MCKELVEY ENGINEERING

Momentum

Across Disciplines. Across the World® // **FALL 2019**

Washington University in St. Louis

Snapshot //

A trio of students studying electrical & systems engineering helped to expand the solar power generating capabilities at the Tyson Research Center, which has frequent outages and suffers from a failing power grid. As part of their senior design capstone course last spring, Kyle Cepeda, Sarah Chen and Maya Coyle designed a sustainable power system for the center using materials from previous projects. The team got so invested in the design that it decided to continue its work the following semester as an independent study course.

WHITNEY CURTIS

From the dean //

Dear Friends,

As dean, most of my day is spent meeting with people connected to the operations of the school, learning about possible opportunities or challenges, and then making decisions. And while I always try to remember the goals and initiatives of our strategic plan — still online and discussed in the magazine two years ago — much of the effort is absorbed by purely tactical considerations.

But this fall and this magazine edition are great reminders to me — and I hope to you — the power of Thinking Big.

Dean Aaron Bobick and Jim McKelvey Jr.

Our cover story, and in some sense the story of the century for Engineering, is about Jim McKelvey Jr. As I mentioned in the last edition — and I hope you have heard through numerous outreach efforts — this past spring, Jim and his wife, Anna McKelvey, provided a unparalleled gift to name the school. This transformative act will propel us forward, reaching more students, impacting more domains and contributing to the region and the world in new and innovative ways. When you read about Jim, I hope you will take away the same lesson I do: see the opportunity and seize it in a big way. Just because it hasn't been done before doesn't mean you can't go after it, and at scale. And it is scale that makes the impact.

Also this fall, we dedicated the new East End, when we celebrated the biggest construction project ever on the Danforth Campus. The result is five new buildings (two for Engineering, including Henry A. and Elvira H. Jubel Hall for Mechanical Engineering & Materials Science and James M. McKelvey, Sr. Hall for Computer Science & Engineering), a two-floor underground parking garage, and a magnificent park anchoring the entire East End. While the entire construction took only 22 months — with the exception of McKelvey Hall, which was added later to the project — the planning for the project was considerably longer. Chancellor Emeritus Mark Wrighton once said: "There is nothing Washington University cannot do if it makes a plan." Frankly, the plan was audacious; the execution, extraordinary; and the impact, undeniable. The power of Thinking Big.

As we move McKelvey Engineering forward, I hope you will join me in helping us to Think Big — helping us to focus on what we can achieve if we are determined, passionate and fearless. And to make sure that I and the deans that follow spend our days advancing the truly important goals.

Aaron F. Bobick
Dean & James M. McKelvey Professor
afb@wustl.edu

DEAN'S **PODCAST**

ENGINEERING *the* FUTURE

The host, Dean Aaron Bobick, talks with engineers and scientists who provide expert insight on how they are addressing problems through research and emerging technologies and helps to break down sometimes complex ideas and methods into easy-to-understand language. You'll get a better grasp on many issues affecting our environment, our health and our security.

Available on iTunes and SoundCloud

engineering.wustl.edu/podcast

In this issue //

FALL 2019

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THE BUZZ

We are McKelvey!

A historic milestone

On Jan. 31 the school changed its name to the McKelvey School of Engineering following a gift from trustee and distinguished alumnus Jim McKelvey Jr. *Read more on pg. 16*

The first-ever multi-department STEM Poster Palooza celebrated undergraduate research.

Yes! McKelvey Engineering undergraduate students can now study abroad in London and get up to six class credits.

Women at work

Trading a backpack for a hard hat

"As an intern, everyone on my Jubel Hall team was male, but no one ever made me feel like my voice was not important. No one ever shut me down or failed to ask if I had anything else to say at the end of a meeting."

Maya Wong, master's in mechanical engineering, Class of 2018

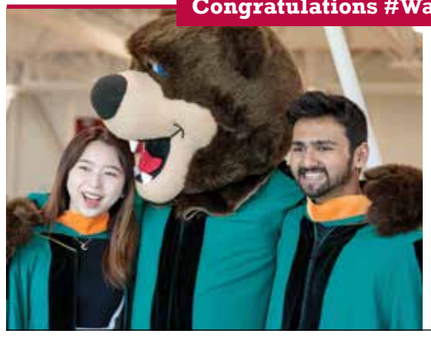
WUSEF ignites love of research in junior BME student

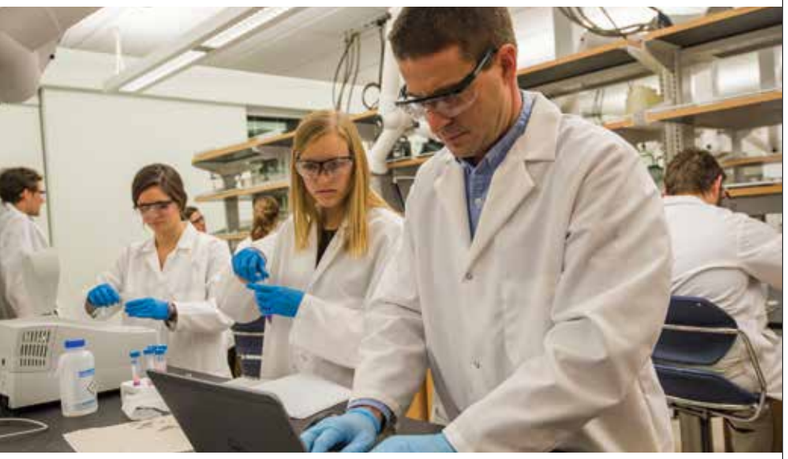
"What I like about medicine — why I want to be a doctor — is how you can make a difference and interact with people from diverse backgrounds."

Andrew Whitaker, a junior majoring in biomedical engineering

Alumnus Richard Bose manages the technical efforts of the SuperTIGER and X-Calibur research teams in Antarctica.

Congratulations #WashU19





McKelvey School of Engineering debuts undergraduate environmental engineering degree

Every year, about 40 students in the McKelvey School of Engineering's Department of Energy, Environmental & Chemical Engineering (EECE) earn a bachelor's degree in chemical engineering. About a quarter of those students also receive a minor in environmental engineering science.

Beginning in the fall of 2019, however, EECE welcomed its first cohort of students who will graduate with a bachelor's degree in environmental engineering. In true Washington University form, it won't be a typical environmental engineering program.

"We'll have more thermodynamics. More mass and energy balance. More green engineering," said Daniel Giammar, the Walter E. Browne Professor of Environmental Engineering and chair of the group that developed the new program.

That's "more" in comparison to traditional environmental engineering programs, which tend to have developed in concert with civil engineering programs, Giammar said. "It will be environmental engineering with the greatest utilization of chemical engineering."

Or, as Pratim Biswas, the Lucy & Stanley Lopata Professor and chair of EECE, put it: "We are offering environmental engineering with a chemical engineering flavor and more."

Among the differences between this new program and those tied to civil engineering will be the study in some of the foundational sciences.

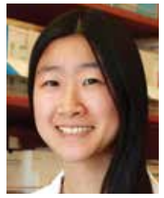
"The amount of physics, chemistry and math are somewhat similar," Biswas said. "But more chemistry, some biology, more math is required in chemical engineering, which will help with environmental engineering."

In addition, students will study more thermodynamics and mass and energy balance, transport phenomena, and the application of these foundational subject areas to not only understand environmental problems, but also help in solving them.

Environmental engineering students' early coursework will closely mirror that of their chemical engineering peers. Once they advance into more specialized coursework, chemical engineers will have the option to take some of the environmental engineering courses as electives.

Written by Brandie Jefferson

McKelvey Engineering student Xu receives prestigious Goldwater Scholarship



A McKelvey Engineering student has received the prestigious Barry Goldwater Scholarship, which honors students who conduct research in the natural sciences, mathematics and engineering.

Lily Xu, a biomedical engineering major, is a research intern at the School of Medicine, where she studies virus proteins and the Zika virus. Xu wants to conduct research in biomedical engineering with a focus on virology.

More than 5,000 college sophomores and juniors applied for the scholarship, which was established by Congress in 1986 to honor the legacy of U.S. Sen. Barry Goldwater. Scholars receive a $7,500 award.

McKelvey Engineering hosted summer research program in thermal management

Undergraduate students interested in learning more about thermal management research had the opportunity to participate in a new summer research program at the McKelvey School of Engineering in the summer of 2019.

The Research Experience for Undergraduates (REU) Site program, Thermal Management on Multiple Scales, is supported by a three-year, $367,000 grant from the National Science Foundation. It is designed for rising juniors and seniors from academic institutions where research opportunities in science, technology, engineering and math (STEM) are limited and included 50% women and 30% of students from groups traditionally underrepresented in the STEM fields, including those with disabilities.

HIVE wins $30,000 grand prize in 2019 Discovery Competition

"This year's teams were a great mix of teams ready to hit the ground running with their products and teams with exciting potential technology development," said Dennis Mell, director of the Discovery Competition and professor of practice in electrical & systems engineering.

HIVE's technology is designed to monitor compliance with outpatient parental antimicrobial therapy (OPAT). The goal is to provide accurate, real-time data to physicians and insurance companies, including but not limited to: when the patient takes their medication, how many times a day the patient takes their medication, and how long the patient takes their medication. The key aspect of its technology is that it will not require any additional steps by the user.

Team members include Joe Beggs (CEO/engineer), a student majoring in biomedical engineering; Sai Dodda (clinical coordinator), a student at St. Louis College of Pharmacy; Allie Frank (clinical coordinator), a master's student in occupational therapy; Glen Kleinschmidt (engineer), a BS/MS student in biomedical engineering; and Chris Sleckman (engineer), a BS/MS student in biomedical engineering.

Students take first place at Deloitte cybersecurity competition

A team of students from the McKelvey School of Engineering took first place at the 2019 Deloitte Capture the Flag Competition.

Students Pranav Maddula, Patrick Naughton, Ryan Xu and Yiheng Yao won $3,000 at the competition, hosted by Venture Café St. Louis. Maddula, Naughton and Xu are sophomores, and Yao is a first-year student.

WashU Racing moves up 14 spots at 2019 Formula SAE Michigan

WashU Racing, the formula-style racing club at the McKelvey School of Engineering, wrapped up another successful season at Formula SAE Michigan, held May 8-11. The team placed 19th in the design competition and 47th overall — moving up 14 spots compared with last year.

"This season was a massive overhaul of the entire platform of the car, and we are very proud of the results it has yielded thus far," said Alex Dutton, 2018-19 president of WashU Racing and a senior majoring in mechanical engineering. "This new architecture for the project led us to take a more analytical focus on the development of the car by placing a priority on concrete testing and hand calculations."

Washington University, Saint Louis University partner to grow region's economy

COLLAB
WASHINGTON UNIVERSITY / SAINT LOUIS UNIVERSITY

Washington University in St. Louis and Saint Louis University are launching the COLLAB, a first-of-its-kind initiative designed to harness the research- and talent-generation capacities of the region's universities to accelerate innovation and growth through connection, collaboration and commercialization.

Underscoring their shared commitment to the St. Louis region, the two universities will share space in the COLLAB, a 7,700-square-foot suite in the heart of Cortex, the region's largest innovation district.

Through the COLLAB, Washington University and SLU will pursue joint and separate programs that educate and train students in cybersecurity, entrepreneurship and other high-demand fields; move research discoveries into the marketplace; and build innovative partnerships with industry. The COLLAB will also support the growth of university-industry collaborations in areas of common regional interest, such as technology talent, geospatial research, data science and health informatics.

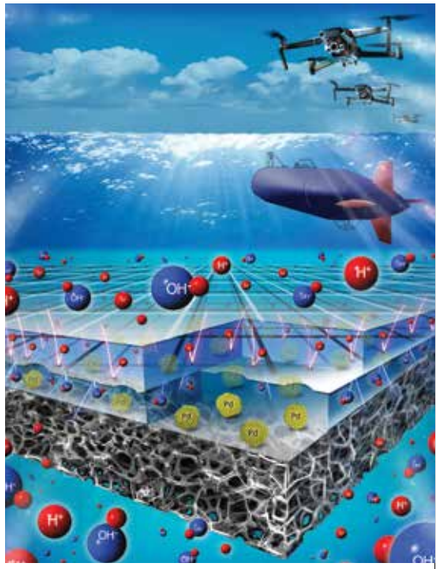
Written by Brandie Jefferson

High-powered fuel cell boosts electric-powered submersibles, drones

The transportation industry is one of the largest consumers of energy in the U.S. economy with increasing demand to make it cleaner and more efficient. While more people are using electric cars, designing electric-powered planes, ships and submarines is much harder due to higher power and energy requirements.

A team of engineers in the McKelvey School of Engineering has developed a high-power fuel cell that advances technology in this area. Led by Vijay Ramani, the Roma B. and Raymond H. Wittcoff Distinguished University Professor, the team has developed a direct borohydride fuel cell using a unique pH-gradient-enabled microscale bipolar interface (PMBI) that operates at double the voltage of today's commercial fuel cells.

This advancement using a unit pH-gradient-enabled microscale bipolar interface (PMBI), reported in *Nature Energy* Feb. 25, could power a variety of transportation modes — including unmanned underwater vehicles, drones and eventually electric aircraft — at significantly lower cost.



"The pH-gradient-enabled microscale bipolar interface is at the heart of this technology," said Ramani, also professor of energy, environmental & chemical engineering. "It allows us to run this fuel cell with liquid reactants and products in submersibles, in which neutral buoyancy is critical, while also letting us apply it in higher-power applications, such as drone flight."

Pioneering biopreservation method to focus on kidney, prostate cancers

An interdisciplinary research team at Washington University in St. Louis has been developing a low-cost alternative preservation method using nanotechnology that does not require any refrigeration. Srikanth Singamaneni, a professor in the McKelvey School of Engineering, and Jeremiah Morrissey, a research professor of anesthesiology at the School of Medicine, will validate their novel preservation method using biomarkers for kidney and prostate cancers with a three-year, $550,000 grant from the National Cancer Institute of the National Institutes of Health.

Singamaneni and Morrissey use an emerging class of nanoporous materials known as metal-organic frameworks (MOF) that form a protective

layer around proteins and other biomolecules in a sample of blood, urine, serum or plasma, essentially shrink-wrapping the biomarkers and preserving them regardless of temperature. With this funding, they will test the MOFs with perilipin-2 and aquaporin-1, protein biomarkers for kidney cancer in urine, and prostate-specific antigen and circulating miRNA, miR-141, an emerging molecular biomarker, for prostate cancer in serum.

Chen receives $1.6 million to study combining intranasal drug delivery, focused ultrasound

Hong Chen, assistant professor of biomedical engineering and of radiation oncology at the School of Medicine, received a $1.6 million grant from the National Institutes of Health's National Institute of Biomedical Imaging and Bioengineering. The research will fund a broader understanding of Chen's earlier work combining intranasal drug delivery and focused ultrasound.

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Faculty members have NSF CAREER Awards

Wang wins NASA grant

Jian Wang, professor of energy, environmental and chemical engineering in the McKelvey School of Engineering, received a $516,989 grant from NASA to study the ways in which aerosol particles affect clouds — and how clouds affect aerosols. Wang will deploy a novel instrument he developed onboard NASA research aircraft that flies for about eight hours at a time.

NSF CAREER Award

Boosting scientific discovery through intelligent experimental design

Roman Garnett, in the McKelvey School of Engineering, will build new algorithms for a method known as active machine learning that will accelerate extracting knowledge from big data with a five-year, $497,693 CAREER Award from the National Science Foundation (NSF).

"We take data that we've already collected and use it to give us an idea about what is happening," said Garnett, assistant professor of computer science & engineering. "Then we build a model to reason about what outcomes of new experiments might be based on what we've already learned. We use that model with our goals to develop a rule or method to look at a large collection of data and identify what is the most useful. The hope is that we are able to achieve our goal more efficiently than we would have with, for example, randomly selected data."

For instance, Garnett said astronomers are building better telescopes to get a better look at stars, galaxies and quasars in the sky. Thousands of these objects can be imaged in one night, creating hundreds of gigabytes of data. That's where Garnett's work comes in.

"Having the data is not the point," he said. "You want to extract some knowledge. Now we've got a thousand times more data than we used to have, so we have an even bigger challenge. Astronomers are now resorting to 'citizen-scientist' volunteers to analyze some of these images to classify the objects and search for rare phenomena. There is a big challenge in effectively prioritizing the data for these volunteers to make the best use of their time."

The sticky science of underwater adhesives

Scientists at the McKelvey School of Engineering have replicated the mussel's sticky protein and are now working to improve it for everyday use. The strong underwater adhesive could have many applications. It could even help to fix the very boats now vexed by the mollusks.

"Most synthetic glues do not work on wet surfaces, but mussel foot proteins (Mfp) can adhere to surfaces even underwater," said Fuzhong Zhang, associate professor of energy, environmental & chemical engineering. "This unique property makes Mfp suitable for many applications, from underwater repair to biomedical glues. With further engineering, an Mfp glue could be used to heal wounds or maybe even to replace sutures."

Zhang has received a $502,034 grant from the Office of Naval Research to improve on their initial success, microbially produced underwater adhesives that are stronger than those created naturally by mussels.

Written by Brandie Jefferson

Zhang wins 'Best Paper Award' at international conference

A paper co-authored by Xuan "Silvia" Zhang, an assistant professor of electrical & systems engineering, recently won the Best Paper Award at the 2019 Design, Automation and Test in Europe Conference in Florence, Italy. The conference is one of the world's top conferences on electronic design automation.

The paper, titled "When Capacitors Attack: Formal Method Driven Design and Detection of Charge-Domain Trojans," was selected from a field of more than 800 submissions.

Engineering treatments for the opioid epidemic

A biomedical engineer is developing a therapeutic option that would prevent opiates from crossing the blood-brain barrier, preventing the high abusers seek.

Jai Rudra, assistant professor of biomedical engineering, is developing nanovaccines to combat opioid misuse with a two-year, $373,068 grant from the National Institutes of Health's National Institute on Drug Abuse (NIDA) through its Cutting-Edge Basic Science Research award program.

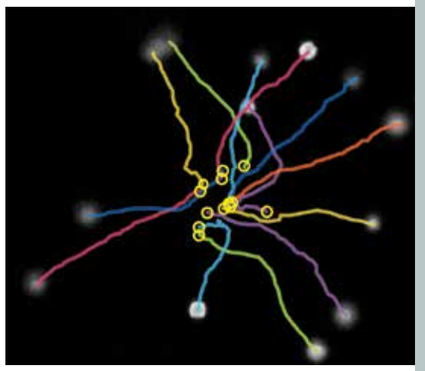
"We are developing a therapy that will generate an anti-opioid antibody that will arrest the drug in circulation and prevent it from getting to the brain," he said. "While this immunotherapy does not directly address the underlying neurobiological mechanism behind drug abuse, it is intended to treat a person in recovery in the event of a relapse. The patient will obtain no pleasure from taking the drug and will be further motivated to continue toward recovery."

Huebsch earns AHA Career Development Award

Nate Huebsch, an assistant professor of biomedical engineering in the McKelvey School of Engineering, has received the 2019 Career Development Award from the American Heart Association (AHA).

He'll receive more than $230,000 over three years in support of his project studying how exercise leads to sudden death in patients with arrhythmogenic cardiomyopathy, a genetic disease that is one of the most common causes of sudden cardiac death in young athletes.

Trap-and-release accelerates study of swimming ciliated cells



Researchers have been studying cilia for years to determine how their dysfunction leads to infertility and other conditions associated with cilia-related diseases. Now, they will be able to perform these studies more rapidly through a new method that uses sound waves to momentarily trap cells propelled by cilia, then releases them to measure their movement as they swim away.

An interdisciplinary team led by J. Mark Meacham, assistant professor of mechanical engineering & materials science, and students in his lab used an acoustic microfluidic approach that uses ultrasonic standing waves within a small fluid-filled chamber to collect groups of the single-cell green algae cells *Chlamydomonas reinhardtii*, a model organism for studying human cilia. The so-called acoustic trap takes advantage of material properties of the cell bodies to hold them in place without damaging them. By first collecting the cells, the team can efficiently analyze hundreds of cells in minutes. Results were published in and featured on the inside back cover of the journal *Soft Matter* in the June 12, 2019, print edition.

Making waves: Researchers shed light on how cilia work

A team of researchers in the McKelvey School of Engineering and the School of Medicine wanted to determine how length affected the mechanical efficiency of beating cilia. They found that most mechanical metrics, including force, torque and power, increased in proportion to the length of the cilia, but there was a "sweet spot" in terms of efficiency. The findings give insight into cilia in humans and how defects lead to disease, such as primary ciliary dyskinesia, which is associated with chronic respiratory infections, changes in the right-left axis and heart defects. Results are published in the April 9, 2019, issue of *Biophysical Journal.*

The study was led by Mathieu Bottier, a postdoctoral researcher in the lab of Philip Bayly, the Lilyan & E. Lisle Hughes Professor of Mechanical Engineering and chair of the Department of Mechanical Engineering & Materials Science, and the lab of Susan K. Dutcher, professor of genetics and of cell biology and physiology at the School of Medicine. The researchers used high-speed video microscopy to analyze a model for cilia to determine their mechanical metrics. After analyzing nearly 400 videos, the team found that the most efficient beating of cilia was at its natural length of 10 to 12 microns, or one-fifth the width of a human hair.

This work may help to understand human mutations that make cilia short and how short cilia will impact the patient's outcome, Dutcher said.

Pappu awarded Mercator Fellowship from DFG

Rohit Pappu, the Edwin H. Murty Professor of Engineering, has been named a recipient of the prestigious Mercator Fellowship from the Deutsche Forschungsgemeinschaft (DFG). The DFG is the leading independent research funding organization in Germany with members from more than 100 universities and research institutions.

Flame design in space may lead to soot-free fire

An experiment aboard the International Space Station aims to determine the true nature of soot formation during combustion.

"We'll measure soot, evaluate the strength of the flame, the radiation that comes off of the flame, and the gas composition and temperatures so that we can ensure our predictions are correct," said Richard Axelbaum, the Stifel & Quinette Jens Professor of Environmental Engineering Science. For this project, he'll have assistance from Peter Sunderland, a professor at the University of Maryland.

Axelbaum is also the director of the Consortium for Clean Coal Utilization, and there's one thing soot is not: clean.

"Soot, number one, is a pollutant. It can also be carcinogenic, so we don't want to be breathing in a lot of soot," Axelbaum said. "And it can absorb sunlight and heat the planet." It is, in fact, the second-greatest contributor to atmospheric warming, next to carbon dioxide.

With sufficient oxygen, combustion releases the maximum amount of energy available from the fuel being burned — it burns efficiently — and the byproducts are only carbon dioxide and water. Soot, which is a byproduct of incomplete combustion, occurs when oxygen is not available for combustion. For example, in a candle flame, the soft yellow glow is from soot particles — produced in the interior of the flame — being heated to high temperatures.

Written by Brandie Jefferson

Computer Science & Engineering to launch ethics courses with Mozilla grant

Ron Cytron, professor of computer science & engineering, has received a nearly $150,000 grant from Mozilla Foundation to launch new courses in the Department of Computer Science & Engineering on ethics and responsibility.

This grant allows researchers at the McKelvey School of Engineering to investigate the study of ethics in computer science. Those studies will take place in two courses: the introduction to computer science course (CSE 131) and the introduction to data science course (CSE 217A).

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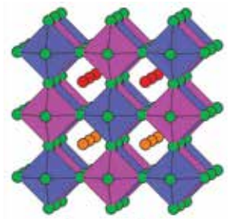
students majoring in computer science & engineering, the most popular major among WashU undergraduates

'A good first step toward nontoxic solar cells'



To meet the ever-increasing demand for solar cells, low-cost and more efficient alternatives to silicon-based solar cells — currently the most widely used technology — are desirable. In the past decade, lead-halide perovskites have surged as the most promising class of alternative materials; however, they are unstable. They contain lead, which is toxic and poses potential health and environmental hazards such as groundwater contamination.

A team of engineers at WashU has found what they believe is a more stable, less toxic semiconductor for solar applications using a novel double perovskite oxide discovered through data analytics and quantum-mechanical calculations.

The work was published online June 11 in *Chemistry of Materials*.

Rohan Mishra, assistant professor of mechanical engineering & materials science, led an interdisciplinary, international team that discovered the new semiconductor, made up of potassium, barium, tellurium, bismuth and oxygen ($KBaTeBiO_6$).

NSF CAREER Award — Understanding low-temperature plasma has technological, human benefits

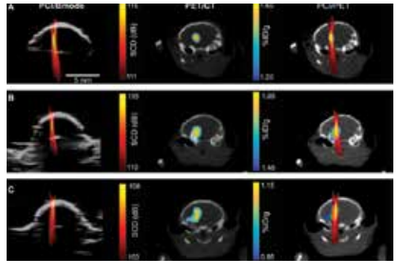
At equilibrium, plasma is the stable state of matter at very high temperatures of thousands of degrees: for example, on the surface of the sun. In the laboratory, it is possible to produce low-temperature plasma by selectively exciting electrons to very high temperatures while the atoms and molecules in the system remain near room temperature. Low-temperature plasma is a highly nonequilibrium state of matter.

Elijah Thimsen will study how chemical reactions occurring in low-temperature plasma move toward a superlocal equilibrium state with a five-year, $500,000 CAREER Award from the National Science Foundation. The awards support junior faculty who model the role of teacher-scholar through outstanding research, excellent 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.

Thimsen, assistant professor of energy, environmental & chemical engineering, will explore the idea of a superlocal equilibrium state, in which a system is constrained to have different temperatures at the same location in space, depending on the species; and entropy is maximized. That idea is a reasonable way to describe low-temperature plasmas from the perspective of thermodynamics, since the gas molecules are near room temperature but the electrons are very hot due to the electricity flowing into the system, he said.

Thermodynamics dictates that normally a chemical reaction will proceed toward the local equilibrium state. For example, carbon monoxide will react with oxygen to form carbon dioxide and the reaction will stop since carbon dioxide is the dominant species at equilibrium.

A new method for precision drug delivery: painting



Researchers are developing the tools necessary for such a drug delivery system, which they call cavitation dose painting.

Their research was published online in *Scientific Reports*.

Using focused ultrasound with its contrast agent, microbubbles, to deliver drugs across the blood-brain barrier (FUS-BBBD), the research team, led by Hong Chen, assistant professor of biomedical engineering in the McKelvey School of Engineering and of radiation oncology at the School of Medicine, was able to overcome some of the uncertainty of drug delivery.

This method takes advantage of the microbubbles expanding and contracting when they interact with the ultrasound, essentially pumping the intravenously delivered drug to wherever the ultrasound is pointing.

Written by Brandie Jefferson

Giving users a handle on their data

Ning Zhang, assistant professor of computer science & engineering, is developing a novel user privacy protection framework that will give users full privacy control over their data. The framework, known as PrivacyGuard, will allow users to enforce that their data can only be used by programs they approve.

The work is funded by a four-year, collaborative, $1.2 million grant from the National Science Foundation.

Peters wins Klemin Award for work in vertical flight aeronautics

David Peters, the McDonnell Douglas Professor of Engineering, has been chosen to receive the Dr. Alexander Klemin Award from the Vertical Flight Society. The award is the highest honor the society gives an individual for notable achievement in advancing the field of vertical flight aeronautics. The award honors Alexander Klemin, a prominent aeronautical engineer, educator, author and pioneer in rotary-wing aeronautics. Peters received the award at the society's Annual Forum & Technology Display May 15 in Philadelphia.

Study first to show processes determining fate of new RNA pesticides in soils

New research shows how these emerging pesticides move through and degrade in soils. The research was published in January in *Environmental Science & Technology*.

Kimberly Parker, assistant professor of energy, environmental & chemical engineering, and a team of collaborators devised a method to track this new pesticide in soils and to begin to understand what processes affect its life span.

This new pesticide is a molecule of double-stranded ribonucleic acid, or RNA. When a pest eats this pesticide, it prevents the critter from making essential proteins, leading either to stunted growth or to death.

The research team devised a method to tag a pesticide molecule with a radioactive atom, allowing them to follow it as it cycled through closed soil systems representing different scenarios.

Written by Brandie Jefferson

In memoriam: Lloyd Brown Sr.

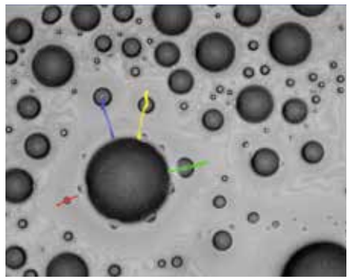
Lloyd "Bob" Brown Sr., a 30-year faculty member in the Department of Electrical Engineering, died Saturday, May 25, 2019. He was 94.

After serving in the U.S. Navy during World War II and earning a bachelor's degree, Brown earned master's and doctoral degrees from Washington University in St. Louis, then worked in industry for several years before returning to teach in the Department of Electrical Engineering for more than 30 years. He was given the Distinguished Faculty Award in 1970 and received several Outstanding Faculty of the Year awards. Later, he became a highly respected fire investigator and forensic casualty consultant.

"Lloyd 'Bob' Brown was a fixture in the Department of Electrical Engineering at Washington University in St. Louis for decades," said Joseph O'Sullivan, the Samuel C. Sachs Professor of Electrical Engineering and professor and dean of the UMSL/WashU Joint Undergraduate Engineering Program. "Students loved his engaging teaching style. When I arrived in 1986, my office was directly across the hall from Bob Brown's. There was always a steady stream of students in his office. He was laid back and made everyone feel welcome and at ease. He inspired many former students both in academic and industrial careers. He was very kind and supporting of me when I was a young faculty member."

Solving a condensation mystery

Water can be harvested from "thin air" or separated from salt in desalination plants by way of condensation. Due to the fact condensing droplets take heat with them when they evaporate, condensation is part of the cooling process in the industrial and high-powered computing arenas. Yet when researchers took a look at the newest method of condensation, they saw something strange: When a special type of surface was covered in a thin layer of oil, condensed water droplets seemed to be randomly flying across the surface at high velocities, merging with larger droplets, in patterns not caused by gravity.



"They're so far apart, in terms of their own relative dimensions" — the droplets have a diameter smaller than 50 micrometers — "and yet they're getting pulled and moving at really high velocities," said Patricia Weisensee, assistant professor of mechanical engineering & materials science in the McKelvey School of Engineering.

"They're all moving toward the bigger droplets at speeds of up to 1 mm per second."

Weisensee and Jianxing Sun, a doctoral candidate in her lab, have determined that the seemingly erratic movement is the result of unbalanced capillary forces acting on the droplets. They also found that the droplets' speed is a function of the oil's viscosity and the size of the droplets, which means droplet speed is something that can be controlled.

Their results were published online in *Soft Matter.*

Written by Brandie Jefferson

New faculty join McKelvey Engineering

Biomedical Engineering

Song Hu, associate professor

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

» BS and MS, electronic engineering, Tsinghua University, Beijing

Hu joins McKelvey Engineering from the University of Virginia (UVA), where he has been an assistant professor of biomedical engineering since 2013.

Hu's research focuses on the development of cutting-edge photoacoustic technologies for high resolution, structural, functional, metabolic and molecular imaging in vivo and their applications in research of a variety of diseases, such as neurovascular disorders and cancer. He begins Jan. 1, 2020.

Chao Zhou, associate professor

» PhD, physics, University of Pennsylvania

» BS, physics, Peking University, China

Zhou joined McKelvey Engineering from Lehigh University, where he was an associate professor in the Department of Electrical and Computer Engineering and a founding member of the Department of Bioengineering. He joined Lehigh in 2012 as an assistant professor and served as the P. C. Rossin Assistant Professor from 2015 to 2017. Zhou joined the WashU faculty July 1.

His research interests are in optical coherence tomography, a growing technology used to perform high-resolution cross-sectional imaging using light.

Computer Science & Engineering

Netanel Raviv, assistant professor

» PhD, MSc, computer science, Technion, Haifa, Israel

» BSc, mathematics and computer science, Technion, Haifa, Israel

Raviv joined McKelvey Engineering Oct. 1. from the California Institute of Technology, where he was a postdoctoral researcher in the Department of Electrical Engineering.

His research focuses on applications of coding techniques to computation, privacy and storage. He spent time as a research intern with IBM Research in Haifa, Israel; and Bing Ads, Microsoft, in Bellevue, Washington.

Energy, Environmental & Chemical Engineering

Zhen (Jason) He, professor

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

» MSc, environmental engineering, Technical University of Denmark

» BS, environmental engineering, Tongji University, China

He joins McKelvey Engineering Jan. 2, 2020, from Virginia Polytechnic Institute and State University, where he is a professor in the Charles E. Via, Jr., Department of Civil and Environmental Engineering. He joined Virginia Tech in 2013 as an associate professor and was named full professor in 2017.

His research centers on environmental biotechnology, bioenergy production, biological wastewater treatment, resource recovery, bioelectrochemical systems and sustainable desalination technology.

Randall Martin, professor

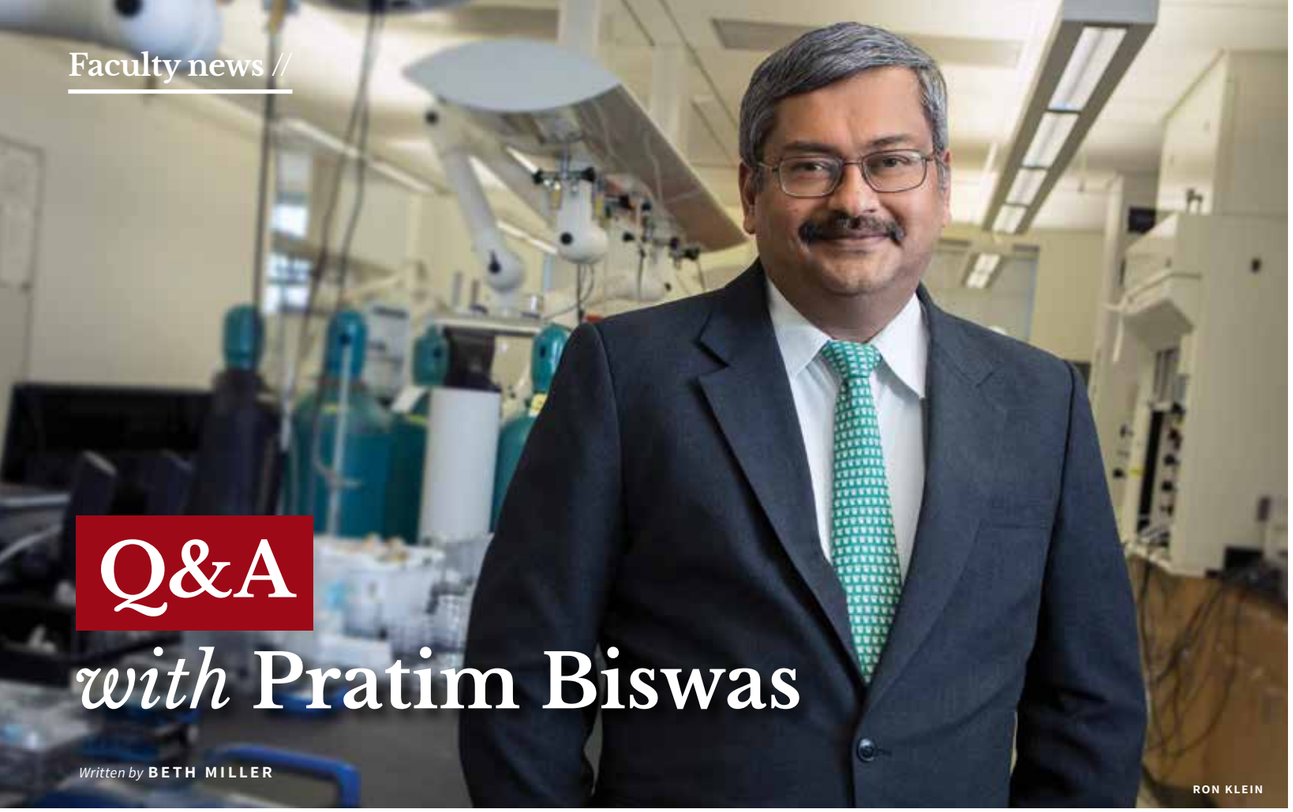
» PhD and MS, engineering sciences, Harvard University

» MSc, environmental change and management, Oxford University

» BS, electrical engineering, Cornell University

Martin joined McKelvey Engineering from Dalhousie University in Halifax, Nova Scotia, where he had been on the faculty since 2003. He was named professor in 2011. He joined the WashU faculty July 1.

Martin's research focuses on characterizing atmospheric composition to inform effective policies surrounding major environmental and public health challenges ranging from air quality to climate change. He leads a research group at the interface of satellite remote sensing and global modeling, with applications that include population exposure for health studies and top-down constraints on emissions.



Q&A *with* Pratim Biswas

Written by **BETH MILLER**

RON KLEIN

Internationally renowned aerosol scientist Pratim Biswas, the Lucy & Stanley Lopata Professor in the McKelvey School of Engineering, was recently elected to the National Academy of Engineering (NAE), considered one of the highest honors in the field of engineering.

Biswas, also assistant vice chancellor of international programs and chair of the Department of Energy, Environmental & Chemical Engineering, holds 10 patents and has spun off two startup companies based on his inventions, including Applied Particle Technology. He has more than 400 refereed journal publications. His work applying aerosol science to energy and environmental nanotechnology, solar energy use, air pollution control, medicine and other areas was recognized in 2018 with the Fuchs Award, the highest honor given worldwide to an aerosol scientist.

Biswas was chosen by his peers in the NAE "for advancing the science of aerosol dynamics and particle removal technologies." He is one of two McKelvey Engineering faculty in the NAE; the other is Yoram Rudy, the Fred Saigh Distinguished Professor of Engineering in the Department of Biomedical Engineering. Biswas was inducted into the NAE Class of 2019 Oct. 6 in Washington, D.C.

Q. When you came to the U.S. from India with your two suitcases, did you ever imagine that you'd be elected to the National Academy of Engineering?

A. One always has high ambition, but at that stage, I was more focused on earning my PhD. I always wanted to make a difference and a contribution, so this is a good recognition of my efforts. Most of the space in the two suitcases that I brought to this country was taken up by books!

Q. What do you find most challenging about your work?

A. One challenge I face is that while I try to do innovative, impactful work, it takes time for the impact to be realized. I work with young, smart minds — our students — who are so motivated that they want to make a difference right away. Hence, a challenging aspect is to inculcate the values of patience and hard work. I also have responsibilities as the chair of the department, ensuring that I set an example and help the entire department to excel. While there are challenging aspects of my work, I think it is fun and enjoyable.

Q. Tell me about a project or accomplishment that you consider to be the most significant in your career.

A. There are several spanning my career. The overall approach of focusing on a fundamental understanding of aerosol science and engineering, and then applying them to a large number of areas, including some that are quite unique and have never been thought about before. One example is capturing emissions of problematic small particles from combustion systems that are very challenging to trap; by understanding and enhancing charging of small particles and advancing the design of particle capture technology. In addition to these systems being applied on our planet, we will now also need these to be applied in outer space as we enhance exploration of that frontier. The ability to synthesize nanoparticles with controlled size, shape and composition that results in desired functionality has allowed us to develop applications in areas such as solar energy harvesting, nanomedicine for targeted drug delivery, the holy grail of carbon dioxide capture and conversion to value-added chemicals, and efficient nutrient uptake by plants for smart precision agriculture.

These developments and accomplishments have been possible due to work with excellent students and collaborations with colleagues in several other disciplines.

Q. You've received several "pinnacle" awards recently. How does that feel?

A. The Fuchs Award is the highest award worldwide in aerosol science and engineering. The awards received from the American Association for Aerosol Research, American Institute of Chemical Engineers, Association of Environmental Engineering Science Professors and the International Society of Electrostatic Precipitation are a few other societies that have recognized my contributions. I feel humbled to be selected for each of these awards. It's a recognition of the work over the years done by past and current students. The recognition by the NAE is special because it's the entire engineering community in the U.S. that you are selected from.

Q. What's the best advice you've ever received in your career?

A. Enjoy your work. Pursue your passion. Be innovative in what you do. Don't worry about the immediate results, and with consistent effort, recognition will follow.

Q. Who has been your biggest influence in your career?

A. There have been several. Professors Rick Flagan (Irma and Ross McCollum-William H. Corcoran Professor of Chemical Engineering and professor of Environmental Science and Engineering) and John Seinfeld (Louis E. Nohl Professor & Professor of Chemical Engineering), from Caltech introduced me to this fabulous field of aerosol science and engineering. Another individual who influenced me was Sheldon Friedlander at UCLA, a pioneer and legend in aerosol science. I should also recognize my undergraduate studies mentor and a fabulous instructor, Suhas Sukhatme at IIT Bombay, who laid the foundation stones for my career.

I must mention my early life mentors, my brother, Gautam Biswas, currently a professor at Vanderbilt, and my father, Professor A.B. Biswas. My father set an example by what he did, and much of his style and approach has been a great influence on me. He was an eminent physical chemist who did postdoctoral work at Caltech with Linus Pauling, and then had an illustrious academic career at IIT Bombay.

Q. What might someone be surprised to learn about you?

A. My interest in other things and passion for sports, especially college basketball. This year, I got tickets ahead of time and saw the Final Four in Minneapolis with my two sons. I used to play basketball for my college in India, and we did reasonably well. We didn't have televisions in India when I was growing up, so I could not watch the games live. However, we had a weekly showing of movies in the theater, and there would be a newsreel on sports results from the U.S. They would show basketball games, and UCLA was a wonder team with John Wooden as the coach.

When I first came to the U.S., I spent a year at UCLA and earned a master's degree there, being attracted by the names of Wooden and Lew Alcindor, who then became Kareem Abdul-Jabbar, though they were retired by then. I saw many a home game at UCLA that year (1980-81). Though Wooden had retired, I was surprised to see that he, too, came to watch the UCLA home games. Once I took up the courage and went to meet him and told him how I enjoyed watching in documentary films his successful teams win championships. I was happy that he talked to me and asked about what I do and told me to work hard in what I did. This short interaction has remained as a motivation for me to this day.

Also, my wife, Sujata Biswas, has been a constant encourager and supporter of all that I have done.

2018-19

in review

868

DEGREES AWARDED

285

FIRST-YEAR ENGINEERING STUDENTS (FALL 2018)

1,100+

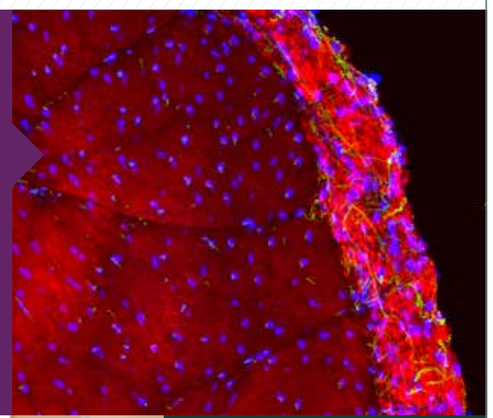
STUDENTS ACROSS THE UNIVERSITY ARE NOW STUDYING COMPUTING

McKelvey Hall

Construction began on the newest academic building, James M. McKelvey, Sr. Hall, that will open in early 2021. McKelvey Hall will house the Department of Computer Science & Engineering

$34.3M

RESEARCH EXPENDITURES (FY2018)



28,600

SQUARE FEET OF RESEARCH SPACE IN THE NEWLY OPENED JUBEL HALL

96.5

TENURED/TENURE TRACK FACULTY

33

TEACHING FACULTY

Engineering Students

1,363

Undergraduate students

625

Full-time master's students

258

Part-time master's students

431

PhD students

14,101 *donors supported Engineering through the Leading Together Campaign*

Fall 2018

WOMEN ENGINEERING STUDENTS

30%

Undergraduate students

28%

Full-time master's students

26%

Part-time master's students

29%

PhD students

UNDERREPRESENTED BACKGROUNDS

19%

Undergraduate students

FINANCIAL SUPPORT

549

Undergraduate students received financial aid in FY19

$44,850

Amount of average need-based scholarship

Jim McKelvey Jr. outside of the James M. McKelvey, Sr. Hall, which is under construction on the East End of the Danforth Campus and will open in early 2021. McKelvey Jr. gave the naming gift for the building.

WHITNEY CURTIS

It was a day long in the making — 162 years, in fact. Since its founding in 1857, the School of Engineering & Applied Science at Washington University in St. Louis built its reputation on its name. As of Jan. 31, 2019, and after more than one and a half centuries of growth and innovation, the school entered a new era as the McKelvey School of Engineering, thanks to a transformative investment by alumnus Jim McKelvey Jr. and his wife, Anna.

The next McKelvey era

Written by **BETH MILLER**

McKelvey, who earned degrees in computer science and economics at WashU in 1987, is a serial entrepreneur and has founded or co-founded multiple startups, including Square, the mobile payment company; LaunchCode, a nonprofit organization that helps companies find skilled workers for the growing number of tech jobs and provides free coding courses for those seeking a technology career; Third Degree Glass Factory; Mira Publishing, which he founded as an undergraduate student; and most recently, Invisibly, which works in the ad tech and media industries. In addition, he is a Washington University trustee, an independent director of the St. Louis Federal Reserve and a partner with FinTop, a venture capital firm he co-founded in 2017 that focuses on financial technology companies.

McKelvey's investment solidifies the school's position as a leader in research and education and will bolster the school's ambitious strategic plan, including support for student scholarships and new faculty professorships, as well as the flexibility to meet future priorities to advance the school's impact on lives and communities both in St. Louis and worldwide. Specifically, the gift will allow the school to marry innovation with science in research; grow the relevance and strength of computing for both education and research; attack great engineering challenges through which the university can have a meaningful impact by hiring outstanding faculty; and elevate the engagement of the school through entrepreneurship.

"Under the strong leadership of Dean Aaron Bobick, the Engineering school is positioned for true greatness, and this is the right time to step forward with this investment," McKelvey said at the Jan. 31 announcement. "Engineering fields are moving at an exponential growth rate, and to keep up with that requires tremendous investment of resources: human, physical and financial."

Bobick, also the James M. McKelvey Professor, said the commitment allows the school to advance into the next tier of top engineering programs worldwide.

"Early on, our school was almost 100 percent focused on education," Bobick said. "It then turned a corner and became about education and fundamental research. Now it's time to turn another corner and be about education, fundamental research and innovation."

Bobick said the potential for innovation is what makes research important, and research is what makes innovation possible.

"Innovation is about creating novel solutions to significant problems, about exploring solution spaces, with a necessary emphasis on design, experimentation, failure and iteration," he said. "We will still place great effort on elevating the significance, caliber and amount of research, because research strength is what attracts great faculty and drives reputation. But our next focus is how do we fit within the innovation ecosystem within St. Louis? What does it mean for us to do innovation in engineering at Washington University in St. Louis?"

"Jim's great talent is that he can see an opportunity, recognize that it's not rocket science to go after it, but knows that you just really have to go after it — and he's relentless. Instilling some of that understanding of the opportunity is a great lesson for our students and for our faculty."

— AARON BOBICK, DEAN

With the McKelvey name, the school must live up to the bar that McKelvey sets for the impact of innovation, Bobick said.

"Jim McKelvey Jr. is pretty sure that he's really nothing special, and he just gets lucky because he's persistent," Bobick said. "While it's clear he is undoubtedly special, Jim's great talent is that he can see an opportunity, recognize that it's not rocket science to go after it, but knows that you just really have to go after it — and he's relentless. Instilling some of that understanding of the opportunity is a great lesson for our students and for our faculty."

The gift will not only provide for new professorships within McKelvey Engineering, but in interdisciplinary programs that partner with Engineering as well, particularly those that partner with computing, such as systems engineering, data science, chemistry, physics and business.

"Attracting faculty who want to sit at that intersection is critical to growing that effort," Bobick said. "Every branch of engineering research and innovation relies on computing not only to reveal novel insights from traditional analytical modeling, but also to procure data and analyze systems for which analytical models are not available.

In an interview, McKelvey shared his vision for the school.

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

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

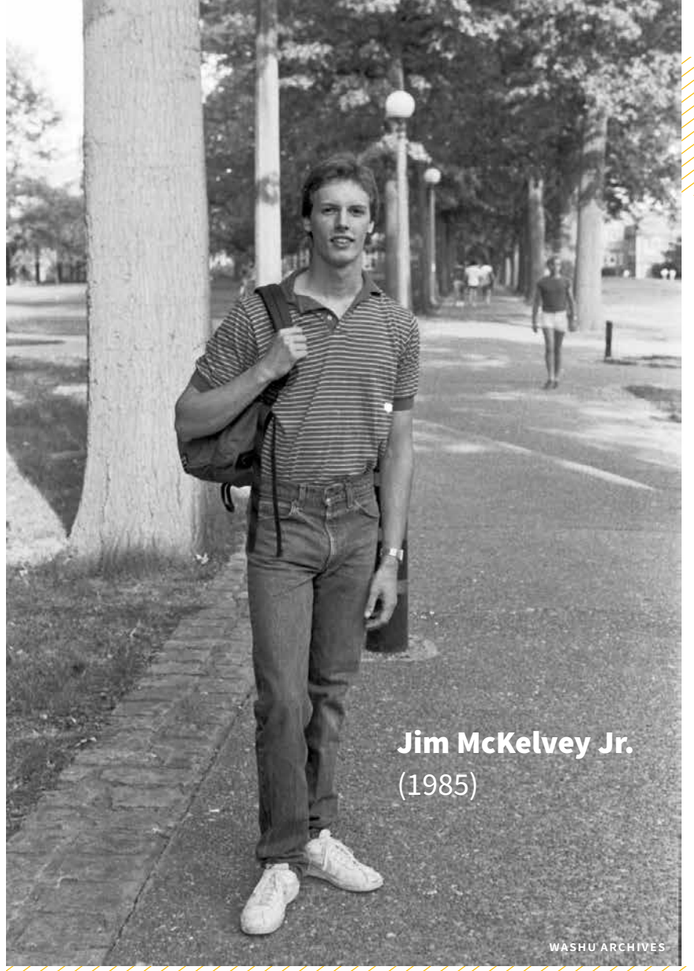
"If you're doing anything creative, the more perspectives you can bring, the better your potential set of outcomes is," he said. "I think it's important for society that we don't want to create elite universities that cater only to elite students. I think we want to have as much diversity in thought and age and everything as possible."

During Bobick's tenure as dean, he has supported student and other organizations that help to broaden the school's demographics and its appeal to women and people of color, such as the Women & Engineering Initiative, the National Society of Black Engineers (NSBE) and the Society of Hispanic Professional Engineers (SHPE). McKelvey's gift will allow for continued support of increasing the school's diversity.

McKelvey also is interested in increasing the school's connections.

"I would offer myself as an example of somebody who really didn't have much direction and serendipitously encountered these fantastically talented students and professors and wonderful resources at Washington U. and changed my life," he said. "It's very scary as a young person, even a young person with a lot of talent, to feel like you've got to make all the right calls when you're 19 or 20. My message would be that you don't have to get it right, but it would be a shame to make decisions that decrease options in the future. One of the great things about Washington U. is it massively increased my options, and I'm hoping to make that available to other people."

McKelvey also gave the gift to honor his father, James M. McKelvey Sr., who was dean of the school for 27 years and transformed it from a regional program into a nationally prominent research institution.



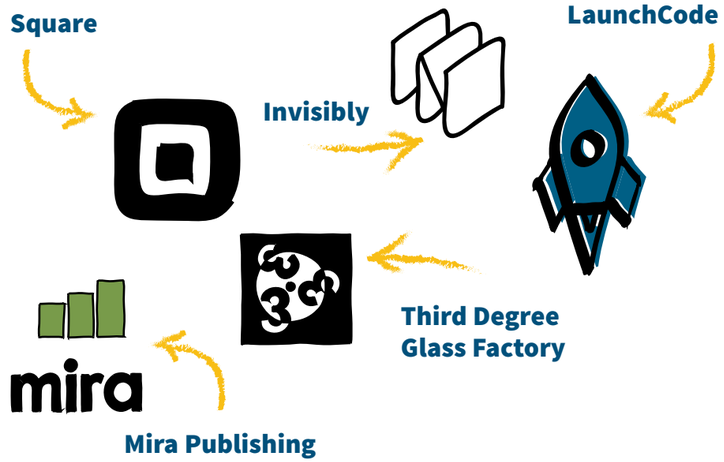
Jim McKelvey Jr.
(1985)

WASHU ARCHIVES

"I would offer myself as an example of somebody who really didn't have much direction and serendipitously encountered these fantastically talented students and professors and wonderful resources at Washington U. and changed my life."

— JIM MCKELVEY JR.

MCKELVEY tech pioneer



WHITNEY CURTIS

The Jan. 31 announcement of the school becoming the McKelvey School of Engineering was filled with fanfare from photos with the WashU Bear to a balloon drop that filled the Whitaker Atrium.


KEVIN LOWDER

Jim McKelvey Jr. received the engineering school's Alumni Achievement Award in 2012. Clockwise from left: Donald Mosby, Jim McKelvey Jr., Anna McKelvey, Judith McKelvey and James McKelvey Sr.

My father is a living example of patience and humility. When I ask for advice, he does not pontificate. But watching him, I just absorb the spirit of someone who is always charitable and kind and modest but also very accomplished."

— JIM MCKELVEY JR.

"My father is a living example of patience and humility," McKelvey said. "When I ask for advice, he does not pontificate. But watching him, I just absorb the spirit of someone who is always charitable and kind and modest but also very accomplished. And that's a great role model, and I learn from him every time."

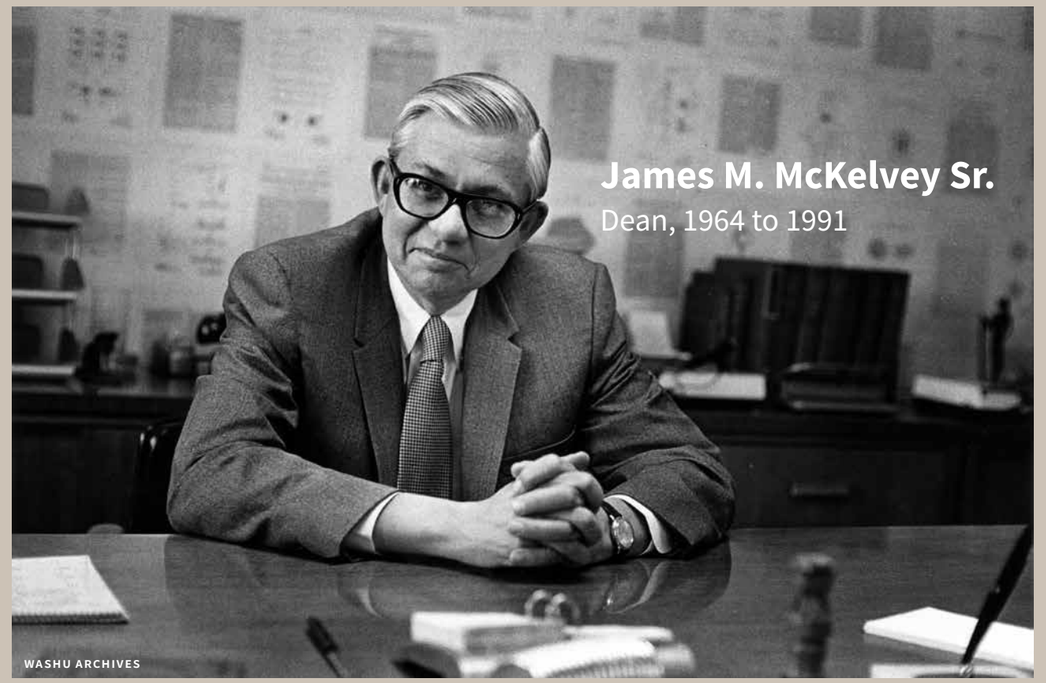
During his more than quarter-century tenure as dean, McKelvey Sr. led the school to prominence in engineering research, education and innovation. He launched the Engineers' Scholarship Program, the Dual Degree Program and the Cooperative Education Program. Under his visionary leadership, three new buildings — Bryan, Lopata and Jolley Halls — were constructed. The school's endowment grew more than tenfold, from $4 million to nearly $52 million, and research expenditures grew substantially. Although he officially retired in 1996, McKelvey Sr. continued teaching in the chemical engineering department through the 2007-2008 academic year.

McKelvey's gift is the latest in representing the family's commitment to Washington University. In 2016, he gave $15 million to build James M. McKelvey, Sr. Hall on the east end of campus to house the Department of Computer Science & Engineering and support the university's data science efforts. His wife, Anna; his father; his late mother, Edith McKelvey; and his stepmother, alumna Judith McKelvey, MD, have been loyal to the university's success for decades.

"We are a Washington University family through and through," he said. "This university has meant so much to us, and it is my privilege to continue our role in providing for the Engineering school's future."

In addition to the naming gift, Jim and Anna established the $30 million McKelvey Engineering Challenge, which allows alumni, parents and friends to contribute to expanding opportunities for students, bolstering cutting-edge research and providing modern facilities. The three-year challenge will provide matching funds to support endowed scholarships, endowed professorships, the school's annual fund, the state-of-the-art James M. McKelvey, Sr. Hall and the Henry A. and Elvira H. Jubel Hall, and for other Engineering projects.

McKelvey said he remembers coming to campus as a toddler and knew early on he wanted to attend Washington University. He began as an economics major, then added computer science courses and later took courses in the Sam Fox School of Architecture. Because of that, some of the matching funds will support professorships in the Computing + X initiative, which will allow students to combine computational thinking with other disciplines outside of Engineering, such as music, social work, political science or economics.



WASHU ARCHIVES

James M. McKelvey Sr.'s vision helped transform the School of Engineering & Applied Science from a regional program to a nationally recognized research institution throughout his 27 years as dean.

The former dean grew up in University City. After earning an undergraduate degree in chemical engineering from the University of Missouri-Rolla, he returned to St. Louis, earning a master's in chemical engineering in 1947 and a doctorate in chemical engineering in 1950, both from Washington University.

After his doctoral studies, McKelvey Sr. joined DuPont, where he researched polymer processing, becoming a pioneer in the field. In 1954, he joined the faculty of Johns Hopkins University and in 1957, he returned to Washington University as an associate professor of chemical engineering. In 1960, he became a full professor and in 1962, he was named department chair. Two years later, McKelvey became the seventh dean of the university's Engineering school, a position he held from 1964 to 1991.

Washington University has honored McKelvey Sr. with the William Greenleaf Eliot Society's Search Award and with an undergraduate research award established in his name. His contributions have also been recognized throughout the years by the school, which has bestowed upon him its Alumni Achievement Award, Distinguished Faculty Award and Dean's Award. In 2003, John F. McDonnell and the JSM Charitable Trust established the James M. McKelvey Professorship in his honor.

Continuing his steadfast commitment to the university, McKelvey Sr. serves on the Planned Giving Committee and was a volunteer for the Engineering school's efforts in *Leading Together*: The Campaign for Washington University.


WASHU ARCHIVES

Family and friends gathered for Dean McKelvey's retirement party in 1991.

James M. McKelvey, Sr. Hall

McKelvey Hall, named in honor of James M. McKelvey Sr., will be located south of Preston M. Green Hall. It will include faculty spaces and labs from each of the school's five departments, house the Department of Computer Science & Engineering and support WashU's data science efforts.

Fuzhong Zhang

REIMAGINING SYNTHETICS

Written by **BETH MILLER**

In his wallet, Fuzhong Zhang carries a small slip of paper from a fortune cookie that says, "Avoid unchallenging occupations — they will waste your great talents."

Though he set out to be a chemist — in itself a challenge — earning three degrees in chemistry, ultimately, he became a chemical engineer who has won nearly every young investigator award available to engineers. During his doctoral work at the University of Toronto, he discovered the work of Jay Keasling, professor of chemical engineering and bioengineering at the University of California, Berkeley, and a pioneer in the growing field of synthetic biology. Zhang decided on a career in engineering. As a postdoctoral researcher in Keasling's lab, he learned how to use engineering tools to skillfully alter the chemistry of cells.

Zhang, associate professor of energy, environmental & chemical engineering in the McKelvey School of Engineering, now runs a busy lab with 10 doctoral students and postdoctoral researchers using synthetic biology to create new products, such as stronger spider silk and better biofuels that could one day replace fossil-derived materials and transportation fuels. He holds three U.S. patents and is applying for two more.

CAROL GREEN

FUZHONG ZHANG EMBRACES CREATING BETTER MATERIALS THROUGH SYNTHETIC BIOLOGY

Cover of Nature Chemical Biology, May 2016

One of his projects uses engineering tools to reprogram the biosynthetic machinery and metabolism of microbes to produce high-performance protein materials, leading to a variety of new applications. His team has engineered bacteria to yield synthetic spider silk that is as strong and tough as natural spider silk fibers, the toughest material in nature. They are currently expanding the biosynthetic power of microbes to create novel proteins that can be even stronger and tougher than spider silk and more suitable for scalable production. His vision is to one day produce various fiber products that could be used to stitch wounds or woven into fabric to stop bullets. His team also engineered bacteria to produce sticky proteins that mimic the underwater adhesive proteins found in mussels and use them for sealing wounds and repairing cracks in underwater vessels.

"With better understanding and more experience with engineering cells, we can create novel materials that nature does not evolve but may have more attractive properties and be able to perform functions that natural materials cannot do," Zhang said.

cells. Another tool from his lab allows cells to constantly monitor their environment and their own metabolism to adjust their biosynthetic performance according to those environmental changes.

These and other projects underway continue to motivate Zhang to solve problems.

"The potential of synthetic biology and microbial engineering excites me," he said. "Very often, I feel the potential is beyond my imagination. When reading scientific news or articles that discuss current problems, I always think whether these problems can be solved by synthetic biology. We have the microbial engineering tools in our hands; with a quantitative understanding of the problem, we may have the opportunity to solve it by precisely controlling the metabolic behavior of engineered cells."

Zhang's expertise in synthetic biology has led to a variety of collaborations at Washington University. With Gautam Dantas, professor of pathology & immunology at the School of Medicine; Yinjie Tang, professor, and Marcus Foston and Tae Seok Moon, both associate professors, all in the Department of Energy, Environmental & Chemical Engineering, Zhang is collaborating on a project to model, design and engineer *Rhodococcus Opacus* mutants to produce advanced biofuels and bioproducts from lignin, an organic polymer in the cell walls of plants that is usually discarded. He also is working with Srikanth Singamaneni, professor of mechanical engineering & materials science; with Guy Genin, the Harold and Kathleen Faught Professor of Mechanical Engineering; with Rohit Pappu, the Edwin H. Murty Professor of Engineering; and with Jianjun Guan, professor of mechanical engineering & materials science on various new protein materials.

Using bacteria, Zhang's lab created synthetic spider silk (right) that is as strong as natural spider silk.

DEVON HILL

> *"WE CAN CREATE NOVEL MATERIALS THAT NATURE DOES NOT EVOLVE BUT MAY HAVE MORE ATTRACTIVE PROPERTIES AND BE ABLE TO PERFORM FUNCTIONS THAT NATURAL MATERIALS CANNOT DO."*

Zhang also is working to develop tools that other microbial engineers can use to make their work more reliable and efficient. He and his team discovered that genetically identical microbial cells have different work ethics. His team developed a quality-control tool that can keep the hard-working, high-performing cells working while eliminating the low-performing

Zhang's lab uses engineering tools to reprogram the biosynthetic machinery and metabolism of microbes to create high-performance protein materials.

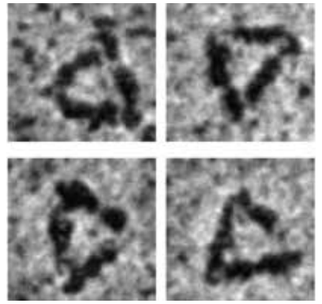
DEVON HILL

Zhang's early career awards:

- Society for Industrial Microbiology and Biotechnology (SIMB)
- Biotechnology and Bioengineering Daniel I.C. Wang Award
- ORAU Ralph E. Powe Junior Faculty Enhancement Award
- National Aeronautics and Space Administration (NASA)
- Office of Naval Research
- Air Force Office of Scientific Research
- National Science Foundation
- Defense Advanced Research Projects Agency (DARPA) of the U.S. Department of Defense
- Human Frontier Science Program Organization

Education & training

- Postdoctoral research: University of California, Berkeley
- PhD, University of Toronto
- MS, McMaster University
- BS, Peking University



Zhang's team made these protein triangles that could be used to speed chemical reactions and aid in drug delivery.

"Fuzhong Zhang is a really innovative researcher who effectively uses fundamental knowledge and applies it to solve challenging problems," said Pratim Biswas, the Lucy & Stanley Lopata Professor in the McKelvey School of Engineering, assistant vice chancellor of international programs and chair of the Department of Energy, Environmental & Chemical Engineering. "With his colleagues Yinjie Tang, Tae Seok Moon and Marcus Foston in the biocluster in the department, he works very effectively to advance the science and applications of synthetic biology and protein engineering. It is great to have a colleague who does not hesitate to operate out of his comfort zone and challenge his group to come up with innovative applications."

Although Zhang already is involved in many projects, the innovative applications keep coming, he says.

"Ideas often come quickly, but the real question is which one we should pursue and which one will result in bigger impacts," he said. "I always remind myself that a hot topic with readily available funding may not be worth pursuing if its future is unclear."

And he is definitely looking ahead.

"When I retire, I would like to see people using products or technologies developed from my lab," he said.

DESIGN BUILD FLY

Written by **DANIELLE LACEY**

From left, Ellie Macklin, Devin Williamson and Cameron Urban, members of Design/Build/Fly, work on the team's plane in the makerspace in Urbauer Hall.

Photos by **WHITNEY CURTIS**

Patrick Naughton, above, and Kian Dahlberg, left, help manufacture WashU DBF's plane.

Building an aircraft from the ground up is no easy task. Building one that can compete in an international competition is even more difficult. Nevertheless, each year, members of Design/Build/Fly (DBF) in the McKelvey School of Engineering take on the challenge.

For many of them, building a plane isn't so much a school project as it is a passion.

"I love engineering," says Austin Stover, a senior majoring in electrical engineering. "I love building stuff. I like figuring out challenges, and without WashU DBF, I don't know what I would be doing on weekends."

Sponsored by the American Institute of Aeronautics and Astronautics, Design/Build/Fly challenges teams of students from top engineering programs around the world to — well, design, build and fly their own aircraft. Teams must build a remote-controlled aircraft according to strict design guidelines, then successfully fly it through a course that includes challenges, such as 360-degree turns, payload drops, and takeoff and landing specifications.

"The competition is an incredibly positive environment because everyone knows exactly what goal you are trying to achieve," says Taylor Tuleja, who is earning a master's degree in mechanical engineering after earning dual bachelor's degrees from WashU and Hawaii Pacific University. "You see how different schools thought of different ways to solve the problem."

Chris Bonney, left, collaborates with Austin Stover, leader of DBF's avionic division.

DESIGN

Before their aircraft can hit the runway, though, the students first need to determine what they're building. Along with their plane, teams submit a lengthy design report that makes up a big portion of their final score.

"They're often very harsh grading those reports, so few teams score well," Stover says. "It's basically a compilation of your entire design, and while it's a lot of work, it can also be good to reflect on why you're doing what you're doing."

The team has until March to work on its design report, allowing members to tweak the design as necessary before the final competition. It aims to save teams time and money spent on poor designs, and WashU DBF takes full advantage of the opportunity.

"We have the tools that allow us to do a bunch of simulation work before we start building," says Tuleja, the club's administrative president. "Some members of our team have actually made a kinematics simulation software to help us do air optimization prior to building."

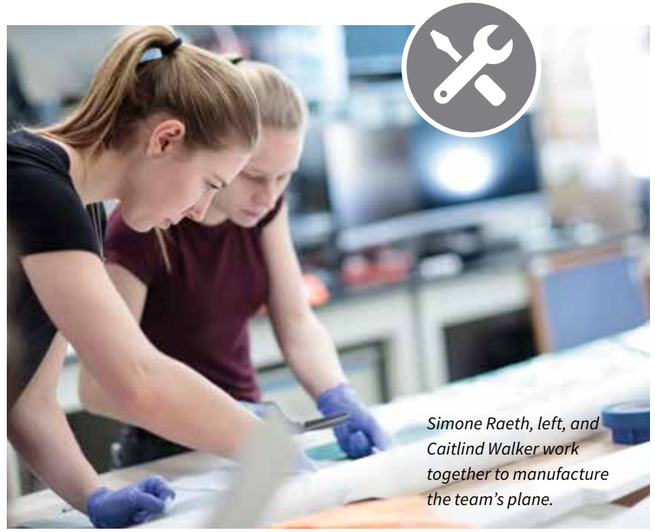
BUILD

Once the build is underway, nearly 40 team members are on hand to help code, manufacture and assemble the plane — a time-intensive project.

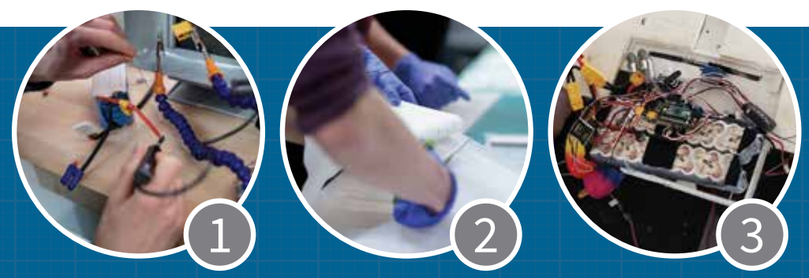
"Odds are, if you've ever passed by the makerspace, there's somebody from Design/Build/Fly in there," Tuleja says. "Leadership meets every Friday and will stay in there until midnight. We have meetings that start at 11 a.m. on Saturdays. We stay until 5 or 6 and take a break for dinner — and sometimes come back."

For many team members, the hands-on building experience is their first opportunity to work with materials and build prototypes. More experienced club leaders even gather resources such as YouTube videos to help prep new members for the build.

"All of the guys and girls on the team are very open and friendly and willing to teach anyone who wants to join the club about aerospace engineering," Tuleja says. "Even if you know absolutely nothing, our motto is 'Come, and whatever you're willing to put into it, you'll get out of it.'"



Simone Raeth, left, and Caitlind Walker work together to manufacture the team's plane.



1. A lithium polymer battery pack that powered the propulsion system during motor tests
2. A foam airfoil that became one of the plane's control surfaces
3. The plane's avionics package, which contains the flight management system, sat on top of the final NiMH propulsion battery pack

COURTESY PHOTO

COURTESY PHOTO

SimDev team goes open source

WashU's DBF team includes an advanced Simulation Development Team that allows members to test designs before building. This year the team, along with graduate adviser Kevin Hainline developed a program in MATLAB for aircraft analysis. It will be available as an open-source program and published on the MathWorks website.

"This is an incredible honor, for not only our team and Kevin, but for the entire university," Tuleja says. "It will probably be used by every Design/Build/Fly team in the world after being published, as well as many other people doing remote-controlled aircraft design."

FLY

At competition time, the team loads up and heads to either Wichita, Kansas, or Tucson, Arizona — the competition site alternates each year. Once there, team members continue refining their plane until it's time to fly.

"You put all of your time during the year building this plane, and you don't realize how many revisions you're going to have to do at competition when things break and stuff doesn't go as planned," Stover says. "Maybe your design is finished and you tested it, but you haven't tested it in 20 mile-per-hour winds or in the rain. It's definitely a lot of pressure, but that is where you learn the most as an engineer."

In 2018, the team placed in the top five for its design report, but gusty winds hindered the plane's performance.

"It was in Wichita, Kansas," Tuleja said, "and we were flying a very tiny plane."

The team went in a different direction this year, designing a plane with a 2-meter wingspan. The team placed 64th out of 104 teams.

"Unfortunately, we did not fly during the competition due to issues with our wing folding mechanism, but we did fly earlier, before the competition," Stover said. "This year's competition taught us how to better divide our time between the different complexities of the aircraft components."

> "We had one of the riskiest and most complex designs at competition; we tried to incorporate thrust vectoring into our aircraft this year, which no one else attempted. I think we placed so high on the report because of the complexity of our design, and I think the judges were impressed by how incredibly advanced our analysis of design was." — TAYLOR TULEJA

"We had one of the best design reports, which is how we were able to place so high without a flying aircraft," Tuleja said. "And although we were only 64th, we still beat many top universities like Columbia and Cornell."

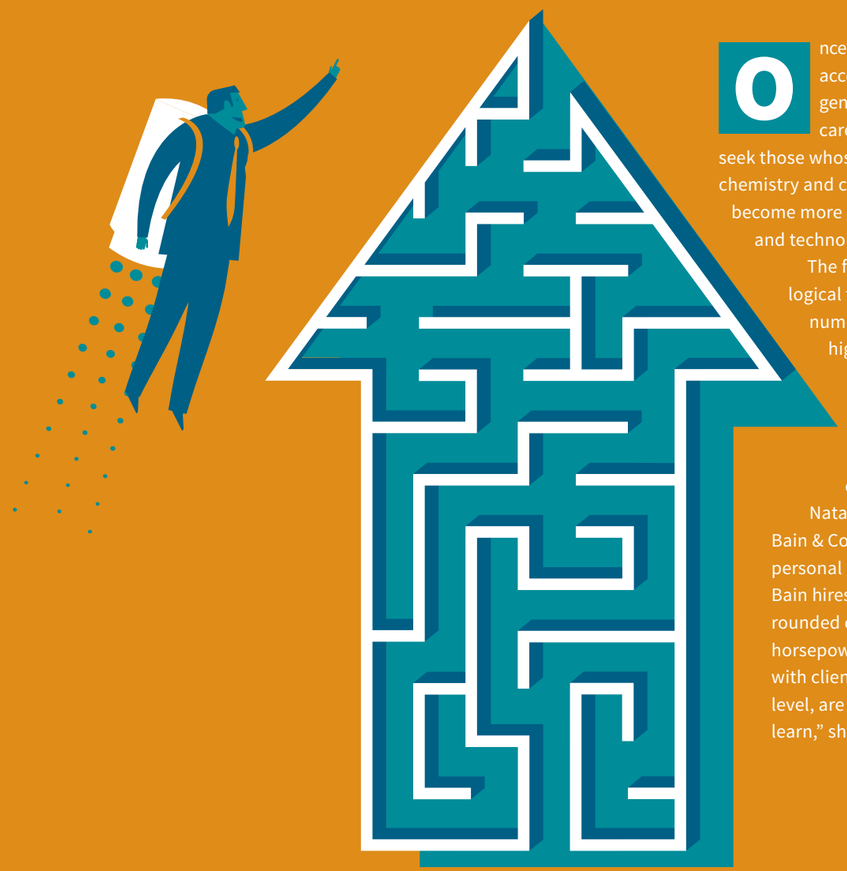
Win or lose, team members say the experience is an invaluable one. Stover credits his work with the team as part of the reason he changed his major from mechanical engineering to electrical & systems engineering.

"In DBF, I learned a ton about circuits and the logic that went into designing and sizing a motor electronics speed controller," Stover said. "This is the kind of logical electrical engineering stuff that I really grew passionate about."

Analytical brainpower

Consulting firms like the way engineers think.

Written by **JOE DWYER**



Once seen as the domain of people with accounting, finance, economics and general business degrees, consulting is a career that has morphed to increasingly seek those whose fields of study focus on engineering, chemistry and computer science as companies become more sophisticated in their use of data and technology.

The fundamental skill set of engineers — logical thinking, applying science and using numbers to solve problems — are in high demand across broad business sectors. As a result, students and graduates of the McKelvey School of Engineering are being heavily recruited by international consulting firms.

Natasha Curtis, a recruiting associate for Bain & Co., said being able to connect on a personal level is vital. "Generally speaking, Bain hires across majors and looks for well-rounded candidates that have the analytical horsepower to do the job, are able to interact with clients on a personable and professional level, are humble, have grit and are hungry to learn," she said.

Hands-on experience

Ramona Durham, who earned a degree in biomedical engineering from the McKelvey School of Engineering in 2017, said a WashU lab internship and her extracurricular activities helped steer her career toward consulting.

"I was doing research in a traumatic brain injury lab, and it was a great experience, but I determined that I didn't want to do research long-term," said Durham, who is a consulting senior analyst at Accenture in the Minneapolis-St. Paul area. "Another lady in the lab was getting her PhD and ended up working for Accenture. From there I met others who were engineers and were working in consulting, so that's when I first saw that it was possible."

It was WashU's extensive networking opportunities that allowed her to get to know how people were applying their educations to careers in engineering as well as outside engineering, she said.

"Working as a consultant, you realize that they love the way that (engineers) think and how you analyze things," Durham said.

Jonathan Frick, a partner at Bain & Co., graduated from the McKelvey School of Engineering in 2003 with a degree in computer science. He also has a degree in economics from WashU and an MBA from Stanford.

Frick said that in the consulting business, the ability to break down an ambiguous problem is a big thing, and having more ways of thinking in your toolkit, especially the way engineers approach problems, is extremely valuable.

"During my summers at WashU, I worked as an intern as a software engineer at tech companies. What struck me was, it seemed the businesspeople were the ones making the interesting and momentous decisions that had all the impact on what the engineers did. So, that's the main reason I decided to switch over to consulting," Frick said. "I thought consulting would be an interesting way to get exposure to the business side of things."

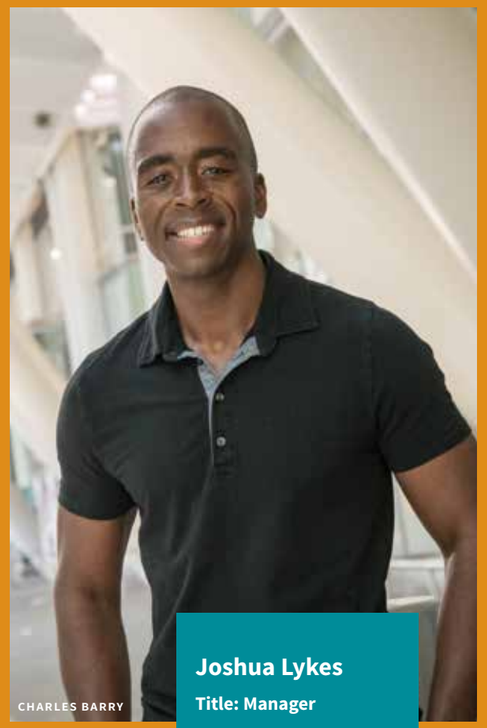
BABAJIDE OLUPONA

Ramona Durham
Title: Consulting Senior Analyst
Employer: Accenture
Based in: Minneapolis-St. Paul

Jonathan Frick
Title: Partner
Employer: Bain & Co.
Based in: London


RON KLEIN

David Brablec
Title: Engagement Manager
Employer: McKinsey & Co.
Based in: Chicago


CHARLES BARRY

Joshua Lykes
Title: Manager
Employer: Bain & Co.
Based in: San Francisco


JOHN BOAL

Lauren Krone
Title: Associate
Employer: McKinsey & Co.
Based in: Washington, D.C.

The big picture

After David Brablec completed an engineering internship at Boeing, it was the opportunity to work on a variety of projects, industries and innovative technologies that drew him to consulting. Brablec, who graduated from WashU in 2016 with bachelor's degrees in mechanical engineering and economics, is an engagement manager with McKinsey & Co. in Chicago. Among the projects he's working on include city future mobility, autonomous vehicles and aerial mobility.

"These are projects on society's largest technology disruptions, and I can serve decision-makers in the industry more than I could have as a line engineer," Brablec said.

Lauren Krone comes from a family of engineers. She is a 2012 WashU graduate with a degree in chemical engineering. She spent three years using her degree at Dow Chemical before moving to her current job as an associate at McKinsey in Washington, D.C.

"I always loved math and chemistry and chemical engineering, and my degree was the perfect way to marry those interests," Krone said.

But it was the ability to do something bigger that caused her to move to consulting.

"Something that I thought WashU did a good job of was that they took engineering and said, 'So, how do we use that to not just make a company do better but how do you clean a river or create green energy using engineering?' That was a perspective that not many universities do, or at least did at that time."

As a freshman at WashU, Joshua Lykes considered a career in engineering, but also was interested in careers outside of engineering, including law. Lykes, who graduated in 2009 with a degree in chemical engineering, did an internship at Anheuser-Busch before deciding to pursue a different career path than chemical engineering. Lykes, who is now a manager for Bain & Co. in San Francisco, made the jump to consulting, in part because of the opportunity to work on a variety of projects.

Kara Donato graduated from WashU in 2013 with degrees in systems science and engineering and a business degree in operations and supply chain management. She is a senior consultant with Deloitte Digital in Chicago, working on customer-facing, user-experience design of digital products.

"What I would encourage (students) to think about when they're looking at consulting is, 'What's the environment that I want to be in?' I think the environment at WashU for me was so reflective of consulting — a place that was very collaborative, very user-focused."

It was a robotics lab her sophomore year that best helped prepare Donato for a career in consulting.

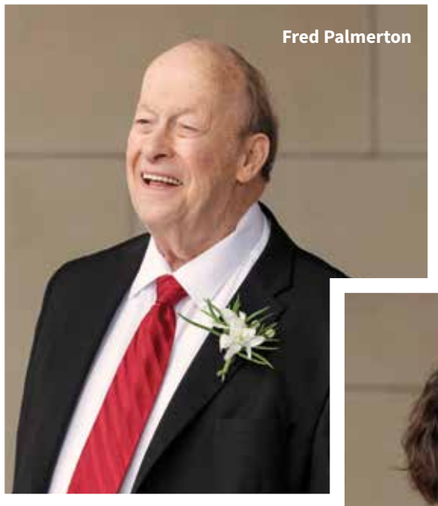
"It was a completely new topic for me. It was a new way of applying the topic. But what I really took away from it was, how do I succinctly summarize the problem and how do I ask the right questions in order to move us in the right direction? And that, for me, is consulting at the core."

"The environment at WashU for me was so reflective of consulting — a place that was very collaborative, very user-focused." — KARA DONADO


ANJALI PINTO

Kara Donado
Title: Senior Consultant
Employer: Deloitte Digital
Based in: Chicago

The 2019 McKelvey Engineering Awards were held April 25 at the Saint Louis Art Museum.


Fred Palmerton

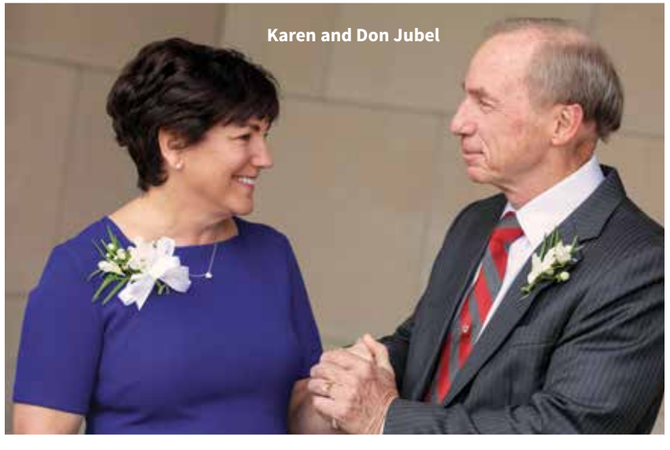

Charles Eggert

Photos by **WHITNEY CURTIS**


Lorrie Faith Cranor


Deanne Bell


Raj Gupta


Karen and Don Jubel

Seven honorees given 2019 McKelvey Engineering Awards

Young Alumni Award

Deanne Bell

As an engineer, television host and the founder/CEO of Future Engineers, Deanne Bell is introducing the field of engineering to new audiences. Bell worked as an engineer prior to her career in television, which began as co-host of the PBS children's series "Design Squad." Subsequent hosting credits include ESPN, Discovery Channel, National Geographic, DIY Network and, most recently, CNBC. She also founded the award-winning education technology company Future Engineers, which hosts online challenges for K-12 students. Bell earned a bachelor of science degree in mechanical engineering from WashU in 2002.

Alumni Achievement Award

Lorrie Faith Cranor

At Carnegie Mellon University, Lorrie Faith Cranor is director and Bosch Distinguished Professor in Security and Privacy Technologies, FORE Systems Professor of Computer Science and Engineering & Public Policy, and director of the CyLab Useable Privacy and Security Laboratory. In 2016, Cranor was chief technologist at the U.S. Federal Trade Commission. She also co-founded Wombat Security Technologies Inc. Cranor earned a bachelor's in engineering and public policy in 1992, a master's in technology and human affairs in 1993, a master's in computer science and a doctor of science in engineering and policy in 1996, all from WashU.

Charles Eggert

As senior adviser for Arsenal Capital Partners, a New York City-based private equity firm, Charles (Chas) Eggert acquires and builds midsize specialty chemical companies. He is a board director at J. M. Huber Corp. and is recognized as a Governance Fellow with the National Association of Corporate Directors. Before joining Arsenal Capital, Eggert was president and CEO of OPX Biotechnologies, helping the company grow from a small startup to raising more than $70 million of venture capital funding. Eggert earned a bachelor's in chemical engineering in 1975 and an MBA in 1985, both from WashU.

Raj Gupta

As executive chairman of Environmental Systems Design (ESD), Raj Gupta emphasizes innovation in creating smart, sustainable spaces and ways to interface with the built environment. Founded in 1967 by Gupta's father, ESD is known for its forward thinking and creativeness. Jeddah Tower in Saudi Arabia, slated to be the world's tallest building, will have essential systems provided by ESD. As a dual degree student, Gupta earned a bachelor's in mechanical engineering from WashU in 1984 and a bachelor's in engineering management from Claremont McKenna College in 1984.

Fred Palmerton

As founding president, Fred Palmerton established Palmerton & Parrish Inc. (PPI) as an engineering corporation in 1989. PPI is a leader in geotechnical engineering and construction materials, with projects ranging from dams and levees to health care and educational facilities. The consulting engineering and materials testing firm has 50 employees with offices in Missouri and Oklahoma. Palmerton is an active member of several professional organizations, including the Missouri Society of Professional Engineers (MSPE), for which he was president in 1998. Palmerton earned a bachelor's degree in civil engineering from WashU in 1960.

Dean's Award

Don and Karen Jubel

A St. Louis native, Don Jubel is executive chairman of Spartan Light Metal Products, a supplier of die-cast parts and assemblies for the automobile industry. He and his wife, Karen, who serves as a board member for the company, are a family whose history has been intertwined with Washington University for three generations. Don and Karen have honored his late parents with the Henry A. & Elvira H. Jubel Hall. Don is a member of the Washington University Board of Trustees, the Engineering National Council and is past chair of the Engineering Eliot Society Committee. He has received numerous awards from the university and co-chaired 35th, 40th and 45th reunions for his class of 1973. In addition, Don and Karen received the university's Founders Day Robert S. Brookings Award in 2014. Don earned a bachelor's degree in mechanical engineering from WashU in 1973. Karen is a graduate of Maryville University.

Elisabeth Koral

COURTESY PHOTO

Written by **BETH MILLER**

While engineering and law may seem somewhat incongruous, for alumna Elisabeth Koral, her engineering degree from Washington University in St. Louis was excellent preparation for her career as a patent attorney.

"All of the skills you learn and develop while an engineering student, such as critical thinking and problem-solving, are skills that can be applied across a wide spectrum of fields," said Koral, JD, a principal who practices patent law at Harness Dickey in St. Louis. "As I went through the engineering program, a career in patent law presented itself as a better fit for all of my interests."

Koral earned a bachelor's degree in chemical engineering from WashU in 2004, then earned a juris doctoris degree from Northern Kentucky University in 2007.

"Even when I knew I was not going to pursue a traditional chemical engineering career, I knew I wanted to continue to use my engineering degree and to work in the science field. Patent law was a natural fit for that," said Koral, a native of Cincinnati, Ohio.

As a patent attorney, Koral focuses her practice on securing patent rights for her clients through all stages of patent preparation and prosecution.

"It's really exciting to work with inventors and be a part of new science and new technology," she said. "I am able to work with innovations in many fields; for example, pharmaceuticals, chemical engineering processes, materials, organometallic chemistry and semiconductors. It is very rewarding to work with so many different innovations and to help inventors secure their rights."

Earlier this year, Koral was named St. Louis Small Business Monthly's Best Patent Attorney, and in 2018, she was named among Missouri Lawyer's Weekly's "Up & Coming."

Koral was drawn to WashU by the flexibility allowed in the curriculum.

"WashU offered me the opportunity to explore outside of the engineering field and take other classes that interested me," she said. "I always enjoyed writing and history and was able to get a history minor."

Koral said that female inventors seeking patents are still a small minority, meaning there is still so much underutilized potential from female inventors.

"All of the skills you learn and develop while an engineering student, such as critical thinking and problem-solving, are skills that can be applied across a wide spectrum of fields."

Growing up, Koral was supported by her family and teachers to pursue her interest in the STEM fields, so it is important for her to give back and encourage and support women to pursue the STEM fields.

"I feel very lucky to have had access to programs to learn more about careers in the STEM fields and to have encouragement from my family to explore my interests in science and math," she said.

She is a member of the Women & Engineering Leadership Society, which fosters professional and personal growth of female engineering students to develop them into leaders and serves as a support and advocacy network for female engineers associated with WashU.

"I really enjoy providing support, encouragement and career advice to my mentees, whether it relates to engineering or if they have an interest in patent law," she said.

Though a transplant to St. Louis, Koral is active in the St. Louis community by serving on the board of the Downtown Children's Center in St. Louis and volunteering with Brazen, a local nonprofit that supports women entrepreneurs.

"St. Louis has a great startup community and culture, and I enjoy participating in it," she said. "I believe it's very important to support the city and the success of our residents."

Opportunity

Written by **TAVIS REED**

Tavis Reed is a senior double majoring in applied science (chemical engineering) and computer science with a minor in mathematics. He is president of the National Society of Black Engineers for the 2019-20 school year.

When I think about the McKelvey Undergraduate Research Scholars program, the first word that pops into my head is "opportunity." Being a McKelvey Scholar has been an amazing opportunity for me to make great strides on my path to become a researcher. When I first came to WashU, I knew that I wanted to get involved with research on campus, but I had absolutely no idea how to do so. The prospect of just going up to a professor and trying to convince them to let me join their lab as a first-year student was, quite frankly, terrifying. Fortunately, through the mentorship that I received through the McKelvey Scholars program, I was able to join a lab during my second semester. My experience in that lab helped me get an internship at Argonne National Laboratory the summer after my first year. Since then, I have had several different research experiences at different labs, both at WashU and at other universities.

As I get ready to apply to PhD programs this fall, I know that these invaluable experiences will help make me a competitive candidate. I wouldn't be in this position if it weren't for the communication, networking, general research and many other skills that I developed from being a McKelvey Scholar. That is why being a McKelvey Scholar has been one of the best opportunities that I have had during my time at WashU.

Inspired by the legacy of former Dean James M. McKelvey Sr., the McKelvey Undergraduate Research Scholars program was created in 2007 for students to work on cutting-edge research projects with faculty from engineering, medicine or the sciences. These scholars also take advantage of special programming, including both cultural and academic activities.

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CHANGE SERVICE REQUESTED

#WashUengineers

$$p = mv$$

Snapshot //

The new east end of the Danforth Campus is open and ready for classes! Jubel Hall, home of the Department of Mechanical Engineering & Materials Science, is complete.

WASHU PHOTO