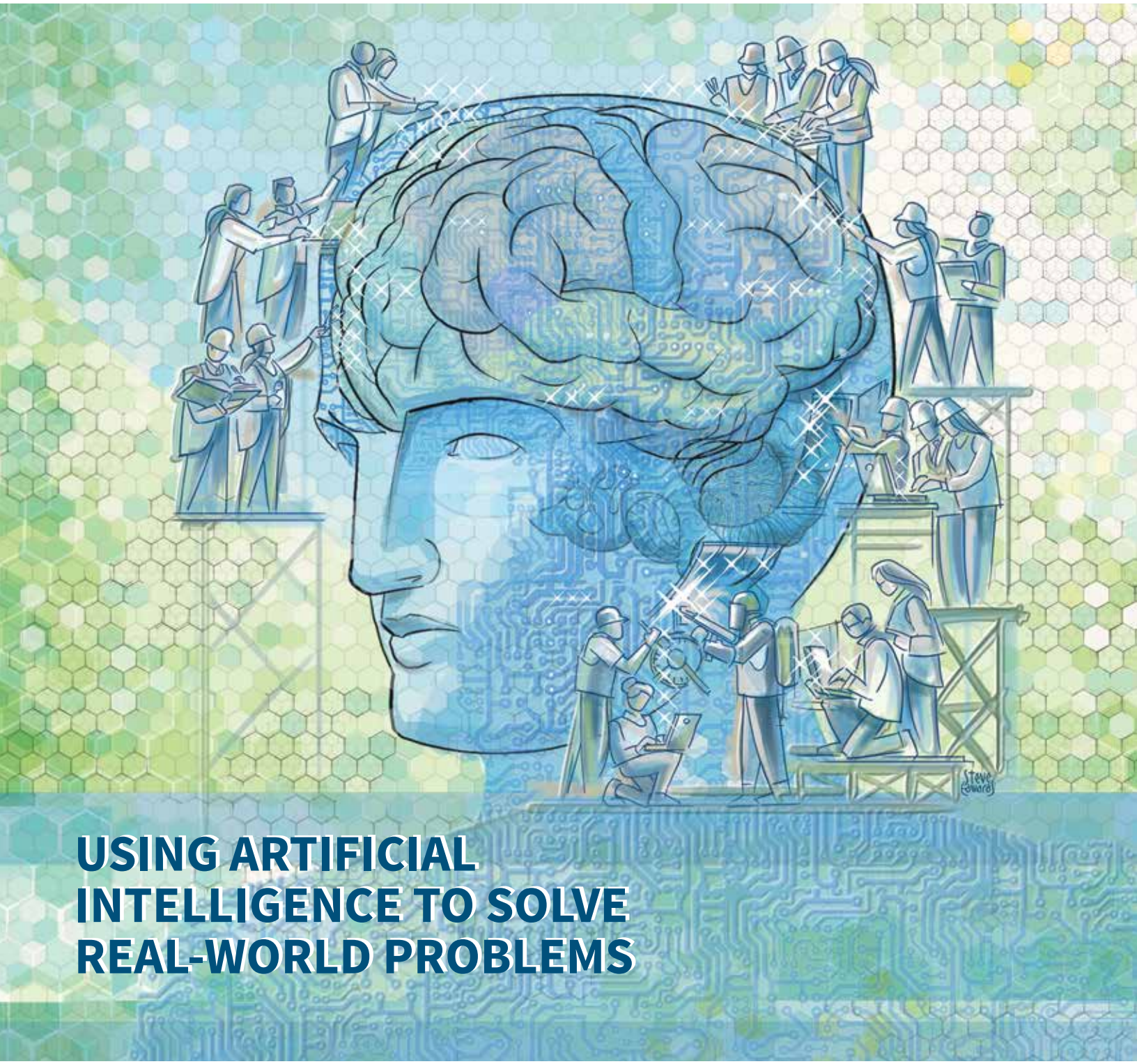
ENGINEERING Momentum

Across Disciplines. Across the World® // **SPRING 2018**



USING ARTIFICIAL INTELLIGENCE TO SOLVE REAL-WORLD PROBLEMS

Washington University in St. Louis

Snapshot //

Undergraduate students in Biomedical Engineering work on a senior design project that was later showcased at the annual BME Day.

DEVON HILL

From the dean //

Dear friends,

Those of you who have been following the school's progress during the past year have learned about our strategic planning efforts and the resulting goals that emerged. If you look through the document — it's online! — you will notice that diversity is not a single explicit objective. Rather, woven throughout the goals you will see diversity as being critical to educating insightful engineers, producing thought-leading research, and providing a working and learning environment that inspires excellence.

In Engineering at WashU and indeed around the country, we face a gender diversity challenge. In the United States, women represent somewhere between 10 percent and 20 percent of the engineering workforce, depending upon domain. And while more women are enrolling as undergraduates in engineering — approximately 20 percent of engineering students nationally and 30 percent at WashU are women — there are additional challenges, such as women leaving the field after starting their careers. Business as usual is not likely to make significant inroads in changing these statistics.

Our school's Women & Engineering program, described in this edition of the magazine, is a critical effort to support women students and alumnae in their efforts to not only become engineers in school, but to be successful in their careers and to be change agents both for WashU Engineering and for the entire field. Staff, students and alumnae coordinate activities that provide mentoring connections, opportunities to explore difficult career and social questions, and leadership development. Additionally, we are working to connect current women student groups, including the Society of Women Engineers and Women in Computer Science, with prospective women students; our goal is to not only encourage them to choose engineering as a field of study but also to show them that WashU provides a unique supportive environment in which to pursue their passion.

I want to take this opportunity to thank many of you, our alumni, who have explicitly helped support this effort. We invest in the program in a variety of ways, from hosting leadership summits and subscribing to mentoring platforms to enabling more students to attend conferences such as the Grace Hopper Celebration of Women in Computing. These efforts make a difference — and promote the diversity of thought and perspective that is essential to be a truly world-class engineering institution.

Aaron F. Bobick
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In this issue //

SPRING 2018

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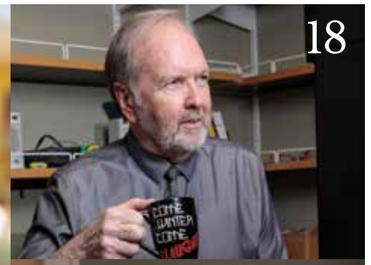


IN EVERY ISSUE

THE BUZZ #WashUengineers

Langsdorf Scholars Summit

More than 60 Langsdorf Scholar alumni and students gathered April 20-21 for an inaugural summit to network and share ideas. The summit was started by two current Langsdorf students, Sydney Katz, '18 (left) and Kailin Baechle, '18 (right).

@laptopsofwashu
#washuengineers edition

New year, new professor. Meet Kimberly Parker

Parker studies organic chemical reactions in natural and engineered systems.

Why WashU? "I love being here!"

PhD Candidate Weimin Zhou received the Cum Laude Poster Award (first place) at the 2018 SPIE Medical Imaging Conference for his paper. Zhou is a member of the Computational Imaging Science Laboratory and a PhD candidate in the Department of Electrical & Systems Engineering.

Read more about the Leadership Summit on p. 22

Women & Engineering Leadership Summit

PHOTOS BY WHITNEY CURTIS

At a glance //

19 Feb 2018 **@JonSilva_StL**
Congratulations to Wandi Zhu on winning a Biophysical Society Student Research Achievement Award! @WashUengineers @SilvaLabWustl #BPS18 #WomenInScience

12 Mar 2018 **@The_Lake_Lab**
We're enjoying #ors2018 and catching up @fffionafei

16 Nov 2017 **@washuengineers**
Cheers to the champion of WashU engineering scholarships. Bill Tao's legacy will impact WashU engineers forever!

WashU Engineering launches PhD in imaging science

The field of imaging science — marked by rapidly changing and improving technology — plays a critical role in applications ranging from cancer diagnosis to virtual reality. With the aim of training the next leaders in imaging, the School of Engineering & Applied Science is offering an interdisciplinary doctoral program in imaging sciences beginning in the 2018-19 academic year.

Designed to prepare students for careers in academic research or in industry, the interdisciplinary doctoral program will incorporate the latest imaging technologies, including biomedical, satellite, seismic, sonic and light detection and ranging (LiDAR).

More than 35 faculty experts in Engineering will train students in quantitative and computational principles of image formation, analysis, understanding and quality assessment. Such faculty members represent a broad cross section of engineering, including those from the graduate program in biomedical engineering and from electrical & systems engineering and computer science. Others involved in the program include Arts & Sciences faculty in physics, applied math, biology and chemistry and School of Medicine faculty in radiology, radiation oncology, and cell biology & physiology.

The doctoral program in imaging sciences — one of only two in the country — is part of a $25 million initiative recently launched by the School of Engineering & Applied Science and School of Medicine, one of the highest ranked in the country. The initiative supports university researchers developing innovative imaging technologies aimed at transforming clinical research and the practice of medicine around the world.

Alumna Gretsch takes two gold medals at Paralympics

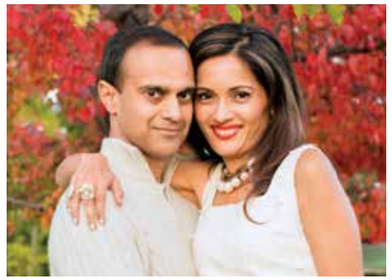
Kendall Gretsch, who earned a bachelor's degree in biomedical engineering in 2014, won the first-ever biathlon Olympic or Paralympic gold medal for a U.S. athlete when she won the sitting biathlon sprint March 10. She also won a gold medal in women's 12-kilometer cross-country skiing. She also competed in the 12.5km individual biathlon, a 5km sitting and a 4x2.5km relay mixed cross-country skiing event.

Alums Brimer, Cohen named to Forbes 30 Under 30

Andrew Brimer, who earned a degree in mechanical engineering, and Abby Cohen, who earned a degree in biomedical engineering, both in 2013, turned their Discovery Competition idea into Sparo Labs, which has continued to grow by leaps and bounds in four short years. The company has raised $2.7 million in funding since it was founded.

CAMPAIGN GIFT

Garg family's $1 million gift pushes Engineering over $150 million in campaign



Venture capitalist and alumnus Gaurav Garg and his wife, Komal Shah, have made a $1 million gift to the School of Engineering & Applied Science. The gift allows the school to surpass $150 million in Leading *Together*: The Campaign for Washington University.

Garg is managing partner of Wing Venture Capital in Silicon Valley, which builds early-stage business technology companies. Wing focuses on companies with the potential to define new categories in cloud computing, mobile and big data and to provide entrepreneurs with the financial and strategic backing to build successful companies. The firm invests over the life of each of its portfolio companies, which include FireEye, Jasper, Nimble Storage and Cohesity.

Garg and Shah's $1 million gift will help fund annual undergraduate scholarships, long-range capital needs, an endowed lectureship, an annual lectureship and other school needs. The university will name the department chair's suite in the future James M. McKelvey, Sr. Hall in recognition of the gift.

WashU Engineering launches master's in cybersecurity engineering degree

High-profile cyberattacks and data breaches have made cybersecurity engineering one of the fastest-growing careers in the world, yet demand for highly qualified leaders exceeds supply: Experts predict a shortage of 3.5 million cybersecurity professionals by 2021. To meet that demand, the School of Engineering & Applied Science is launching a master of science degree in cybersecurity engineering to train new experts for this high-profile field.

The full-time master's program, which begins in Fall 2018, is specifically crafted to provide students with the skills, knowledge and expertise needed to secure jobs in designing and engineering cybersecurity technology. Core principles throughout the curriculum, taught by computer science faculty and experienced industry professionals, include developing secure technical environments and defending against the spectrum of cybersecurity threats.

Students will learn in a robust technical environment in which they will evaluate cyberattack vectors, assess cyberdefense methods, conduct research, and design and develop new methods, protocols and techniques.

Empowering high school students

The School of Engineering & Applied Science recently hosted two unique groups of middle and high school students to empower them to pursue degrees and careers in science, technology, engineering and math (STEM). Frank Wilson, who earned a master of construction management from Engineering in 2010, coordinated the events with Joseph O'Sullivan, professor and dean of the University of Missouri-St. Louis/Washington University in St. Louis Joint Undergraduate Engineering Program and the Samuel C. Sachs Professor of Electrical Engineering. Wilson, who owns BFW Construction Co. and is an adjunct professor in the UMSL/WashU Joint Program, and O'Sullivan brought 100 high school students in foster care to campus March 15, where they heard from alumni, motivational speakers and entrepreneurs. On March 16, nearly 170 students from seven area high schools took part in a STEM Youth Empowerment and Leadership Summit.

Computer science student 'broke' Facebook during her internship

Grace Egbo, a computer science student, learned a lot about Facebook during her first summer there as an intern.

Mark Zuckerberg really does wear gray hoodies. The free cafeteria serves killer nachos. And "move fast and break things" is not just the company motto; it's a mode of operation.

"During orientation, they told us to test new ideas and take risks," said Egbo, now a junior in the School of Engineering & Applied Science. "On the day I broke Facebook, I realized they meant it."

To be clear, Egbo didn't actually break the globe's largest social networking platform. Facebook's roughly 2 billion users could still post, like and share. But Egbo's experiment crashed the company's employee site for more than an hour.

"I knew it was bad when my friend in the New York office called and said, 'Were you the one who broke Facebook?' And I was like, 'Oh my goodness! It went national,'" Egbo recalled.

Fellow employees jumped in to help Egbo, and the site was back up in an hour. Still, Egbo feared her boss would chastise her for her mistake.

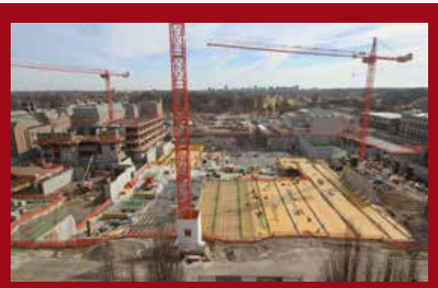
"The exact opposite happened," Egbo said. "He said, 'Hey, how are you? Heard you broke Facebook. Did you learn anything?' I came away understanding it really is OK to break things. It's OK to fail at things, as long as you don't settle into that and feel like a failure. What mattered is that you tried something new."

Written by Diane Toroian Keaggy

East End *Transformation*

Ten months into construction of the east end, and the buildings are coming out of the ground. Over Spring Break in March, crews removed masonry and part of the exterior wall on the third floor of Whitaker Hall in preparation for the bridge connection to Jubel Hall.

December 2017



February 2018

April 2018

Simplifying samples

Inexpensive, novel method to transport blood, urine samples without refrigeration developed at Washington University

Using nanotechnology, a team of researchers at Washington University in St. Louis has eliminated the need for refrigeration by developing a new low-cost technique that creates a protective shield around protein biomarkers in the sample. With this method, the samples maintain 95 percent of their purity and the information on which important health care decisions are based.

The team is led by Srikanth Singamaneni, associate professor of mechanical engineering & materials science in the School of Engineering & Applied Science; and two scientists at Washington University School of Medicine in St. Louis: Jeremiah J. Morrissey, research professor of anesthesiology; and Evan D. Kharasch, MD, PhD, the Russell D. and Mary B. Shelden Professor of Anesthesiology and professor of biochemistry and molecular biophysics. They used a nanoporous material to essentially shrink wrap protein biomarkers in blood and urine samples by growing crystals around the molecules. Then, they transferred the shrink-wrapped molecules onto standard lab filter paper. Once dry, the paper can be shipped at any temperature to a lab for testing.

"Once you are ready to analyze the sample, you extract everything from the paper back into liquid," Singamaneni said. "We showed that this method maintains the integrity of the biospecimens."

The research, recently published in *Chemistry of Materials*, is the first published work that uses an emerging class of nanomaterials known as metal-organic frameworks with biospecimens such as blood, urine, serum and plasma.

Wang elected to National Academy of Engineering

Lihong Wang, a former professor in the School of Engineering & Applied Science for more than 10 years, has been elected to the National Academy of Engineering. He is renowned for his innovative work in high-resolution imaging for biomedical applications.

Jerina receives Coffin-Manson Fatigue Achievement Award

Ken Jerina, senior professor of mechanical engineering & materials science, has been awarded the Coffin-Manson Fatigue Achievement Award from the American Society for Testing and Materials International (ASTM). The award recognizes individuals who have made outstanding contributions in the field of fatigue of materials.

Agarwal receives ASME's highest honor

Ramesh Agarwal, the William Palm Professor of Engineering in mechanical engineering & materials science, received ASME Honorary Membership at the ASME 2017 Honors Assembly ceremony in Tampa Nov. 6.

Researchers discover higher environmental impact from cookstove emissions

Cookstoves are a central part of millions of homes throughout Asia: Families often use readily available and cheap biofuels — such as crop chaff or dung — to prepare the food needed to survive.

Previously, numerous research groups worldwide have shown, mostly based on laboratory experiments, smoke emitted from stoves used for both cooking and heating have a definite, detrimental environmental impact, particularly in India. Despite advances in technology, many people are reluctant or unable to adopt the newer, cleaner cookstoves. For several years, a collaborative team from Washington University in St. Louis has studied the issue and potential solutions. Now, new research gives them a clearer picture of the topic's true scope.

"Our project findings quantitatively show that particulate emissions from cookstoves in India have been underestimated," said Rajan Chakrabarty, assistant professor of energy, environmental & chemical engineering in the School of Engineering & Applied Science.

The research, published in *Atmospheric Chemistry and Physics*, was the culmination of field studies conducted in India by faculty members at the School of Engineering & Applied Science and the Brown School. In December 2015, the researchers spent 20 days running a series of tests in Raipur, a city in central India where more than three-quarters of the families use cookstoves to prepare their meals.

Written by Erika Ebsworth-Goold

WashU startup SentiAR Inc. awarded $2.2M NIH grant

SentiAR is developing augmented reality software for use in cardiac procedures. Through a holographic headset, the SentiAR platform converts outputs from CT, MRI and catheter mapping into a real-time hologram of the heart that "floats" above the patient. Within this sterile field, cardiologists can view, measure and manipulate the holographic heart model in real time in the operating room. The real-time aspect of SentiAR's technology is key: While other companies have used holographic technology for training simulations, SentiAR is one of the first to offer a live, real-time view of the patient's actual anatomy in the operating room. The goal of the SentiAR technology is to reduce operating time and exposure to radiation while improving accuracy. Another advantage: Using multiple headsets, more than one clinician can view the heart at the same time.

The platform uses technology developed by founders (and husband-and-wife team) Jennifer Silva, MD, and Biomedical Engineering Associate Professor Jon Silva at Washington University in St. Louis.

Lake receives early career award from ASME

Spencer Lake, associate professor of mechanical engineering & materials science, has been awarded the Y.C. Fung Early Career Award from the American Society of Mechanical Engineers (ASME), the highest award for young investigators in bioengineering. Lake was chosen for his pioneering work in musculoskeletal biomechanics and mechanobiology. He will receive the award, which recognizes an individual for outstanding contributions to the field of bioengineering through research, in July at the 2018 Eighth World Congress of Biomechanics in Dublin, Ireland.

Lake's research focuses on soft tissue biomechanics, with an emphasis on orthopedic tissues, such as tendons and ligaments. His research uses a multiscale experimental and computational approach to evaluate the in vivo loading environment, tissue properties, and microstructural structure-function relationships of tissues that function in complex physiologic environments.

WashU engineer wins IEEE Signal Processing Society Best Paper Award

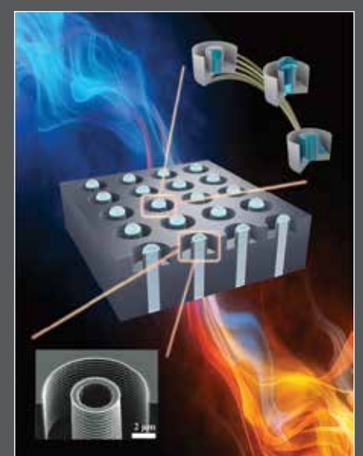
Ulugbek Kamilov, assistant professor of computer science & engineering and electrical & systems engineering, received the IEEE Signal Processing Society 2017 Best Paper Award for his paper titled "Message-Passing De-Quantization with Applications to Compressed Sensing."

Cooling method could relieve heat woes in data centers, electric vehicles

Electronic systems, such as electric vehicles and large data centers, generate a lot of power, which creates tremendous heat. An engineer at Washington University in St. Louis has developed a unique evaporative cooling system using a membrane with microscopic pillars designed to remediate the heat, ultimately improving performance.

The method, developed by Damena Agonafer, assistant professor of mechanical engineering & materials science, is the first approach to retaining liquids using microfabricated micropillar structures. His theoretical, computational and experimental analyses are published in the March 15 print issue of the *Journal of Colloid and Interface Science.*

While a postdoctoral researcher at Stanford University, Agonafer developed a method to mitigate high heat-flux generation using water. However, water cannot be used safely in electrical applications, so Agonafer uses dielectric liquid, such as refrigerant, an electrical insulator in high voltage applications that has low surface tension.



$3.9 million supports research to turn bacteria into biofuel producers

Researchers at Washington University have received a $3.9 million grant from the Department of Energy (DOE) to develop bacteria that manufacture renewable biofuels — energy sources made from plants or microbes.

The researchers seek to make biofuels whose production would not compete with the food supply. For example, ethanol is an alcohol-based fuel typically made from corn or sugar cane. Instead, the researchers will engineer microbes to make biofuels from a toxic waste product of papermaking called lignin.

The grant supports research in five WashU labs, including those led by co-principal investigators Gautam Dantas, an associate professor of pathology and immunology; Tae Seok Moon, associate professor of energy, environment & chemical engineering; Marcus B. Foston, assistant professor of energy, environment & chemical engineering; Yinjie Tang, associate professor of energy, environment & chemical engineering; and Fuzhong Zhang, associate professor of energy, environment & chemical engineering. Hector Garcia Martin of Lawrence Berkeley National Laboratory is another collaborator.

Written by Julia Evangelou Strait

Trap, contain and convert

New research by scientists at Washington University in St. Louis sheds light on what happens underground when CO_2 is injected into basalt, illustrating precisely how effective the volcanic rock could be as an abatement agent for CO_2 emissions. The research, led by Daniel Giammar, the Walter E. Browne Professor of Environmental Engineering, was conducted in collaboration with researchers at Pacific Northwest National Laboratory and Philip Skemer, associate professor of earth and planetary sciences in Arts & Sciences at Washington University.

To obtain a clearer, quantifiable look at carbon trapping rates in basalt, Giammar collected samples of the rock from Washington state, where researchers

previously injected a thousand tons of CO_2 gas deep underground into a basalt flow. He placed the rocks in small reactors that resemble slow cookers to simulate underground conditions, and then injected CO_2 to test the variables involved in the carbonization process.

Written by Erika Ebsworth-Goold

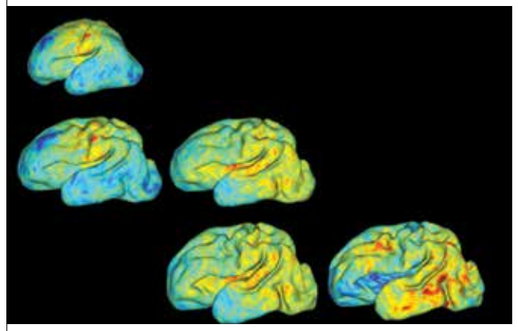
Brent elected to AIMBE College of Fellows

Michael Brent, the Henry Edwin Sever Professor of Engineering, has been elected to the American Institute for Medical and Biological Engineering (AIMBE) College of Fellows — Class of 2018.

Anastasio to chair NIH biomedical imaging technology group

Mark Anastasio, professor of biomedical engineering and of electrical & systems engineering, has been appointed chair of the National Institutes of Health Biomedical Imaging Technology B Study Section (BMIT-B) for a two-year term beginning July 1.

3-D mapping babies' brains



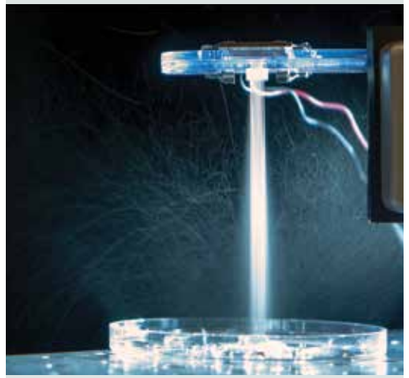
During the third trimester, a baby's brain undergoes rapid development in utero. The cerebral cortex dramatically expands its surface area and begins to fold. Previous work suggests that this quick and very vital growth is an individualized process, with details varying from infant to infant.

Research from a collaborative team at Washington University in St. Louis tested a new, 3-D method that could lead to new diagnostic tools that will precisely measure the third-trimester growth and folding patterns of a baby's brain.

The findings, published online March 5 in *PNAS*, could help to sound an early alarm on developmental disorders in premature infants that could affect them later in life.

"One of the things that's really interesting about people's brains is that they are so different, yet so similar," said Philip Bayly, the Lilyan & E. Lisle Hughes Professor of Mechanical Engineering.

Written by Erika Ebsworth-Goold



Engineer develops enabling technology for emerging gene therapies

For years, researchers have attempted to harness the full potential of gene therapy, a technique that inserts genes into a patient's cells to treat aggressive diseases such as cancer. But getting engineered DNA molecules into cells is not an easy task.

J. Mark Meacham, assistant professor of mechanical engineering & materials science, leads a team of researchers that has developed a method enabling effective insertion of large molecules — such as DNA, RNA and proteins — into cells and propels them into the cell nucleus. By combining a technique known as Acoustic Shear Poration (ASP) with electrophoresis, the approach uses ultrasound waves and focused mechanical force to create nanoscale holes, or pores, in the cell membrane that are big enough for large macromolecules or nanoparticles to pass into the cell's interior.

So far, ASP has achieved greater than 75 percent delivery efficiency of macromolecules. DNA insertion, or transfection, which is of most interest in gene therapy, is significantly more challenging. Yet the combined application of mechanical and electrical forces pioneered by Meacham and colleagues yields roughly 100 percent improvement in transfection versus pure mechanoporation. Results of the research are published in *Scientific Reports*.

Arthur named Outstanding Professional Engineer in Education

Martin Arthur, interim chair of the Department of Electrical & Systems Engineering and the Newton R. & Sarah Louisa Glasgow Wilson Professor of Engineering, has been selected as the Outstanding Professional Engineer (PE) in Education-2018 by the St. Louis Chapter of the Missouri Society of Professional Engineers.

Research team developing new pediatric neuroimaging technology

A team of scientists is developing a new way to look inside the brains of the littlest patients — a technique that will provide precise measurements without requiring children to stay perfectly still or the use of ionizing radiation.

"The methods we are developing are brand new and state of the art," said Mark Anastasio, professor of biomedical engineering. "This is cutting edge."

The National Institutes of Health (NIH) recently awarded Anastasio and former Engineering colleague Lihong Wang, professor of medical engineering and electrical engineering at the California Institute of Technology, a five-year, $2.96 million grant to develop their novel imaging approach. It involves photoacoustic computed tomography (PACT), which is a hybrid imaging method that combines the advantages of optical and ultrasound imaging.

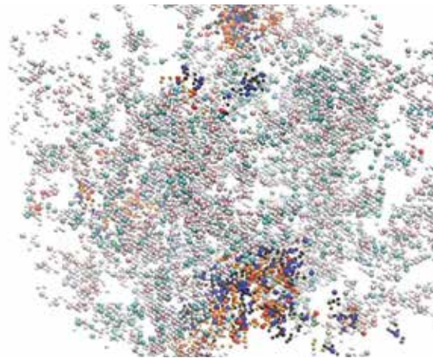
Written by Erika Ebsworth-Goold

Engineers uncover the design principles of cellular compartments

New research from the School of Engineering & Applied Science, published in the journal *eLife*, uncovers the principles underlying the formation and organization of membraneless organelles.

"If our theory and modeling are correct, we ought to be able to design these organelles in the way we want to," said Rohit Pappu, the Edwin H. Murty Professor of Engineering in the Department of Biomedical Engineering.

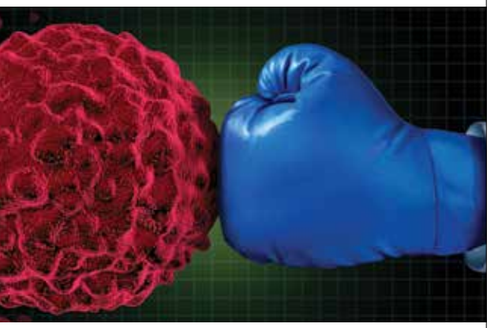
Protein molecules that drive the formation of membraneless organelles are like pearl necklaces. They consist of multiple sticky domains (the pearls) connected by flexible linkers (the necklace). These so-called multivalent proteins come together to form networks that are held



together by physical crosslinks among the sticky domains. The number of domains within a molecule contributes to the number of crosslinks that are realizable.

Written by Erika Ebsworth-Goold

Cancer immunotherapy target of WashU mechanobiology research



One of the latest treatments for cancer is immunotherapy, which involves genetically modifying a patient's own immune cells to fight tumor growth and spread. An engineer and an immunology researcher at Washington University in St. Louis are collaborating to find a better way to prepare and treat these immune cells to maximize their effectiveness in patients.

Amit Pathak, assistant professor of mechanical engineering & materials science in the School of Engineering & Applied Science who specializes in mechanobiology, and Eynav Yafit Klechevsky, assistant professor of pathology & immunology in the School of Medicine, have received a three-year, $610,000 Trailblazer Award from the National Institutes of Health's National Institute of Biomedical Imaging and Bioengineering.

In immunotherapy, researchers extract T cells — immune cells that fight infection in the body — from a patient's blood, manipulate them in a lab to recognize cancer cells, then return them to the patient to destroy the cancer cells.

Pathak, who studies how cells' behavior and properties can be modified by the type of material the cells sit on, or its microenvironment, will work with Klechevsky to modify the microenvironment in which T cells are manipulated in the lab to mimic the biomechanical properties of dendritic cells, which are Klechevsky's focus of research. Dendritic cells are found in most of the body's tissues and process foreign substances or toxins known as antigens and present them to T cells to promote immunity.

Pathak receives seed grant from CEMB

Amit Pathak, assistant professor of mechanical engineering & materials science, has received a one-year, $37,500 seed grant from the Center for Engineering MechanoBiology (CEMB) for a project titled "Mechanical memory in collective cell migration through nuclear-cytoskeletal crosstalk."

Academy of Science-St. Louis honors researchers

Raj Jain received the James B. Eads Award, which recognizes an individual for outstanding achievement in engineering or technology, at a dinner April 5.

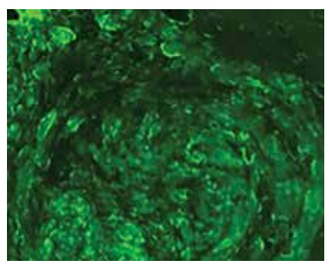
Genin named inaugural Faught Professor of Mechanical Engineering

Guy Genin, an internationally renowned expert in mechanobiology, was installed as the Harold and Kathleen Faught Professor of Mechanical Engineering Feb. 12.

Genin studies interfaces and adhesion in nature, physiology and engineering. His research focuses on mechanobiology and aims to understand and harness the role of force in living systems. His group works on pathologies whose underpinnings have an important mechanical component, including cardiac fibrosis and pathologies of interfaces in the body.

The professorship was made possible through a bequest from the late Harold Faught. He was a longtime friend and volunteer for the School of Engineering & Applied Science, serving on the National Council for nearly a decade.

Noninvasive brain tumor biopsy on the horizon



Taking a biopsy of a brain tumor is a complicated and invasive surgical process, but a team of researchers is developing a way to detect tumor biomarkers through a simple blood test.

Hong Chen, a biomedical engineer, and Eric C. Leuthardt, MD, a neurosurgeon, led a team of engineers, physicians and researchers that has developed a groundbreaking, proof-of-concept technique that allows biomarkers from a brain tumor to pass through the tough blood-brain barrier into a patient's blood using noninvasive focused ultrasound and some tiny bubbles, potentially eliminating the need for a surgical biopsy.

Chen, assistant professor of biomedical engineering and of radiation oncology in the School of Medicine, said while researchers have already learned how to get a drug through the blood-brain barrier into the brain via the bloodstream, no one — until now — has found a way to release tumor-specific biomarkers — in this case, messenger RNA (mRNA) — from the brain into the blood.

In the media //

CNN

Flu warfare may look different next year

Professor Pratim Biswas shared how aerosol technology can capture and kill infectious flu particles in the air.

Not only does the air purification technology capture potentially infectious particles "with extremely high efficiency," it kills them.

Science AAAS

Concussions originate from ringing deep inside the brain, modeling suggests

Professor Philip Bayly

It's the low frequencies that dominate, and you can simulate the brain with just a few low-frequency modes.

FOX NEWS

Stop talking about the need for computer science and start teaching it

Aaron F. Bobick, guest column for Fox News

The "nice-to-have" or "competitive advantage" skill is no longer an option; it's now a requirement. This is because any domain in which people make decisions, monitor situations or take action based on information has been dramatically impacted by advances in computing.

SCIFRI

The Story Of Aerosols (Science Friday)

Aerosols do play a role in climate change, but not the one you might think. Assistant Professor Rajan Chakrabarty joined Ira Flatow to discuss the complex chemistry of the particles in our air.

SCIENTIFIC AMERICAN

A new way to 'see' cancer

Quing Zhu, professor of biomedical engineering, for *Scientific American*

Preliminary findings in a pilot study suggest that, after just a couple of weeks, the technique can show how a patient's breast tumor is responding to a particular chemotherapy regimen, based on the amount of vascular activity and changes.

VentureBeat

Insects are revealing how AI can work in society

Assistant Professor Silvia Zhang, guest column for Venture Beat

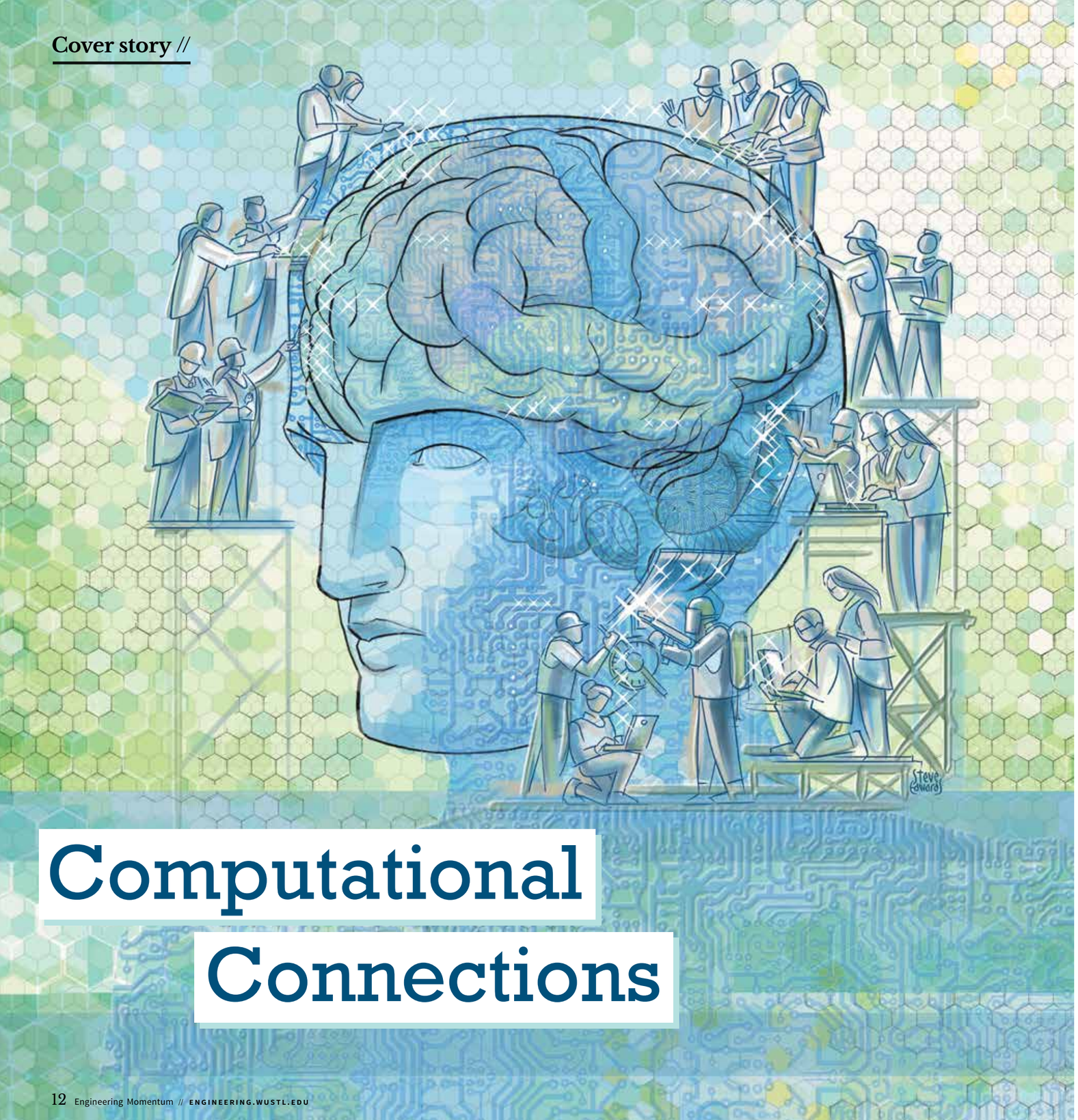
While there is an abundance of AI software startups, the design, assembly and fabrication of hardware components for AI, in addition to the power consumption of hardware systems, are far from cheap.

Forbes

From cancer to crops: engineering small solutions for the world's big problems

Pratim Biswas & Ramesh Raliya, guest contributors to *Forbes*

From drug delivery and energy sources to agriculture and water treatment, some of the world's largest and most complex problems can be solved today with the smallest, simplest structures using principles of aerosol science and technology.



Computational Connections

USING ARTIFICIAL INTELLIGENCE TO SOLVE REAL-WORLD PROBLEMS

Written by **STEPHEN ORNES** *Illustrations by* **STEVE EDWARDS**

Last fall, pet lovers rejoiced when Google unveiled a new feature for its photo storage application. Thanks to cutting-edge technology, users who want to find images of their cats or dogs, or pictures of themselves with their pets, no longer have to scroll through thousands of photos. Instead, they can search the images using only the pet's name. The software does the rest.

The feature runs an algorithm, a mathematical recipe, that teaches the device how to recognize the faces. Facebook, Apple and Google incorporated human facial recognition software into their photo software years ago, so this app may have been inevitable.

Facial-recognition software represents yet another sign that artificial intelligence is steadily infiltrating daily life.

The term "artificial intelligence" broadly refers to ongoing efforts by computer scientists and others to develop machines that can not only perform tasks that seem to require intelligence but also can learn to improve their performance: AI algorithms get smarter the more they are used. And recent developments have been inspired by the structures of the human brain.

Facial recognition software imitates the brain's hardwired ability to identify patterns; the more photos a program studies, the more accurate it gets. And while the goal of many AI projects is to get machines to do things that humans ordinarily do, some say it may be most useful when it automatically does the things that humans *don't* want to do.

Around the turn of the 21st century, machine learning began to take off. A subfield of computer science, machine learning uses large datasets to train a computer to make predictions and decisions independently. It is the success of machine learning that has made AI so ubiquitous that most people interact with AI on a daily basis. Voice-recognition programs built into smartphones and computers, such as Siri and Alexa, use AI to determine how to respond to spoken requests. Netflix uses algorithms to recommend movies. Online stores such as Amazon use AI to set prices and suggest items to shoppers.

The technology isn't perfect. Self-driving cars aren't ready for all public roadways, as evidenced by the self-driving Uber striking and killing a pedestrian in Arizona in March. Amazon shoppers have been baffled by the program's purchase suggestions at one time or another. Those flaws show that there's a lot of work to be done to make AI useful.

At the same time, the goal of AI isn't a system that's perfect, but one that can learn from its mistakes, get better and heal its virtual wounds. At the School of Engineering & Applied Science at Washington University in St. Louis, researchers are leveraging the power of AI to address the challenges of making this technology useful in the real world. They're collaborating with colleagues on a range of interdisciplinary projects, from the best way to help the homeless to programming drones that can monitor farmers' fields or find survivors in disaster-stricken areas.

"AI really captures the imagination regardless of your familiarity with computing," says Aaron Bobick, dean of the School of Engineering & Applied Science and the James M. McKelvey Professor. "It challenges the notion

that intelligence is predominantly a human characteristic, which makes it both startling and sometimes alarming." At the same time, for the technology to mean something, "it has to be useful in the human world."

The eyes of a computer

As a graduate student at MIT, Bobick grew interested in computer vision and focused his research career on how to teach a computer to perceive human behavior and act on those observations.

As research into AI and robotics grew, Bobick later founded Georgia Tech's School of Interactive Computing, a department that focuses on understanding how computing can change the way people interact with information and the world. Fundamental to those questions are how robots engage with people in the human world.

Bobick said he thinks AI can help robots and people interact in a meaningful way.

"Right now, most robots exist in worlds that are designed for robots," he says.

At car manufacturing plants, for example, robots do the heavy lifting, including assembling the car's body. But those robots are kept behind fences and interact with human workers only when they're deactivated.

"What we really want to be able to do is to have humans and robots integrated much better," Bobick says. "To do that, robots have to be able to anticipate what people are going to do."

When Bobick arrived at WashU in 2015, he found a research environment primed to push the usefulness of AI forward.

"We want to leverage the growth in AI with the areas at WashU in which we have deep strengths," he says.

> We want to leverage the growth in AI with the areas at WashU in which we have deep strengths.
>
> — AARON BOBICK

From helping the homeless to saving disaster survivors

The work of Sanmay Das, associate professor of computer science & engineering, shows that kind of collaboration. Das trained as a computer scientist, but most of his projects find him exploring the intersection of AI and social science. With researchers in the finance industry, he's developed machine-learning tools designed to help credit card companies and regulatory agencies identify individuals at risk of making late payments or defaulting on debt. He's looking at ways to scale those tools up so they might be used to analyze the economic performance and risk of banks. Many of his projects involve using AI approaches to help systems distribute scarce resources.

On another project, he's been analyzing homelessness as a data science problem. More than half a million people may live on the streets in the United States. City governments offer programs including shelters and clinics to help this population, but Das says there is an opportunity to use vast amounts of data on people, their interactions with the system and their outcomes to understand the effects of different kinds of interventions on different people and to use that understanding to improve resource allocation.

Sanmay Das

Working with psychologist Patrick Fowler, associate professor in the Brown School, Das developed algorithms to predict whether homeless people were likely to return to the homelessness system after receiving help. The algorithm aims to find optimal ways for a city to deliver aid.

"Who are the kinds of people who would benefit from one type of homeless service or another?" Das asks.

Such research will be a part of the university's new Division of Computational and Data Sciences aimed at training students interested in applying data and computing to some of today's important societal problems. The new division, which will offer a doctoral degree, will be led by faculty from the Brown School, the School of Engineering & Applied Science, and Arts & Sciences.

Das sees thematic parallels between that type of research and precision medicine, which uses a patient's genomic data to identify the optimal treatment for a disease. He has been studying kidney transplant systems with colleagues at Barnes-Jewish Hospital. When a person experiences organ failure, neither kidney works, and the person needs a replacement. In roughly one-third of cases, a kidney is donated by a compatible living donor. But sometimes the donor and the recipient are incompatible.

In those cases, they might enter a kidney exchange where the donor gives a kidney to another patient in need, and that patient's donor gives a kidney to the original patient. This idea has given rise to chains of donors, Das says, but he suspects those exchanges could be more efficient. He is building AI algorithms to optimize those cycles of donations and produce more matches, with the goal of getting kidneys to the people who need them.

William Yeoh, assistant professor of computer science & engineering, also says he's motivated by the intention of using AI where it is most beneficial. Recently, he has built AI systems to enable communication among groups of connected devices. Imagine a cluster of small flying drones that use cameras to monitor a farmer's fields for signs of drought or scan a disaster-ridden city for survivors in need of help. Those devices need to talk with each other while flying to avoid collisions and to cover the most area in the least amount of flying time.

William Yeoh

Yeoh points to another situation that may seem unrelated, but actually poses a very similar challenge: the "smart home." People are increasingly buying household appliances and other devices connected through a wireless router. This is the Internet of Things, a vision of a world where anything can be programmed to respond to the world around it. Smart refrigerators can help one achieve a healthier diet; smart garage doors can open with a swipe on a smartphone. Yet for all of their smarts, these gadgets don't know about each other.

"They don't really interact," Yeoh says, but they could. AI could be used in algorithms that unify all these devices and teach them how to respond to the homeowner.

In Yeoh's vision of a smart home, a short statement such as "I want to watch something" triggers a chain of events: The lights dim, the temperature lowers and a show begins. And this connectivity arises organically: The system becomes more intelligent because the devices talk to and learn from one another.

Bugs, subs and vital signs

When Xuan “Silvia” Zhang, assistant professor of electrical & systems engineering, thinks about how to make AI useful in the real world, she looks to nature. Insects provide a ruthlessly efficient model: What they lack in cognition they make up in unmatched agility. Zhang and her students have been building insect-inspired, autonomous flying robots that use AI to zip through the air like bugs. Small devices require less power and less money to build and offer a cheap and efficient way to increase the reach of AI. But they pose some challenges, like integrating AI algorithms into small spaces and designing systems of miniature batteries and sensors. In her lab, Zhang develops systems of sensors and batteries that can store and distribute power in devices, including AI-powered robots.

Yixin Chen, professor of computer science & engineering, is looking for ways to extend AI’s reach into the hospital setting. Last fall, Chen launched a project with anesthesiologist Michael Avidan, MBBCh, at the School of Medicine. In a pilot study, they are using AI to monitor the vital signs of patients undergoing surgery in all 48 operating rooms at Barnes-Jewish Hospital. The data, displayed on screens in a nearby room, is monitored by a clinician. Green lights indicate normal vital signs, yellow suggests trouble and red lights flag an urgent problem.

Identifying real-world applications for AI isn’t the only challenge to making the technology useful. There also are theoretical hurdles, like understanding how an algorithm works in a particular situation, and design challenges, such as developing new materials that incorporate AI. WashU researchers are working on these fronts as well.

Vijay Ramani, the Roma B. & Raymond H. Wittcoff Distinguished University Professor of Environment and Energy, works at the intersection of electrochemical engineering and materials science. He and his collaborators have designed batteries and fuel cell systems for autonomous submarines and other submersibles that might be useful for military and research use. And Brandon Juba, an assistant professor who teaches AI classes in computer science & engineering, works on the theoretical development of algorithms that not only learn, but can reason using common sense.

When Bobick came to WashU, one of his goals was to foster projects where humans and computers interact in a way that builds on the university’s research strengths. AI, he says, can be used to make effective systems that benefit humankind. Its ultimate goal isn’t to take over the world, but to help people make good choices.

“You end up with decisions that get made better because they’re based on models, supported by a lot of data,” he says. “We want computers to be partners with people.”

As part of that initiative, in 2019, WashU will join such prestigious universities as Stanford, Princeton, Boston, Carnegie Mellon, Simon Fraser and the University of California, Berkeley, to host AI4All, a summer education program that emphasizes using AI for social good for high school students from underrepresented groups.

The late scientist Stephen Hawking once said that AI would be either the best or the worst thing ever to happen to humanity, but it was too early to tell which.

> The development and validation of AI algorithms that can participate in such decision-making in an economically efficient and equitable manner, respecting human judgments of morality and ethics, will be a major area of research and development.
>
> — SANMAY DAS

The future

AI now touches nearly every aspect of existence in modern societies and provides data on our bodies through wearable trackers, energy usage, road usage and our social networking behavior. All of this has brought some to call for AI to be regulated, including Elon Musk, CEO of Tesla.

“I think whenever something is — whenever there’s something that affects the public good then there does need to be some form of public oversight,” Musk said on CBS News on April 11. “I do think there should be some regulations on AI. I think there should be regulations on social media to the degree that it negatively affects the public good.”

Das said with the availability of this data comes the opportunity to learn more about ourselves as well as to make better decisions.

“I expect, in the future, to see a society in which many more decisions, both at the individual and societal level, are taken by combinations of humans and intelligent agents, from decision-making about medical interventions, to traffic routing and eventually driving, to the allocation of societal resources,” Das said. “The development and validation of AI algorithms that can participate in such decision-making in an economically efficient and equitable manner, respecting human judgments of morality and ethics, will be a major area of research and development.”

While there are benefits to AI, Yeoh says there are risks — as with any technology — such as the self-driving vehicles and Facebook’s sharing of data of 50 million of its users with Cambridge Analytica, the British political consulting firm that used data mining to target Facebook users with political posts.

“AI researchers are very cognizant of these risks and are actively looking into incorporating ethics in AI education and training, such as at conferences dedicated to ethics in AI,” Yeoh said. “We also will need to do a better job at reaching out to the general public to inform and educate them on the strengths and limitations of AI techniques. That way, the general public will better understand how their data might be used and take steps toward ensuring that they are only rightfully used; they will also have reasonable expectations of AI technologies instead of hype-driven inflated ones.”

Martin Arthur

'FINALLY READY TO GRADUATE'

Written by **BETH MILLER**

WHITNEY CURTIS

When R. Martin Arthur arrived at Washington University in St. Louis in 1969, "Get Back" by The Beatles was among the top hits and Neil Armstrong became the first person to walk on the moon. Over the course of his unprecedented 50-year career in the School of Engineering & Applied Science, he has made a difference in the education, careers and lives of thousands of Engineering students, all while carrying out his research in health care diagnostics, starting several companies and serving as department chair three times.

Arthur's long-standing place in the Department of Electrical & Systems Engineering will come to an end later this year when he leaves the university to continue working on his health care startup, ATM Cardiac Diagnostics LLC, which he formed with Jason Trobaugh, professor of the practice in electrical & systems engineering, and Scott Marrus, MD, a Washington University cardiologist at Barnes-Jewish Hospital.

"After 50 years, I'm finally ready to graduate and get a job," he says, with his characteristic dry humor.

WashU was a different place when Arthur arrived as a postdoctoral researcher to work with professors Russell R. Pfeiffer and Charles Molnar on peripheral auditory mechanisms: James M. McKelvey Sr. was dean; Urbauer and Bryan halls were new (Lopata and Jolley halls were yet to be built); and Jerome R. Cox Jr. and his team had brought the room-sized, then-revolutionary Laboratory Instrument Computer (LINC) — often considered the first personal computer — from Massachusetts Institute of Technology only five years prior.

"To me, that was the start of the university becoming world-class and put the medical school on the map," Arthur says. "Having the ability to have that personal computer made all the difference — it gave many here the ability to do things that weren't possible before that technology existed. Since then, the university has built on that initiative."

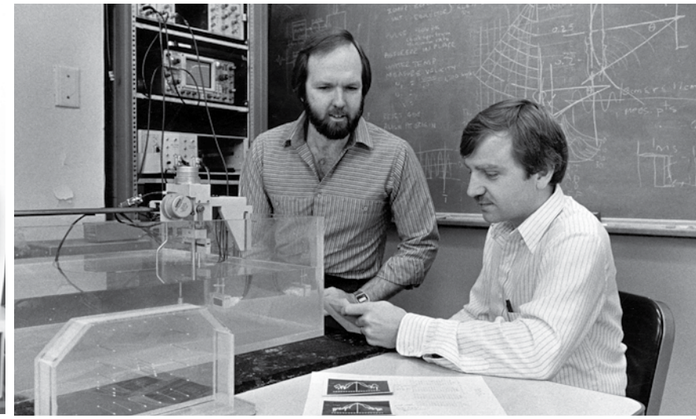
Arthur began teaching courses to first-year students almost immediately. As he moved through the ranks up to full professor, and eventually became the Newton R. and Sarah Louisa Glasgow Wilson Professor of Engineering in 2004, he has taught more than 150 courses, touching the lives of two generations of Engineering students.

> Arthur has taught more than 150 courses, touching the lives of two generations of Engineering students.

"It's a huge responsibility," he says. "You're making judgments that effect students' careers because you're evaluating their work. It's a huge responsibility evaluating the performance of faculty for promotion and tenure, as well. I take it very seriously."

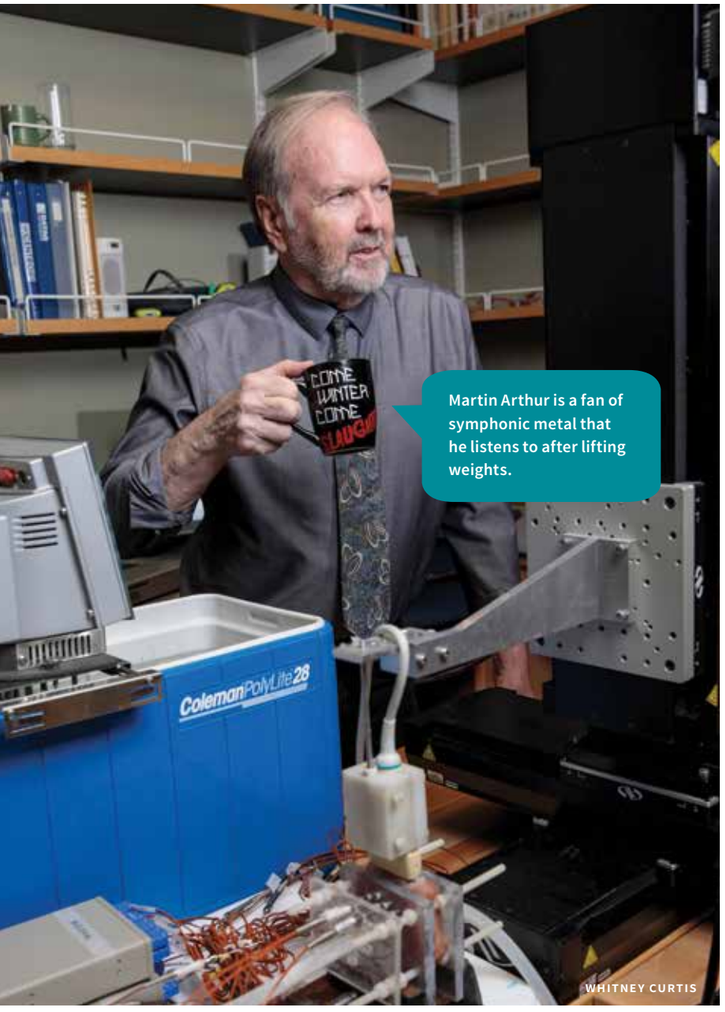
During his three stints as department chair, providing a high-quality and balanced curriculum to the department's undergraduate and graduate students is something else Arthur, who was named the 2018 Outstanding Professional Engineer in Education by the Missouri Society of Professional Engineers – St. Louis Chapter, has taken seriously.

"In my class, we were talking about communication theory, and I said they could get the basic information online, but you don't have a group to help you assimilate that information, understand what it means, and be able to create new intellectual



Arthur, left, with Daryl Beetner

WASHU ARCHIVES



Martin Arthur is a fan of symphonic metal that he listens to after lifting weights.

WHITNEY CURTIS

property based on that experience," he says. "That's what keeps the brick-and-mortar universities going, because people like to work together, and it's the way people are most productive."

Not only has Arthur had a tremendous impact on the many students he has mentored in his lab, but with colleagues as well, including Michael E. Cain, MD, vice president for health sciences and dean of the Jacobs School of Medicine and Biomedical Sciences at the University of Buffalo.

"Martin was instrumental in opening my eyes in the 1980s to the value as an individual investigator, as well as to cardiology broadly, of collaborations between physician-scientists and engineers," Cain said. "Martin made it easy because the added and needed value he brought to our research program was obvious and because he was such a welcoming champion of collaboration. His direct impact on my work made me an advocate for further medicine/engineering partnerships at Washington University and now at the University at Buffalo."

In 1970, Arthur co-founded Aspen Signal with his mentors, Pfeiffer, who was chair of the Department of Electrical Engineering from 1971-75, and Don Snyder, department chair from 1976-86. Pfeiffer died unexpectedly, and the team closed Aspen in 1980. In 1984, he co-founded a company with William (Dave) Richard, professor of computer science & engineering, called Ultrasonics in Health Care, which develops computer architectures to support real-time ellipsoidal backprojection imaging.

His other research was aimed at identifying adults who have had a heart attack and are at increased risk of having another. Arthur and his colleagues identified small changes in different characteristics of electrocardiograms from at-risk patients. In addition, he devised algorithms

Arthur, says the time has gone by quickly, attributing that to his focus on three things:

COMPETENCE, CHARACTER AND FUN.

CAMPUS IN FOCUS

for medical ultrasonic imaging for cancer using ultrasound to monitor temperature during heating and ablation therapy. He has been named a fellow of the American Institute for Medical and Biological Engineering for these activities.

After he leaves WashU, he will focus on the company he co-founded with Trobaugh and Marrus to get its two products from the lab into the market and the clinic. The company makes MiDetect, a device designed to detect ischemia, a shortage of oxygen, in patients who come to the emergency department with chest pain more quickly than can be done with current bioassays, then help to determine if the patient needs cardiac catheterization; and NICE, a full-body surface map for noninvasive cardiac evaluation. The team has a license from the university's Office of Technology Management and is working on a provisional patent.

While 50 years with one employer is nearly unheard of today, Arthur says the time has gone by quickly, attributing that to his focus on three things: competence, character and fun.

"If I'm not having fun, forget it," says Arthur, who lifts weights almost daily and has a penchant for symphonic metal music.

While Arthur does have fun with his students and colleagues, his competent and caring character shines through. He recalls a student who had some personal problems that were negatively affecting his academic performance. Arthur and a few colleagues gently encouraged the student to withdraw and return later to finish the degree.

"He appeared at my office door a few years later," Arthur says softly. "He was carrying a picture that his mother had made to thank me, and it's now over my mantle at home. He understood that we were all trying to help him. That's the good stuff. That's what it's about."

About Martin Arthur

1953

Arthur testing his engineering skills by making a homemade cart. Even at a young age, he knew he already was an engineer.

1960s

PhD, University of Pennsylvania, 1968

MS, Rice University, 1964

BS, Rice University, 1963

BA, Rice University 1962

Martin Arthur with the LINC computer

ouch!

Arthur broke his arm after hang gliding in 1979. After he retires, he plans to go back to paragliding.

73

refereed journals

6

book chapters

49

refereed conference presentations

2015

Arthur co-founds a company with Jason Trobaugh (left) and Scott Marrus, MD

Arthur receives Faculty Award for Extraordinary Service from Engineering

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Denise Bobick at the Women & Engineering Leadership Summit

Building the Future for WOMEN ENGINEERS

Written by **JUDY H. WATTS**

Photos by **WHITNEY CURTIS**

Not long ago, a successful woman engineering student or career professional had to be not only brilliant but brave. At a recent conference, alumna Michele Liebman was dismayed to learn from a woman presenter that in the 1960s, her engineering professors told her she "was taking some man's place." And beyond academe, strongly male-dominated workplaces were notoriously challenging for women engineers.

"Things have changed," says Liebman, who earned a bachelor's degree in engineering in 1986 and was a principal at Edward Jones before she retired. "But we haven't yet come all the way in achieving equality."

At the School of Engineering & Applied Science, progress that will have far-reaching effects is rapid and ongoing, driven by a dedicated community comprising Aaron Bobick, dean and James M. McKelvey Professor; Denise Bobick, JD, the dean's wife; Engineering alumni, faculty, staff and students. These stakeholders enthusiastically support the school's pivotal support organization for students, Women & Engineering (W&E).

Originally, W&E was a networking resource for engineering alumnae, including Jan Holloway, who earned a master's degree in applied mathematics and computer science in 1983 and is now senior vice president and chief of staff at Monsanto Co. In 2016, W&E opened to undergraduate women, and Liebman and Holloway launched a fundraising challenge for the group. In recognition of their work, both received the Dean's Award at the Engineering Alumni Achievement Awards April 26.

An umbrella and omnibus organization, W&E connects and supports students and alumnae by hosting myriad events, including networking opportunities with the goal of establishing a community for students and alumnae and enhancing the resources WashU offers them. It also works with and helps support student-led groups populated with women: the National Society of Black Engineers (NSBE), Women in Computer Science (WiCS), the Society of Women Engineers (SWE) and Alpha Omega Epsilon (ΑΩΕ), an international technical science and engineering sorority for women.

One of the reasons frequently attributed to lower female graduate rates in the engineering fields is a lack of woman engineer role models — something Women & Engineering was created to address.

"It is important to provide the opportunity for our students to have development and support in addition to what they get at the university," Holloway said. "My hope is that our students and alumnae continue to benefit from some great connections and relationships."

Haley Nichols, a senior from Memphis majoring in mechanical engineering, is chapter president of NSBE. In February, NSBE and W&E co-hosted an event offering the opportunity for black and Latino students to connect with industry representatives.

At an earlier W&E networking event, Nichols secured an internship as a process engineer at General Motors, where she will work full time after she graduates.

From left: Cheryl Perlmutter, Polly Shrewsbury, Katie Johnson, Mariah Gratz and Emily Boyd

Leadership Society Summit

Women & Engineering hosted its first Leadership Society Summit in April to strengthen relationships and to provide the opportunity to form new ones.

The summit, held April 7 at the Knight Center, hosted about 70 students, alumnae, faculty, staff and guests for a day-long series of presentations, workshops and breakout sessions with alumnae designed to present a variety of perspectives on entrepreneurship, engineering careers and other topics.

The alumnae speakers were:

- Abby Cohen, BS '13, co-founder and co-CEO of Sparo Labs;
- Katie Johnson, BS '10, senior user experience researcher, EchoUser;
- Cheryl Perlmutter, BS '00, PMBA '05, senior manager of sourcing at Edward Jones;
- Polly Shrewsbury, BS '95, COO of FourLeaf and founder of Pollyseon;
- Mariah Gratz, BS '02, CEO of Weyland Ventures.

"It was inspiring to share a space with such empowering women and be able to focus on the unique challenges facing women in STEM fields, how to succeed despite these challenges and how affect change to the system that creates these challenges."

Michele Anderson, a junior majoring in mechanical engineering

"It is important to provide the opportunity for our students to have development and support in addition to what they get at the university."

— JAN HOLLOWAY

The public faces of W&E are co-leaders Emily Boyd, teaching professor in mechanical engineering & materials science and faculty adviser; and Empress Sanders, assistant dean and academic adviser in Engineering Student Services.

"When Dean Bobick arrived in July 2015, he made supporting our female and other minority students a top priority," Boyd said. "The rate at which things are accomplished here is truly inspiring."

Sanders, who helps the leadership of the student groups with organizational development, budgets and succession planning, says W&E has made a noticeable impact on women students in a very short time.

"The women feel valued," Sanders said. "They have talked with company executives about the many possibilities that come with an engineering degree. They are increasingly confident. They are getting fantastic internships and jobs. They realize that they do have a place in the industry, so when they talk about their aspirations, they're owning that reality. The field remains male-dominated overall, but they're certainly making headway."

"The word about W&E is out," said Denise Bobick, who helps to facilitate events, supports the group's members and co-hosts W&E gatherings at her home. "Alumni elsewhere in the country want to support it, and now Kansas City has its own W&E alumnae group."

Boyd said Denise Bobick has been a constant advocate of W&E, promoting it to prospective students as well as with alumnae and donors.

"Denise has been tremendously supportive and helps W&E in any way she can," Boyd said. "She facilitates meetings and events and is always looking for ways to grow W&E and do what is best for students."

50%
of current undergraduate biomedical engineering majors are women

31%
of current WashU undergraduates studying computer science are women

A small sampling of W&E's trove of notable offerings for women engineering students:

The Leadership Society:

Boyd initiated this organization, which matches junior and senior women with compatible alumnae mentors, dubbed Bear Pairs. The connections are maintained with the help of the Mentorship Collective, an online platform for mentors and mentees. Student-centered events are held throughout the year to help prepare the women for their future careers and bond as a group. The Society also hosts an annual Leadership Summit, which was held April 7 and brought the Bear Pairs and other female students and alumnae together for a day of networking, workshops and speakers dealing with personal and professional development.

Many-faceted support:

WiCS President Saron Belay, a senior majoring in computer science, often consulted Sanders but had no trouble getting on the dean's calendar to discuss WiCS funding. When 15 women students flew to Orlando for the 2017 Grace Hopper Celebration, the world's largest gathering of women technologists, funds from Dean Bobick and Roch Guérin, chair of the Department of Computer Science & Engineering and the Harold B. & Adelaide G. Welge Professor of Computer Science, covered their trip.

Expert advising:

A first-generation American from Dallas, Sofia Joison, a senior majoring in computer science, credits guidance and advice from Boyd and Sanders with helping her become a better president of SWE and get hired as a program manager at Microsoft's Redmond, Wa. headquarters.

These women students plan to become alumnae mentors to a future student. Without doubt, they, their peers and the school community are closing in on the day when, to paraphrase Sanders, positive numbers about women in engineering are not news but the norm.

Expanded mentoring:

St. Louisan Jackie Wong, a sophomore majoring in computer science and a member of AΩE and WiCS, will intern this summer with Mastercard on a cryptocurrency team. She has met with her mentor twice.

Tony and Andy Nocchiero

Offering a helping hand

Written by **BETH MILLER**

> We applaud the university's increasingly robust outreach to students with greater financial need, and we want to support it."
>
> — ANDY NOCCHIERO

Tony and Andrea (Andy) Nocchiero know personally how a helping hand can change someone's life.

Both received full scholarships to attend Washington University in St. Louis. Without them, neither would have been able to earn undergraduate degrees from WashU that influenced the direction of their lives. Now, it is their turn to provide that helping hand.

The Nocchieros, of Evanston, Illinois, have made a gift to support need-based scholarships to students in the School of Engineering & Applied Science and in the College of Arts & Sciences.

"We think the Washington U. experience is unique and wonderful," said Tony, who earned a bachelor's degree in chemical engineering in 1973. "We want to help others, regardless of means, to be able to have it, too."

Together, they have sponsored annual scholarships in the School of Engineering & Applied Science and in the College of Arts & Sciences for the past five years. The new gift, the Nocchiero Family Scholarship, will continue those and add endowed scholarships in both Arts & Sciences and in Engineering.

The Nocchieros said they feel that the university is stronger and better when students come from a variety of backgrounds and means.

"We applaud the university's increasingly robust outreach to students with greater financial need, and we want to support it," Andy said.

MATTHEW GILSON

Tony

Education:

BS, Chemical Engineering, Washington University, 1973

MBA, Northwestern University, 1975

Andy

Education:

BA, English, secondary teaching certificate, Washington University, 1974

MA, English Literature, University of Michigan, 1975

Andy was involved with the dedication festivities for SUPAC (Student Union and Performing Arts Center) in 1973. The building was renamed Mallinckrodt Center in 1976.

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Andy speaking at the Arts & Sciences Scholarship Dinner in 2017

DANNY RIESE

Both describe WashU today the same way they did when they first visited the campus as high school seniors.

"WashU just felt so warm and encouraging and inclusive from the very beginning," Andy said. "Whenever we're on campus, it still has that same feel, which is a testament to the university's commitment to building and preserving that culture."

Tony grew up in The Hill neighborhood in St. Louis and was the first in his family to finish high school, let alone go to college.

"The scholarship gave me time to sample more of the WashU experience, and I think that's important because you also learn so much outside the classroom," he said.

As students, Tony and Andy were part of the first freshman orientation committee in which students designed all of the programming for the incoming class. Tony also was co-chair of the student committee that ran the Assembly Series, and Andy led the committee for the opening gala for what is now Mallinckrodt Center. They remain very involved with the university: Tony is a member of the School of Engineering & Applied Science National Council, Andy is working with the Arts & Sciences Honorary Scholars Program alumni, and both are active members of the Chicago Regional Council.

As much as he loved studying chemical engineering, Tony realized after a summer internship at a Texas oil refinery that a career in business or research would be a better fit. He earned an MBA at Northwestern University in 1975 and joined Amoco Corp., where he worked for 27 years in various finance roles, ultimately as chief financial officer of BP Chemicals after the companies merged.

A few years later, Tony became vice president and CFO for Merisant Worldwide Inc., then returned to the chemical industry as senior vice president and CFO of CF Industries Inc. He retired from full-time work in 2010, though he occasionally does some consulting and is a director of Callon Petroleum Co.

Andy was in the second class of George E. Mylonas Scholars in Humanities, part of the Honorary Scholars Program. She earned a degree in English and a secondary teaching certificate in 1974. She earned a master's degree in English literature from the University of Michigan in 1975 and then taught high school English. In 1991, she co-founded

> "WashU just felt so warm and encouraging and inclusive from the very beginning. Whenever we're on campus, it still has that same feel, which is a testament to the university's commitment to building and preserving that culture."
>
> — ANDY NOCCHIERO

a nonprofit that mentored teen mothers and promoted early literacy. Now, she reads to kindergarteners in Chicago, continuing her interest in early literacy. In addition to helping to re-engage other recipients of the Honorary Scholars Program, she was the speaker at the 2017 Arts & Sciences Scholarship Dinner.

The Nocchieros enjoy traveling. Their favorite destinations are the Colorado mountains and Italy, where they have relatives. Their visits inspired Andy to learn to speak Italian, which she has studied for a dozen years. In addition, they volunteer in local and national politics, including at the national headquarters of Barack Obama's presidential campaigns. They have two adult sons, Daniel and Peter.

"We are paying the university back for its kindness to us, but also 'paying it forward,' as they say, helping someone after us who needs the same help we did," Andy said about their motivation for the gift. "We probably shouldn't have been surprised, but we are also having so much fun getting to know 'our' students."

"We missed our active connection to the university during the hectic years of career and kids," Tony said. "Our reconnection to WashU and being a small part of the important work of the university has been wonderful — an unexpected result of creating our scholarships."

STRATEGIC PLAN

Leadership Through Excellence

The School of Engineering & Applied Science undertook a strategic planning process, beginning with an internal assessment in spring 2016 and then in earnest that fall. A strategic planning committee of 20 faculty, students and staff was formed to shepherd a more organic process of ideation and refinement than is typical in many strategic planning efforts. The committee developed a "call for ideas" — an invitation to all our constituents to provide suggestions and ideas about possible opportunities. Students, faculty, staff and alumni, along with partners in industry, government and other organizations, were all invited to provide input through a variety of channels, including email, web forms and even personal communication. The goal of the committee was to gather these ideas and then to distill the important thematic efforts identified. Once these efforts were refined, the resulting documents could be considered and from those initiatives a set of objectives and goals articulated; likewise, the mission and vision would be self-evident.

VISION

The School of Engineering & Applied Science at Washington University in St. Louis will be recognized as a leader in providing scientific insights and enabling technologies critical to solving fundamental research challenges of the world today and in preparing students for the rapidly changing world of tomorrow.

MISSION

The mission of the School of Engineering & Applied Science at Washington University in St. Louis is to promote independent inquiry in engineering research and education with an emphasis on scientific excellence, innovation and collaboration without boundaries.

READ ALL 19 WHITE PAPERS: ENGINEERING.WUSTL.EDU/STRATEGICPLAN

SUMMARY OF OBJECTIVES

I. **Provide an undergraduate education experience that promotes independent inquiry, is grounded in fundamentals, affords opportunities for innovation and leads to successful career outcomes.**

II. **Achieve internationally recognized contributions in both fundamental and translational research.**

III. **Develop world-class researchers.**

IV. **Through research and education, create a positive impact on the local community, the country and the world.**

V. **Promote an environment where all faculty and staff are encouraged, empowered and incentivized to pursue excellence.**

VI. **Ensure the financial stability and health of the School.**

WHAT HAVE WE ACCOMPLISHED SO FAR

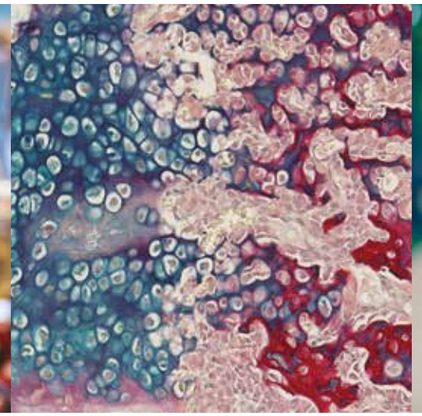
- Launched new academic programs
  - PhD in Imaging Science
  - PhD in Data Science
  - MS in Cybersecurity Engineering
  - BS in Business & Computer Science
  - BS in Math & Computer Science
- Building on strengths in key research areas with additional investments, including new centers and faculty growth
- Created Office of Graduate Student Services
- Created Office of International Relations
- Created new position for career engagement
- Improving workplace culture for teaching faculty
- Building Jubel Hall and McKelvey Hall

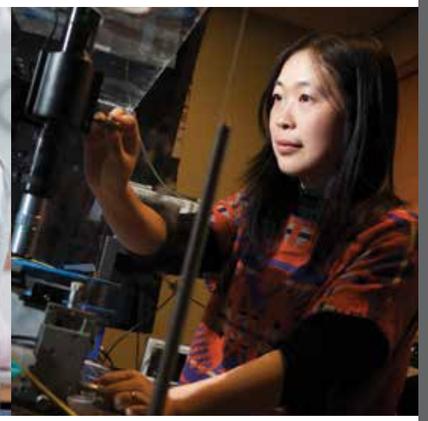
STRATEGIC PLANNING COMMITTEE CO-CHAIRS

- Rohit Pappu, Edwin H. Murty Professor, Department of Biomedical Engineering
- Jessica Wagenseil, associate professor, Department of Mechanical Engineering & Materials Science
- Nick Benassi, senior associate dean & chief of staff, School of Engineering & Applied Science

COMMITTEE

- Mark Bober, manager of computing services, Engineering IT
- Emily Boyd, teaching professor, Department of Mechanical Engineering & Materials Science
- Alex Carr, director of development, Engineering Alumni & Development
- Sanmay Das, associate professor, Department of Computer Science & Engineering
- Ramona Durham, undergraduate student, Class of 2017
- Cathy Freesmeier, associate dean, Engineering Graduate Student Services
- Kelsey Haddad, PhD student, Department of Energy, Environmental & Chemical Engineering
- Tao Ju, vice dean for research & professor, Department of Computer Science & Engineering
- Young-Shin Jun, professor, Department of Energy, Environmental & Chemical Engineering
- Laura Kraus, director, Financial/Operations Planning & Analysis
- Ron Laue, assistant dean, Engineering Undergraduate Student Services
- Vijay Ramani, Roma B. & Raymond H. Wittcoff Distinguished University Professor of Environment & Energy, Department of Energy, Environmental & Chemical Engineering
- Srikanth Singamaneni, associate professor, Department of Mechanical Engineering & Materials Science
- Jay Turner, vice dean for education & associate professor, Department of Energy, Environmental & Chemical Engineering
- Patricia Widder, senior lecturer, Department of Biomedical Engineering
- Lan Yang, Edwin H. & Florence G. Skinner Professor, Department of Electrical & Systems Engineering
- Quing Zhu, professor, Department of Biomedical Engineering

Jeff Nelson

COURTESY PHOTO

Written by **BETH MILLER**

From the time he was a child selling candy to neighborhood kids and writing a neighborhood newspaper, Jeff Nelson has been an entrepreneur. That longtime entrepreneurial spirit, combined with a degree from the School of Engineering & Applied Science at Washington University in St. Louis, prepared him for his current role as a founder and co-founder of several companies all aimed at solving problems.

Nelson, who earned a degree in applied science in 2010, now spends his time running Cinchapi, an Atlanta-based startup that helps companies and organizations use the data they create to best optimize their businesses. The company's name, a blend of the word cinch, meaning easy, and API, a set of tools used to build programs, is designed to show power in simplicity.

"Engineers tend to complicate things because we live in a very technical world, and we are so consumed with details that sometimes we don't come up to see the big picture," he said. "Because data is changing in real time, people can't understand it and use it quickly enough to have it make a difference in their businesses. We're solving that problem by giving people real-time insights on their data with the power to act on what matters."

Nelson said he thinks of himself as an optimizer.

"What that means to me is surveying my surroundings, my community, the organization or company of which I'm a part and really figuring out how I can make things more efficient, how I can make things more productive, and how I can understand problems and come up with solutions," he said.

"The hardest and most fascinating part of being a software engineer is trying to build a solution to a common problem and building an architecture that can scale and is secure."

— JEFF NELSON

In addition to being founder and CEO of Cinchapi, Nelson is co-founder and CTO of Blavity, one of the fastest-growing media and tech startups aimed at African-American millennials with more than 10 million visitors a month. Founded with fellow WashU alumni Morgan DeBaun (Arts & Sciences, 2012); Jonathan Jackson (Arts & Sciences, 2013); and Aaron Samuels (Business, 2011), Blavity grew out of a term the group developed while they were WashU students to describe how black students gravitate toward each other.

"Being at WashU was the first time I was in an environment where everyone wasn't black," said Nelson, who was Student Union president his senior year and represented scholarship recipients in the $150 million university scholarship initiative. "What I learned was how different black people were. With Blavity, we wanted to celebrate the diversity within the black culture and create this platform where black people can gravitate toward it."

In the past year, Blavity has acquired two companies, launched a brand for women's empowerment called 21Ninety, and hosted two conferences: EmpowerHer for black women in technology and AfroTech for black entrepreneurs and technical professionals.

To get ahead in computer science, Nelson advises current students to contribute to open-source projects.

"The wonderful thing about computer science is that there are very few barriers to experience," he said. "If you are privileged enough to have access to technology, you can get experience and contribute to open-source projects. When you go for an internship or a job, you're going to be competing against people already doing those things, so make sure you're doing those things."

Sofia Joison is a senior majoring in computer science. She will graduate in May 2018.

Synergy

Written by **SOFIA JOISON**

I could tell you some staggering statistic about the lack of women in the engineering field, but you already know that. The conversation, while not new, is still not over. Engineering isn't easy (any engineer reading this can attest to that), and if it were, it wouldn't be so rewarding. Having support and people to fall back on is crucial within this field. That's when I thought of synergy and how the coming together of entities generates a greater value than being apart. This word really struck me because there is a certain power in an embracing community of women within engineering. That's exactly why WashU's Women & Engineering initiative is so important.

Mentoring is critical to the success of women and minorities across engineering industries. This is not just intuitive, but also backed by research that states that female engineers feel more motivated and self-assured when they have a strong female mentor. Think about a mentor you've had. How did they define the trajectory of your career? One of the goals of WashU's Women & Engineering seeks to connect past, present and future female engineers to provide the support needed to rocket (for some, quite literally!) your career forward.

As a future computer scientist, I often found myself looking around the classroom wondering if I fit in. Do I really have what it takes to be a software engineer? Am I talented enough to make it in the tech industry? These fears and doubts were abated through my time as president of Society of Women Engineers and working with the members and staff of WashU's Women & Engineering. I am incredibly grateful for the courage and wisdom I have gained through this experience, and I know that I'm better for it. The mentors, advice and support I have received through this program drive me to start and continue a career in engineering and pay it forward to future female engineers.

WHITNEY CURTIS

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#WashUengineers

$$p = mv$$

Snapshot //

The southeast view of the new academic building, James M. McKelvey, Sr. Hall. The building will open in 2020.

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