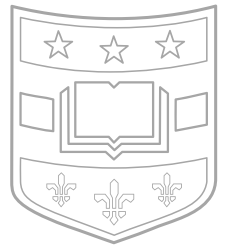# ENGINEERING
Momentum

Across Disciplines. Across the World® // **FALL 2016**

{launch_code}

**LaunchCode, WashU Engineering team
to meet demand for tech professionals**

Washington University in St. Louis

DEVON HILL

From the dean //

We are planning for our future. Please share your thoughts and insights for WashU Engineering's next strategic plan: engineering.wustl.edu/strategicplan

Dear friends,

A university runs with a strong annual rhythm, and one really has to experience the full academic year before developing a feel for the place. Though it's hard to believe it is already my second year, I do have a much stronger understanding of not just WashU, but also the strengths and opportunities in the Engineering school.

As you can read in the following pages, you will find our students and faculty have achieved great accomplishments this past year. I have experienced repeatedly that our undergraduates are truly gifted learners, which is perhaps unsurprising given the quality of the incoming first-year students. But as you can read in the LaunchCode story, they also engage with our community, connecting the intellectual powerhouse that is WashU to the broader social fabric. And, as you will also read, our students represent the four corners of the earth. This not only brings a variety of perspectives to their research, but it also means that our work reaches back to help advance the global quality of life.

Of course as a premier research university, the work of the faculty and their research-engaged students is what drives the school forward. One surprising element for me about WashU Engineering is the importance of work at the smallest scales. In fields ranging from medicine to energy to materials, the properties of larger structures

— be they ligaments or trusses — emerge from the characteristics of the smaller-scale elements. As you read about Srikanth Singamaneni's research on nanoparticles or the new NSF Science and Technology Center focused on cellular mechanobiology (a new word for me), I hope you'll come to appreciate that we can control and engineer processes at these small scales, giving great power eventually in the large.

Having spent a year listening and learning, it is now time for us to focus strategically on developing areas in which we can operate at a truly world-class level, both in research and education. This fall, we started a "bottom-up" strategic planning effort designed to solicit ideas from all our stakeholders: undergraduate and graduate students; faculty and staff within the Engineering school and colleagues across the university; alumni; industry partners and other friends. The strategic planning committee will continue to solicit, gather and synthesize these ideas into a set of white-paper initiatives, each articulating a specific set of goals, a means of assessing progress and the specific tactical steps that must be taken to advance the agenda. The idea is to not only have a strategy-defining document — the traditional strategic plan — but also a set of action plans that we can begin to implement immediately. The entire process will be completed by mid-spring, so you will be hearing more from us.

Here's to a great sophomore year.

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

18

22   28

THE BUZZ #WashUengineers

Geneoscopy has developed a proprietary and novel technology to pull down and evaluate human biomarkers in intestinal cells that are sloughed off from the colonic walls. This method allows Geneoscopy to directly evaluate stool samples for human markers within cancer and pre-cancerous cells.

From left: Andrew Barnell, Erika Barnell, MD/ PhD student, and Yiming Kang, PhD student in Computer Science.

Student start-up: Geneoscopy

GENEOSCOPY

WashU students waited in Whitaker Hall Oct. 9 to hear the results of the debate ticket lottery. In total, 352 tickets were given to students.

Frank Wilson, alumnus and lecturer in the WashU/UMSL Joint Undergraduate Engineering Program, was honored by the City of St. Louis Oct. 5 for his service to the community and contributions to the construction industry.

ArchHacks

NOV. 4-6, 2016

ArchHacks, a hackathon hosted by WashU, brought together more than 500 students from around the country for 48 hours of collaboration, problem solving and building. The HealthTech theme focused on innovative technology.

PHOTOS BY BRIAN LAM

New faculty join WashU Engineering

Damena D. Agonafer
» Assistant Professor in the Department of Mechanical Engineering & Materials Science
» PhD, mechanical science and engineering, University of Illinois at Urbana-Champaign
» Agonafer's research focuses on the intersection of thermo-fluid sciences, electrokinetic and interfacial transport phenomena and renewable energy.

Alvitta Ottley
» Assistant Professor in the Department of Computer Science & Engineering
» PhD, computer science, Tufts University
» Ottley's research focuses on designing personalized and adaptive visualization systems, including information visualization, human-computer interaction, visual analytics, individual differences, personality, user modeling and adaptive interfaces.

Kimberly M. Parker
» Assistant Professor in the Department of Energy, Environmental & Chemical Engineering
» PhD, environmental engineering & science, Stanford University
» Parker investigates environmental organic chemistry in natural and engineered systems. She also is exploring how hydraulic fracturing can impact downstream drinking water quality.

Vijay Ramani
» Professor in the Department of Energy, Environmental & Chemical Engineering
» PhD, chemical engineering, University of Connecticut
» Ramani's research focuses on a variety of areas, including corrosion resistance in mixed-metal oxide electrocatalyst materials; anion conducting polymers in situ electrochemical diagnostics to probe electrochemical systems; microstructure property relationships in porous electrodes; hybrid polymer electrolytes; degradation mitigation through in situ radical scavenging and bifunctional electrocatalysts.
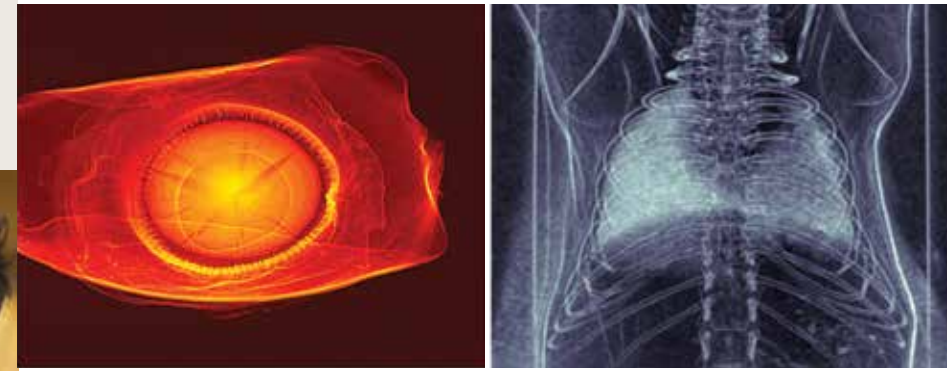
Patricia Weisensee
» Assistant Professor in the Department of Mechanical Engineering & Materials Science
» PhD, in mechanical science and engineering, University of Illinois at Urbana-Champaign (December 2016)
» Her research interests include solid state and phase change heat transfer, two-phase flows, droplet impact and wettability of surfaces.

Quing Zhu
» Professor in the Department of Biomedical Engineering
» PhD, bioengineering, University of Pennsylvania
» Zhu combines ultrasound and near infrared (NIR) imaging modalities for clinical diagnosis of cancers. This combined approach overcomes the localization uncertainty of optical reconstruction and improves the ultrasound diagnosis. She and her team have explored the theory and modeling behind this novel technique and have conducted clinical studies at the UConn Health Center and Hartford Hospital. Initial results have shown great success in early diagnosis of malignant and benign breast lesions and in predicting and monitoring breast cancer treatment response using this technique. Her pioneering research has now been heralded by the imaging and radiology community as an important advance in society's ability to distinguish benign and malignant lesions in the breast.

"These faculty members will bolster already-strong areas of research and add new areas of inquiry to our research portfolio. With these new hires, the school is on track to reach 100 faculty members by 2020."
— AARON BOBICK

Washington University to invest $25 million in imaging sciences during next five years

Building on its extensive history in imaging — from individual cells and nerves to cancerous tumors and Alzheimer's plaques — Washington University in St. Louis is launching a bold $25 million initiative to support researchers across the university as they develop innovative technologies aimed at improving science and medicine worldwide.

Initially, the Imaging Sciences Initiative, a partnership between the School of Engineering & Applied Science and the School of Medicine, will bring in more than a dozen new faculty with strengths in various aspects of imaging sciences. Both schools have their own long-standing strengths in the field, with more than 300 imaging scientists between them.

The new initiative strengthens the connection between the schools and encourages the development of new imaging technologies to diagnose and treat disease as well as study intricate biological structures, metabolism and physiology, and critical molecular and cellular processes.

"This initiative allows us to attack challenges in imaging that can only be addressed by collaborations between medicine and engineering, including developing fundamental new technologies and advanced computational methods," said Aaron F. Bobick, dean of the School of Engineering & Applied Science and the James M. McKelvey Professor. "Washington University will further establish its place at the forefront of groundbreaking biomedical engineering and imaging research that can have an immediate impact in the world."

Ju, Turner named vice deans in Engineering

TAO JU

Tao Ju and Jay Turner have been named vice dean of research and vice dean for education, respectively, in the School of Engineering & Applied Science by Dean Aaron Bobick.

Ju, professor of computer science & engineering, is recognized as a leader in computer graphics and biomedical modeling research. In his research, funded by both the National Science Foundation and the National Institutes of Health, he has collaborated with faculty across the university, including at the School of Medicine as well as with several international investigators.

JAY TURNER

In the new role of vice dean for education, Turner will lead the schoolwide effort to enhance the undergraduate student experience in consideration of what is taught and the best way to teach the next generation of engineers and leaders. Turner has served as director of undergraduate programs in the Department of Energy, Environmental & Chemical Engineering and has received several teaching awards, including the inaugural Dean's Award for Excellence in Teaching and the school's Professor of the Year Award.

Setton named Lopata Distinguished Professor of Biomedical Engineering

LORI SETTON

Lori Setton, a renowned researcher into the role of the degeneration and repair of the body's soft tissues, has been named the Lucy and Stanley Lopata Distinguished Professor of Biomedical Engineering at Washington University in St. Louis. She was installed Oct. 24 in a ceremony at Whitaker Hall. Setton joined the School of Engineering & Applied Science faculty in 2015 from Duke University.

Jain named Cox Professor in Computer Science

RAJ JAIN

Raj Jain has been named the Barbara J. and Jerome R. Cox, Jr. Professor in Computer Science at Washington University in St. Louis. He was installed May 24. Jain is a professor of computer science & engineering in the School of Engineering & Applied Science, where he has been on the faculty since 2005. Previously, he was on the faculty at the Ohio State University.

Engineers to use cyborg insects as biorobotic sensing machines

Barani Raman, associate professor of biomedical engineering, has received a three-year, $750,000 grant from the Office of Naval Research (ONR) to use the highly sensitive locust olfactory system as the basis to develop a bio-hybrid nose. Joining Raman in the research are Srikanth Singamaneni, associate professor of materials science, and Shantanu Chakrabartty, professor of electrical & systems engineering, all in the School of Engineering & Applied Science.

Biological sensing systems are far more complex than their engineered counterparts, including the chemical sensing system responsible for our sense of smell, Raman says. Although the sense of smell is a primitive sense, it is conserved across many vertebrate and invertebrate species.

"It appears that biology converged onto a solution for the problem of non-invasive, or 'standoff' chemical sensing, and has replicated the same design and computing principles everywhere," Raman says. "Therefore, understanding the fundamental olfactory processing principle is necessary to engineer solutions inspired by biology."

Building a better internet

PATRICK CROWLEY

The team of engineers led by Patrick Crowley, professor of computer science & engineering, has received a $499,960 three-year grant to focus on further developing the concept of Named Data Networking (NDN).

"The two big issues for most people when they think about the internet are how can it become more trustworthy and if can it really accommodate all the devices that we want to connect to it," said Crowley. "It's in that context that NDN emerged as a network architecture idea."

Crowley says complications with the internet's current framework arose because it's based on a relative antiquity: the telephone and its model of communication. Two devices are used, a channel is opened between them and communication is shared, without accommodating specific requests. NDN has emerged as the best possible solution to widen the communication model. While the telephone framework addresses the "where" of online addresses and hosts, NDN is further inclusive, handling the "what" that's specific to the exact content a user expects to be delivered.

Written by Erika Ebsworth-Goold

Building smarter, safer infrastructure

A team of engineers is turning to cloud computing for a smarter, self-monitoring solution that can better sound the alarm in specific cases of infrastructure failure. The concept got its first test when it was installed Sept. 21 on Michigan's Mackinac Bridge, the largest suspension bridge in the Western Hemisphere.

"Right now, the maintenance of infrastructure has an enormous cost," said Shantanu Chakrabartty, professor of electrical & systems engineering at the School of Engineering & Applied Science. "It's hard to know how to prioritize. So if you have data, you can do condition-based maintenance. Depending on which part of a structure is vulnerable, you can assign manpower according to that."

The National Science Foundation has awarded Chakrabartty's team a four-year, $1.1 million grant to develop long-term monitoring of our country's infrastructure. The goal: to create smart civil infrastructure that can self-monitor, enabling it to predict any failures in case of an extreme event such as an earthquake or flood, and also to prioritize areas for emergency response.

Written by Erika Ebsworth-Goold

NSF announces new Science and Technology Center

Washington University–Penn partnership will investigate biology's mechanics

GUY GENIN

The National Science Foundation (NSF) has added a newly formed collaboration between Washington University in St. Louis and the University of Pennsylvania to its list of Science and Technology Centers (STC). The center and its collaborative efforts will be supported by a $23.6 million grant from the NSF.

"This award from the National Science Foundation reflects outstanding faculty achievement at Washington University in St. Louis," Chancellor Mark S. Wrighton said. "As the university advances its commitment to groundbreaking, high-impact research, winning the new Science and Technology Center is a major accomplishment."

The Science and Technology Center for Engineering MechanoBiology (CEMB) will bring together a consortium of researchers, including engineers, biologists and biophysicists. The group's mission: identify and harness the mechanical functions of both plants and animals at the cellular level. Mechanical force is a critical component of all biological systems, allowing cells to divide, migrate, adapt and differentiate. It is hoped that this deeper dive into how single cells function will transform both medicine and plant science.

"The STC grant represents significant support from the National Science Foundation for a large-scale, complex research undertaking," said Dedric Carter, vice chancellor for operations & tech transfer at Washington University. Carter, a former senior adviser for strategic initiatives at the NSF, participated as part of Washington University senior leadership during the site visit process.

"This is a remarkable opportunity for Washington University to advance its international leadership in research and innovation in a potentially transformative area," Carter said. "We look forward to the great work that will likely emerge from this new center."

"Mechanobiology has incredible potential," said Guy Genin, professor of mechanical engineering & materials science in the School of Engineering & Applied Science, and principal investigator of Washington University's portion of the grant. "It could change the way we view many of the world's most complex questions and issues.

"For the field to fully realize its enormous potential, a large commitment and scope of study is needed," Genin said. "We are most grateful for the National Science Foundation's support. Being named an STC is a prestigious distinction reserved for sweeping research projects that have the power to change lives. We're ready to get to work."

Written by Erika Ebsworth-Goold

"The possible advances that could be realized with this research team and our collaborators are nearly limitless. If we can override cellular mechanical behavior, we could stop cancer cells from metastasizing. We could also improve our bodies' system functions and vastly change the way we approach injuries, with the potential to speed up rehab."

— GUY GENIN

CEMB
Center for Engineering MechanoBiology

Brain's activity, health in coma focus of WashU study
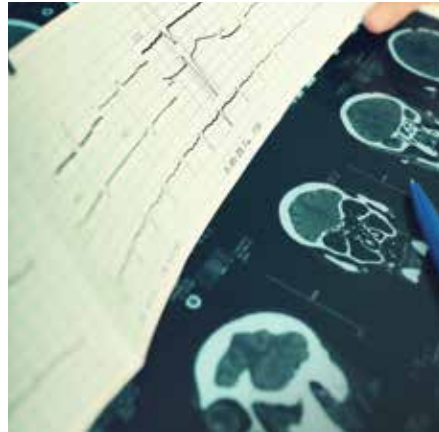
ShiNung Ching, assistant professor of electrical & systems engineering in the School of Engineering & Applied Science, and Terrance Kummer, MD, assistant professor of neurology in the School of Medicine, have received a two-year, $403,625 grant from the National Institute of Neurological Disorders and Stroke of the National Institutes of Health to develop a method termed Network Reachability Analysis (NetRA).

When a patient is in a coma, often after a traumatic brain injury (TBI), his or her brain is not functioning — its electrical activity is disrupted — which can lead to long-term disability. Physicians and researchers are looking to improve treatment and outcomes of patients, but need a better understanding of what causes coma.

"We have specific treatments for types of coma, but often struggle to identify the root cause," Kummer said. "We're hoping to better understand these causes by analyzing their electrical effects on the brain."

Ching and Kummer plan to take bedside electroencephalogram (EEG) recordings from patients diagnosed with coma in the Neurology/Neurosurgery Intensive Care Unit at Barnes-Jewish Hospital in St. Louis, then create mathematical models with NetRA to determine the causes of the coma.

Huntington's disease target of $4.5 million in NIH grants

Rohit V. Pappu, the Edwin H. Murty Professor of Engineering in the School of Engineering & Applied Science, has received two grants from the National Institutes of Health totaling more than $4.5 million to study the causes behind this disease that may ultimately provide clues for a treatment or cure.

"We are hoping that we can make profilin a better profilin," Pappu said. "We can use it for mimicry purposes and also as an entity that gives us rules that we can adapt to other proteins that might interact with other aggregation-prone molecules that are implicated in diseases other than Huntington's, such as Parkinson's disease and Alzheimer's disease."

Positively charged: Engineers win $2 million grant to design better batteries

Vijay Ramani, an expert in electrochemical engineering and renewable energy integration at Washington University, has received a $2 million grant from the U.S. Department of Energy's Advanced Research Projects Agency–Energy (ARPA-E) to create a new membrane that can be used in batteries for grid-scale electric energy storage.

Ramani's team will use inexpensive commercial polymers to create the membrane for redox flow batteries, which are rechargeable batteries that store electricity in chemical solutions during charging and release electricity on demand while discharging. The layered membrane, which the team will make functional with a nanopowder, prevents the chemicals in the two sides of the battery from mixing, which would lead to a chemical short circuit, while enabling ions to flow effectively between the solutions. A key novelty is that this membrane would also allow for different chemical combinations to be used at each electrode of the battery, which increases versatility while lowering costs. Ramani's lab will primarily investigate cerium, iron and chromium couples in their research.

Dirty to drinkable

Graphene oxide has been hailed as a veritable wonder material. When incorporated into nanocellulose foam, the lab-created substance is light, strong and flexible, conducting heat and electricity quickly and efficiently.

Now, a team of engineers at Washington University has found a way to use graphene oxide sheets to transform dirty water into drinking water, and it could be a global game-changer.
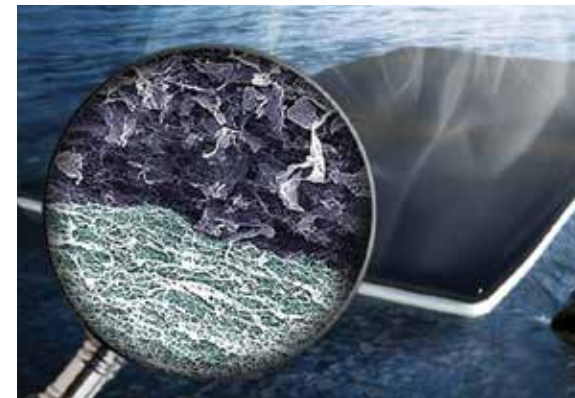
"We hope that for countries where there is ample sunlight, such as India, you'll be able to take some dirty water, evaporate it using our material, and collect fresh water," said Srikanth Singamaneni, associate professor of mechanical engineering & materials science at the School of Engineering & Applied Science.

The new approach combines bacteria-produced cellulose and graphene oxide to form a bi-layered biofoam. A paper detailing the research is available online in *Advanced Materials*.

"The process is extremely simple," Singamaneni said. "The beauty is that the nanoscale cellulose fiber network produced by bacteria has excellent ability move the water from the bulk to the evaporative surface while minimizing the heat coming down, and the entire thing is produced in one shot.

"The design of the material is novel here," Singamaneni said. "You have a bi-layered structure with light-absorbing graphene oxide-filled nanocellulose at the top and pristine nanocellulose at the bottom. When you suspend this entire thing on water, the water is actually able to reach the top surface where evaporation happens."

Written by Erika Ebsworth-Goold

A closer look inside
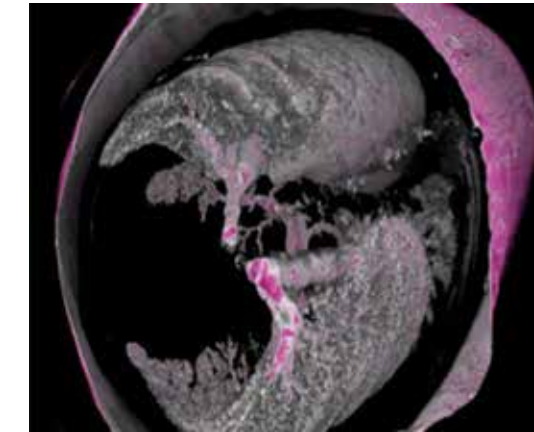
Mark Anastasio, professor of biomedical engineering, will use a four-year, $2.2 million grant from the National Institutes of Health (NIH) to create a new X-ray technique that will assist engineers as they develop new bioengineered tissues.

"We are developing a new imaging technology based on phase-contrast X-ray imaging," Anastasio said. "It will serve as an enabling technology for tissue engineering studies."

A typical X-ray image forms as radiation that is absorbed by tissues and bones, providing doctors with a look inside the body. Anastasio's new technology doesn't rely entirely on the absorption of X-ray energy, it also exploits wave optic effects, measuring the X-ray's refractions for a much more precise peek inside.

Faculty team awarded $1.25 million to study 'swimming cells'

The wavelike motions of flagella have been known since Antony van Leeuwenhoek observed swimming sperm cells and protozoa in the 1600s; how they do it remains much less clear.

"They spontaneously beat," said Philip Bayly, the Lilyan and E. Lisle Hughes Professor of Mechanical Engineering and chair of the Department of Mechanical Engineering & Materials Science at the School of Engineering & Applied Science. "But how they beat is really a mystery."

A team from Washington University, comprised of engineering faculty and faculty from Washington University School of Medicine in St. Louis, has been awarded a five-year, $1.25 million grant from the National Science Foundation (NSF) to study how these tiny organelles actually work. Unlike the oscillations of a heartbeat, which are well documented and explained, the cyclical behavior of cilia and flagella remains an active research area.

"We understand the basics," Bayly said. "There are motor-proteins that must be responsible for the movement, but why things move back and forth as opposed to just moving in one direction is a mystery. It's a problem that intrinsically needs an interdisciplinary team to work on it."

The entire team will examine the movement and mechanics of flagella in a green alga called *Chlamydomonas reinhardtii*, or Chlamy, an unlikely but nearly perfect research substitute for human cells.

Written by Erika Ebsworth-Goold

Engineering a better biofuel

While the bacteria *E. coli* is often considered a bad bug, researchers commonly use laboratory-adapted *E. coli,* which lacks the features that can make humans sick but can grow just as fast. That same quality allows it to transform into the tiniest of factories: when its chemical production properties are harnessed, *E. coli* has the potential to crank out biofuels, pharmaceuticals and other useful products.

Now, a team from the School of Engineering & Applied Science has developed a way to make the production of certain biofuels in *E. coli* much more efficient. Fuzhong Zhang, assistant professor of energy, environmental & chemical engineering, along with researchers in his lab, have discovered a new method to cut out a major stumbling block to the production process.

Their findings were recently published in the journal *Metabolic Engineering.*

"It's a critical step that we've figured out how to solve this problem," Zhang said.

Written by Erika Ebsworth-Goold

Engineering team to improve wireless network technology

A team of engineers will work to solve the lost data problem in industrial applications with a three-year, $500,000 grant from the National Science Foundation by approaching the communication from both ends of the spectrum: the controller and the network.

Humberto Gonzalez, assistant professor of electrical & systems engineering, leads the team, which includes Chenyang Lu, the Fullgraf Professor in the Department of Computer Science & Engineering, both in the School of Engineering & Applied Science, as well as PR Kumar, professor and College of Engineering Chair in Computer Engineering at Texas A&M University, who received a $250,000 grant as part of the collaboration.

Industrial processes, such as those at an oil refinery, begin with a controller, or a computer that sends and receives signals, driven by code, to the plant, such as when to open and close valves or to turn the boiler on and off. In the past, those signals were sent over vast lengths of wire. However, new technology is wireless, requiring a very different code. A wireless network also is prone to communication delays and dropped packets, or digital information, which is disruptive to production in an industrial setting.

Gonzalez, a systems engineer who works in control, and Lu, a wireless network expert, plan to develop a new generation of industrial wireless control in which the controller and the wireless network can communicate in real time more efficiently.

Waste not, want not: Discarded plant material could replace petroleum in chemicals

Marcus Foston, assistant professor of energy, environmental & chemical engineering, has received a three-year, $224,970 grant from the National Science Foundation to find catalysts that will break down lignin, a tough part of the cell walls of woody and grassy plants, into chemicals that can be used as building blocks for materials. He will collaborate with Susannah Scott, professor of chemical engineering and of chemistry and biochemistry at University of California, Santa Barbara, who also received $225,000, bringing the total grant amount to $449,970.

Foston, who specializes in using lignin characterization and conversion, said plants developed lignin as a protective mechanism from microbes and fungi, so it is difficult to break down and is often discarded or burned for power or heat. Instead of wasting this material left over from papermaking or bioethanol production, Foston is looking to pull it out of the cell wall to use its chemical structure for products.

"We are looking to develop catalysts and to understand the structures of catalysts that allow us to pull out the aromatic building blocks from lignin in a very selective way," Foston says.

Fighting crime at the intersection of science and social justice

Researchers from Washington University are using science to fight crime, developing a high-tech approach to combat the sex trafficking trade. Teaming up with a nonprofit organization called the Exchange Initiative, Robert Pless, professor of computer science & engineering in the School of Engineering & Applied Science, and research associate and doctoral candidate Abby Stylianou have contribute data to fight these horrible crimes; and second, by creating new image-analysis tools so law enforcement can best use these images in investigations."

The app, called TraffickCam, allows travelers to upload images of their hotel rooms to a database. Law enforcement officers can search the database to pinpoint where a particular photo was taken in order to track down where a victim has been.

"My lab works to create new ways of understanding and using images collected by webcams and smartphones. Sex trafficking criminals take advantage of new technologies, especially image-sharing to advertise and coordinate illegal acts."

— ROBERT PLESS

designed a new, web-based application that helps fight sex trafficking by targeting the places where the crimes usually occur.

"In this project, we are working to build new technologies and tools to fight sex trafficking — first, by making tools so everyone can

Developed by Pless and Stylianou to maximize the accuracy and usefulness of the imagery, TraffickCam is a user-friendly, high-tech approach that allows citizens to fight one of the fastest-growing and most heinous crimes in our country today.

Written by Erika Ebsworth-Goold

Breaking the laws of science

"To push the boundaries of science and engineering, you need to break the old laws to open up different insights, scenarios, structures and possibilities," said Lan Yang, the Edwin H. & Florence G. Skinner Professor of Electrical and Systems Engineering.

Yang is the principal investigator of a four-year, $2 million grant from the National Science Foundation (NSF) in which she will oversee the takedown of two venerable physical laws: time-reversal symmetry and reciprocity.

Yang's multidisciplinary collaborators are from Stanford University, the University of Minnesota, the University of Wisconsin-Madison and Wesleyan University. The team she leads will study novel ways in which light waves can propagate in next-generation technologies, with impacts in public health, computation, information processing and communications applications.

Written by Tony Fitzpatrick

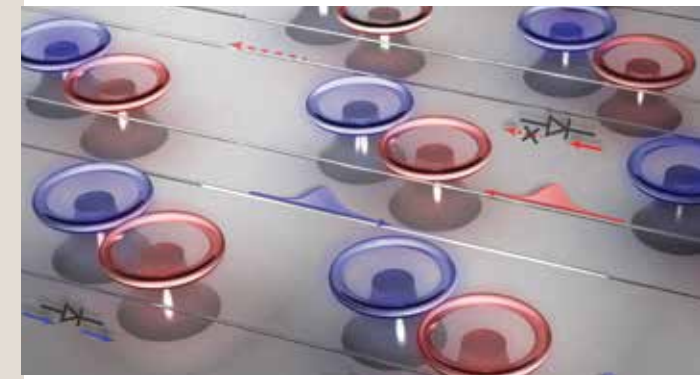## Using nanotechnology to benefit energy, the environment, health

YOUNG-SHIN JUN

An environmental and chemical engineer at Washington University has received more than $1 million to study interfacial reactions that relate to energy, environmental and biomedical systems involving a variety of earth-abundant materials. With the newly developed strategies, these materials can be used most effectively at their smallest size — the nanoscale.

Young-Shin Jun, associate professor of energy, environmental & chemical engineering, has received three grants from the National Science Foundation for this work, totaling nearly $1.03 million over three years.

One grant will fund research into forming manganese oxides in aqueous systems using our most unlimited resource — sunlight. The ultimate goal is to make manganese ions into "nanosheets" — sheets of manganese oxide nanoparticles — that could be used as a sustainable energy material in lithium ion batteries. This new understanding of the changes in manganese in aqueous environments also is critical in controlling water quality and acid mine drainage, Jun said. Results of this work could also influence the development of other energy materials using green chemistry principles.

Another grant, in collaboration with Srikanth Singamaneni, associate professor of materials science, aims to find new ways to meet the growing demand for fresh water. The grant will fund their efforts to develop new photothermal membranes made of nanostructures that could prevent the buildup of microorganisms and biofilms. This research project will be the first to use the photothermal capability of gold nanostars, graphene oxide and molybdenum sulfide for water purification.

launch_code

LaunchCode, WashU Engineering team to meet demand for tech professionals

{launch_code}

Written by **BETH MILLER**

Computer technology jobs are among the fastest-growing occupations in the 21st century, but employers nationwide have more positions than they can fill with qualified candidates. Many of these high-paying technology positions do not require a four-year degree, but a package of fundamental skills that can be supplemented with on-the-job training.

To meet this challenge, Washington University School of Engineering & Applied Science alumnus Jim McKelvey started the nonprofit LaunchCode in St. Louis in 2013 to provide the fundamentals at no cost to area professionals looking for a career in the tech industry, but without previous experience to open the door. Through a unique partnership, Washington University and the School of Engineering & Applied Science are providing some of LaunchCode's students with Engineering's popular introductory computer science course to give them the most relevant skills that can be used right away in the workplace.

McKelvey, who earned bachelor's degrees in computer science and economics from WashU in 1987 and also is a cofounder of Square Inc. and a general partner for Cultivation Capital, formed a team to get LaunchCode off the ground, including Zach Lou, who earned a bachelor's degree in philosophy in 2012, and Brendan Lind, who earned a bachelor's degree in anthropology in 2012 and departed the company in September. LaunchCode's purpose is twofold: to help companies find skilled workers for the growing number of tech jobs and to provide free coding courses for those looking for a career in technology, no matter their previous education or background.

LaunchCode offers 16-week hands-on training courses in several computer programming languages. Near the end of the course, students can apply for a 12-week apprenticeship as a coder/programmer with one of nearly 500 companies, such as MasterCard, The Boeing Co., Express Scripts, Monsanto and Emerson, among others. As apprentices, students earn

In its first year, more than 1,000 people used LaunchCode's mentoring and education programs. More than 80 percent of them did not have a degree in computer science, and 90 percent had no prior programming experience.

$15 an hour as programmers while working with a mentor at the workplace. Ninety percent of people LaunchCode has placed into apprenticeships have gotten permanent, full-time jobs. Since it began, its services have pumped more than $80 million into the economy.

Since LaunchCode began, it has placed more than 480 candidates in technology jobs. That astounding success rate caught the eye of the White House.

President Barack Obama recognized LaunchCode when introducing the TechHire Initiative, which made $100 million in federal grants available to communities nationwide and organizations such as LaunchCode that prepare Americans for well-paying jobs in technology, calling such programs "a pathway to the middle class." LaunchCode boasts that its graduates double their salaries from their previous jobs when accepting permanent placement.

In early September, Vice President Joe Biden, who has been outspoken about providing accelerated, accessible education to nontraditional students, visited LaunchCode in support of the nonprofit's mission. He indicated that by 2022, there would be a need for more than 1 million qualified IT workers.

"As the world figures out how to solve the tech talent gap, Vice President Biden and the Obama administration recognize that what we're doing is unique and has been quite successful," said Mark Bauer, who was recently named executive director of LaunchCode after serving as director of operations for a year. "The vice president used his visit as an opportunity to come here and speak about the way that people in the U.S. can acquire these skills to get that first tech job and use LaunchCode as a conduit to do it."

JIM MCKELVEY

VICE PRESIDENT JOE BIDEN

LAUNCHCODE

WHITNEY CURTIS

WHITNEY CURTIS

WHITNEY CURTIS
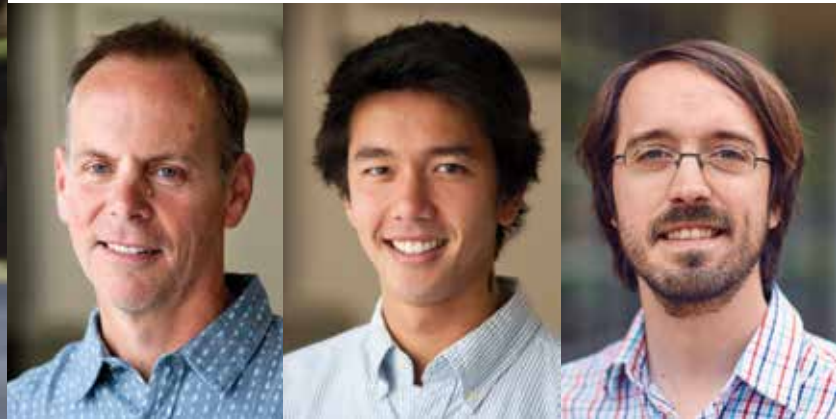
Mark Bauer *Zach Lou* *Doug Shook*

Ron Cytron

The organization's funding comes from three major sources: the government, including the U.S. Department of Labor; private foundations; and earned income through its apprenticeship program. The organization charges a placement fee when one of its apprentices is hired full-time.

LaunchCode's growing leadership team consists of at least a half a dozen WashU alumni. Lou says working with Washington University was a goal from the organization's beginning.

"WashU is the premier educational institution in the region," Lou says. "We reached out, and within Engineering, there are a lot of great people who wanted to collaborate with us and make something happen."

Creating the collaboration

Their first action was to team with Doug Shook, lecturer in computer science & engineering, to offer a 16-week free coding course in the spring 2016 semester using Harvard University's CS50x course, an entry-level computer science course for majors and non-majors. WashU computer science students were teaching assistants (TAs) for the course.

With that success, the LaunchCode staff and the School of Engineering expanded the partnership into the organization's "Summer of Code," a portfolio of four 20-week courses offered in diverse locations in the St. Louis area to reach an equally diverse community. An evening and a daytime course were in partnership with WashU Engineering, using the computer labs in Urbauer Hall for the first third of the evening course and the curriculum of Engineering's CS 131, Computer Science I, developed by Ron Cytron, associate department chair and professor of computer science, and the most popular undergraduate course at WashU with more than 1,000 students each academic year.

CS 131 takes a non-traditional approach: Students watch the lectures online before coming to class, then spend much of the time in the classroom working in small groups, called collaborative studios. In the LaunchCode classes using CS 131, each student is assigned to a group of about eight other students who share a TA, a WashU computer science student who provides help with the in-class problems and homework.

"In teaching CS 131 to undergraduates, I saw that students working together made it more fun, they taught each other, they learned better, and moreover, it sold the idea that computer science is a collaborative discipline right from the very beginning," Cytron says. "It's made a big change in how students view the discipline."

> "I was really excited to teach this curriculum, not only because I know it better, but also because I think it does a better job of getting people working together in groups and getting people interacting with teaching assistants."
>
> — DOUG SHOOK

Moving from using Harvard's CS50x course, which teaches the programming language C, to CS 131's Java was a change for LaunchCode, but one with benefits.

"WashU's CSE 131 was particularly appealing because it is Java-based," Bauer says. "If you do any searching of any job sites, Java is the No. 1 in-demand programming skill. Being able to take advantage of that and having access to WashU students who are actively pursuing their degrees to help teach others has been nothing short of amazing. It has been great for our students to talk to a person who has taken the class and is pursuing a career in technology — it cements the credibility and allows students to learn at a faster pace."

Shook, who earned a master's degree in computer engineering at WashU in 2013, has taught CS 131 since he was a graduate student and was a lecturer for the spring 2016 course.

"I was really excited to teach this curriculum, not only because I know it better, but also because I think it does a better job of getting people working together in groups and getting people interacting with teaching assistants, which is actually very important for programming," Shook said. "The studios especially are well suited for that. The students also get to form a relationship with their TAs."

Unlike the undergraduate students, LaunchCode students do not receive grades for the course, Shook said.

"People still want to get the work done, and there are still deadlines, but there are no letter grades at the end," Shook said. "You either did what we asked you to do, or you didn't."

While the course is intense, there are fun assignments along the way. In the fourth week, students are asked to design their own flag using Java. Along with that, they name their own country and come up with a national anthem, as well.

"It's fun, because there is the creative act of making something out of your own design, which is fun on its own, but you can draw it on the page and think about how to draw it on the computer using shapes that you're able to work," Cytron said.

Not only are Engineering faculty involved with the LaunchCode course, but students are as well. Nikki Wines, a junior majoring in computer science, was a TA for the spring 2016 course that taught the Harvard CS50x curriculum and is a TA for the evening course that began over the summer. She says she notices a difference in how the students are learning using WashU's CS 131 curriculum.

"In the spring, a lot of students became overwhelmed by the amount of information coming at them, so LaunchCode restructured the class," she says. "It's much more structured now and a more cohesive class. LaunchCode has really worked hard to make sure students aren't overburdened or are getting left behind."

WHITNEY CURTIS

WHITNEY CURTIS

WHITNEY CURTIS

> "It's a much more personal experience than being a TA in a WashU class where everyone is the same age and has a relatively similar experience in their daily life. It's definitely rewarding."
>
> — NIKKI WINES

Wines says working with students older than she is was daunting at the beginning, but now she feels responsible for their success.

"It's great getting to know the students," she says. "It's a much more personal experience than being a TA in a WashU class where everyone is the same age and has a relatively similar experience in their daily life. It's definitely rewarding."

Davis Heniford, a senior majoring in economics with a minor in computer science, was a teaching assistant for both of the summer LaunchCode courses using CS 131. As one who had taken the course with Shook as a WashU student, he gained a different perspective as a TA than he had as a student.

"These are people who are very different from WashU students," he said. "They come from very different backgrounds, not only personally, but also coding backgrounds. All have very different experiences, and seeing them come together on these projects is pretty cool."

Students' perspective

The evening LaunchCode course that started at WashU had about 100 students, ranging in age from high schoolers to adults in their 50s and 60s, while a daytime course, offered at the organization's Mentor Center at 4811 Delmar Blvd., had about 50 students. Students are expected to turn in homework weekly, and from these assignments, the LaunchCode staff can determine the effectiveness of the curriculum.

In a class session in the fifth week of the course, the students were learning how to write Java code to create a sine wave, a mathematical curve. One of about a dozen teaching assistants presented the problem with only a partial framework for the solution, then gave the students 10–15 minutes to work on it in their groups.

True to its mission, the evening course attracted students from diverse backgrounds and skill levels. Dave Yoo earned a master's degree in counseling last spring, but decided it wasn't a good fit and took the course to learn development skills.

"I worked as a tech in IT for eight years," he said. "I liked it, but I wanted to do something more creative with it. This course is great, because anywhere else, you'd have to pay for it."

Indeed, coding boot camps are springing up nationwide to meet the shortage of qualified tech workers. However, these boot camps come at a price: one boot camp in San Francisco, which claims a 98 percent job placement rate, costs just shy of $20,000 for a 12-week session, while others are in the $10,000 range. While considerably less expensive than the cost of a four-year degree in computer science, the cost may still be out of range for adults looking for a second career.

Tracie Russell, who was working full-time as a property manager at the beginning of the evening LaunchCode class, said the course is challenging.

> "It's hard to learn new concepts when you haven't been in formal education for a long time," she said. "It's also really nice to get 'a ha!' moments when I get it. It's been absolutely worth it."

Russell, who has a degree in biology, said she spends about six hours outside of the two classes weekly preparing and studying.

"My main goal is to learn something new and decide if this is the direction I want to take," she says.

About halfway through the course, Russell began working as an entry-level software engineer at a local company. She attributed the move to her experience in the LaunchCode course.

Steve Wang, a research technician in radiation sciences at the School of Medicine, took the course to boost his skills for his job.

"I work with optical instruments and scientific instruments that require integration," he said. "I already knew C++ and MatLab, but those are very specific to engineering and don't give as broad a view as you can get with Java. This has definitely been worth the time."

While most students agreed that the Summer of Code was challenging, by more than midway through the course, about three-fourths of the students were still enrolled, compared with about half in LaunchCode's previous courses that used the CS50x curriculum, Lou said.

Growth potential

Though LaunchCode is based in St. Louis, it is expanding to other U.S. cities where there is a demand for workers in tech fields and a need for preparing workers to fill the jobs. Most recently, federal funding allowed LaunchCode to open offices in Seattle and Portland, Ore., adding to its other locations in Kansas City, Mo., Minneapolis, South Florida and Rhode Island, with the goal of offering the same quality education in all of its classes.

WHITNEY CURTIS

The power of small

Written by **BETH MILLER**

There's a saying that doors will open to those bold enough to knock. Srikanth Singamaneni was bold enough to knock several times early in his career, which has helped him to make significant discoveries in materials science that are already making a mark in the world.

Singamaneni works with nanomaterials to create powerful sensors that can be used to detect chemicals and biomarkers that could speed health-care diagnostics and new materials to filter dirty water to make it potable. His work spans from nanomedicine to physics to biology, all from a materials science perspective. Most recently, he has added research into the interface between biotic and abiotic interfaces in an effort to create advanced functional materials at a very small scale — the nanoscale.

Nanomaterials
nan·o·ma·te·ri·al

noun — a material having particles or constituents of nanoscale dimensions, or one that is produced by nanotechnology.

RON KLEIN

Since Singamaneni joined the School of Engineering & Applied Science faculty in January 2010, he has received more than $3.6 million in funding for his research, as well as a National Science Foundation CAREER Award, which is given to faculty early in their careers to jump-start their work, and a Dean's Faculty Award for Innovation in Research. His research with plasmonic biosensors and bioinspired functional materials has been written about in the media worldwide, including in his hometown newspaper in a small village in southeast India.

Singamaneni has uncanny insight for using materials to solve problems. He recently combined a cellulose material created from bacteria with graphene oxide to make a biofoam that can purify dirty water using only sunlight as the trigger to start the process. Both materials are inexpensive and can be created on a large enough scale that the process is viable to purify water in developing countries with abundant sunlight.

He also has used biology and nature as inspiration for new materials, for instance, studying how the exoskeleton protects insects as a model for new materials to protect airmen in combat situations. He also is collaborating with Barani Raman, associate professor of biomedical engineering, and Shantanu Chakrabartty, professor of electrical & systems engineering, to develop bio-enabled sensors that could detect explosives and be used in other homeland security applications. He is collaborating with Young-Shin Jun, associate professor of energy, environmental

& chemical engineering, to improve the performance of reverse osmosis membranes for water purification.

Singamaneni has other collaborations with a variety of faculty both in Engineering and in the School of Medicine, including Samuel Achilefu, the Michel M. Ter-Pogossian Professor of Radiology; and Evan Kharasch, MD, PhD, the Russell D. and Mary B. Shelden Professor of Anesthesiology, director of the Division of Clinical and Translational Research and former vice chancellor for research; and Jeremiah (Jerry) Morrissey, research professor of anesthesiology, with whom he collaborates on developing a test to quickly detect kidney injury or cancer using gold nanoparticles. That collaboration developed from knocking on Kharasch's door, figuratively speaking.

"I felt that I had a technology that could be applied for biomarker detection, and I was looking for kidney cancer biomarkers," he said. "I did not know that Evan was then vice chancellor for research and had a tight schedule, so I just emailed him. We got together, and he brought Jerry with him. We put together a proposal and got funded."

That work, which has been ongoing since 2012, continues to grow. Singamaneni said within the next four years, the team hopes to collect patient samples to test with their technology and compare them to the results produced by the gold-standard tests.

After earning a bachelor's degree in electrical engineering from Nagarjuna University, Singamaneni left India to get a master's degree in electrical

Singamaneni lab members

RON KLEIN

2013

Singamaneni receives the NSF CAREER Award

"Plasmonic Nanoclusters with Built-in Artificial Antibodies for Label-free Biosensing"

$3.6

million in funding for his research

engineering at Western Michigan University, where the culture was very different from the one he knew. For instance, he had only used the internet a couple of times before coming to the U.S. However, his determination to succeed led to a new direction.

"I was randomly knocking on professors' doors trying to find a grading position, and I did not realize that I'd gone into the materials part of the building," Singamaneni recalls. "I knocked on a professor's door, and he said he didn't have a grading or teaching position, but he did have a research position that required some level of electrical engineering expertise, so I told him I'd take it."

Singamaneni worked with atomic force microscopy for the professor, who then asked him to demonstrate ultrasonic force microscopy using some samples. He got interested in the samples, then got interested in the materials and decided to earn a doctorate in materials science at Georgia Institute of Technology (Georgia Tech), a powerhouse for materials science where Singamaneni thrived.

At Georgia Tech, he studied under Vladimir Tsukruk, the Dean's Distinguished Professor of Engineering, a founding director of Microanalysis Center and founding co-director of DoD BIONIC Center of Excellence, who quickly became Singamaneni's role model.

"What I admired most in this group is the freedom he provided to students," Singamaneni said.

> "We could come up with our own ideas and execute them, and he almost never said no to any idea that we wanted to try. Yes, you get to fail, but that's the learning process. And you build confidence — you do this once, twice, thrice, and by the time you finish your PhD, you feel like you can conceive of an idea and execute it and write it up."
>
> — SRIKANTH SINGAMANENI

Although Singamaneni's name and work have been shared worldwide, what drives him is a deep sense of giving.

"If you only think about yourself, that's not enough motivation for you to do good work," he said. "You care about society and care about giving something back, be it knowledge or some well-trained person that you are sending out, or great products that might come out of your lab. All of this has to be what you want to give. Once that feeling is there, you are caring about something bigger than just your career or yourself."

passion for the world

Written by **BETH MILLER**

Although the School of Engineering & Applied Science makes its home in St. Louis, our students arrive aware that they are citizens of a global society and with a passion to tackle engineering challenges in all corners of the world, whether it be designing medical devices at a U.S.-based company or building a water treatment system in a school in Africa.

Through the curriculum and extracurricular opportunities that focus on global applications, students learn to think broadly to find answers to the world's largest engineering problems, such as those in energy, the environment, medicine and health. The vast perspectives students and faculty bring into the school from all over the world enriches not only the classroom experience, but hands-on experiences outside of the classroom. By sharing these perspectives, students get a better understanding of the world's needs and ways to meet them.

More than half of Engineering faculty members have an international background, bringing the global perspective directly into the classroom and laboratory environments. Many faculty members have collaborations with peers at research universities around the world, including Patrick Crowley, professor of computer science & engineering, who leads a global Named-Data Networking testbed; Pratim Biswas, assistant vice chancellor, the Lucy & Stanley Lopata Professor and chair of the Department of Energy, Environmental & Chemical Engineering, has collaborations with researchers in India in areas such as clean water, clean air and solar energy; Lan Yang, the Edwin H. & Florence Skinner Professor in Electrical & Systems Engineering, has collaborators in Austria, China, Germany and Japan for her work in lasing systems and applications.

Biswas, also assistant vice chancellor of international programs, says addressing global challenges is a main focus within the school.

"I can't sit within my borders and say 'I'll just tackle what's in St. Louis,'" he says.

"We are absolutely pushed to collaborate with others in other countries, and we do it because the problems are challenging. That brings an added benefit to our students. This is also part of their education that these are not simple problems — you can't just take a two-week summer trip and solve these problems."

— PRATIM BISWAS

International students in Engineering
2016-2017 academic year

11.5%
undergraduates

61%
doctoral students

From left: Pierce Dhaese, Maya Poncelet and Ryan Sharma, all juniors majoring in Engineering, in Ethiopia with Engineers Without Borders.

In the 2016-2017 academic year, 11.5 percent of undergraduate students are international students, while 68 percent of full-time master's students and 61 percent of doctoral students come from outside of the U.S.

In addition to addressing global challenges and needs through the curriculum, undergraduate students have a variety of ways to put their global citizenship in action through participation, in student groups and competitions, extended international service trips and more than 100 study-abroad opportunities.

The WashU Engineers Without Borders (EWB) student group, a chapter of the international organization that partners with communities to meet their basic human needs, has about 30 active members who divide their interests among two current international projects: the Mekelle School for the Blind in Ethiopia, where they have installed new lighting systems, water storage and drainage systems, and Roosevelt Hospital in Guatemala, where they repair ventilators and teach local medical students how to maintain the equipment.

The Engineering World Health student group specifically works toward advancing global health by creating devices to meet crucial needs in developing countries. One team of students, led by chapter president Kailin Baechle, a junior majoring in biomedical engineering, is working on a device to pull humidity from the air to create clean water in developing countries with high humidity, such as Madagascar. The team, Water Out of Thin Air (WOOTA), won $25,000 in the 2016 Discovery Competition.

The Discovery Competition, which is in its fifth year, provides students with the opportunity to explore their entrepreneurial interests by developing a product or service in competition for up to $25,000 in cash and legal services.

Israel

Hungary

India

Germany

Nigeria

Kirby Simon and Caroline Avery enjoyed learning more about the Hungarian culture during the Summer 2016 International Experience.

About 20 percent of teams have designed a product or idea specifically to meet global needs, such as inexpensive, 3-D-printed eyeglass frames with interchangeable lenses, and about half of the teams have created medical devices that could be implemented globally, such as the low-cost spirometer that eventually became the signature product of Sparo Labs.

The Department of Energy, Environmental & Chemical Engineering offers the McDonnell Academy Global Energy & Environment Partnership International Experience, an annual course and summer trip in which students attend lectures at one of the university partners in the McDonnell International Scholars Academy and participate in local culture. Since 2014, the student groups have visited Singapore, Turkey and Hungary, respectively, with a trip to Thailand planned for 2017.

Caroline Avery, a junior majoring in chemical engineering, said the trip to Hungary in the summer of 2016 was the perfect opportunity to tie her passion for chemical engineering with a once-in-a-lifetime cultural exploration.

"It allowed me the opportunity to savor some of the most fascinating and life-changing ventures that I never would have been exposed to otherwise," Avery says. "It empowered me as a chemical engineer to see some of the work and problems I solve every day in St. Louis literally in action around the world."

Biomedical engineering students get hands-on experience in creating orthotic devices for children with cerebral palsy in an annual trip to Hong Kong and China. The students work with Hong Kong Polytechnic University students to assess the needs of the children then create custom-fitted devices to help the children walk and build muscle strength.

Jessica Lin, a senior majoring in biomedical engineering, said work was integral to her education.

"I was eager to see the impact we had on the children in helping them walk for the first time," she said. "This will be a trip I will remember for the rest of my life, the fuel for my motivation for pursuing an MD/PhD and serve underserved communities and people internationally ."

International students in School of Engineering & Applied Science bring their own global perspective into the student body.

Jay Vaidya, a junior majoring in computer science and math, with a minor in linguistics, is from Mumbai, India, and came to WashU at the recommendation of a family friend. He says international students develop a diverse culture and environment.

Jay Vaidya, a junior majoring in computer science and math), is from Mumbai, India. He has been very involved in student groups and said WashU provides an excellent support network for international students.

"In a world that is constantly globalizing, being able to connect with people from other cultures is going to be a necessary skill."

— JAY VAIDYA

Caroline Trier (left) and Savannah Est spent the summer of 2016 in Aachen, Germany, in a competitive research program at RWTH Aachen University. Est said it was the first time she had to speak a language other than English. "In the lab I worked in, we had people from Iran, Germany, Portugal and Taiwan, and it was normal for them to be adaptable to other cultures."

Amir Ben-Nun and Shachar Dekel are exchange students in computer science from the Interdisciplinary Center Herzliya (IDC) in Tel Aviv, Israel, one of the McDonnell International Scholars Academy universities. Not only do they bring their perspective as international students, but they bring life experience different from most U.S. undergraduate students — each served a mandatory term in the Israeli military before starting college. Ben-Nun was a combat soldier before becoming injured, then became a programmer for the rest of his term, and Dekel was in the intelligence department, serving five years as a programmer during his term. He now works as a programmer in addition to being a full-time student at IDC.

Dekel says the WashU curriculum is very practical.

"The teaching here is more about actual experience," Dekel says. "They don't tell you what to do – you have to actually learn it yourself, which is very important for programmers and computer science."

Shachar Dekel and Amir Ben-Nun, exchange students from the Interdisciplinary Center Herzliya in Tel Aviv, Israel, are studying computer science at WashU and soaking in the American college experience.
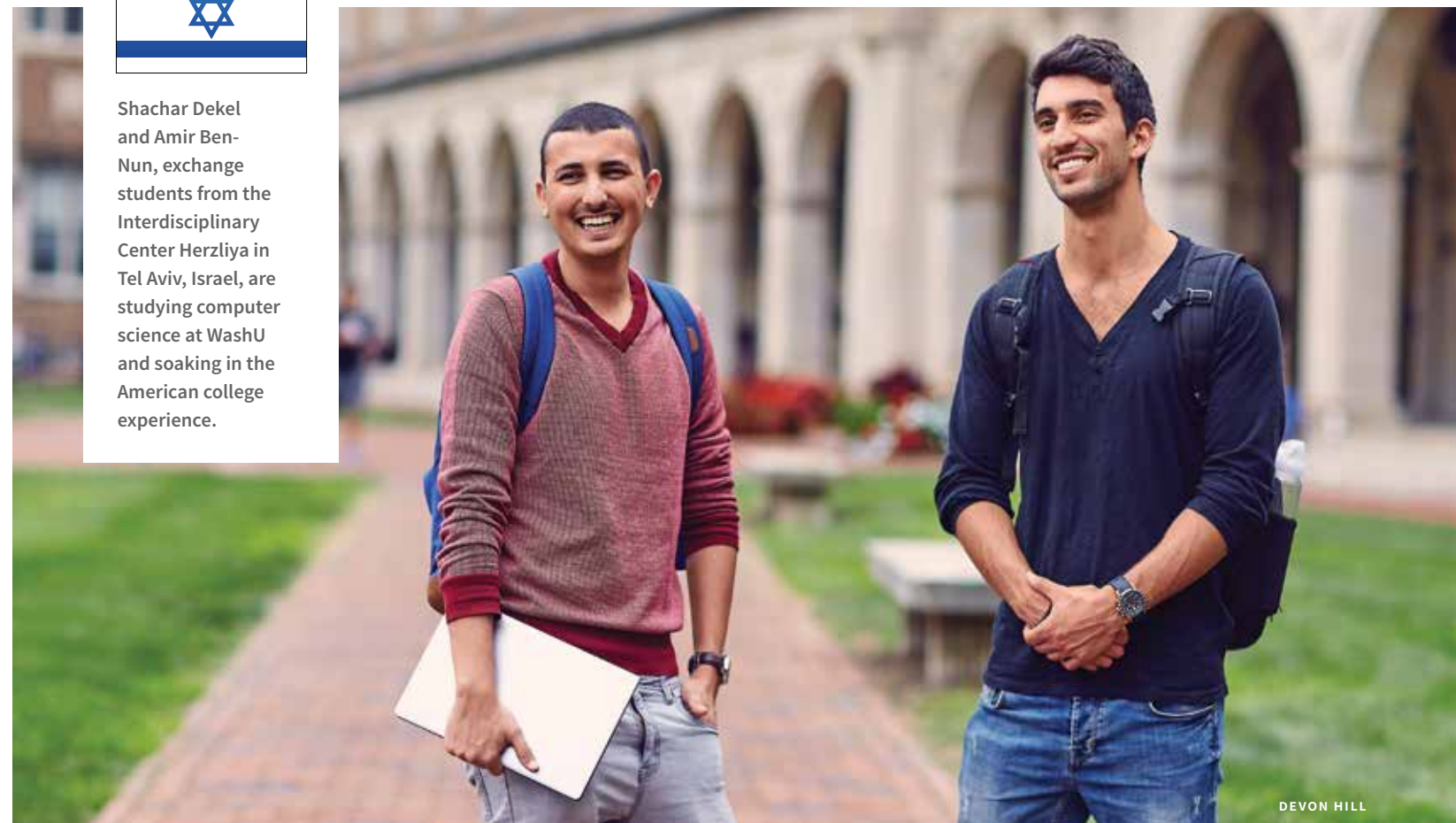
DEVON HILL

DEVON HILL

The McDonnell International Scholars Academy, a network of 32 universities worldwide, focuses on attracting talented international and domestic doctoral students in areas such as climate change, energy and environment, public health and social development. Currently, there are 21 scholars from around the world earning doctorates in Engineering. Scholars also participate in social and cultural experiences that focus on international issues. Since the Academy began, 13 of the 85 graduates have earned doctorates and four have earned master's degrees in Engineering.

Andrea Balassy is a fifth-year doctoral student in energy, environmental & chemical engineering and one of the McDonnell Scholars in Engineering. A native of Hungary, she came to WashU from Budapest University of Technology & Economics.

"The McDonnell scholarship helped me a lot, because I knew I had the support for five years to do my research," she says. "It's been a positive experience. I've learned how to interact with people and have grown a lot."

Kelsey Haddad, a fourth-year doctoral student in energy, environmental & chemical engineering, is one of the U.S. Scholars in the McDonnell International Scholars Academy. As a U.S. Scholar, she will study for at least one semester at one of the other universities in the academy.

"This experience has really given me the opportunity in parallel to try to be interdisciplinary as far as a different field, understanding different cultures and how they are going to interact with the technology that we're trying to develop."

— KELSEY HADDAD
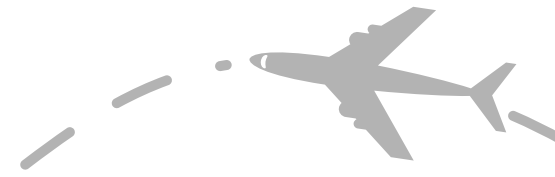
McDonnell International Scholars Academy

32 partner universities worldwide

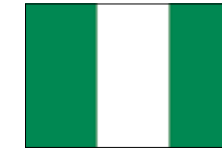### 21 scholars currently earning doctorates in Engineering

Adewale Adeosun, a fourth-year doctoral student from Nigeria, earned a bachelor's degree in chemical engineering in Nigeria and a master's degree in Dubai. He came to WashU with his wife and young son attracted by the unique opportunities offered by the Department of Energy, Environmental & Chemical Engineering that he says were "a perfect fit" for his previous education and research interests.

"I'm really passionate about finding a way to use my knowledge to help my country," he says. "Many people in Nigeria don't have electricity. If you really want to push a country forward, you need electricity, because that opens businesses."

While Engineering has strong collaborations around the world, new programs and partnerships are being developed to continue enriching the global experience for students.

The MAGEEP Education Network recently launched to bring faculty from various institutions together to create content for courses that could be offered internationally to companies, industry and governments. Initial courses offered through the network include Energy for Leaders, Sustainability for Business, Water Treatment, and Fundamentals of Aerosol Science and Technology.

In addition, a program to allow doctoral students to be co-advised at both WashU and McDonnell Academy partners has begun, allowing doctoral students to do research at one of the other institutions.

DEVON HILL

"Understanding the link between energy and environment using chemical engineering principles is critical to sustainable use of abundant fossil fuels. This experience has really sharpened my mind and exposed me to the big challenges of the 21st century."

— ADEWALE ADEOSUN

Lorrie Faith Cranor, the Federal Trade Commission's chief technologist, wants to make online privacy more secure, using computer science, engineering and policy to safeguard information

P@$$WORD PROTECTOR

Written by **CHRISTOPHER TRITTO**

Lorrie Faith Cranor is one of the nation's leading experts on online privacy, password protection and technological security. So much so that Federal Trade Commission Chairwoman Edith Ramirez tapped the Washington University in St. Louis–trained computer science professor in January to take a leave of absence from Carnegie Mellon University and become the agency's chief technologist.

The appointment apparently cued the gods of irony. Two months into Cranor's new gig, thieves stole her identity and used it to hijack her mobile number and pocket a couple of new iPhones charged to her wireless account.

"I was very annoyed, but it helped me understand what it's like for someone going through this and how they can use FTC tools to help," Cranor says.

Cranor's firsthand experience helped her spur improvements in FTC consumer protection programs. It prompted her to publish a blog post on the subject and even led to a June appearance on NBC's "Today" show to warn others about this form of identity theft.

The experience also validated the importance of her ongoing research on passwords and data protection. As technology continues to infiltrate our everyday lives — through desktop and mobile devices, personal fitness trackers, internet-connected devices in our homes and more — security measures are becoming increasingly vital to privacy protection but also becoming more difficult to navigate.

"There are a lot of exciting but scary things on the horizon," Cranor says. "Smart cars are collecting increasing amounts of information about drivers and passengers that are almost completely unregulated. Virtual reality systems can collect information on what you are looking at, your heart rate and who knows what else. Makers of many health monitoring devices and fitness wearables have privacy policies, but studies show a lot of these companies are not adequately protecting the information they collect."

Add to that the dizzying array of privacy practices and legal disclosures consumers encounter on a regular basis — check the box, "Agree" to terms — and technology users rarely know what information is secure as it moves about the Web.

Cranor's family hiking in Colorado (from left): Lorrie, Nina, Shane, Chuck and Maya.

COURTESY PHOTO

Cranor is working to make privacy tools and disclosures simpler and more functional for consumers. At Carnegie Mellon in Pittsburgh, she is director of the CyLab Usable Privacy and Security Laboratory and co-directs the master's program in privacy engineering. She has written more than 150 research papers on privacy-related subjects, co-edited the book "Security and Usability" and founded the Symposium on Usable Privacy and Security.

Now at the FTC, she advises the chairwoman and staff on a variety of technology issues, is helping the White House shape a national privacy research strategy and is organizing workshops on how to evaluate disclosures on everything from energy labels and clothing care tags to nutrition labels and drug risk statements.

All of this has grown out of Cranor's seven years of education at Washington University, where she earned a bachelor of science and two master of science degrees before ultimately receiving a doctorate in engineering and public policy from the School of Engineering & Applied Science in 1996.

Cranor grew up in Maryland immersed in science and technology. Her mother was a mathematics professor, and her father worked as a biomedical engineer. They brought home computers before people had PCs, and as doctoral students, printed Cranor's birth announcement on punch cards.

Cranor's tips for avoiding identity theft

After Cranor's identity was stolen, she shared tips for consumers to avoid it on her blog:

"One of the most important steps you can take is to establish a password or PIN that is required before making changes to your mobile account. Using this extra password or PIN is a good idea and should help reduce your risk of mobile account takeovers. However, it does not offer complete protection, so make sure you remain alert for phishing attacks, protect your financial account information, and examine your mobile phone and credit card bills carefully every month for signs of fraud. If your phone stops receiving a signal and says 'emergency calls only' or 'no network,' even after you restart your phone, contact your mobile carrier to see whether your account has been hijacked."

Follow Lorrie Cranor's blog, Tech@FTC at https://www.ftc.gov/tech

When it came time for college, her mother heard about WashU and its engineering scholarships.

"My first reaction was, 'I've never been to Missouri. I don't think I want to go to Missouri,'" Cranor says. "But I was a finalist for a Langsdorf Scholarship and went to visit. I was blown away and turned down my other admissions."

As a doctoral student, she researched electronic voting systems with guidance from Ron Cytron, professor of computer science & engineering.

"Ron was a wonderful adviser and taught me a lot about how to do research," Cranor says. "Often in graduate school, people are very focused on their particular narrow research area. But I found a lot of things I learned in other courses turned out to be helpful later."

Indeed, Cranor balanced her primary academic focus with interests in people, government and art. She helped found the Association of Graduate Engineering Students, served as a student representative on the university's Board of Trustees, edited *XRDS* (formerly *Crossroads*), the student magazine of the Association for Computing Machinery, and minored in fine art.

Today Cranor balances her career with family — she and her husband, Chuck Cranor, also a WashU alumnus, have three children. She practices yoga, enjoys photography, helps run the parent-teacher organization at her kids' school and has founded a local soccer organization for moms. On sabbatical during the 2012–13 academic year, Cranor cultivated her love of quilting, a hobby that has earned her national awards, a public exhibit and a feature in *Science* magazine.

7 *years of education at WashU: bachelor of science, two master of science degrees and a doctorate in engineering and public policy*

"Often in graduate school, people are very focused on their particular narrow research area. But I found a lot of things I learned in other courses turned out to be helpful later."

— LORRIE CRANOR
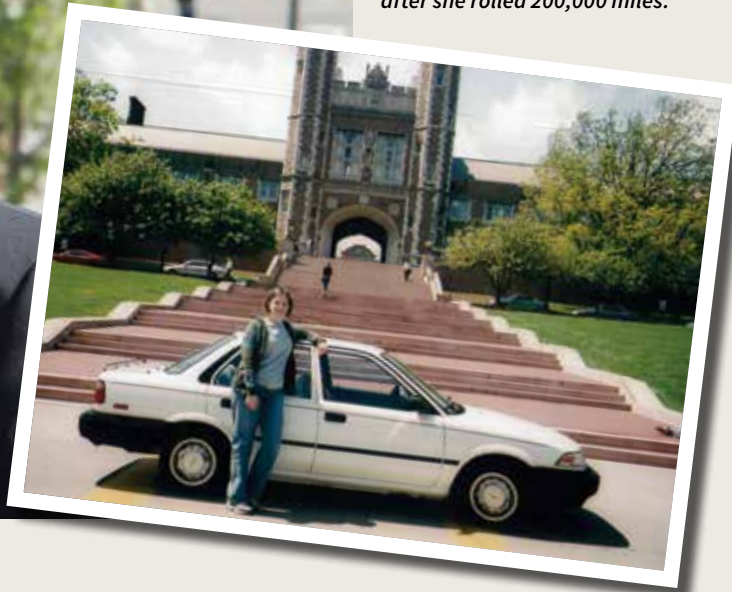
150 research papers on privacy-related subjects

To see more of Cranor's quilts and her explanations of the designs, visit lorrie.cranor.org/quilts

Her most famous quilt, inspired by her research, is one emblazoned with common passwords. Its name? What else? Security Blanket.

Albrecht with her Toyota Corolla after she rolled 200,000 miles.

JOE FUQUA

Amanda Albrecht

Written by **BETH MILLER**

When Amanda Albrecht first came to Washington University in St. Louis, she thought she would stay for four years then get a job. But learning that four years isn't always enough and a campus construction project changed everything.

Albrecht's experience as a work-study student in a biology lab showed her that graduate school was necessary for a career in the field. At the same time, she was fascinated by the construction of a new residence hall on the South Forty. A talk with Kevin Truman, chair of the Department of Civil Engineering, sold her on changing her major to civil engineering. Working summers and part-time through the school year at a construction firm confirmed her choice, and she was prepared to graduate in May 2002.

"WashU helped me to be open and comfortable with different possibilities in my life," said Albrecht, who is now an assistant professor and program chair of construction management at the University of Cincinnati (UC). "When you're 18 or 19, you feel pressure to stay on the path you've chosen, and to switch off of that path is a major decision. Having someone like Professor Truman to talk with made me more willing to think outside of the path that I was on and helped me decide to switch over to civil engineering."

One autumn day during Albrecht's senior year, the Sept. 11 terrorist attacks changed the nation's economy and halted new construction projects, making jobs in the field scarce. Albrecht adapted by staying at WashU for another year to earn a master's degree in construction management before taking a job with the U.S. Army Corps of Engineers and later with a construction firm in Cincinnati.

When yet another economic downturn put construction on hold, Albrecht decided to change paths again and earn a law degree at UC in 2010. Her education in engineering and experience

> **"WashU helped me to be open and comfortable with different possibilities in my life."**
>
> — AMANDA ALBRECHT

in construction management led her to practice at a large Cincinnati law firm, where she handled construction-related litigation. While practicing full-time, Albrecht accepted an invitation to teach a night class at UC as an adjunct instructor. That decision ultimately opened the door to yet another opportunity to change paths and led to her current position at UC's College of Engineering & Applied Science.

Now, Albrecht uses her unique experience in construction management and law to teach six courses a year, advise student groups and competition teams and administer the construction management program, while also maintaining a part-time law practice.

"I am involved in a lot of the industry groups in Cincinnati, and I try to connect my students with the opportunities those groups provide," she says.

Albrecht encourages her students to be more involved to show them there is more to college than grades.

"When I was at WashU, I was really focused on grades, and I didn't take advantage of other opportunities, like getting leadership positions with student groups and competitions," she says. "That's a regret that I have. I tell my students, 'Take a B+ in my class instead of an A+ and go get involved in something. You'll be a better person for it, you'll be more well-rounded, you'll be interesting in your interviews, and you'll open up more opportunities than if you're a straight-A student with nothing else to talk about.'"

A TRIBUTE TO ARYE NEHORAI

Sparking growth

Written by **BETH MILLER**

When Arye Nehorai came to the School of Engineering & Applied Science as chair of the Department of Electrical & Systems Engineering in 2006, the department was at somewhat of a standstill: No new faculty had been hired in more than 15 years, and funded research and student enrollment were low.

But today, the department has nearly 600 total students taught by faculty active in research, many of whom were hired by Nehorai, who stepped down as chair June 30.
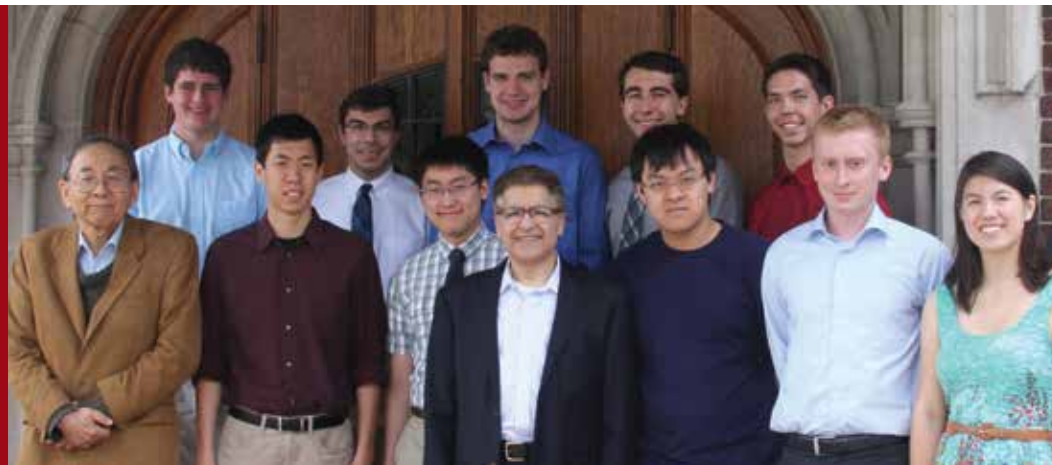
RON KLEIN

> "His focus on research excellence in hiring faculty coupled with the goal of growing the undergraduate programs has established the department as a critical component of the school."
>
> — AARON BOBICK

Hiro Mukai (far left) with Nehorai and ESE students in 2015

Nehorai with his wife, Shlomit

Hiring excellent faculty members is one thing Nehorai looks back on with pride. One of the first he hired was Lan Yang, now the Edwin H. & Florence G. Skinner Professor, who has received international recognition for her work with advanced nano/micro photonic devices. He has since hired eight of the current 14 tenured/tenure-track faculty members and eight lecturers and has appointed two professors of practice.

"All of the faculty I've hired have come from top-ranked universities," Nehorai says. "It is important that they would work on exciting and important topics that would have long-term impacts, were multidisciplinary and offered collaborations in different areas."

Nehorai, the Eugene and Martha Lohman Professor of Electrical Engineering, also has made a personal effort to recruit students, from undergraduate to doctoral students. Between 2008-2012, the enrollment of undergraduate students more than tripled, with much of the growth attributed to students who transfer into the department from other disciplines. That led to the department having the largest number of

awarded bachelor's and master's degrees in the school in spring 2015.

To reach his goal of recruiting more students, Nehorai went to the source for ideas.

"We listened to what the students wanted, and they wanted a more hands-on experience," he says. "I was fortunate to have faculty and the school help me make it happen."

"The impact Arye has had on the department cannot be overstated," says Aaron Bobick, dean of the School of Engineering & Applied Science and the James M. McKelvey Professor. "The strengths he developed, including photonics and neuro-systems modeling, provides a strong base upon which to build further excellence."

In addition, he created and coordinated a summer study abroad program, supported by a donation from alumnus Charlie Simmons, that gives students the opportunity to visit various university labs and startup companies in those countries.

Simmons, who earned a bachelor's degree in electrical engineering in 1970, and Nehorai became acquainted when Simmons was a member of the school's

National Council.

"I expressed concern that the Engineering school didn't have the same opportunities to study abroad and learn about other cultures that were available to other schools," said Simmons, who is retired from Network Appliance Inc., where he was vice president of marketing and of corporate development. "Arye quickly agreed that this would be a good experience for his students, and with my funding and his hard work, established a summer program for interested students in Electrical & Systems Engineering to visit universities in Israel and Germany. The students were universally pleased with what they learned about the research and teaching in these countries as well as the different cultures they experienced."

Simmons has stayed in contact with Nehorai over the years and is a former member of the department's external advisory board.

"The new talent he has recruited is outstanding," he said. "He has worked hard to get input from alumni and has grown the department in a way that I, as an alum, am very proud of."

A native of Israel, Nehorai has stayed close to the growth of the tech industry in that country with frequent visits to his alma mater, the Technion-Israel Institute of Technology, where he earned both bachelor's and master's degrees in electrical engineering after serving the required three years in the Israeli Air Force during some turbulent years from 1969-72. He left Israel in 1979 to earn a doctorate from Stanford University.

Nehorai attributes his love for higher education to his parents.

"I was fortunate to grow up with parents who gave me a guide for the future," he says. His mother encouraged his love for higher education and the pursuit of an academic career.

"My father was an entrepreneur — he started a foundry — and I was always impressed by how he did it," he said. "Eventually I decided on an academic career, but somehow I feel like I combined both of

them as a department chair."

After working in industry for a year, Nehorai went to Yale University, where he was on the faculty for 10 years before moving to the University of Illinois at Chicago, where he spent 10 years as a professor, including serving as chair of the Electrical & Computer Engineering Division before joining WashU.

Perhaps Nehorai's most visible accomplishment during his tenure as chair is the Preston M. Green Hall, which was completed in 2011 and houses the department. When he was hired at WashU, he knew that a new building was in the planning stages and began working with Nancy Green, the widow of alumnus Preston M. Green, as well as Mike Altepeter, director of Engineering facilities planning & management, on the process of creating a building that would meet the department's needs.

Nehorai will be taking a sabbatical, during which he plans to conduct research in signal processing and imaging, which has wide-reaching applications in security, defense and health, as well as energy and environment. He develops mathematical models of various systems, such as biological and physical,

and uses statistical signal processing, machine learning tools and imaging to study measurements of the systems.

Earlier this year, he and his team developed a realistic 3-D multiscale mathematical model of the electrophysiology of pregnant women's contractions as they begin from a single cell to the myometrium, or uterine tissue, into the uterus that may aid in predicting preterm birth. Nehorai is principal investigator of research funded by the Office of Naval Research to study signal processing and of a multi-university grant funded by the Air Force Office of Scientific Research investigating advanced machine learning for radar systems. In addition, he is collaborating with faculty from the Sam Fox School of Design & Visual Arts to develop smart grids, smart homes and smart cities and to evaluate the benefits of using vacant land in shrinking cities.

Nehorai leaves the department leadership while it's still growing. Following his initiative, plans are underway for a new program in financial engineering, in partnership with the Olin Business School, that Nehorai says will create more interest in the department and searches for new faculty.

1976–83

PhD, Stanford University, 1983

MSc, Technion, 1979

BSc, Technion, 1976

2006

Nehorai became chair of the Preston M. Green Department of Electrical & Systems Engineering

Installed as the Eugene and Martha Lohman Professorship of Electrical Engineering
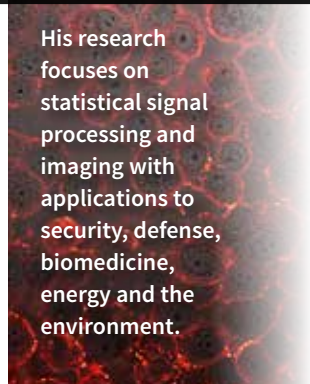
2011

His research focuses on statistical signal processing and imaging with applications to security, defense, biomedicine, energy and the environment.

Preston M. Green Hall, the new home of the department, is dedicated in September 2011

2012

Nehorai became a fellow of the American Association for the Advancement of Science (AAAS)
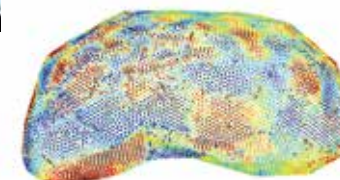

2015

Department has the largest number of awarded bachelor's and master's degrees in the school in spring 2015

2016

Nehorai and his collaborators have developed a multiscale model they believe may aid in predicting preterm birth

Nehorai will co-lead a CHRD multidisciplinary team in examining current inpatient practices and the future of the patient room.

Washington University hosted the second presidential debate Oct. 9. Leading up to the event, students across campus participated in many pre-debate activities and also took part in a push to get people registered to vote.

#WashUdebate2016

Questions for the candidates?

"How do you think the health-care industry can keep up with the constantly evolving changes in medical technology?"

— ILAN PALTE

"I would like to hear your stance on using drones and other unmanned aerial vehicles for either offensive or defensive purposes."

— STELLA FANG

"What would your administration do to increase the number of women and minorities in the STEM fields?"

— CHARLES AHRENS FELDMAN

Engineering students and Dean Bobick enjoy some pre-debate action between the Hillary Clinton and Donald Trump battle bots.

} Rock 'em, Sock 'em Robots

Top: Student Blake Hallman gets to act as a stand-in for CNN news anchors.

Right: Student Ramona Durham is registered to vote.

Engagement

Written by
RUBEN SCHUCKIT

President of the WashU College Republicans, Computer Science major

The political mood was heightened leading up to the presidential debate held on our campus Oct. 9. Students who were otherwise politically unengaged made earnest attempts to become knowledgeable about and a part of the political process. When the debate finally occurred, students listened intensely with their newfound knowledge and opinions from this election cycle and began making preparations to vote — most for the first time in a presidential election.

As president of a political club on campus, I was thrilled with the uptick in political engagement. Washington University provides us with phenomenal tools to go out into the world, identify problems and effect change. However, armed with this knowledge, too few of us have taken the time to learn about the state of politics in this country. Luckily this has changed, especially since civic engagement is crucial to shaping the world we want. Although the presidential election is the primary attraction this year, I am glad to see the level of engagement with down-ballot candidates, races and currently elected officials (collectively the individuals who actually write the laws) increase, too. And it is this newfound interest in politics among all students that is a testament to the diverse array of skills WashU strives to give its students.

After seeing history firsthand, I am hopeful that the political excitement and engagement on campus will not only continue but increase. This is a particularly salient time in politics for engineers. Out of the hundreds of members in Congress, only a mere five are engineers. Still, after seeing and experiencing the multidimensionality of WashU engineering, I am confident that future WashU Engineering alums will help improve this deficiency.

#WashUengineers

$$p = mv$$

Snapshot //

Construction of Henry A. and Elvira H. Jubel Hall, the new home of the Department of Mechanical Engineering & Materials Science, will begin in 2017.