SPRING 2013

Engineering Momentum

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Washington University in St. Louis

Engineering

Security Innovators

inside

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EDWARD JUNG, FOUNDER OF INTELLECTUAL VENTURES

CHAD WILLIAMS

MYTHBUSTERS' TORY BELLECI AND GRANT IMAHARA IN GRAHAM CHAPEL

CHAD WILLIAMS

WUSTL PHOTO

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Engineering

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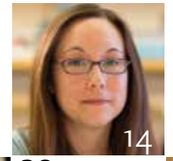

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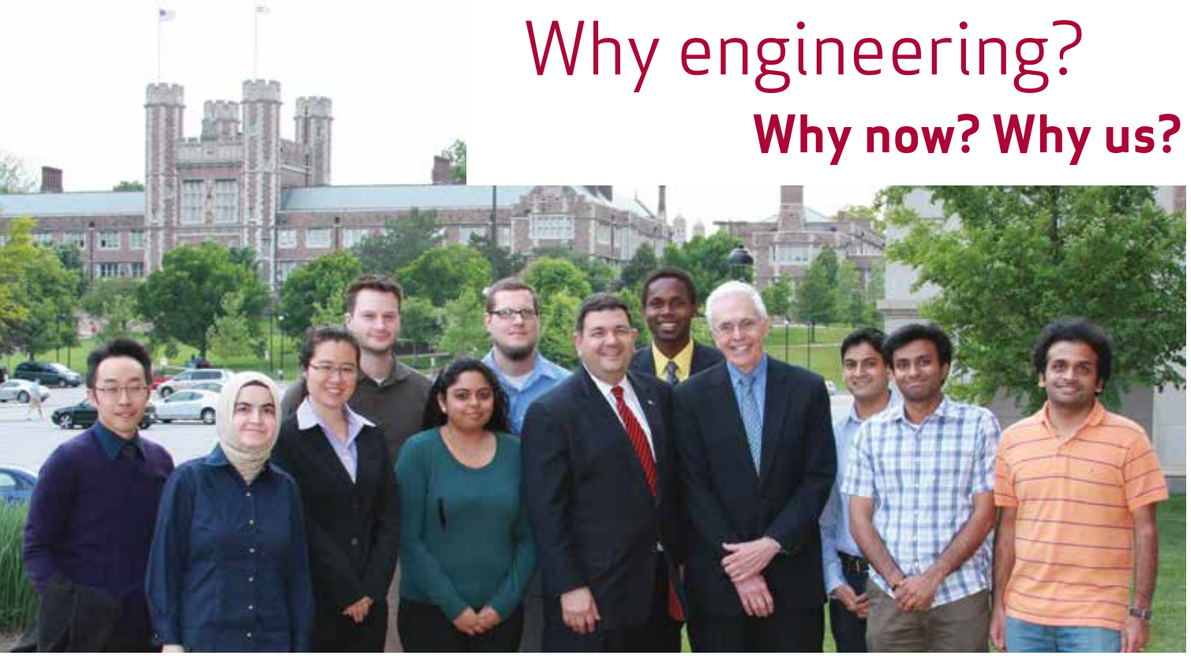
Why engineering?

Why now? Why us?



Engineering graduate students meet with alumnus Zach Lemnios (fifth from left), former assistant secretary of defense for research and engineering for the U.S. Department of Defense, and Dean Quatrano (third from right).

The School of Engineering & Applied Science (SEAS) is in a period of tremendous growth. Building on the firm foundation we have enjoyed since the school was established in 1857, we are uniquely positioned to leverage our strengths and achieve our goal of being ranked among the top 25 engineering schools in the country.

We continue to attract the very best faculty, and prospective undergraduate students are applying to SEAS in record numbers. For the 2013-14 academic year, we received nearly 6,200 applications for approximately 250 openings, up more than 20 percent from last year. Additionally, we received more than 1,000 applications for faculty positions. From this pool of faculty candidates, we experienced an unprecedented yield, with 10 of the 12 finalists choosing Washington University, including a new chair of Computer Science & Engineering and the associate director of the new Institute of Materials Science & Engineering.

Certainly, our new state-of-the-art facilities have helped us attract our exceptional faculty and students, but so has our international reputation for research. For example, in collaboration with our partner in India, IIT Bombay, we conducted a multi-institutional symposium focused on energy and the environment (see page 26), and last year, we joined a $125 million U.S.-India Joint Clean Energy Research and Development Center to expand our global reach in solar energy research.

We want you to be part of our vision for the future and to help us continue our momentum. Since releasing our strategic plan last fall (engineering.wustl.edu/vision), we have made exceptional progress toward achieving our goals, some of which are highlighted in this magazine. I hope you enjoy reading the following stories and will visit our website at engineering.wustl.edu for additional content. As always, I encourage you to send me your ideas and feedback.

Ralph Quatrano, PhD
Spencer T. Olin Professor & Dean
rsq@wustl.edu

Growth during the past **10 years**

2003 | **2013**

1/2
of the current faculty joined the school

&

tripled
the number of faculty from underrepresented groups

92%
increase in undergraduate applications

56%
increase in annual research expenditures

increase in average SAT verbal and math and ACT scores for admitted undergraduate students

	2003	2013
SAT Math	738	762
SAT Verbal	683	722
ACT	31.5	33.3

continued on page 4

Growth during the past **10 years**

2003 | **2013**

20%
increase in alumni to 22,946

$150 million
invested in new and renovated space

2003 **WHITAKER HALL**

2010 **BRAUER HALL**

2011 **LOPATA GALLERY & STANLEY'S CAFE**

2011 **GREEN HALL**

everyday tips *from our experts*

1

"The ability to write simple computer programs is a skill that is increasingly important across all fields. Tools like Looking Glass (lookingglass.wustl.edu) can provide a fun way to introduce kids to the basics."

Caitlin Kelleher, PhD
Hugo F. & Ina Champ Urbauer Career Development Assistant Professor

Kelleher is helping to carry out her mission to make computer programming fun with funding from the Alfred P. Sloan Foundation.

engineering.wustl.edu/sloan

"Kids love to touch new things, to pull on them, to pry them apart and to ask questions all along the way. This natural curiosity easily leads to the fun aspects of science and engineering, the 'wow' and 'aha' moments. If we can work opportunities for creativity exploration and even destructive testing into their everyday life, kids will come to see a future in engineering as the next step in the game."

Young-Shin Jun, PhD
Assistant Professor of Energy, Environmental & Chemical Engineering

2

Engineering undergraduate students are putting this into practice each week by hosting a Young Engineers Club at Brittany Woods Middle School.

engineering.wustl.edu/brittanywoods

3

"Kids need to see the relevance of math and science to engineering as they are learning it. They need to see how they can use it. Schools can have demonstrations, contests and more interaction with professionals in the field to get kids interested in engineering."

Ikenna Odinaka
Doctoral student, Electrical & Systems Engineering

The engineering school offers local high school juniors and seniors interested in math and science the opportunity to apply to a free, one-day, hands-on introduction to engineering called Explore Engineering. Students will see how math and science can be applied to solve problems.

engineering.wustl.edu/explore

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Roch **Guérin**

New Department Chair of Computer Science & Engineering

Q&A

Written by **BETH MILLER**

Roch Guérin, PhD, will begin as chair of the Computer Science & Engineering department at Washington University in St. Louis July 1. He also will be named the Harold B. and Adelaide G. Welge Professor of Computer Science at Washington University. Until then, Guérin is the Alfred Fitler Moore Professor of Telecommunications Networks and professor of electrical and systems engineering and computer and information science at the University of Pennsylvania, where he has been on the faculty since 1998.

Q: Why Washington University? What attracted you here?

A: It's a great department and a great school, and I knew several people here — Jon Turner (PhD, the Barbara J. and Jerome R. Cox, Jr. Professor of Computer Science), Patrick Crowley (PhD, associate professor) and Raj Jain (PhD, professor). That played a big role. The second thing is both in terms of potential for growth of the department and the vision that the dean has for the school, I felt that this was an opportunity to be a part of something that would be exciting.

Q: What is your vision for the department?

A: First and foremost, academia is really an environment where people count. I think it would be foolish to say I'm a chair coming in with a vision and that's what's going to happen. I think it's going to be the vision of the department, and in some sense, it's my job to nudge it here or there and help it evolve. I think computer science as a whole has gone through an incredible story over the past 20 years and is going to go through even more for next 20 years. This department has the opportunity to play a significant role in that area. The medical field is one that Washington University is uniquely positioned to take advantage of, whether it's direct collaboration with the School of Medicine or the whole cyber-physical system area, where I think the department is already very strong.

There are many other areas in which the department can grow and take an important role, cybersecurity being one of them. Another one is computational algorithms. We have all this computational power, but it's never enough for all the important problems that we want to tackle. Again, this is an area where there are core strengths in the department. If you look at some of the problems that arise in the medical field — genetics, genomics and biology — solving them depends on understanding how to compute things and doing it efficiently on new platforms. I think we are very well positioned to play an important role in all these areas, with a caveat that if you look at predictions of the future, most of them are wrong. It may well be that the place where we make a really big impact will be something that will emerge from informal interactions, and that's the beauty of academia.

Academia is really, more than any other place, a place where success is a function of people. There's nothing more important than the people you hire except for your students.

Q: What are your first priorities?

A: In some sense, my first priority is not to mess it up (Laughs). The first priority of any department chair is to make sure we hire the best people. The second priority is making sure that at all levels, from the undergraduate to the doctoral level, we provide our students with the best opportunities, and that means looking at the curriculum and the research projects and training them the right way. We have a great student population, but you can't take that for granted.

Q: How do you plan to make connections with the other departments within the school and with the other schools?

A. It has to be driven by the interest of individual faculty. Whether it's at the school or department levels, we can facilitate things and make sure there are no barriers. There are obvious synergies that we are already leveraging with the medical school.

Q: You've talked about medicine and health. How would Computer Science & Engineering relate to the other pillars of the school: energy and environment, entrepreneurship and security?

A: With energy and environment, we only need to look at smart grids. We need new technology to produce energy, but we also need computers and algorithms to drive the computer networks and sophisticated control systems these technologies will require. These things make it clear that computer science and computer engineering have a big role to play.

On the environment front, we now also have a plethora of sensors that create massive amounts of data that need to be processed and analyzed. Computer and communications systems again play a vital role in realizing this.

The topic of smart grids also dovetails with security. We have sophisticated control loops, and if someone tampers with these systems, bad things happen, so there is clearly a strong link.

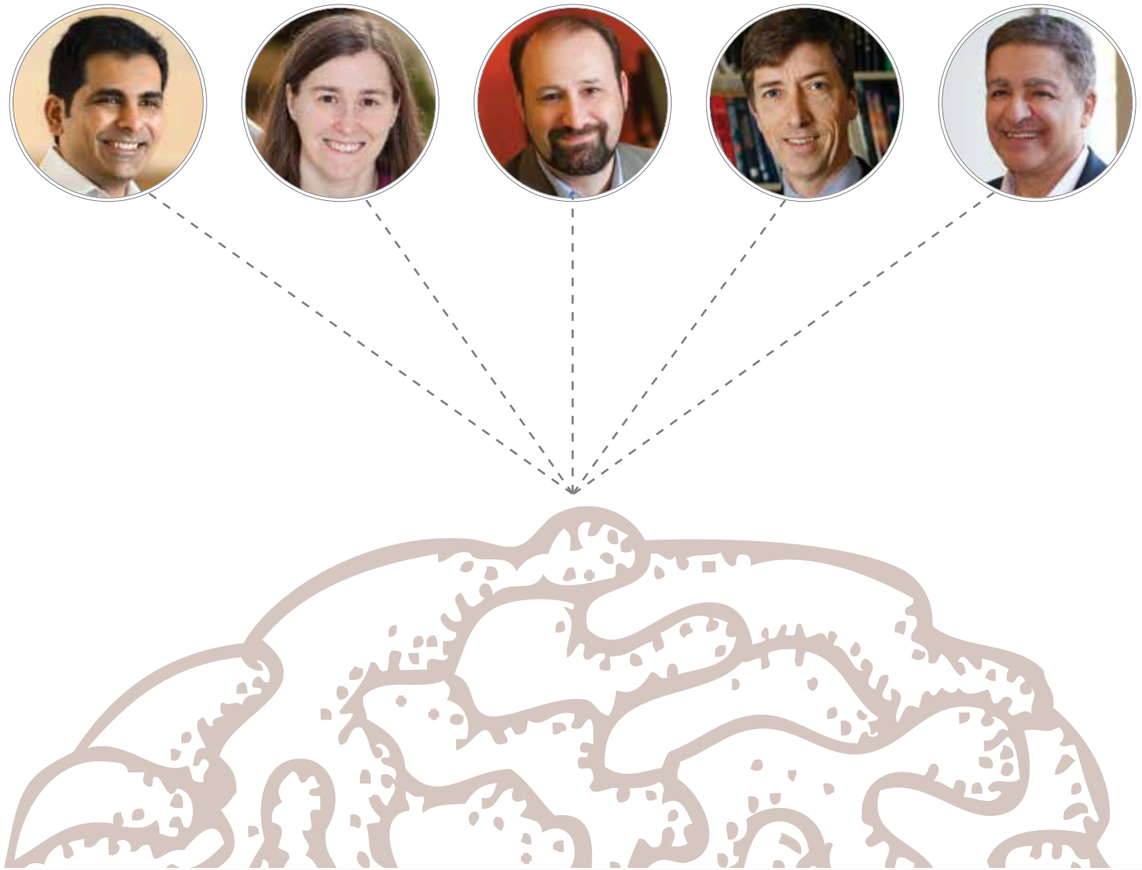
I see entrepreneurship on two levels: one, how do we prepare students to be entrepreneurs and desire to continue learning, and two, what role do our faculty play in creating startup businesses? Students have a natural interest in trying things out, and the school encourages that. In particular, while it is important to create a fertile intellectual ground, it is equally important to put in place the necessary logistical support to facilitate the emergence of startups.

I really believe that computer science and computer engineering are at the nexus of many of the exciting things that are going to happen. Everything today depends on computers, and this will fuel the need for new innovations and a constant evolution across all areas where they are being used. I see a huge future.

THE BRAIN TRUST: Security Innovators

Written by **BETH MILLER**

BARANI RAMAN • KATHY FLORES • PATRICK CROWLEY • JOSEPH O'SULLIVAN • ARYE NEHORAI



Chemical weapons. Computer hacking. Power grid attacks. Phishing. Health-care record theft. Though new technologies make our lives easier and give us more options, they also create more opportunities to threaten our security.

The issue is so important nationally that President Barack Obama signed an executive order Feb. 12 calling for the creation of voluntary standards to boost the security of computer networks in critical industries, such as mass transportation and public utilities. In the State of the Union address, he also called on Congress to pass legislation giving the government a greater capacity to secure the nation's networks and deter attacks.

Security is the most critical topic of engineering one can identify, says Zachary Lemnios, who earned a master's in electrical engineering from WUSTL in 1979 and is now vice president for research strategy at IBM Research.

"The way we think about Internet security is interwoven in our lives every day — the iPhone, bank transactions, the hospital data and national security data that the nation needs to keep secure," says Lemnios, who was assistant U.S. secretary of defense for research and engineering from 2008-December 2012.

"It's among the most complex problems that we see, and it's not just a simple engineering solution. This is probably the largest research topic that universities can take on, because there are many different facets, such as policy, engineering and business applications," he says. "It touches every part of our society."

Engineers at Washington University School of Engineering & Applied Science are using interdisciplinary methods inspired by biology, economics, physics and statistics to stay ahead of the world's security needs. Engineering faculty had more than $1.7 million in grants combined from the U.S. Department of Defense (DOD) in fiscal year 2012 and millions more from other agencies that have security applications.

CHEMICAL DETECTION

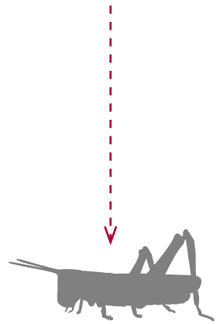
When you walk into a coffee shop, a variety of scents greets you — brewing coffee, sweet pastries, fruit and chocolate. The human brain is able to break down a complex cocktail of signals, detect all of the different odorants and locate their sources without us giving it a thought. Even more importantly, our interactions with our environment are highly dynamic in nature. Our brains adapt to their environments, and we desensitize ourselves to the smell of coffee. This enables our olfactory systems to explore newer chemical species introduced into the environment.

Barani Raman, PhD, assistant professor of biomedical engineering, has spent nearly a decade trying to determine how the human brain and olfactory system operate to process various scent and odor signals. His research, funded by the DOD, seeks to recreate this olfactory system.

"The olfactory environment is complex," Raman says. "Someone wearing perfume, someone drinking coffee — all of these things give off volatile chemicals. So how do you design a sensing system that desensitizes itself to its background and picks up what you're looking for? This is what we call the 'chemical needle in a haystack' problem."

Raman is taking clues from biology to develop an artificial or electronic nose that would be able to detect volatile chemicals without threat to humans.

"Someone wearing perfume, someone drinking coffee — all of these things give off volatile chemicals. So how do you design a sensing system that desensitizes itself to its background and picks up what you're looking for? This is what we call the 'chemical needle in a haystack' problem."



Raman uses grasshoppers as models in his research.

"There's something very unique about how neural computations are being performed and how our brain does certain things," he says. "We're trying to study a relatively simpler system and learn how it deals with the olfactory environment, what the design principles are and what are its computational principles, then, determine if we can make a device that will do all of those tasks."

Raman is working on this project through a three-year, $735,000 grant from the Office of Naval Research. His ultimate goal is to create a handheld device that could sense explosives or hazardous chemicals noninvasively, saving humans or scent-detection dogs from potential harm.

BETTER BOMBSHELLS

Militaries worldwide often use underground bunkers as protection for troops or to store weapons and munitions. There are bunkers built into caves in Asia and concrete bunkers buried deep under the sand in the Middle East.

To get to these bunkers deep under the earth, the military uses "bunker busters," bombs or munitions designed to blast through the sand and destroy underground bunkers.

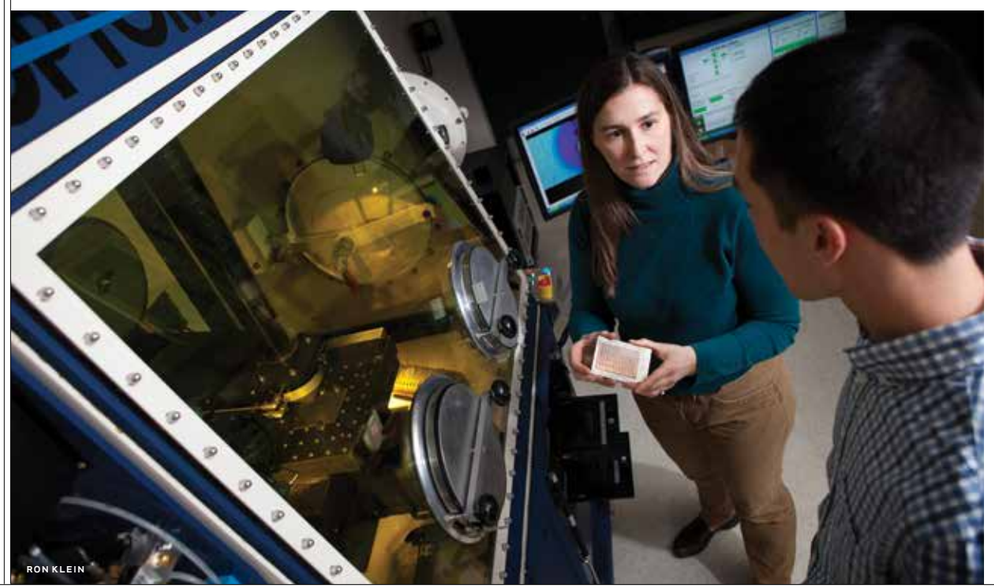
Katharine Flores, PhD, professor of mechanical engineering and materials science and an expert in metallic glasses, is developing a material for the shell of the bunker buster bombs. Funded by the DOD's Defense Threat Reduction Agency, Flores is working to develop metallic glass that is strong, wear-resistant and has low friction to penetrate various types of sand.

"The properties of sand are completely different, so depending on what kind of sand you have, different ordnances will penetrate further or not as far," Flores says.

Flores is using computational modeling to help identify what combination of elements might create an optimal metallic glass to coat the outside of the bomb.

In addition, Flores has funding from the Air Force Office of Scientific Research to develop composite materials that will potentially be used in gears, ball bearings or other small parts for vehicles and machinery such as the Mars Rovers.

"We are looking to design a material that is very wear-resistant in an inhospitable environment for a long time," Flores says.



RON KLEIN

Katharine Flores, PhD, and Peter Tsai, a doctoral student, discuss using a laser additive manufacturing process to produce metallic alloys with graded compositions.

SAFE COMPUTING

Nearly everyone has received the email from someone in a foreign country asking for assistance to transfer money to the United States, or asking you to go to a particular website to download some "important" software. Scams seeking personal information, called "phishing," are rampant today. These targeted attacks cost brands and corporations more than $1.3 billion a year, according to a study by Cisco. And there's a new scam called "spearphishing," in which online scammers target a smaller group of victims, pretending to be legitimate companies, such as banks, telling victims that their bank account is overdrawn and seeking account numbers. These messages look nearly identical to authentic emails from companies, leading them to bring in more than 10 times the profit of a mass email attack.

Patrick Crowley, associate professor of computer science and engineering, is looking at how this happens.

"All information is digital today, and the unfortunate state of affairs is that anything digital can be hacked," he says. "That's what drives the core of global interest in improving the structural foundation of our global networks."

Crowley has developed a novel view of how hacking happens.

"There's a mismatch between the way we communicate and how our networks are built today," he says. "That mismatch is where you find the problems."

Today's Internet protocols use a communications model that can only support and secure point-to-point communication between devices with network addresses, Crowley says. For example, your web browser sends a request for a page to a server's network address. The network then tries to secure the "tunnel" between the two devices, but that's the wrong target.

Crowley and his collaborators have developed a different approach to computer communications called named data networking, which builds security methods around the data one is requesting.

"I request data, and I want the ability to independently validate that my information is secure and that it came from the entity I wanted it from," he says.

Last year, Crowley gave a live demonstration of how named data networking works on a national scale across four time zones. In May, Crowley will present the named data networking concept at the 2013 China-America Frontiers of Engineering Symposium in Beijing, where 60 of the most promising engineers under age 45 from China and the United States will meet.

Crowley also has a startup company, Observable Networks, which provides a new approach to network monitoring and security. Crowley is chief executive and founder, and Peter S. Finley, an adjunct professor of entrepreneurship in the Olin School, is chief operating officer.

Observable Networks works by using "big data" methods to monitor and model the behavior of all devices on an enterprise network so that customers can understand the good behaviors and fix the risky or dangerous ones, Crowley says. It uses information that only network administrators can access to tilt the playing field.

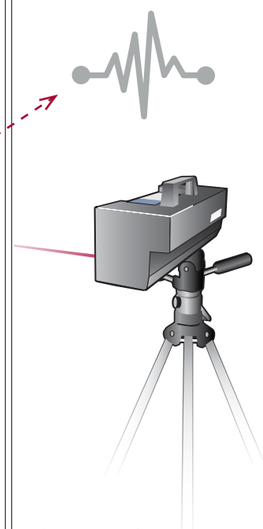
JUST ONE HEARTBEAT

Taking one's vital signs is routine at a doctor's visit. But what if the heart rate and pulse could be measured from a distance without touching the person? A group of researchers from the schools of engineering and medicine say it is possible with the right equipment.

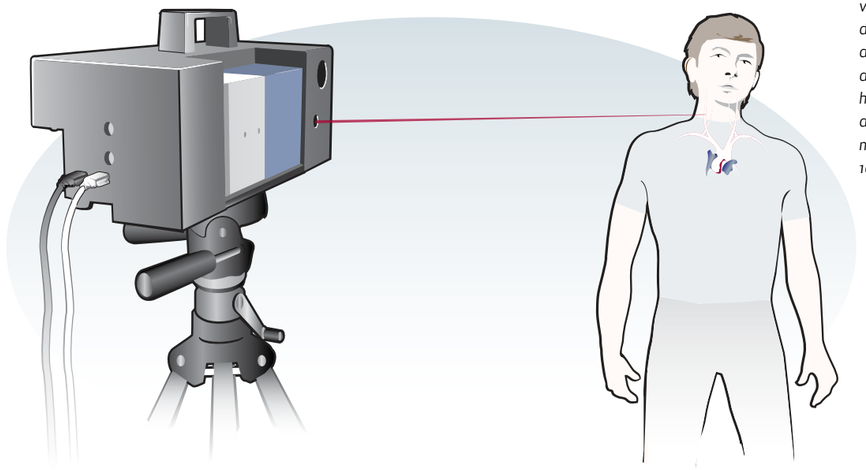
Joseph O'Sullivan, PhD, the Samuel C. Sachs Professor of Electrical Engineering and dean

"Often, the problem is in the devices themselves, so that the secure channels are passing the wrong information. You have to secure the data, not the channel."

Watch a video of Crowley's demonstration: engineering.wustl.edu/ndn



A rendering of the laser device used in laser doppler vibrometry



In laser doppler vibrometry, the device points a laser at a person's carotid artery, reading heart rate, pulse and other biological markers, from up to 100 meters away.

KEVIN SWIFT

"There is no faking this in terms of stealing a fingerprint or trying to fool an iris or retina scan."

Doctoral student Ikenna Odinaka

of the UMSL/WUSTL Joint Undergraduate Engineering Program, and a doctoral student, Ikenna Odinaka, are developing equipment for this purpose with John Rohrbaugh, PhD, professor of psychiatry, and Erik Sirevaag, PhD, research assistant professor of psychiatry. The process is called laser doppler vibrometry, which uses electromagnetic waves pointed at the carotid artery in the neck or at the temple for as short a time as one heartbeat. Accurate measurements can be made from up to 100 meters away, O'Sullivan says.

"You can listen to a heartbeat with a stethoscope on the skin's surface and make inferences about the person," O'Sullivan says. "That's what we're looking at — the mechanical effects at the surface that you can use to make inferences about the state of the individual."

O'Sullivan and Odinaka are working to take heart rate, pulse and other physiological measurements, or biometrics, of individuals over time and create a database of measurements and the shape of the heartbeat. That data could later be used to authenticate one's identity.

"Much of what goes on in the body has a mechanical basis and makes noises, rubs, squeaks, pulses and vibrations that we can sometimes hear, but there are tiny versions of this as well," Rohrbaugh says. "If we point this laser at someone's skin, we can pick up that energy that's generated inside the body and communicated in vibrations in the skin. Collectively, this tells us a lot about the status of the whole cardiovascular system."

One of the potential applications is in a neonatal intensive care unit, where a human touch could alter a newborn's heartbeat or pulse, or signal.

"If we can take a measurement without touching them and get the cardiovascular health of the baby, we can constantly monitor them without changing the signal," Odinaka says.

Another potential application is triage on a battlefield or disaster situation.

"If there are wounded individuals on the battlefield or in a disaster scene, and first responders aren't sure of the safety of the area, they can try to make an assessment at a distance of the health status of the wounded individuals and determine who is dead or who is alive and needs immediate attention," O'Sullivan says.

Other researchers from Engineering working on the project include William Richard, PhD, associate professor, and Robert Pless, PhD, professor, both from Computer Science & Engineering; and Robert Morley, PhD, associate professor, and Ed Richter, research associate, both in Electrical & Systems Engineering.

SIGNAL PROCESSING

We've all seen cameras in ceilings or swiped a card to enter a building or hotel room. The cameras and the card readers act as sensors that collect data about the user. But with multiple types of data, how does one merge the data to detect the signals of interest?

That's what Arye Nehorai, PhD, the Eugene and Martha Lohman Professor and chair of the Preston M. Green Department of Electrical & Systems Engineering and director of the Center for Sensor Signal and Information Processing, is trying to find out through his studies of sensors and signals.

"The challenge is to extract the signal, or the important information, from the noise in the presence of mostly unknown environments," Nehorai says.

Funded by the U.S. Air Force, U.S. Navy and the National Science Foundation, Nehorai and his research team take the data from a variety of sensors and model what they measure in a mathematical form, then analyze the data using statistical tools based on inference and prediction. The research is typically multidisciplinary as the modeling is based on physics, biology or chemistry, depending on the applications, and the inference analysis is statistical.

One of his research areas is through-the-wall imaging, which uses remote sensing based on radar outside of a building to detect what's happening inside the building. He developed methods that can estimate the indoor layout, track people in the building and determine if there are weapons inside. These methods consider reflection, diffraction and refraction of the signals for various wall materials. This type of sensing is being used by the U.S. military.

"Remote sensing uses electromagnetic waves that we transmit using radar," Nehorai says.

Nehorai proposed the use of multi-dimensional sensors that measure the complete electromagnetic or acoustic field information at a point to maximize the sensing capabilities of the measurement systems. In fact, he coined the term "vector sensors," which are now deployed in defense systems worldwide.

Recently Nehorai's group developed

methods to track targets using multiple types of sensors, including electromagnetic, optical and human scouts. The new methods for the optimal fusion of the different types of sensors are analogous with pricing theory in economics. His group also developed optimal selections of radar waveforms that can track evading targets using game theory, which also originated from economics.

Nehorai's research translates from defense and security to civilian applications. For example, clinical researchers are using through-the-wall imaging to detect breast cancer using microwaves. Other sensors are being used to model the activities of the brain, which helps them to find the source of seizures in patients with epilepsy by using a variety of electrodes or magnometers.

"The common thing is that we have sensor arrays, and we try to learn about the environment," Nehorai says. "The methods are similar, but the model is different."

GOING FORWARD

As security needs rapidly change, the engineering field also will need to adapt. Engineers are needed to develop solutions to thwart potential attempts to sabotage the power grid, financial institutions and air traffic control systems.

Engineering is adding new faculty who have interest and expertise in research with applications in critical areas of security, including cybersecurity, public policy and ethics. In addition, faculty will address security issues within the curriculum and in special projects challenging students to imagine new approaches to preventing attacks.

"With the growth of data on the Internet and the growing use of the multimedia systems that we all carry — iPhones, Blackberries — all of this has changed the way we're connected," Lemnios says. "Everyone on the planet will be part of this wired network."

"If we know a little about the physical environment, we can exploit this knowledge to model the reflections from the walls and find what happens inside the building."

Engineering's Professional Education program will launch a new master's degree program in cybersecurity management beginning in Fall 2013. The 36-credit-hour program will focus on cyber security knowledge and management practices for both public and private enterprises.
For more information: engineering.wustl.edu/csm

The Center for the Application of Information Technology (CAIT) offers classes and workshops in information security.
>> **cait.wustl.edu**

FORWARD THINKER

Written by **BETH MILLER**

When Shelly Sakiyama-Elbert, PhD, earned bachelor's degrees from the Massachusetts Institute of Technology in 1996, Washington University's Department of Biomedical Engineering was on the verge of being founded.

Nearly 17 years later, Sakiyama-Elbert, professor and associate chair of biomedical engineering, has been an emerging leader in the fast-growing department and has become widely known for her groundbreaking work in tissue engineering techniques.

Her career has been fast-growing as well. Sakiyama-Elbert was named a Faculty Fellow in the Office of the Provost by Edward S. Macias, PhD, provost and executive vice chancellor for academic affairs, for which she will work on a variety of university initiatives, including strengthening diversity, increasing faculty leadership opportunities, particularly among women and underrepresented faculty, and encouraging interdisciplinary cooperation. She also is adding to her arsenal of skills by participating in the Women's Leadership Forum Certificate Program at the Olin School of Business, which prepares high-potential women for even higher levels of impact in their organizations.

Sakiyama-Elbert and her husband, Donald L. Elbert, PhD, associate professor of biomedical engineering, were faculty members No. 5 and No. 6 in the department, which was only three years old when they arrived, so they've seen a lot of growth.

"What attracted me to Washington University was the opportunity to have really outstanding collaborations with clinicians in an environment where people were really open to working together, viewing it as a two-way street, and also the opportunity to get involved in a new biomedical engineering department at a very early stage," she says. "I feel we've had a big impact in the shaping of the curriculum and the faculty for the undergraduate and graduate programs."

Sakiyama-Elbert's research expertly blends biology, chemistry and biomedical engineering to focus on developing biomaterials for drug delivery and cell transplantation to treat peripheral nerve and spinal cord injuries. Her research is funded by the National Institute of Neurological Disorders and Stroke at the National Institutes of Health.

Sakiyama-Elbert is working to find novel biomaterials that will allow controlled release of growth factors, or protein molecules made by the body that regulate cell division and survival, and promote regeneration in the spinal cord after a traumatic injury.

PHOTOS BY DEVON HILL

These growth factors are delivered via a "scaffold," or a temporary support structure. She can also add stem cells to repopulate the injured spinal cord with neurons and other cells that have been lost as a result of injury.

But her research isn't limited to the School of Engineering & Applied Science — it often crosses Forest Park to the School of Medicine.

"What's great about Washington University is that there are so many clinicians interested in collaborating and who have interesting clinical problems," she says. "But they don't necessarily have the tools to take basic science discoveries that might be useful for solving their problems, and they need a framework. In engineering, we gather the design criteria for the problem from the clinicians, and we can take that back and translate the basic discoveries into something applicable to a clinical problem."

"She is not afraid to move out of her area of expertise to look at someone else's work and shed light on it. She's extremely generous academically, and she's not a self-promoter — two good qualities to have when you're in a university environment with people who need your help."

— Susan E. Mackinnon, MD

Some of those clinical problems come from long-standing collaborations with Susan E. Mackinnon, MD, chair of the Department of Plastic and Reconstructive Surgery, and Richard Gelberman, MD, chair of the Department of Orthopedics.

"We have developed a very tight relationship that is mutually beneficial," Mackinnon says. "Shelly has a very broad knowledge and sees applications for things that other people might not notice."

"Shelly picks up on things quickly," Gelberman says. "She has worked for years in nerve tissue engineering and has taken what she's learned there and applied it to tendon tissue. She is contributing greatly with her experience in and knowledge of bioscaffolds and biomaterials. It's a terrific collaboration."

Sakiyama-Elbert has been working with Gelberman and Stavros Thomopoulos, PhD, associate professor of orthopaedic surgery, to find ways to deliver drugs to enhance the regeneration to the flexor tendon in the hand after an injury, such as a deep cut on the palm side of the fingers or hand. The team is working on a new study adding in stem cells to boost the healing process.

"Stem cells could be differentiated into tendon fibroblasts (connective tissue cells that make and secrete collagen proteins), either before or after transplant, where we would put them in and try to get them to differentiate in vivo," she says.

In the classroom

While she enjoys working with physicians, Sakiyama-Elbert also enjoys being in the classroom and working with students in her lab.

Dylan McCreedy, a doctoral student in biomedical engineering, has been working in Sakiyama-Elbert's lab for nearly five years, focusing on tissue engineering for repairs to injuries in the central nervous system.

"Shelly has been an excellent mentor," he says. "She has allowed me to be a very independent worker, which has been nice as it allows me to explore many areas in the lab. She's been very good about helping me understand the many facets of research, including how to get funding, writing papers for journals and dealing with regulatory agencies and has really shown me what it takes to be a professor."

Although she gives McCreedy and other members of her lab independence, she's never far away, he says.

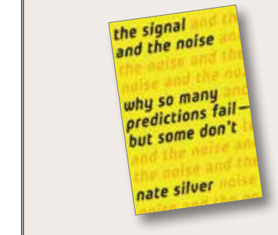
"She's always there to answer questions and provide guidance when you ask for it, but she's not one to tell you how to do her research," he says.

Since she arrived at WUSTL in 2000, she has designed four primarily graduate courses: Engineering Aspects of Biotechnology, Tissue Engineering, Biotechnology Techniques for Engineers and Molecular Cell Biology for Engineers.

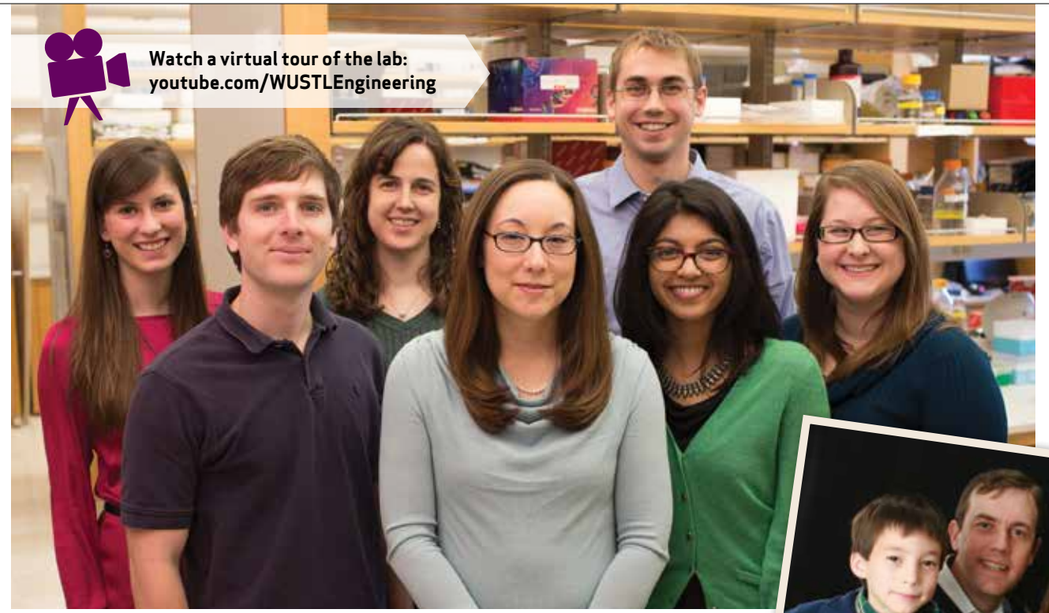
"I like teaching — it's fun to share my excitement with the students," she says. "In Molecular Cell Biology, we learn how to read primary literature and think about it critically. What I want them to take away from the class is that when they read a paper in a journal, not to take it all as fact. Think about it critically, analyze the data and determine if it supports the author's conclusions."

Facts

- **Number of publications:** 55
- **Number of doctoral students:** 6
- **Total research funding:** $1.76 million



- **Book recently read:** *The Signal and the Noise: Why So Many Predictions Fail But Some Don't*, by Nate Silver



Left to right: Lab members Jessica Butts,Thomas Wilems, Sara Oswald, Shelly Sakiyama-Elbert, Dylan McCreedy, Nisha Iyes and Laura Marquardt (not pictured: Hao Xu, Xi Lu and Chelsea Brown)

Below (from left): Alex, Don, Ryan and Shelly

The path to Washington University

Sakiyama-Elbert always liked biology and chemistry, and as she went through her education at MIT, she wanted to create potential therapies that could help patients with medical issues. She considered medical school but was drawn to research and teaching, particularly after serving as a teaching assistant in organic chemistry while an undergraduate.

"I chose biomedical engineering because I could pull together biology and chemical engineering," she says. "I really enjoy taking the engineering piece and applying it to problems in biology and medicine."

After earning bachelor's degrees in chemical engineering and biology from MIT, Sakiyama-Elbert went to California Institute of Technology to earn a master's and doctorate in chemical engineering. It was there she met Don Elbert, who also was working in the lab of Jeffrey A. Hubbell, PhD. They went to Zurich, Switzerland, with Hubbell from 1997-2000 and married in 1999.

Working together is nothing new for them. The two are co-investigators on a National Institutes of Health R21 grant, which created an interesting requirement, Don Elbert says.

"In writing the grant as co-PIs, we had to write a plan for conflict resolution," he says.

Managing a family that includes two full-time faculty and two children — sons Alex, 7, and Ryan, 4 — takes some schedule coordination, Sakiyama-Elbert says, but it works well. Her parents also live in the area.

Of all the aspects of her job, she enjoys freedom of thinking the most, she says.

"I appreciate the autonomy to really think about interesting problems and come up with a way to solve them," she says. "If you can have a good idea and can convince others that it's reasonable to give you some money, you can really explore whatever problems you want to look at. I enjoy planning where we want to go, what is the next thing we want to go forward with in our research and where we are going to go next."

» engineering.wustl.edu/faculty/sakiyama-elbert

RON KLEIN

ABIGAIL COHEN

Pipeline Entrepreneurial Fellow

Written by **BETH MILLER**

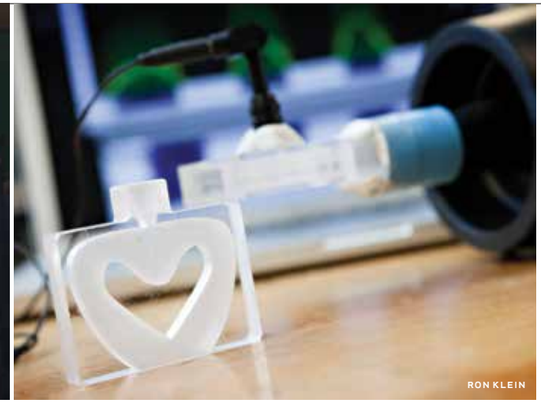
Abigail R. Cohen, a senior biomedical engineering student, has had a lot of good things happen in the past several months. She is part of a team that won a $30,000 prize in this year's Olin Cup and was recently chosen to join the 2013 Class of Entrepreneurial Fellows by Pipeline.

Kansas City-based Pipeline is a community of Midwest entrepreneurs designed to build high-growth companies, empower entrepreneurs and build the region's economy. Each year, about a dozen entrepreneurs from Missouri, Kansas and Nebraska are selected to join Pipeline for a yearlong business development program designed to speed the growth of their companies. Participants attend four three-day modules a year.

Cohen is the only woman and the only undergraduate student selected for the 2013 class.

"From my initial contact with Pipeline, the experience has been amazing," Cohen says. "The energy from the organization is overwhelming in a good way, from the members to the leaders to the people planning the events. Everyone is so excited to help us entrepreneurs. It's been wonderful because we're always looking to reach out to people and get some advice. It's going to be a great network, but it's also a great group of people."

MARY BUTKUS



RON KLEIN

Left to right: Cohen and Andrew Brimer at the 2013 Olin Cup competition; Spirometer prototype

Cohen is part of a student-led team that founded Sparo Labs, which stems from an award-winning project to develop a low-cost spirometer, a device that measures lung function. The team has spent about a year and a half developing the product and a prototype that conquers the historical issues of high cost and difficulty of use. Most spirometers cost between $1,000-$2,000, making them unaffordable for hospitals and clinics in the developing world. However, the device the student team designed costs about $8. The low cost could allow health-care providers in developing countries to purchase the spirometers, which are specially designed for accuracy and durability despite their price.

Other team members include Andrew Brimer, also a senior majoring in mechanical engineering, Jonathon Koo and Chris Cassidy, both Olin Business School students.

Cohen says being chosen for Pipeline was unexpected because Sparo Labs is in its early stages.

"But we're at a stage where we are ready to take in as much information as we can," she says. "We want to network around the country and connect with as many people as we can. It's going to be an exciting year."

Cohen and Brimer originally developed the device with other students from the university's Engineers Without Borders/Engineering World Health (EWB/EWH) student group. Now, Sparo Labs is preparing a product for clinical trials and FDA approval that empowers patients to quantitatively track and proactively manage asthma, cystic fibrosis, chronic obstructive pulmonary disorder and other respiratory diseases via seamless integration with smartphones, tablets and computers — ultimately implementing low-cost diagnostic and monitoring spirometry worldwide. The team has filed for a patent.

Cohen and Brimer, along with other students, also won first place in two national engineering competitions last summer, resulting in $15,000 in prizes.

In addition to the $30,000 Olin Cup prize, the Sparo Labs team won one of three $5,000 student grants. The team also is entering a variety of other competitions to raise seed funding. Cohen and Brimer plan to work for Sparo Labs full-time after they each graduate in May.

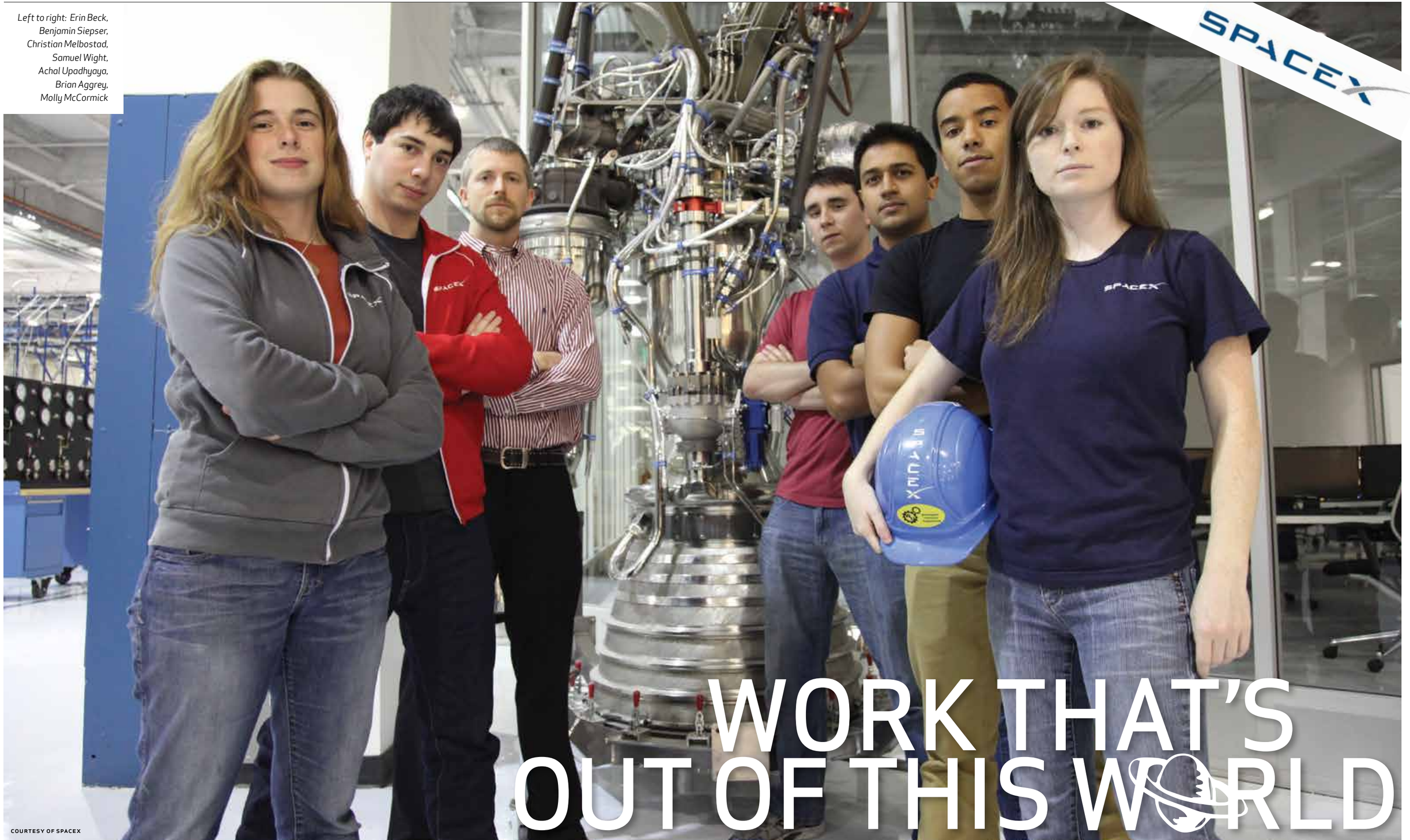
In addition to her work with Sparo Labs, Cohen has been actively involved in the engineering school. She received the Linda M. Berger Scholarship in Engineering, is vice president of EWB/EWH, is on the Senior Gift Committee and is a member of Alpha Eta Mu Beta, a national biomedical engineering honor society. Previously, she was a leader for Peer Led Team Learning for three years and was on the Division 3 National Championship basketball team her freshman year.

She also conducted research in two labs at Barnes-Jewish Hospital and one at Wayne State University and is co-author of an article that was recently accepted for publication. She completed an internship with Stryker Orthobiologics.

"I've known Abby as a strong student and leader in EWB/EWH, but her work on the spirometer is one of the most impressive efforts I have seen from a WU student," says Melanie Osborn, assistant dean for student services at the School of Engineering & Applied Science. "Abby asked me to give a quick review of her proposal for her patent attorney, but I think she did his work for him! Abby and Andrew have developed a potentially lifesaving device at low cost, and her dedication to getting this product to the people who need it most is nothing short of inspiring."

Sponsored by the Skandalaris Center for Entrepreneurial Studies, the Olin Cup typically awards $70,000 in seed investment money to fund startup businesses and a $5,000 student prize. Winners may receive in-kind services from one or more of the competition sponsors in addition to any cash investment.

Left to right: Erin Beck, Benjamin Siepser, Christian Melbostad, Samuel Wight, Achal Upadhyaya, Brian Aggrey, Molly McCormick



COURTESY OF SPACEX

WORK THAT'S OUT OF THIS WORLD

Last fall, the world watched with fascination as the first commercial resupply mission to the International Space Station was completed. Previously, only nations had accomplished the feat. A Washington University School of Engineering & Applied Science student and several alumni were also watching closely, as they all had a hand in the mission's successes.

Written by **BETH MILLER**

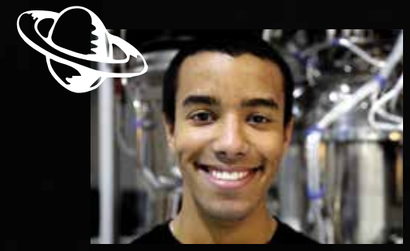
The WUSTL Engineering alumni and student intern all work for Space Exploration Technologies Corp., better known as SpaceX. The California-based, 11-year-old privately held company designs, manufactures and launches rockets and spacecraft. Now, with the National Aeronautics and Space Administration (NASA) as a multibillion-dollar customer and with nearly 50 governmental and commercial launches planned, SpaceX is the fastest-growing U.S. launch-services company.

And SpaceX is doing more than flying rockets and delivering supplies. It is working with NASA to develop its Dragon spacecraft to carry astronauts to space.

The man with the dream that became SpaceX is PayPal founder Elon Musk, who is chairman of SolarCity, a residential solar provider, and co-founder, chairman and chief executive of Tesla Motors, an all-electric American car company, as well as chief executive and chief designer at SpaceX.

SpaceX's Dragon, a free-flying, reusable spacecraft that can attach to the International Space Station, is launched by the Falcon 9 rocket. Undergraduate student Brian Aggrey, a mechanical engineering major expected to graduate this December, spent the summer and fall of 2012 as a structures intern working on the Falcon 9. He was recruited as an intern at the Career Fair by Washington University alumni who now work at SpaceX.

Aggrey says the internship was a perfect fit for his interests.



"When I heard about SpaceX and how it is revolutionizing space flight — making it more cost-effective, more reliable and more routine than it has ever been in the past — that goal resonated with me."

— BRIAN AGGREY

Watch a tour of the SpaceX facility: youtube.com, search "Elons Tour of SpaceX"

View from the International Space Station of the SpaceX Dragon spacecraft as the station's robotic arm moves Dragon into place for attachment to the station. May 25, 2012.

COURTESY OF NASA

"I've always been interested in things that fly," he says. "But it seemed like NASA and space flight were so far out there, and I didn't think rockets were my thing. But when I heard about SpaceX and how it is revolutionizing space flight — making it more cost-effective, more reliable and more routine than it has ever been in the past — that goal resonated with me."

The Washington University contingent at SpaceX is diverse, but they have several things in common: a belief in the company's mission to change the space industry and pride in being part of next-generation space technology. All of the alumni and Aggrey also say having hands-on, practical experience, as well as the development of critical-thinking and problem-solving skills while students at Washington University, were among the most important factors in getting hired.

"SpaceX is unique in the aerospace industry with the opportunities that it offers to new graduates," says Erin Beck, who earned degrees in engineering and physics from Washington University in 2008 and works as an avionics systems integration engineer on the Dragon project. "Young people can come to SpaceX right out of school and have a lot of opportunity and responsibility very quickly. My education and hands-on experiences at Washington University were the perfect preparation for my role at this history-making company," she says.

Aggrey got a taste of the responsibility even as an intern.

"The company culture at SpaceX is very fast-paced and very performance-driven," Aggrey says. "There is a big emphasis on being able to accomplish a lot within a short amount of time. But I think that sort of culture is what separates SpaceX from older aerospace companies. We have a lot of engineers who are very enthusiastic about the work they are doing, and that enthusiasm carries a company a long way."

That responsibility also is a source of pride for the employees.

"One of the things I like best about SpaceX is that you feel like you have ownership of what you work on and that your work makes a very big difference to the company and the vehicle," says Samuel Wight, a 2010 graduate with a bachelor's and a master's in mechanical engineering. "That helps to motivate people. I'm getting a huge amount of experience."

Wight, who started working at SpaceX in August 2010, is a lead engineer for payload accommodations in the structures group, working on release systems for satellites. He credits Guy Genin, PhD, associate professor in the Department of Mechanical Engineering & Materials Science, for giving him practical experience in the Center for Innovation in Neuroscience and Technology (CINT) designing an implantable hydrocephalus monitor that is in the process of getting a patent.

"The reason I came here was to be a part of something monumental, something that would change the way humans access space and change the way we do things technologically and further exploration. There are not a lot of places to do that, especially as a young person."

— ERIN BECK

"We offer students hands-on experience in research, design, analysis, prototyping, testing and leadership," Genin says. "Students who tap into some of these end up far ahead after graduation. Sam tapped into all of them."

Benjamin Siepser, who earned a degree in electrical and computer engineering in 2008, works on digital logic systems.

"What I like about SpaceX is that I get to work on projects from the ground up," he says. "I get to design protocols, figure out how to make them work and take part in the testing. It's fast — at SpaceX, the time of inception of a project to getting the hardware and working on it is months at most, not years. It's exciting that within a year of me starting a project, it's in space."

Christian Melbostad, a 2001 graduate in electrical engineering and finance and now a SpaceX mission manager, says the sense of pride and ownership of work at SpaceX is similar to the "space race" culture at NASA in the 1960s.

"Today, we're working with a conviction matching our predecessors, but space exploration is the objective," Melbostad says. "Our singular goal is to provide safe, reliable and economical access to space. It is an aspiring motivator, and we take pride in our contributions. This manifests itself in a rise-to-the-challenge, go-above-and-beyond, get-it-done attitude throughout SpaceX."

COURTESY OF SPACEX

SpaceX's Dragon spacecraft

From membership in ENCouncil to coordination of Vertigo to involvement in the WURacing Formula SAE race-car team, all of the alumni and interns at SpaceX say having hands-on, practical experience, getting involved in extracurricular projects, and having critical-thinking and problem-solving skills are among the most important factors for students interested in a career in aerospace.

"My engineering education has governed all of the things that I deal with on a day-to-day basis," Aggrey says. "It provided the background and the way of thinking that I use daily at work. But just as important as my engineering education within the curriculum is what I've done outside of classes. Being on the Formula SAE race car team in particular has really given me a lot of experience that I call on for design."

COURTESY OF NASA

The SpaceX team aren't the only Engineering alumni involved with the International Space Station. Air Force Col. Robert L. Behnken, PhD, who earned a bachelor's in mechanical engineering and physics from WUSTL in 1992, is the chief astronaut officer for NASA and has taken two missions to the International Space Station for NASA.

Global leaders gather in India

Professor Pratim Biswas

Washington University in St. Louis and its academic and corporate partners worldwide put research into action in December by leading a major initiative in Mumbai, India, to address global energy and environmental solutions.

The WUSTL-led McDonnell Academy Global Energy and Environmental Partnership (MAGEEP), a consortium of 28 international universities, convened for the Fourth International Symposium on Energy and Environment: ACCESS (Abundant Clean Cost-effective Energy Systems for Sustainability).

"We know that by working together, we can address what are some of the most critical challenges facing our planet. We believe we have an opportunity and responsibility to the people of the world to work toward meeting these challenges," says Pratim Biswas, PhD, chair of the Department of Energy, Environmental & Chemical Engineering and the Lucy and Stanley Lopata Professor.

engineering.wustl.edu/india

Students to turn university housing 'green'

Students from three WUSTL schools, including the School of Engineering & Applied Science, are participating in a pioneering project to make some university-owned housing more sustainable.

The project, called "The Quadrangle Experiment," is designed to find the most efficient way to renovate 1920s and '30s-era apartment buildings owned by Quadrangle Housing, the university's nonprofit housing office, to become more environmentally friendly and to make better use of the space.

This spring, students have designed renovations for 745 and 749 Westgate Ave. One building will be renovated using standard procedures and used as a control, while the other will be renovated using sustainable procedures and best practices with the ultimate goal of net-zero energy, water and waste.

engineering.wustl.edu/greenhousing

Course embeds students with startup companies

Washington University's business, engineering and law schools are collaborating on a new course in 2013 that will embed students in the center of the thriving entrepreneur community in downtown St. Louis.

Students will trade their campus classroom for working space at T-REx, a new St. Louis tech incubator that offers startup companies affordable offices in the historic Railway Exchange Building. As part of the new course, Washington University students will engage in consulting projects for resident entrepreneurs at T-REx to better understand the inner workings of growing a business from the ground up.

The course is open to undergraduates and graduate students in Washington University's business, engineering and law schools.

engineering.wustl.edu/trex

ADAM SCHULTZ — CLINTON GLOBAL INITIATIVE

Clinton Global Initiative University

held at Washington University in St. Louis April 5-7

Written by **BETH MILLER**

Five School of Engineering & Applied Science student teams presented their commitments to action at the sixth annual Clinton Global Initiative University (CGI U).

Correctional Education Reform Through Technology: Xiaochang Song (freshman) — His project focuses on fundraising, recruiting and working with the correctional department in the St. Louis County Jail to plan a schedule to build a computer lab by March 2014.

Development of Systems Thinking Curriculum in Schools: Madeleine Polk (junior) — Polk plans to develop a means of replicating and implementing Systems Thinking curriculum in schools, design new materials for more teachers to see the relevance of Systems Thinking for their students and measure impact based on interviews with participating teachers and administrators.

Educational Asthma Management Campaign: Abigail Cohen (senior) and Andrew Brimer (senior) — Cohen and Brimer are committed to partnering with a national organization, such as the Asthma and Allergy Foundation of America or American Lung Association, to develop a campaign that raises asthma awareness and educates patients on how to best manage their asthma.

Engineering My Future Mentorship Program: Jasmine Kwasa (senior), Deborah Ohiani-Jegede (junior), Jennifer Onyi Oradiegwu (junior) and Imani Smith (freshman) — Engineering My Future will address the low interest, enrollment and retention of women of color in undergraduate STEM majors. The program will team female high school students with female WUSTL-National Society of Black Engineers mentors.

Team Photocure: Charles Wu (sophomore), Huy Lam (freshman), Matt Speizman (freshman) and Fangzhou Xiao (freshman) — Our goal is to make a low-cost and portable phototherapeutic treatment device for one of the most significant factors that contribute to neonatal deaths — hyperbilirubinemia, or jaundice.

CGI U, led by President Bill Clinton and Chelsea Clinton, brought together more than 1,000 college students with innovators, thought leaders and civically engaged celebrities to make Commitments to Action to address the most pressing challenges facing their campuses and communities in areas such as education, environment and climate change, human rights, poverty alleviation and public health.

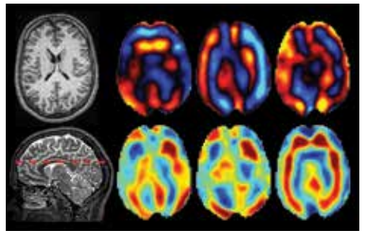
More than $400,000 in funding was available for students to carry out their commitments made at CGI U, primarily through the newly established CGI University Network of 33 colleges and universities that have committed to support, mentor and provide seed funding to student innovators and entrepreneurs from their respective schools.

Washington University in St. Louis was chosen to host this year's CGI U because it is recognized as an international leader in contributing to dialogue, finding solutions and preparing young people to address the world's most pressing challenges.

This year's program addressed issues throughout CGI U's five focus areas: Education, Environment and Climate Change, Peace and Human Rights, Poverty Alleviation and Public Health.

cgiu.wustl.edu

Bayly, team get $2.25 million grant to study brain mechanics

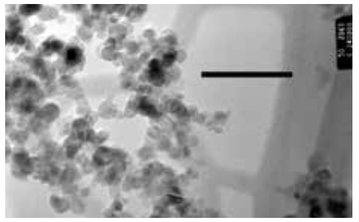


School of Engineering & Applied Science researchers have received a five-year, $2.25 million grant to better understand traumatic brain injuries in efforts to improve methods for prevention and treatment.

Philip Bayly, PhD, the Lilyan and E. Lisle Hughes Professor of Mechanical Engineering and chair of the Department of Mechanical Engineering & Materials Science, is principal investigator of the grant from the National Institutes of Health. The grant will allow Bayly and his research team to develop 3-D computer models of brain biomechanics that will give researchers and clinicians a better understanding about what happens to the brain during traumatic brain injury. Previously, Bayly and his research team measured brain motion and mechanical properties of the brain in 2-D.

engineering.wustl.edu/brainmechanics

New device better traps viruses, airborne pathogens



School of Engineering & Applied Science researchers have created a new type of air-cleaning technology that could better protect human lungs from allergens, airborne viruses and ultrafine particles in the air.

The device, known as the SXC ESP, was created by a team led by Pratim Biswas, PhD, the Lucy & Stanley Lopata Professor and chair of the Department of Energy, Environmental & Chemical Engineering. A recent published study of the device found that it could help to prevent respiratory and viral infections and inhalation-induced allergic reactions more efficiently than existing filter-based systems. The device finds viruses or toxic particles or bioterror agents and inactivates them in one application.

engineering.wustl.edu/cleanair

Genes provide clues to gender disparity in human hearts

Healthy men and women show little difference in their hearts, except for small electrocardiographic disparities. But new genetic differences found by Igor Efimov, PhD, the Lucy and Stanley Lopata Distinguished Professor of Biomedical Engineering, in hearts with disease could ultimately lead to personalized treatment of various heart ailments.

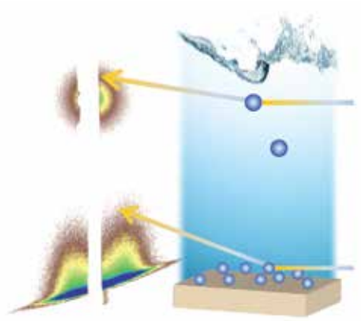
While prior studies have clearly established differences in the development of heart disease between men and women, very few studies had looked at the molecular mechanisms behind those differences in human hearts.

Efimov and a former doctoral student, Christina Ambrosi, PhD, analyzed 34 human hearts. They expected very large gender differences in expression of genes in the ventricles, but did not find them. Unexpectedly, they found huge gender differences in the atria.

engineering.wustl.edu/geneclues

Jun to use novel process to study nanoparticle formation

Sunscreen contains nanoparticles to protect our skin by reflecting hazardous ultraviolet radiation from the sun. But what happens to those nanoparticles when you wash the sunscreen away?



Young-Shin Jun, PhD, assistant professor of Energy, Environmental & Chemical Engineering, has received a three-year, $382,000 grant from the National Science Foundation to determine the physical and chemical evolution of environmental and engineered nanoparticles in natural and engineered aquatic systems, such as wastewater treatment plants. But instead of starting at the end of the life cycle of nanoparticles, she's starting at the very beginning .

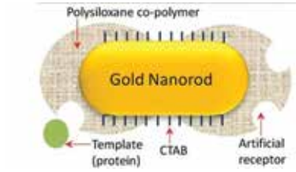
The goal is to determine whether nanoparticle transformation in wastewater treatment will introduce more adverse effects on the quality of the effluent water from wastewater treatment systems, how these nanoparticles can be removed from the system or how they can be further used to better remove toxic contaminants.

engineering.wustl.edu/sunscreen

Technique to uncover proteins could simplify kidney disease detection

Detecting whether a patient will have acute kidney injury could become as simple as dipping a paper test strip printed with gold nanorods into urine, Washington University researchers have found.

Srikanth Singamaneni, PhD, assistant professor of Mechanical Engineering & Materials Science, along with Evan Kharasch, MD, PhD, and Jerry Morrissey, PhD, at the School of Medicine, have developed a biomedical sensor using gold nanorods designed to detect the elevation of a promising biomarker for acute kidney injury in urine. Biomarkers are small molecules or proteins in the body whose concentration changes in response to disease or therapy.



The team's goal is to print this sensor on a piece of paper with an everyday inkjet printer so physicians and clinics have an inexpensive test available when they need it. If they can create an inexpensive technology that could be used more efficiently, physicians could catch the disease much earlier and save a lot of lives.

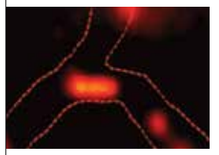
engineering.wustl.edu/kidney

Wang to study oxygen consumption in cells

In an engineering breakthrough, a Washington University biomedical researcher has discovered a way to use light and color to measure oxygen in individual red blood cells in real time.

The technology, developed by Lihong Wang, PhD, the Gene K. Beare Distinguished Professor of Biomedical Engineering, could eventually be used to determine how oxygen is delivered to normal and diseased tissues or how various disease therapies impact oxygen delivery throughout the body.

The research was published March 25 in *PNAS Online Early Edition.*

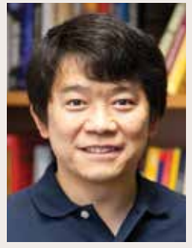


The new technology that Wang developed, called photoacoustic flowoxigraphy, uses light in a novel way that allows researchers to watch red blood cells flowing through tiny capillaries, the smallest of the body's blood vessels at about the width of one red blood cell.

The technology could help researchers and physicians to determine how cancer or diabetes change oxygen metabolism.

engineering.wustl.edu/oxygen

NSF grants CAREER Award to Jung-Tsung Shen



JUNG-TSUNG SHEN

Jung-Tsung Shen, PhD, the Das Family Distinguished Career Development Assistant Professor, has won a prestigious Faculty Early Career Development Award (CAREER) from the National Science Foundation.

This is a five-year, $400,000 grant to study the mechanisms for enhancing optical nonlinearity in subwavelength metallic nanostructures. Results of the research will benefit optical science, providing mechanisms to enhance and tailor the optical nonlinearity to create multifunctional nonlinear optical materials that will have potential applications for ultracompact optoelectronics, ultra-fast telecommunications and high-resolution optical imaging beyond the diffraction limit.

Caitlin Kelleher receives Sloan Foundation Fellowship

CAITLIN KELLEHER

Caitlin Kelleher, PhD, the Hugo F. & Ina Champ Urbauer Career Development Assistant Professor in the Department of Computer Science & Engineering, has received a prestigious research fellowship from the Alfred P. Sloan Foundation.

The two-year, $50,000 fellowship supports early-career scientists and scholars in science, mathematics, economics and computer science.

"My research centers on 'democratizing' computer programming," Kelleher says. "Today, computing enables progress across nearly all fields. It's something everyone should be able to do."

Kelleher will use the funding from the Sloan Foundation to continue researching how to make computer programming accessible to everyone.

When Frank Yin, MD, PhD, steps down as chair of the Washington University Department of Biomedical Engineering this June, he'll emulate St. Louis Cardinals manager Tony LaRussa by going out at the top of his game.

Tribute to **Frank Yin**

Written by **BETH MILLER**

Clockwise from top: Yin with his wife, Grace, Camilla and Stephen F. Brauer at his professorship installation; Yin with 2012 biomedical engineering graduates; Yin gets a pie in the face during EnWeek; Yin testing out a student project at the BME senior design poster presentation; Yin with students in China

Yin, the Stephen F. and Camilla T. Brauer Distinguished Professor of Biomedical Engineering, is stepping down as department chair June 30, 2013, and will take a yearlong sabbatical before returning as a full-time faculty member.

During his 15-plus years as chair of the department, he created a legacy by building one of the top biomedical engineering departments in the United States. With the skill of a professional baseball manager, Yin has handpicked 18 of the now 20 world-class faculty members who make up his team and have propelled the department to one of the fastest-growing and most successful at Washington University.

The department has consistently been ranked among the top 15 U.S. biomedical engineering departments. It 2010 it ranked No. 1 in both per capita faculty research funding and publication citations.

This spring, Yin will receive the Dean's Award — the highest honor bestowed by the dean — for his accomplishments in Engineering. In addition, Yin chose to donate any school funds for a party in his honor to endow a graduate fellowship in his and his wife's names.

It was support from the university's administration, many faculty and members of the Board of Trustees and the opportunity to build a department from the ground up that brought Yin to the university in 1997 from Johns Hopkins University School of Medicine.

"It took a leap of faith to decide to come here," Yin says. "However, with the breadth and depth of commitment that was clearly evident, I thought this was a once-in-a-lifetime opportunity to make a difference, so I took the plunge."

And many are glad he did.

"I am personally grateful for the enormous contributions of Frank Yin," says Chancellor Mark S. Wrighton. "Washington University has long been regarded as an institution of great strength in the sciences. Our biomedical engineering department has flourished over the past 15 years under Frank's leadership and is today regarded as one of the world's top programs, furthering the university's position as a leader in scientific teaching and research."

> **"Frank's impact will be realized for many years to come through the work of the outstanding faculty and students who Frank helped recruit and mentor."**
>
> *— Chancellor Mark S. Wrighton*

BIOMEDICAL ENGINEERING TODAY

20
full-time faculty

115
graduate students

400
undergraduate students

$13
million in research funding (FY12)

12
the graduate program tied for No. 12 in the 2013 *U.S. News & World Report* rankings

Uncas A. Whitaker Hall

Frank Yin with doctoral alumna Sara Smith Taylor

While building a department was a new venture for Yin, he had a guiding principle and a few goals in mind.

"The principle I started with — and still hold to — is that it's vitally important to aim for the highest quality in all aspects," he says. "I also had an idea about what areas would be important and compelling to build a new department around — those on the cutting edge and with a good future."

A good baseball team needs not only outstanding players but also a stadium in which to play. So in 1999, Yin helped bring in a $15 million grant from the Whitaker Foundation that allowed the department to recruit and hire new faculty and launch the building of Uncas A. Whitaker Hall, completed in 2002, as the home base for the growing department. The $41 million, 55,000-square-foot structure made subsequent recruitment much easier, Yin says.

"By the time the building opened, it was pretty clear to everyone that this was going to be a thriving enterprise," he says.

Thriving it is, with 20 full-time faculty, 115 graduate students and about 400 undergraduate students, or about one-third of the school's total undergraduate students. It also boasts more than 1,000 alumni and nearly $13 million in research funding in fiscal year 2012, or about 50 percent of the school's total research expenditures.

What makes the department different from others around the country is its extensive interactions with the School of Medicine as well as its focus on cutting-edge areas, Yin says.

"We have a world-class medical school across the park, and it would be foolish not to take maximal advantage of that," he says. "This interaction really helps our students by providing them access to a tremendous pool of talented mentors. That close connection also sets the tone for our multitude of educational and research partnerships and collaborations that exist."

Yin has received accolades from others for his accomplishments as well.

Ralph Quatrano, PhD, dean of the School of Engineering & Applied Science, says he and Yin came to the university at about the same time — Yin as chair of biomedical engineering and Quatrano as chair of biology in Arts & Sciences. The two thought very similarly on many research topics and teaching in the basic biological and biomedical fields, worked closely within the Division of Biology & Biomedical Sciences and showed how two programs in two different schools can work together in developing curriculum and in hiring faculty that complemented each other.

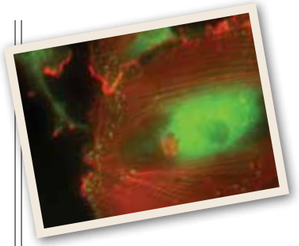
"I have admired Frank for his focus on quality at all levels of the teaching and research enterprise and his dedication to build a quality program that has set a standard to be emulated across the university," Quatrano says. "He has been a terrific colleague and leader for the last 15 years, and I look forward to his continuing service to Engineering, the university and to our friendship."

William A. Peck, MD, who was dean of the School of Medicine when Yin came to WUSTL and is now the Alan A. and Edith L. Wolff Distinguished Professor, says Yin is an extremely talented biomedical engineer.

"We wanted to recruit the best, and we got the best," Peck says. "He did a fabulous job in building the department and has been very effective in interacting with the other components of the university, including medicine and its faculty. We appreciate that the enhancement of biomedical engineering enriches the medical and engineering schools."

Sal Sutera, PhD, who was acting chair of the department before Yin's arrival and is immediate past dean, said the university was extremely fortunate to attract Yin from Johns Hopkins.

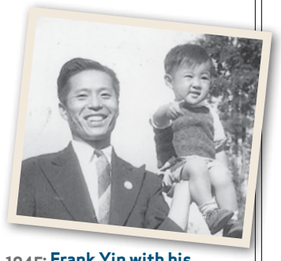
"Under his leadership, the new department was quickly populated with outstanding young and mid-career faculty who were able to build strong bridges of collaborative research and earn high national rankings," says Sutera, who also headed the search committee.



Yin's research encompasses soft tissue biomechanics, cell mechanics and hemodynamics

"He was the perfect fit: as an MD-PhD, an excellent teacher and active researcher, he filled the bill as a dual citizen of the engineering and medical communities of Washington University."

— Former dean Sal Sutera, PhD



1945: **Frank Yin with his godfather, William Tao**

"Frank was transformative when he was hired, and biomedical engineering really did not catch on until Frank arrived in St. Louis."

— Stephen F. Brauer

Sutera also called on Yin years later.

"While I was serving as interim dean of SEAS, I was able to count again on Frank Yin's experienced leadership and management skills to help me deal with the school's diverse and growing departments," Sutera says.

During his tenure in St. Louis, Yin has made personal connections as well. He and his wife, Grace, have become close friends with Lucy Lopata, widow of Stanley Lopata, a longtime friend of the university and the School of Engineering & Applied Science.

"Frank and Grace came here when my husband was still very active as a trustee, and I really fell in love with both of them," Lucy Lopata says. "At that time, his wife said to me, 'I really don't know anyone in St. Louis.' And I told her that I would adopt her as my Chinese daughter. That's how the friendship started, and we've been friends ever since."

He also has become good friends with other supporters of the school, including Jerry and Rosalie Brasch, Hank and Gini Schreimann and Stephen and Camilla Brauer.

"He was instrumental in attracting the Whitaker grant. He made all the difference leading biomedical engineering," Brauer says.

And when the Yins came to St. Louis, they were reunited with his godparents, William Tao, a 1950 graduate of the university and longtime teacher, and his wife, Anne. William Tao is also the founder and head of William Tao and Associates, Consulting Engineers.

Yin says he has mixed feelings about leaving his post. He says he will most miss being able to recruit and guide new talent, but will greatly enjoy watching the careers of those he recruited continue to blossom.

"I think the department is in terrific shape," he says. "It is mature, has great faculty and students, has wonderful physical facilities, has impact nationally and internationally, and still has room to grow. This is the right time to hand it to somebody who wants to take this opportunity and create or input his or her own vision into the department."

THE LAST WORD:

Legacy

Biomedical Engineering (BME) at Washington University is a living legacy composed of several different elements. First is its home — the superb, state-of-the-art teaching and research facilities in the Uncas A. Whitaker and Stephen F. & Camilla T. Brauer halls. Second is its administrative structure. It is not only the newest department in the university, going from no students in 1997 to 400 undergraduate students and 115 doctoral students in 2013, but also an exemplar of "interdisciplinarity" because of its extensive ties to our world-class School of Medicine. Third is its financial underpinning, which will ensure its sustainability. As important as these elements are, however, the fourth — the outstanding faculty, students and staff — is the most crucial. Without them, the others would be merely symbols without real impact. It is these people who make this living entity a true success — one that is well-poised and ready to further expand and adapt to meet the myriad challenges in the years and decades ahead.

Much has been done by many over the past 15-plus years to create this legacy. It started with a vision by members of the School of Engineering & Applied Science's National Council; strong commitments by Chancellor Mark Wrighton and other university leaders, including the deans of both the engineering and medical schools; and enthusiastic support from senior faculty in both schools. These, together with transformative commitments from the Whitaker and Danforth Foundations, as well as numerous friends and alumni of the university, were key enablers. The trust and faith of the faculty and students who committed to join and help build the enterprise in its early years were the final, critical pieces needed to ensure success. To all of them, I owe my sincerest and most profound thanks for this once-in-a-lifetime opportunity. The department is in an excellent position to make great strides to advance basic science with the hope of improving the diagnoses and treatment of human diseases.

Written by **FRANK YIN, MD, PHD**

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SURPRISE VISITOR
Jack Dorsey, co-founder of Twitter and Square, made a guest appearance in Patrick Crowley's computer science class on Friday, April 5.

WUSTL PHOTO

#wustlengineers: