, $4.3 million grant from the National Science Foundation's Integrative Strategies for Understanding Neural and Cognitive Systems (NCS) program. The grant converges years of research in Raman's lab with that of his longtime WashU collaborators, including Shantanu Chakrabartty, professor of electrical & systems engineering, and Srikanth Singamaneni, professor of mechanical engineering & materials science, as well as Alexandra Rutz, assistant professor of biomedical engineering, and Yehuda Ben-Shahar, professor of biology, also at WashU.

"Insects are an engineering marvel," Raman said. "They possess diverse sensing modalities and locomotory responses yet contained in such a small package. We want to engineer tools to study the amazing capabilities of these relatively simpler organisms."

The research brings together Washington University's strengths in neural engineering, integrated circuits, biomaterials, synthetic biology and genetic engineering to understand how the insects use olfactory cues to navigate toward an odor source.

Turning trash into treasure to help quench the world's thirst sustainably

Reverse osmosis (RO) is used to purify water worldwide for both drinking and industrial use, and it will only become more important in the future as additional desalination plants are required to meet demand. Particularly in areas where freshwater scarcity is an issue, RO provides the principal method to desalinate water for human consumption and to recycle wastewater for use in agricultural or industrial applications. However, RO water processing requires pretreatment with antiscalants and produces a large quantity of concentrated waste, known as reverse osmosis concentrate (ROC), which must be treated before it can be disposed of safely.

With a $1.35 million grant from the U.S. Department of Energy, Young-Shin Jun, professor of energy, environmental & chemical engineering, aims to turn this concentrated waste into valuable products for industrial use.

Efficient lithium-air battery under development to speed electrification of vehicles

With $1.5 million from the U.S. Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E), Xianglin Li, associate professor of mechanical engineering & materials science, will lead a multi-institutional team to develop a lithium-air (Li-air) battery with ionic liquids to deliver efficient, reliable and durable performance for high-energy and high-power applications. The Phase I, 18-month funding is part of $15 million ARPA-E awarded to 12 projects across 11 states to advance next-generation, high-energy storage solutions to speed electrifying the aviation, railroad and maritime transportation sectors.

Funded through the Pioneering Railroad, Oceanic and Plane ELectrification with 1K energy storage systems (PROPEL-1K) program, projects aim to develop emission-free energy storage systems with "1K" technologies capable of achieving or exceeding 1,000-Watt-hours per kilogram (Wh/kg) and 1,000 Watt-hours per liter (Wh/L).

Skin pigmentation bias in pulse oximeters to get closer look

Pulse oximeters send light through a clip attached to a finger to measure oxygen levels in the blood noninvasively. Although the technology has been used for decades — and was heavily used during the COVID-19 pandemic — there is increasing evidence that it has a major flaw: it may provide inaccurate readings in individuals with more melanin pigment in their skin. The problem is so pervasive that the U.S. Food & Drug Administration recently met to find new ways to better evaluate the accuracy and performance of the devices in patients with more pigmented skin.

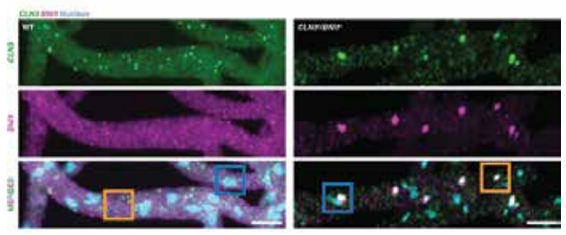
Christine O'Brien, assistant professor of biomedical engineering in the McKelvey School of Engineering and of obstetrics & gynecology in the School of Medicine, and Leo Shmuylovich, MD, PhD, assistant professor of medicine in the Department of Dermatology at the School of Medicine, are seeking ways to mitigate this potential bias. With a two-year, $375,000 grant from the National Institutes of Health's National Institute of Biomedical Imaging and Bioengineering, O'Brien and Shmuylovich are looking at using new experimental systems that allow skin pigmentation to be varied while all the other physiologic parameters remain the same, as well as changing the pulse oximeter wavelengths from red light to short-wave infrared light, which minimizes melanin absorption and scattering.

Guerin wins grant to enhance atmospheric simulation speed

Roch Guerin, the Harold B. & Adelaide G. Welge Professor of Computer Science and chair of computer science & engineering in the McKelvey School of Engineering, leads a team working to improve the speed of GEOS-Chem, a 3D atmospheric simulation software designed to study climate change. With a two-year, $207,394 grant from the National Science Foundation, Guerin and his collaborators seek to enhance the ability of GEOS-Chem to rapidly simulate how Earth's atmosphere responds to changes in its chemical composition.

The project brings together expertise in computer and atmospheric science and includes McKelvey Engineering faculty Kunal Agrawal, professor of computer science & engineering, and Randall Martin, the Raymond R. Tucker Distinguished Professor in energy, environmental & chemical engineering and model scientist of the GEOS-Chem project.

Timing matters: Condensates' composition determined by when RNA is added



Rohit V. Pappu, the Gene K. Beare Distinguished Professor of biomedical engineering, in collaboration with Amy S. Gladfelter, professor of cell biology and of biomedical engineering at Duke University, and their labs have found that the order in which different RNA molecules are added to the condensates determines how they will be composed, providing new information on how these important cellular compartments are formed. Pappu also is director of the Center for Biomolecular Condensates in the McKelvey School of Engineering, and Gladfelter is a member of the center's Scientific Advisory Committee.

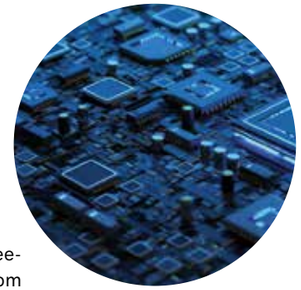
The team made the discovery using a protein from *Ashbya gossypii*, a fungus with long filaments that is closely related to yeast. Using live cells, they found that a lack of dynamical control, achieved by synchronizing the production of RNA molecules, resulted in a loss of compositional identity of condensates, which impacted the ability of the fungi to form long, healthy cells with well-defined branches.

Co-learning to improve autonomous driving

Nathan Jacobs, professor of computer science & engineering, and a team of graduate students developed a joint learning framework to optimize two low-level tasks: stereo matching and optical flow. Stereo matching generates maps of disparities between two images and is a critical step in depth estimation for avoiding obstacles. Optical flow aims to estimate per-pixel motion between video frames and is useful to estimate how objects are moving as well as how the camera is moving relative to them.

Ultimately, stereo matching and optical flow both aim to understand the pixel-wise displacement of images and use that information to capture a scene's depth and motion. Jacobs' team's co-training approach simultaneously addresses both tasks, leveraging their inherent similarities. The framework, which Jacobs presented Nov. 23 at the British Machine Vision Conference in Aberdeen, UK, outperforms comparable methods for completing stereo matching and optical flow estimation tasks in isolation.

Research network to focus on AI, integrated circuits

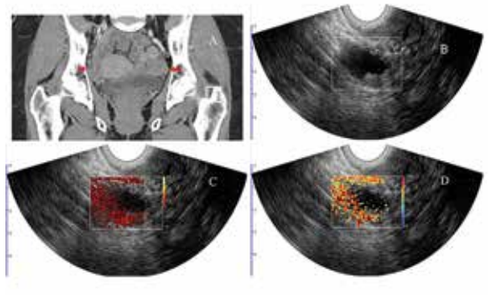


Shantanu Chakrabartty, the Clifford W. Murphy Professor and vice dean for research and graduate education, is leading a Neuromorphic Integrated Circuits Education (NICE) research coordination network (RCN) with a three-year, $900,000 grant from the National Science Foundation.

By looking at the way the brain is structured and its neural mechanisms, researchers will develop hardware and algorithms that make the most of computational performance with the least amount of power.

The NICE network will allow researchers to acquire design skills that can be applied to integrated circuits design, helping to meet the education and workforce gap in integrated circuits design and fabrication. The project will use the infrastructure of the annual Telluride Neuromorphic Cognition Engineering Workshop to organize discussion groups and hands-on training events and create research cohorts around neuromorphic integrated circuits. Results of their research were published in *Nature Communications* Aug. 5, 2023.

Photoacoustic imaging improves diagnostic accuracy for cancerous ovarian lesions



Researchers and clinicians at WashU have found a way to improve the standard of care diagnostic accuracy of potentially cancerous lesions in the ovaries and adnexal regions, or the fallopian tubes, by incorporating functional biomarkers with photoacoustic imaging, a technique that illuminates tissue with near-infrared light at specific wavelengths that are absorbed differently by oxygenated and deoxygenated hemoglobin. Results of this new additional assessment technology may allow some patients to avoid surgical removal of abnormally appearing lesions, reducing health care costs and potential complications from the procedure.

Quing Zhu, the Edwin H. Murty Professor of Engineering, worked with a team of Washington University School of Medicine physicians to add photoacoustic imaging to the standard of care for women scheduled to have their ovaries and/or adnexal lesions surgically removed due to potential malignancy.

The findings of their research were published in the December 2023 issue of *Ultrasound in Obstetrics and Gynecology*.

COVER STORY

The Plastics Problem

McKelvey engineers tackle one of the biggest environmental issues of our time

by Beth Miller

ILLUSTRATIONS BY AIMEE FELTER | PHOTOS BY JERRY NAUNHEIM

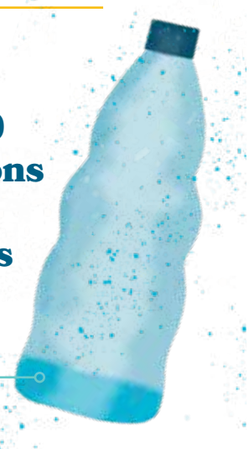
Plastic is everywhere in our lives, from furniture to food packaging to diapers. It is nearly impossible to go for one hour without touching or using something made from petroleum-derived plastic. While the material is durable and cheap to produce, its impact on the environment and on our health is so costly that researchers predict more plastic than fish in the world's oceans by 2050, and microplastic particles are now found in human blood.

We've been told since at least the 1970s to "reduce, reuse, recycle," but only about 15% of the 300 million tons of plastic waste generated annually gets recycled, while the rest ends up in landfills, where it can take hundreds of years to break down. In 2020, the U.S. Environmental Protection Agency announced its goal to increase the U.S. recycling rate to 50% by 2030 and proposed specific actions to address plastics, including reducing pollution during plastic production, improving post-use materials management, preventing trash and micro/nanoplastics from entering waterways and removing trash from the environment.

But will these efforts, coupled with existing plastic reduction and replacement efforts, be enough to make a difference?

We asked that question of some of the researchers in the McKelvey School of Engineering who are developing creative solutions to the plastics problem that they expect will lead to measurable change within our lifetime. Their answers are cautiously optimistic.

Only 15% of the 300 million tons of plastic waste gets recycled annually



WATCH: Learn how and why the Synthetic Biology Manufacturing of Advanced Materials Research Center makes synthetic biomaterials.

(From left) Minkyoung Jung, a doctoral student, and Andrea Carbonell, a first-year student, in z.

Nanoplastics

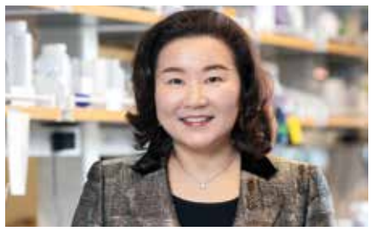
In January 2024, Columbia University researchers detected and identified 240,000 plastic particles per liter of bottled water, of which about 90% were nanoplastics, or particles about one-billionth of a meter in size — a significantly higher number of particles than what scientists previously thought — raising concerns about the potential for toxicity.

Nanoplastics form when plastics break and degrade. They can generate highly reactive species particularly in light. Young-Shin Jun, professor of energy, environmental & chemical engineering, studies the effects of this degradation on the soil and water systems in her Environmental NanoChemistry Laboratory.

"All of the plastic that we use will eventually enter into the environment, which will affect our health and ecosystems," says Jun, who also is the chair of the Science and Technology Subcommittee of the American Chemical Society's Committee on Science.

Ping-I-Chou, a doctoral student, works in Young-Shin Jun's Environmental NanoChemistry Lab, where they study nanoplastics in the environment.

"All of the plastic that we use will eventually enter into the environment, which will affect our health and ecosystems.



– YOUNG-SHIN JUN

Recently, Jun and her team analyzed how sunlight breaks down polystyrene, a nonbiodegradable plastic from which packing peanuts and disposable utensils are made. The research showed that when exposed to light, nanoplastics generate reactive oxygen species, rapidly facilitating a transformation from aqueous manganese ions into manganese oxide solids. This unexpected reaction can occur even faster with smaller nanoplastics, changing the fate and transport of nanoplastics themselves and other co-existing contaminants, such as organic contaminants and heavy metal ions, and affecting the environmental quality.

Using creative materials

One way to address the plastics problem is to create biodegradable plastic from materials other than petroleum — whether it be renewable materials, recycled materials or new materials created from natural resources.

"We are a long way from being able to solve the problem, but it's really urgent that we start doing transformative work now," said Guy Genin, the Harold and Kathleen Faught Professor of Mechanical Engineering and a faculty member in the school's Synthetic Biology Manufacturing of Advanced Materials Research Center (SMARC). "Relying on oil as the major feedstock for the production of fuels, chemicals and materials is problematic — we will eventually need new resources. But it's hard to match the price and properties of existing plastics derived from oil."

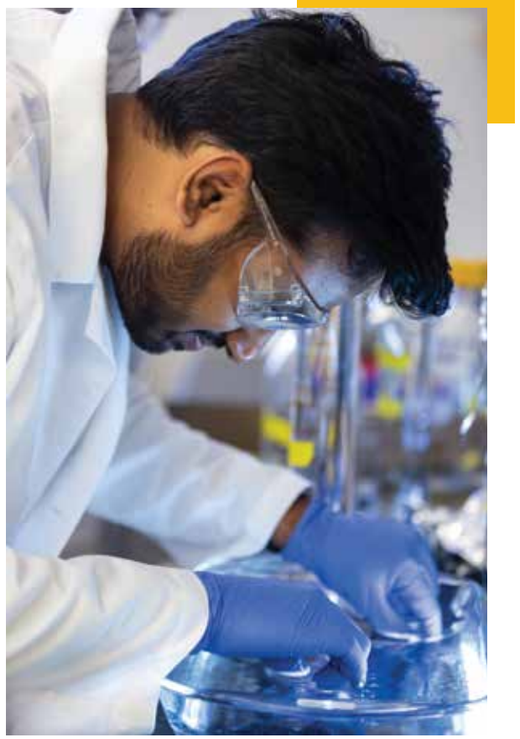
SMARC is co-directed by Marcus Foston, associate professor, and Fuzhong Zhang, professor, both in the Department of Energy, Environmental & Chemical Engineering. Partially funded by a five-year, $3.6 million grant from the National Science Foundation, the center's collaborators plan to develop a new class of biologically synthesized, protein-based and biodegradable materials that harness themes from nature to replace traditional petroleum-derived plastics. Roman Garnett, associate professor of computer science & engineering, is also on the team, along with researchers from Northwestern University, Iowa State University and University of South Florida.

Zhang, an expert in synthetic biology who has used bacteria to create renewable fuels and other materials, is now using bacteria to create renewable plastics that will not harm the environment.

"We are aiming to create advanced materials that degrade naturally or can be recycled more efficiently and in an environmentally friendly and cost-effective manner," he said. "Biological engineering provides a solution to address that."

Zhang's lab is working to achieve new materials made from renewable feedstock independent of petroleum through a biological manufacturing process and has tunable properties to meet the needs for different applications. One product his lab is making is adhesives for medical products, such as surgical glues, from biological materials. His team has mimicked the sticky proteins secreted by mussel feet that allow them to stick to different surfaces under water, making them into hydrogels that are biocompatible and durable.

Joshua Yuan, the Lucy & Stanley Lopata Professor and chair of energy, environmental & chemical engineering, and collaborators at Texas A&M University



Shri Venkatesh, a doctoral student, works in Fuzhong Zhang's Biomolecular Engineering and Synthetic Biology Lab.

are using carbon dioxide, a waste product from greenhouse gas emissions, to produce biodegradable plastics. This system, which took more than two years to create, uses carbon dioxide to produce intermediates that can feed bacteria to grow and produce bioplastics. His team also uses diverse waste streams like food waste and black liquor to produce bioplastics. If able to be scaled up to an industrial scale, the process could help to replace petroleum-based plastics with products that have fewer negative environmental impacts.

Yuan and his team also are working to make biopolymers, including lignin and cellulose, to improve biodegradability and the mechanical performance of biodegradable plastics. He recalled a trip to Hawaii, where nondegradable plastics are banned from use.

"The plastic bags there were made of degradable materials, but they were not as good as regular plastic bags and were difficult to handle," he said. "The faculty in our department are working hard to make these degradable materials perform as well as petroleum-based plastic."

(From left) Fuzhong Zhang, professor of energy, environmental & chemical engineering, and Juya Jeon, a doctoral student, in Zhang's Biomolecular Engineering and Synthetic Biology Lab.

Upcycling

Since plastic can be recycled only a few times, researchers are looking for ways to upcycle, or reuse a product or material for a new purpose. McKelvey Engineering researchers are looking for a way to break down plastics to make a new materials, therefore creating a circular economy. For example, polyethylene, the most produced plastic, can be broken down to be used as valuable lubricants, Foston said. However, due to economics and lack of industry buy-in, no large-scale operation exists to upcycle plastic, and thus researchers must address barriers to adoption.

"Our center is designed to bring in industry to influence early-stage science," Foston said. "These problems require transdisciplinary research that depends heavily on the way in which business and markets work, on how people adopt technologies and barriers to those technologies."

We have potential solutions, but how much do they cost?

While many of these alternative plastics may be better for the environment, they come at a cost.

"If the cost is not competitive to current petroleum-derived plastics, you will not see renewable plastics in the market," Zhang said. "And that cost comes from multiple aspects: the feedstock, the process, overall yield, scalability, capital costs, operating costs and many others.

"Very often, products with large market sizes have low profit margins, whereas those yielding higher margins trend to cater to limited market segments prone to rapid saturation," he continued.

"The transition from petroleum-based plastics to renewable, degradable materials is likely going to be a progressive evolution, initially emerging through expensive specialty materials, with gradual advancements toward materials suitable for widespread applications," he said.

Can plastic alternatives make a difference?

"I don't think the answer is a simple yes or no," Zhang said. "As an engineer, after we learn from all the previous successes and failures, it's going to be a long path, and if we're trying to quantify things, how do we define success?"

Many companies have launched everyday household products, such as laundry and dishwasher detergent sheets and personal care products, that claim to be "plastic free." However, some contain PVA, or polyvinyl alcohol, a dissolvable synthetic polymer, or plastic. And paper bags aren't always a better choice than plastic bags, since getting paper bags to far-flung locations can take more oil than is used to produce plastic bags.

(From left) Marcus Foston, associate professor of energy, environmental & chemical engineering, with Zhenqin "Jerry" Wang, in Foston's Bioproducts Engineering Lab.

While composting and recycling have benefit, these changes require people to adopt them, Foston said. But for other products, we must look at the long view, he said.

"When you do a lifecycle analysis of a paper straw, there is more CO_2 released in producing a paper straw than a plastic straw, but we're not putting plastic back into the environment," he said. "If we had the right kind of disposal system that kept the plastic straw from getting into the environment, then it would be a better option."

Paper straws have also been found to contain poly- and perfluoroalkyl substances (PFAS), also known as "forever chemicals" because they break down very slowly and can remain for millennia in the environment, as well as having potential harmful effects on human health, according to a 2023 study in *Food Additives and Contaminants*.

> **If we had the right kind of disposal system that kept the plastic straw from getting into the environment, then it would be a better option.**
>
> 
>
> — MARCUS FOSTON

The public's part

In 2008, Frito-Lay introduced a compostable bag for Sun Chips made from a biodegradable corn-based material that took four years to develop. However, consumers quickly deemed it too loud, with one user measuring its crinkly noise at 95 decibels, which is in the harmful range. In 2021, the company launched a new compostable bag in its quest to make all its packaging recyclable, compostable, biodegradable or reusable by 2025. But will consumers accept it this time?

Foston said it's all about understanding human behavior and the systems humans have built, which is why SMARC has social scientists and communications professionals on its team.

"Our job as engineers is to figure out how to address the existential threat that's two, three or four generations away," Foston said. "In free market economies, such as those in the U.S., how do we design solutions that fit into our fundamental understanding of those market dynamics? How do we make materials that are as cheap as or cheaper than petroleum-derived plastics while having industries and consumers value those same materials beyond cost? Can we educate our population so that they understand these new materials and how they address existential threats, maybe so much so that they are willing to pay more?"

What's next?

McKelvey Engineering researchers, within SMARC or in their own labs, will continue to look for solutions to mitigate this global problem.

"Our job is to figure out how to explore the massive design space that nature has been accessing through evolution by trial and error, but we can't wait for evolutionary time scales to do it," Genin said. "SMARC is injecting physics-based machine learning and modeling into this process to produce novel and sustainable materials with properties such as durability, strength, toughness and thermal conductivity that outperform polymers made with petroleum or even found in nature."

Not only is the plastics problem a focus of research in McKelvey Engineering, but it is also at the core of the university's Here and Next strategic plan, launched in 2022.

"WashU has an excellent foundation in this area and has our story to tell, and with continuous advancement and support from the central administration and from the McKelvey School of Engineering, we have rallied the support to become a national leader in this area," Yuan said.

FACULTY FEATURE

CREATIVE MARKET

Where engineering and public health meet

Dan Giammar wants to put himself out of business

by Shawn Ballard

RON KLEIN

"At heart, I'm an engineer, and I want to make the world better."

Like many successful engineers, Daniel Giammar, the Walter E. Browne Professor of Environmental Engineering in the McKelvey School of Engineering, has found himself in the right place at the right time with the right experience to make an impact. The child of a mechanical engineer, who worked on scrubbers to remove acid rain-forming chemicals from coal-fired power plants, and a public school nurse, Giammar describes his career as an environmental engineer focused on issues affecting public health as "practically preordained."

"When I was young, we spent our family vacations driving all over the country, camping in national parks and national forests, so a love of nature was part of how I grew up," Giammar recalled, noting that he visited roughly 40 states before he was 12 without stepping on an airplane. "I remember drawing pictures of sad, dead flowers with acid rain falling on them, which was maybe a little disturbing, but also scientific, thanks to a father doing technology for the environment and a mother focused on public health. And that's what environmental engineers do. I learned a lot from their examples."

As an undergraduate Giammar declared a major in civil engineering, thinking that chemistry wasn't his cup of tea. After discovering that he liked chemistry when paired with environmental science, Giammar shifted to environmental engineering with an emphasis on aquatic chemistry.

"A key lesson I learned from my advisers was to stay true to fundamentals and to understanding the role of chemical speciation as it relates to metals at solid-water interfaces," Giammar said. "I'm not a uranium person, not a lead person, not an arsenic person, not a chromium person. I'm an aquatic chemistry person. Applying that core set of tools and expertise in the chemistry of metals and how it impacts water systems has given me the opportunity to see what happens in my lab informing decisions made in the real world."

Going unleaded

Giammar jokes that just as most parents can't choose a favorite child, he can't choose a favorite toxic heavy metal. Early in his career at WashU, he shifted his focus from uranium geochemistry and carbon sequestration to tackling the problem of lead in drinking water. Missouri has a long history of lead mining, often with negative environmental and health consequences. Giammar dug into lead in soil and its eventual leaching into water.

In 2004, lead levels far above the regulatory limit were discovered in Washington, D.C.'s drinking water, prompting widespread concern — especially around the long-term damage lead contamination could cause in children — and an investigation by the U.S. House of Representatives.

True to his roots, Giammar saw a crisis impacting public health where the underlying cause was environmental chemistry, and he knew he could help.

"It was somewhat serendipitous that I had been spending several years really going deep and trying to understand the chemistry of how lead behaves in water, thinking about soils," Giammar said. "Then, something in drinking water comes up, and I know these reactions. I understand this system. This is an area where my lab can contribute our expertise."

Since the 2004 lead crisis, Giammar's group has grown into a leading lab on lead corrosion and related issues around clean drinking water. His team has continued to help mitigate lead in drinking water, primarily through corrosion control, which happens at water treatment plants and can benefit many households. Giammar also served as a technical expert to the Natural Resources Defense Council on a civil suit that was settled for $87 million in March 2017 to provide funds for the replacement of all lead pipes in Flint, Michigan.

"Until we spend the tens of billions of dollars required to get all the lead pipes out of the ground, we're going to need mitigation," Giammar said. "After Flint, we're paying more attention to monitoring lead in drinking water to understand the issue. With that attention and recent investments in infrastructure, I look forward to the day we put ourselves out of business and have solved all drinking water issues related to lead. I'm hoping I'll see that in my career."


WASHU PHOTO

Cultivating collaboration

Giammar was recently appointed the inaugural director of WashU's Center for the Environment, an interdisciplinary hub of environmental research launched as part of the university's Here and Next strategic plan. As director, Giammar fosters collaborative research across the university and beyond, drawing researchers from engineering, environmental science, public health, social work and more.

"If we want to do research that solves the world's problems, we have to collaborate," Giammar said. "It's energizing for lifelong learners to work with other experts and learn what they know. As we've moved more into interdisciplinary research, we need people who have deep expertise and bring that to a team."

The strategic plans recently launched by McKelvey Engineering and WashU open what Giammar sees as a potentially game-changing window of opportunity.

"The societal needs have never been greater, especially for the challenges of climate change and threats to water quality and air quality," Giammar said. "With universitywide strategic planning, we have the broad investment to solve these big problems. I'm excited to see people working together in creative ways in air quality and public health, in sustainable food systems and nutrition, and in connections between biodiversity and infectious disease, like tick-borne diseases and zoonotic disease. These are areas of strengths where we have huge opportunities to make an impact." *M*

WATCH: Learn more about Dan Giammar and his lab

Dan Giammar

Bachelor of Science in Civil Engineering

+ **Carnegie Mellon University**
+ **Adviser:** David Dzombak

Doctor of Philosophy and Master of Science in Environmental Engineering

+ **California Institute of Technology**
+ **PhD thesis topic:** Uranium geochemistry at mineral surfaces
+ **Adviser:** Janet Hering

A New Course

Family inspiration, on-campus community support essential to their success

by Shawn Ballard

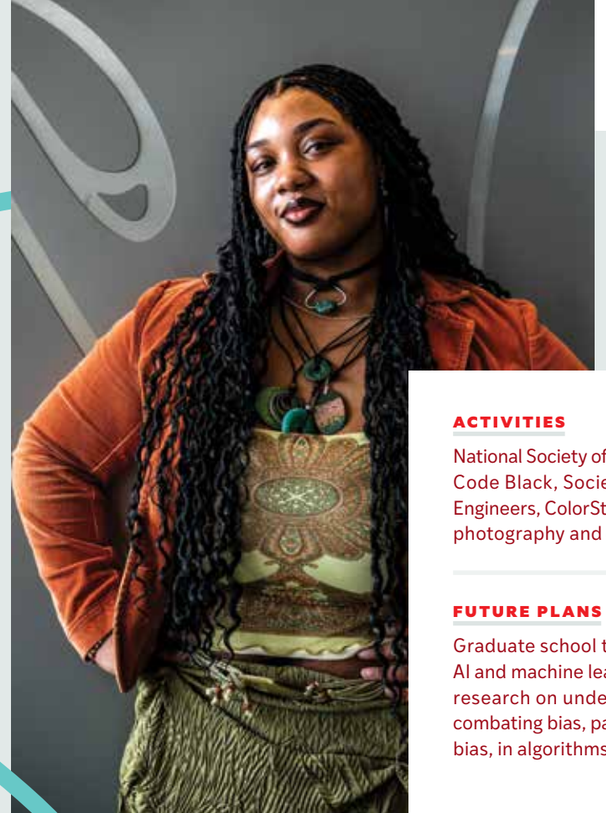
FIRST-GENERATION COLLEGE STUDENTS may not have the same familial models for higher education as their continuing-generation peers, but these driven students craft their own communities and support systems. By charting a different path for themselves, they break down generational boundaries and discover new futures.

"The overall best thing about first-generation students earning college degrees is that it changes all generations after them," said Chris Kroeger, associate dean for undergraduate student services and a first-generation college graduate. "Their kids will be in a better position to go to college, and so will their grandkids. Earning a college degree can have a long-term ripple effect."

First-generation students also enrich the university experience, especially in the STEM fields, said Lisa Gillis-Davis, senior assistant dean, who leads the development of student support initiatives for first-generation undergraduate students in McKelvey Engineering. Research shows that including more underrepresented minority and first-generation students in a class is positively associated with better outcomes for all students in STEM courses.

Around 1,600 of Washington University's 7,400 full-time undergraduate students in the 2023–24 academic year are limited income or first-generation students. In the McKelvey School of Engineering, the share of first-generation students in the incoming class has increased from roughly 5% to 20% in the past decade.

WATCH: Learn more about WashU and our first-gen students.



PHOTOS BY SID HASTINGS

Dominique Bradshaw

CLASS OF 2026 | **HOMETOWN:** St. Louis, Mo.
MAJORS: Data Science in McKelvey Engineering and African and African American Studies in Arts & Sciences

ACTIVITIES

National Society of Black Engineers, Code Black, Society of Women Engineers, ColorStack, FSAP, TRIO, photography and clothing design

FUTURE PLANS

Graduate school to specialize in AI and machine learning; conduct research on understanding and combating bias, particularly racial bias, in algorithms

WHY DID YOU CHOOSE WASHU?

"My dad is from St. Louis, and he always wanted to be a WashU dad. When I was a senior in high school, I toured campus, including McKelvey Hall, where I got to meet with a computer scientist doing research in this beautiful new facility, and I knew I had to come here.

Since I've been a student, WashU has been everything I expected it to be and more. I knew I'd have opportunities to grow, but what has exceeded my expectations is the community I've found here."

Ariel Nochez

CLASS OF 2026 | **HOMETOWN:** Germantown, Md.
MAJORS: Data Science in McKelvey Engineering and Linguistics in Arts & Sciences | **MINOR:** Speech and Hearing Sciences in Arts & Sciences

ACTIVITIES

McKelvey Believes; Unlocked Labs, a nonprofit that teaches basic technology skills to incarcerated and recently released, formerly incarcerated individuals; reading; working and playing with children at the Central Institute for the Deaf; tutoring

FUTURE PLANS

Joint PhD program in hearing and speech science and continuing research in computational linguistics with goal of becoming an audiologist working on hearing aid devices

WHAT ARE THE KEYS TO YOUR SUCCESS?

"My first semester at WashU, I didn't do as well as I wanted, and I struggled in terms of mental health. I could have given up, but my parents taught me the value of hard work, and their example helped me push through and seek out resources. Now I'm doing a lot better both academically and mentally. That 'never give up' attitude that I learned at home helped me find support here at WashU through the Student Success Fund, and the Taylor Center for Student Success."

> **The overall best thing about first-generation students earning college degrees is that it changes all generations after them."**
>
> — CHRIS KROEGER

Jenna Nguyen

CLASS OF 2025 | **HOMETOWN:** Oxnard, Calif., and Phoenix, Ariz. | **MAJOR:** Biomedical Engineering
MINOR: Mechanical Engineering

ACTIVITIES

Researcher in Assistant Professor Nathaniel Huebsch's lab, working on optimizing growth of micro-heart tissue; public relations chair for Washington University STEM Education Association; and resident adviser in the William Greenleaf Eliot Residential College

FUTURE PLANS

Complete master's degree in mechanical engineering in four years alongside bachelor's degree, then continue on to a PhD or enter industry with a focus on research, development and manufacturing of biomedical devices

WHO INSPIRES AND MOTIVATES YOU TO EXCEL?

"My biggest support and inspiration come from the friends I've made at WashU, especially other BME majors, who are going through the same very tough courses I am. I've found my people here. Every one of them — my friends and my partner — are so amazing that they inspire me to do better myself. I always try to be a better person and to expand my perspective beyond my identity as a first-generation, low-income student.

Part of that drive also comes from my family. My grandparents escaped Vietnam on their fishing boat with my father and his siblings during the war, so a lot of what I do is motivated to make my parents proud and to be a good example for my little brother, whom I want to have the same opportunities and support I've had."

Christina Alexakos

CLASS OF 2025 | **HOMETOWN:** Lincolnshire, Ill.
MAJOR: Chemical Engineering
MINOR: Environmental Engineering

ACTIVITIES

Working at the Women & Engineering Center, tutoring General Chemistry, attending WU Cinema events, reading, drinking matcha lattes, and walking in Forest Park

FUTURE PLANS

Renewable energy internship this summer with Electric Hydrogen, which will focus on electrolyzers and fuel cells, then continue with a career in renewable energy space

WHY DID YOU CHOOSE WASHU?

"I chose to study chemical engineering here because of WashU's emphasis on environmental applications. I knew I wanted to pursue a career in sustainability, but I didn't know what that would be exactly.

After taking classes here with professors like Dan Giammar and Young-Shin Jun, I learned there's a lot you can do with renewable energy. There's a lot you can do with water treatment. This degree will help me do what I want to do in sustainability while being hands on and working on issues that give me a sense of purpose and let me make a difference in the world."

Will Smith Jr.

CLASS OF 2025 | **HOMETOWN:** Memphis, Tenn.
MAJOR: Biomedical Engineering

ACTIVITIES

Running club; WashU Robotics Club; Books and Basketball, a student-led group that visits local schools weekly to provide tutoring and engage in recreation with students

FUTURE PLANS

Get a master's degree at McKelvey, then work in the medical device industry at Abbott, building on a summer internship as a development quality engineer

WHO ARE YOUR ROLE MODELS?

"My mom always pushed me to get a college education. She encouraged me to break generational boundaries, and she gives me the support I need to move forward in stressful times. My mom is a single parent with an incredible work ethic, so that has inspired me to work hard, too.

My mentors have also been really helpful for my intellectual and emotional growth. My scholarship sponsor, Rhonda Germany Ballintyn, helped me get acclimated to WashU and continues to mentor me professionally. Professor Patricia Widder and Dr. Patrícia Pereira have helped me feel included and succeed in a really difficult major." *M*

YOUNG ALUMNI

Angelica Harris

PHOTO BY RON KLEIN

Angelica Harris, who earned bachelor's degrees in computer science and finance at Washington University in St. Louis in 2021 and a master's degree in computer science from the McKelvey School of Engineering in 2022, is the founder and CEO of Top Tutors for Us, a software platform that matches Black and Brown high school students with tutors with similar backgrounds and creates personalized test prep curricula to fill gaps in academic skills resulting in higher test scores and admissions rates.

Despite maintaining a 4.0 GPA in her New Orleans high school, Angelica Harris encountered the stark reality of educational inequity when faced with the ACT. Her initial score of 16 left her struggling to reconcile the gap between her academic achievements and test performance. Determined to address this disparity, she enrolled in a test prep course, only to find herself the sole minority among high-scoring peers, which left her feeling disheartened and out of place. Harris took matters into her own hands and created a test prep program focused not only on test strategies but also on academic skill development. Through perseverance and dedication, she elevated her score to 32, with an impressive 35 in math, earning her more than $1.5 million in scholarships. At WashU, Harris was a John B. Ervin Scholar and a member of the varsity women's golf team.

Q: *How did you get Top Tutors for Us started?*

A: While I was in my master's program in computer science, I developed a program for test prep after being a test prep tutor for more than six years. I had helped a family friend improve his score from 18 to 27. As a student, I had the opportunity to participate in Skandalaris Center's Accelerator program. I got to conduct customer discovery with students, teachers, counselors and parents about what they liked about test prep tutoring for minority students. Through these discussions, I discovered a significant disparity in standardized test performance among Black students compared with their peers. Recognizing the importance of these exams, I also found that many Black students experienced feelings of microaggression in traditional test prep programs, with some never having a Black teacher.

My research on cultural competency further emphasized its benefits for students, particularly in closing the education achievement gap. Studies have shown that matching Black students with Black teachers can increase graduation rates by 30%. However, access to qualified Black tutors remains a challenge due to the underrepresentation of Black teachers in the education workforce, particularly Black males, who comprise less than 1.3%. This disparity sparked the idea of Top Tutors for Us.

Q: *How are you building your business?*

A: I've assembled a small team to drive our efforts. With two former engineering students, we focus on developing our technology. We have won two grants in the Skandalaris Venture Competition, and we won an Arch Grant in fall 2023. We are also a finalist for the 2024 Global Impact Award presented by the Skandalaris Entrepreneurship Center. We work in a coworking space where we have weekly training, use mentors, and are developing an investor pitch deck. We're also a part of the Greater St. Louis Diverse Business Accelerator, which came with funding and mentoring, and the Idea Village out of New Orleans, where I am from.

Q: *Who are your customers?*

A: We work in three school districts — two in St. Louis and one in New Orleans. We gained a partnership early on with St. Louis Public Schools. That gave us a lot of validation. They know the problem first-hand and saw that our company could address it.

Q: *What makes Top Tutors for Us different from existing test prep companies?*

A: We're B2B (Business 2 Business), so we're primarily selling to school districts. This approach allows us to offer our test prep program for free to students, removing the traditional financial barrier. Additionally, our program integrates adaptive lesson plans, providing a more personalized learning experience.

But what really differentiates us is our focus on Black and Brown tutors and that cultural competency, which we incorporate in our matching process. Students begin by completing an online assessment, which feeds into our machine learning algorithm. This algorithm then predicts the best culturally relevant tutor in our system for each student.

Our online assessment identifies the academic areas in need of improvement, allowing our Top Tutors to address educational gaps more efficiently. Our average ACT composite increase is 4.8 points. We've helped students get into schools like Stanford, USC, Vanderbilt, Morehouse, and Xavier in Louisiana, scholarships and financial aid. We're proud of our results, and it drives us to work very hard. I love making an impact in students' lives.

We have more than 170 tutors in our database, and more than a third of those are WashU students. We recruit our tutors from top universities, from Howard to Harvard, with a special focus on historically Black colleges and universities. Additionally, we leverage their networks to collaborate with diversity centers like Black student unions, further enhancing our commitment to diversity in education.

Q: *How did your McKelvey Engineering education prepare you for this?*

A: My engineering education provided me with the necessary skills to develop web apps. Without my engineering background, I would have faced substantial expenses hiring a software engineer to create Top Tutors for Us' web application. Understanding the app development process has significantly reduced our startup costs. One of my favorite courses during my graduate program at McKelvey was Machine Learning, where I gained an understanding of the mathematical principles behind algorithms. It's exciting to apply that knowledge by deploying these algorithms in my current work.

Mentorship Programs Help Students ‘Engineer’ a Successful Career

by Blaire Leible Garwitz

Being an engineering student is tough, and it helps to talk to someone who’s been there, done that. By connecting with a mentor, students can gain valuable knowledge and receive the support they need to achieve success. Finding a good mentor can sometimes be tricky, but for students at the McKelvey School of Engineering, it’s easy to “engineer” a good partnership. The school offers several different virtual and in-person mentoring programs, from flash mentoring to yearlong pairings.

Ian Smith

Master’s degree in information systems management, 2018

Senior Software Developer at Bayer

Connecting with alumni worldwide

Two of the programs use a digital platform (McKelvey CNX for undergraduates and Mentor Collective for graduate students) to connect with alumni around the world. Students can reach out to an alum for a quick chat to answer a specific question or sign up for yearlong one-on-one mentoring to work toward personalized goals.

“Students can seek advice on getting through a tough course, applying for internships, interviewing for jobs, moving up in the industry and finding work/life balance,” says Melanie Osborn, senior assistant dean for engineering study abroad and advising.

Jodi Small, who earned a bachelor’s degree in biomedical engineering in 2015, has served as a mentor for more than five years with McKelvey CNX. “By sharing the knowledge I’ve gained, I can help the next generation of students be successful,” says Small, an IT manager at Abbott.

Ian Smith, who earned a master’s in information systems management in 2018, agrees.

“I do all I can to help my mentees achieve great success,” says Smith, a senior software developer at Bayer, who has mentored more than two dozen students through Mentor Collective. “Mentoring is an enriching experience for me.”

Meeting with community leaders

For students looking for mentoring and networking in the local community, McKelvey Engineering offers a program in partnership with the Regional Business Council, where students can get both real-world knowledge from St. Louis business leaders and insight into regional job opportunities.

While at WashU, Nicholas O’Brien, who earned a bachelor’s degree in engineering in 2017 through the UMSL/WashU Joint Engineering Program, participated in this program, which led to his current job in Boeing’s flight simulation labs.

Bachelor’s degree in biomedical engineering, 2015

IT Manager at Abbott

Jodi Small

> **By sharing the knowledge I’ve gained, I can help the next generation of students be successful.**
>
> **– JODI SMALL**

Exploring specific companies

McKelvey Engineering also offers several programs in which students are paired with a mentor at a specific company.

O'Brien is involved with the Boeing Mentor Program and trains other mentors at the company. Three of the students he previously mentored now work at Boeing.

"I am a strong believer in mentorship and try to support those behind me as much as learn from those ahead of me," he says. "This has helped me grow in innumerable ways, keeps me focused and grounded, and helps me stay curious."

Ashish Heda, who earned a bachelor's degree in biomedical engineering in 2014, has been involved with the Deloitte Mentor Program for five years.

"The Deloitte program is unique because it lays the groundwork for careers in the consulting field," says Heda, manager of strategy and analytics at Deloitte. "We work with students on resume writing, interviewing, networking and preparing for internships and jobs."

Supporting women in engineering

The Mastercard Mentor Program pairs members of the Women in Computer Science organization with a woman Mastercard employee to learn how to thrive in a field in which women have historically been underrepresented.

"We need more women engineers because it's critically important that the people who are mapping out the future of our world and creating the solutions and technology we need to navigate as human beings are representative of the population," says Christine Dearmont, director of McKelvey Engineering Women & Engineering Center.

The center empowers women engineering students to grow in the field through mentoring programs, including one-on-one partnerships, group mentoring based on certain themes or topics, and peer mentoring.

"Women supporting each other in the industry is important," says Yun Que, who earned a bachelor's in mechanical engineering in 2009 and is in her first year as a mentor through WE Pairs, the center's yearlong one-to-one program. "It's great having that perspective and insight from other women because we see and experience the world a little differently."

Bachelor's degree in biomedical engineering, 2014

Strategy and analytics manager at Deloitte

Ashish Heda

Yun Que

Bachelor's degree in mechanical engineering, 2009

Quality engineer at BMW

Nicholas O'Brien

Bachelor's degree in engineering through UMSL/WashU joint program, 2017

Hardware interface systems manager at Boeing

Experiencing mutual benefits

By devoting their time to mentoring, alumni can give back to WashU and support future engineers.

"I wanted to give back to the WashU community that gave so much to me," Que says. "It's inspiring to see the next generation of engineers graduating from the program and entering the industry."

And it's not just students who benefit from mentoring — the experience is valuable for alumni as well.

"The students I've mentored have become part of my family," says Pamela Schweppe, who earned a master's in civil engineering in 1997 and has been involved with WE Pairs for five years. "I helped place two mentees at Lockheed Martin with my extensive aerospace and defense network, and so many of them still reach out to me today. Mentoring has also helped me in my own career. Because of my experience with mentoring and my knack for coaching, I was promoted to vice president of global accounts at iBASEt. Mentoring helped me to expand my role, and I try to pass this along to my mentees."

> **"Students can seek advice on getting through a tough course, applying for internships, interviewing for jobs, moving up in the industry and finding work/life balance."**
>
> — **MELANIE OSBORN**
> *Senior assistant dean for engineering study abroad and advising*

Pamela Schweppe

Master's degree in civil engineering, 1997

VP Global Accounts at iBASEt

IN MEMORIAM

Salvatore P. Sutera, former Engineering dean and professor, 90

Sutera was chair of mechanical engineering & materials science and founding chair of the Department of Biomedical Engineering

Salvatore P. Sutera, former dean of the Engineering school at Washington University in St. Louis and the Spencer T. Olin Emeritus Professor, died Tuesday, Nov. 7, 2023, in St. Louis. He was 90.

For more than 40 years, Sutera was an academic leader at Washington University's School of Engineering & Applied Science, serving as the school's dean from 2008 to 2010, and was an internationally recognized scholar in biomechanics. He and his collaborators made many contributions to the understanding of blood flow in the mammalian microcirculation, flow-induced trauma to blood in artificial organs, and mechanical properties of the red blood cell in health and disease. His research programs won continuous sponsorship from the National Institutes of Health, and his publications include nearly 100 technical papers and two book chapters.

"In a testament to his dedication to the School, in 2008 Sal agreed to come out of retirement after several years to serve as interim dean after a tumultuous leadership transition," said Aaron F. Bobick, dean and the James M. McKelvey Professor. "Sal was not only a successful and respected administrator, but he was also internationally recognized for his research in biomechanics and was a great mentor and friend to many faculty and students."

"This is the end of an era," said David Peters, the McDonnell Douglas Professor of Engineering. "Sal became chair when I was a junior, and he was relentless in talking me into coming back to WashU as a professor. He was always a great friend."

Under his leadership as dean, the school set new records in the quality, size and diversity of the student body. He oversaw the launch of several new master's programs and also interdisciplinary undergraduate minors in mechatronics and energy engineering. Sutera recruited 10 tenured and tenure-track faculty, increasing the total size of the faculty to 81. Perhaps the most visible development during his tenure as dean was the construction of Stephen F. & Camilla T. Brauer Hall, a 150,875-square-foot building featuring state-of-the-art research laboratories and specialized instructional facilities, in 2010.

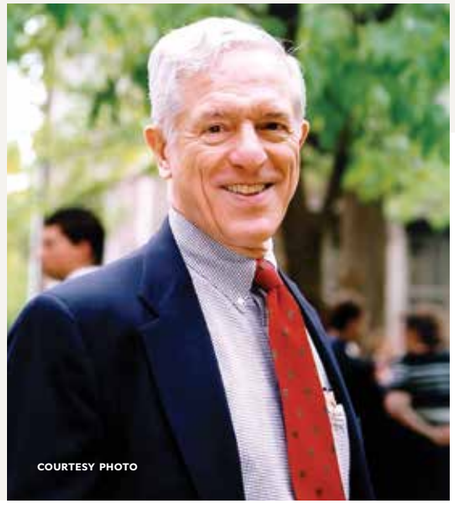
WASHU PHOTO

Sutera joined the faculty at Washington University in 1968 as professor of mechanical engineering and served as chair of mechanical engineering from 1968 to 1982, then again from 1985 to 1997. After the university created the new Department of Biomedical Engineering in 1996, Sutera also served as the founding and acting chair of biomedical engineering during the department's first year. In 1997, he was installed as the first Spencer T. Olin Professor of Engineering & Applied Science, an endowed professorship he held until his retirement. Over the course of his 40-year career at Washington University, Sutera touched the lives of thousands of engineering students, both as a professor in the classroom and laboratory and also as department chair and dean.

"An accomplished scholar, wise mentor and supportive colleague, Sal was a golden role model for any professor or department chair," said Philip V. Bayly, chair of the Department of Mechanical Engineering & Materials Science and the Lee Hunter Distinguished Professor. "He recruited and nurtured a generation of faculty in mechanical engineering at Washington University, building outsized strength in biomechanics, fluids and materials research, along with an uncompromising commitment to undergraduate education. He welcomed me and my family to St. Louis and guided me gently through my early years on the faculty and as chair of MEMS. For all Sal's many contributions to engineering and Washington University, I remember his kindness and courtesy the most."

"The scope of Sal's legacy is remarkable," said Guy Genin, the Harold and Kathleen Faught Professor of Mechanical Engineering. "As chair of mechanical engineering, he recruited one of the premier structural materials research groups — in the 1970s and '80s, WashU became a world leader in composites and fatigue. As founder of the Washington University Department of Biomedical Engineering, he hand-picked the original faculty that grew into a much-renowned program. As dean, his diplomacy piloted us through troubled waters and led us to the new and exciting opportunities we're exploring today. Underlying all of these professional achievements was a steadfast friend and a true gentleman who contributed much to the warm, collaborative spirit that continues to define WashU engineering."

Before joining Washington University, Sutera was a faculty member at Brown University, where he worked from 1960 to 1968. During his last two years at Brown, he served as executive officer for the Division of Engineering.



COURTESY PHOTO

In addition to his academic career, Sutera held several industrial positions, including at the Glen L. Martin Co., Baltimore; North American Aviation, Downey, California; E.I. duPont de Nemours & Co., Newark and Wilmington, Delaware; and Electro-Optical Systems Inc., Pasadena, California.

Throughout his career, Sutera was active in numerous professional societies, among them the American Society of Mechanical Engineers, American Society for Engineering Education, American Association for the Advancement of Science, Biomedical Engineering Society and North American Society of Biorheology.

Sutera earned a bachelor's degree in mechanical engineering in 1954 from Johns Hopkins University and a master's degree and doctorate in mechanical engineering from the California Institute of Technology in 1955 and 1960, respectively. A native of Baltimore, Sutera, who was the first Sutera to attend college, credited his education at the Baltimore Polytechnic Institute with getting him off to a good start in academia.

In 1956, Sutera spent the year as a Fulbright Fellow in Paris conducting research in a French government laboratory. In addition to the year in Paris as a student, Sutera spent a semester as a visiting professor at the University of Paris in 1973. He also was an active member of the Alliance Française of St. Louis for several decades, served on the Board of Directors of St. Louis-Lyon Sister Cities Inc. and was an active board member of the Italian Club of St. Louis for many years.

Sutera is survived by his wife, Celia; brother, Tom; daughters Marie Woodruff and her husband, Bob; Annette Sutera; and Michelle Ludwig and her husband, Danny; four grandchildren and one great-granddaughter.

A memorial mass was held Nov. 25, 2023, at Immacolata Catholic Parish, 8900 Clayton Road, Richmond Heights, Missouri.

Memorial contributions may be made to the Sutera Family Endowed Scholarship for Engineering at Washington University in St. Louis.

> **"As dean, his diplomacy piloted us through troubled waters and led us to the new and exciting opportunities we're exploring today.**
>
> — GUY GENIN

Chen, Silva named senior members of National Academy of Inventors


Hong Chen and Jonathan Silva, both faculty members in the Department of Biomedical Engineering in the McKelvey School of Engineering at Washington University in St. Louis, have been named senior members of the National Academy of Inventors. They will be inducted in June 2024.

Chen and Silva are being recognized as academic inventors who are rising leaders in their fields with success in patents, licensing and commercialization and for producing "technologies that have brought, or aspire to bring, real impact on the welfare of society." They are among 553 senior members affiliated with NAI member institutions worldwide.

Chen, associate professor of biomedical engineering and of neurosurgery in the School of Medicine, focuses on medical ultrasound. Her goal is to develop ultrasound technologies for non-invasive diagnosis and treatment of brain diseases, as well as the deepening of our understanding of brain functions.

Chen co-invented the sonobiopsy technology with Eric C. Leuthardt, MD, the Shi Hui Huang Professor of Neurosurgery and a professor of biomedical engineering, of mechanical engineering and of neuroscience. Sonobiopsy uses focused ultrasound to target a precise location in the brain.

Silva, professor of biomedical engineering, developed software to provide a holographic display to physicians who perform catheter ablations for arrhythmia. Their system, the first FDA-cleared application of its kind, integrates existing imaging systems to create a real-time 3D holographic interface that provides physicians with a more precise way to deliver cardiac ablation therapy to treat arrhythmia patients. This software was recently tested in humans, and the results showed that physician accuracy was significantly improved with the display. Widespread availability of the system in the United States is expected in 2025.

Zhou elected Fellow of Optica, American Heart Association

Chao Zhou, professor of biomedical engineering, has been elected a Fellow of Optica and the American Heart Association. The honor recognizes Chao's outstanding achievements that help shape the future of optics and photonics. He was selected for pioneering advancements in parallel OCT imaging technologies and the development of non-invasive optogenetic pacing techniques in animal models. In addition, Zhou was elected a Fellow of the American Heart Association. This fellowship recognizes members for excellence; innovative and sustained contributions in the areas of scholarship, practice and/or education; and volunteer service within the association.

Wagenseil, Woodhams win Emerson Excellence in Teaching Awards


Jessica Wagenseil and Louis Woodhams were among nine Washington University in St. Louis faculty members selected as 2023 Emerson Excellence in Teaching Award recipients.

Wagenseil is a professor of mechanical engineering & materials science and vice dean for faculty development. She studies cardiovascular mechanics, specifically focusing on cardiovascular development, extracellular matrix proteins, and microstructurally based constitutive modeling. Her work is important for testing clinical interventions for elastin-related diseases and for designing better protocols for building tissue-engineered blood vessels.

Woodhams is a senior lecturer of mechanical engineering & materials science. He uses computational methods to study and model the mechanics and dynamics of cells and cell appendages.

Here and Next
WashU

McKelvey Engineering faculty members awarded Fall 2023 Here and Next Seed Grants

Six faculty members from Computer Science & Engineering and Energy, Environmental & Chemical Engineering have received awards from the Fall 2023 Here and Next Seed Grant Program, sponsored by the Research Development Office, within the Office of the Vice Chancellor for Research.

This program encourages novel and innovative interdisciplinary research excellence among WashU researchers. Research must address five key areas of focus within the Here and Next agenda: public health, global health, environmental research, digital transformation and research impacting the St. Louis community.

The awards to the McKelvey Engineering faculty are:

» *AI for Examining and Predicting Family Involvement with Child Protection Systems*
Co-PIs: Eunhye Ahn, Brown School; Yevgeniy Vorobeychik, McKelvey Engineering

» *Using Mobile Health Technology to Assess Degenerative Cervical Myelopathy*
Co-PIs: Jacob Greenberg, School of Medicine; Caitlin Kelleher, McKelvey Engineering; Brian Johnson, School of Medicine

» *Measuring Spatial Inequities in Urban Communities*
Co-PIs: Rodrigo Siqueria Reis, Brown School; Nathan Jacobs, McKelvey Engineering

» *Leveraging AI to Optimize mHealth's Impact for Reducing Opioid-Related Overdose Deaths in Missouri*
Co-PIs: Hannah Szlyk, School of Medicine; Chenguang Wang, McKelvey Engineering

» *Smart Kitchen to Support Independence for People with Subjective Cognitive Decline*
Co-PIs: Lisa Tabor Connor, School of Medicine; Chenyang Lu, McKelvey Engineering; M. Carolyn Baum, School of Medicine

» *The Environmental Sources of the Infant Nasal Microbiome*
Co-PIs: Leyao Wang, School of Medicine; Jian Wang, McKelvey Engineering

» *The Geospatial Research Initiative* was the one funded university-wide research initiative.
Co-Leads: Nathan Jacobs, McKelvey Engineering; Alex Bradley, Arts & Sciences; Michael Frachetti, Arts & Sciences; Jennifer Moore, Libraries/Arts & Sciences

Oyen named among trailblazing leaders in women's health, FemTech

Michelle Oyen, associate professor of biomedical engineering, has been named among the 200 Trailblazing Leaders in Women's Health and FemTech for 2023 by Women of Wearables. The list recognizes leaders who have dedicated themselves to enhancing the health and well-being of women through their innovative solutions and products for women's health concerns. It also recognizes them for increasing awareness and advocacy efforts surrounding women's health issues. Oyen is director of the Center for Women's Health Engineering at Washington University.

Flores named ASM Fellow

Katharine M. Flores, the Christopher I. Byrnes Professor, has been elected a Fellow of ASM (American Society for Metals) International for her contributions to the field of materials science and engineering. Flores, also associate chair for materials science in the Department of Mechanical Engineering & Materials Science and director of the university's Institute for Materials Science & Engineering, was selected "for contributions to development and processing of metallic glasses and multi-principal element alloys and the characterization of structure, flow and fracture in these materials."

Agarwal receives SAE International Award for Aerospace Innovation

Ramesh Agarwal, the William Palm Professor of Engineering, has been awarded the SAE International Award for Aerospace Innovation. The award recognizes individuals or teams who have demonstrated outstanding innovation in aerospace engineering, making significant contributions during their careers in the innovative design and development of advanced aircraft or spacecraft and resulting in industry- or life-changing impact. Winners' achievements must represent unique and original engineering applications or innovations that have had a demonstrable positive impact on aerospace, and they should have a distinguished career in aerospace with proven accomplishments in the innovative design or operational availability of aircraft or spacecraft.

Parker receives Morgan Early Career Award

Kimberly Parker, assistant professor of energy, environmental & chemical engineering in the McKelvey School of Engineering, won the 2024 James J. Morgan Early Career Award. The honor recognizes Parker's research contributions to environmental chemistry of agrochemicals, environmental impact of novel synthetic biology products, and reaction mechanisms for water treatment and environmental health.

The Morgan Early Career Award is given each year by the Environmental Chemistry Division of the American Chemical Society (ACS); its flagship journal, *Environmental Science & Technology* (*ES&T*); and *ES&T Letters*. The award was established in 2014 in honor of Morgan, the first editor-in-chief of *ES&T*, and recognizes researchers early in their careers who are making waves in environmental science and technology.

Genin awarded Savio L-Y. Woo Translational Biomechanics Medal

Guy Genin, the Harold and Kathleen Faught Professor of Mechanical Engineering and a pioneer in the translation of mechanobiology into improved devices and techniques, has been awarded the Savio L-Y. Woo Translational Biomechanics Medal from the American Society of Mechanical Engineers (ASME). The Savio L-Y. Woo Translational Biomechanics Medal, established in 2015, recognizes an individual who has successfully brought meritorious bioengineering research into clinical practice. Genin earned the award for game-changing innovations in surgical catheters and image analysis, as well as for his leadership in research, education and mentoring.

Genin has spent decades uncovering the ways that plants and animals manipulate forces, fluids and flows. He has collaborated broadly with students and colleagues at the Washington University School of Medicine to translate these natural design principles into transformative solutions for vascular surgery challenges.

Weisensee wins Young Investigator Program

Patricia Weisensee, assistant professor of mechanical engineering & materials science in the McKelvey School of Engineering, has received a Young Investigator Program award from the Air Force Office of Scientific Research (AFOSR). Weisensee is one of 48 scientists and engineers selected as part of the program, designed to foster creative basic research in science and engineering, enhance early career development of outstanding young investigators and increase opportunities for engagement in the Air Force's mission and related challenges in science and engineering.

IN MEMORIAM

Curt Thies, professor of chemical engineering, 89

Curt Thies, a professor of chemical engineering in the Engineering school at Washington University in St. Louis for 30 years, died Saturday, Jan. 6, 2024, from complications of dementia. He was 89.

Thies joined the Engineering school faculty at WashU as an associate professor in 1973. He became full professor in 1976 and retired in 2002.

Thies' research area was in microencapsulation, which is commonly used today in sustained-release medications. He was a member of an international research team developing targeted drug delivery for cancer. The team invented biodegradable microspheres filled with anticancer chemicals to be injected into veins and arteries to make use of the body's own delivery system to send deadly messages to tumors.

He also collaborated on a project to develop a long-acting form of a drug used to treat alcoholism by microencapsulating the drug for injection. This drug produced aversive symptoms in those who drink even small amounts of alcohol. Another project involved the use of microcapsules for fertilizing mushrooms: By putting fertilizer into a microcapsule that dissolves at a known rate, mushroom growers could fertilize less frequently.

More Plastic Than Fish

by Marcus Foston

The MacArthur Foundation's report, "The New Plastics Economy: Rethinking the Future of Plastics," includes a stark warning that by 2050, our oceans could contain more plastic than fish and serves as an urgent call for innovative environmental solutions. This report and prediction are part of a growing conversation about the legacy we leave future generations and the urgent need to redefine our relationship with not only plastics, but also with fossil fuels. This situation calls for a transformative approach to addressing plastic pollution that spotlights the innovative potential of synthetic biology and biomanufacturing. These fields hold the promise of not just mitigating the crisis but fundamentally rethinking our production and consumption of plastics. For example, by harnessing the power of biology, we can engineer microbes to consume plastic waste or produce biodegradable alternatives and transform the problem of plastic waste into an opportunity. This vision aligns with a future circular economy that emphasizes developing biodegradable materials and recycling existing plastics into valuable resources. As we navigate a list of societal challenges, the choices we make and technologies we develop today will shape the legacy we leave for future generations.

"By harnessing the power of biology, we can engineer microbes to consume plastic waste or produce biodegradable alternatives and transform the problem of plastic waste into an opportunity."

– MARCUS FOSTON

Marcus Foston is associate professor of energy, environmental & chemical engineering, co-director of the Synthetic Biology Manufacturing of Advanced Materials Research Center and director of diversity initiatives in the McKelvey School of Engineering.

Washington University in St. Louis
James McKelvey School of Engineering

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Jackson Potter (center), lecturer in the Department of Mechanical Engineering & Materials Science, with (from left) Juliana Bush, Anya Gupta and Helena Teixeira-DaSilva looking at a prototype at the MEMS 411 (Senior Design) "Prototype Expo" event.

WASHU PHOTO/JOE ANGELES