SPRING 2014

Engineering Momentum

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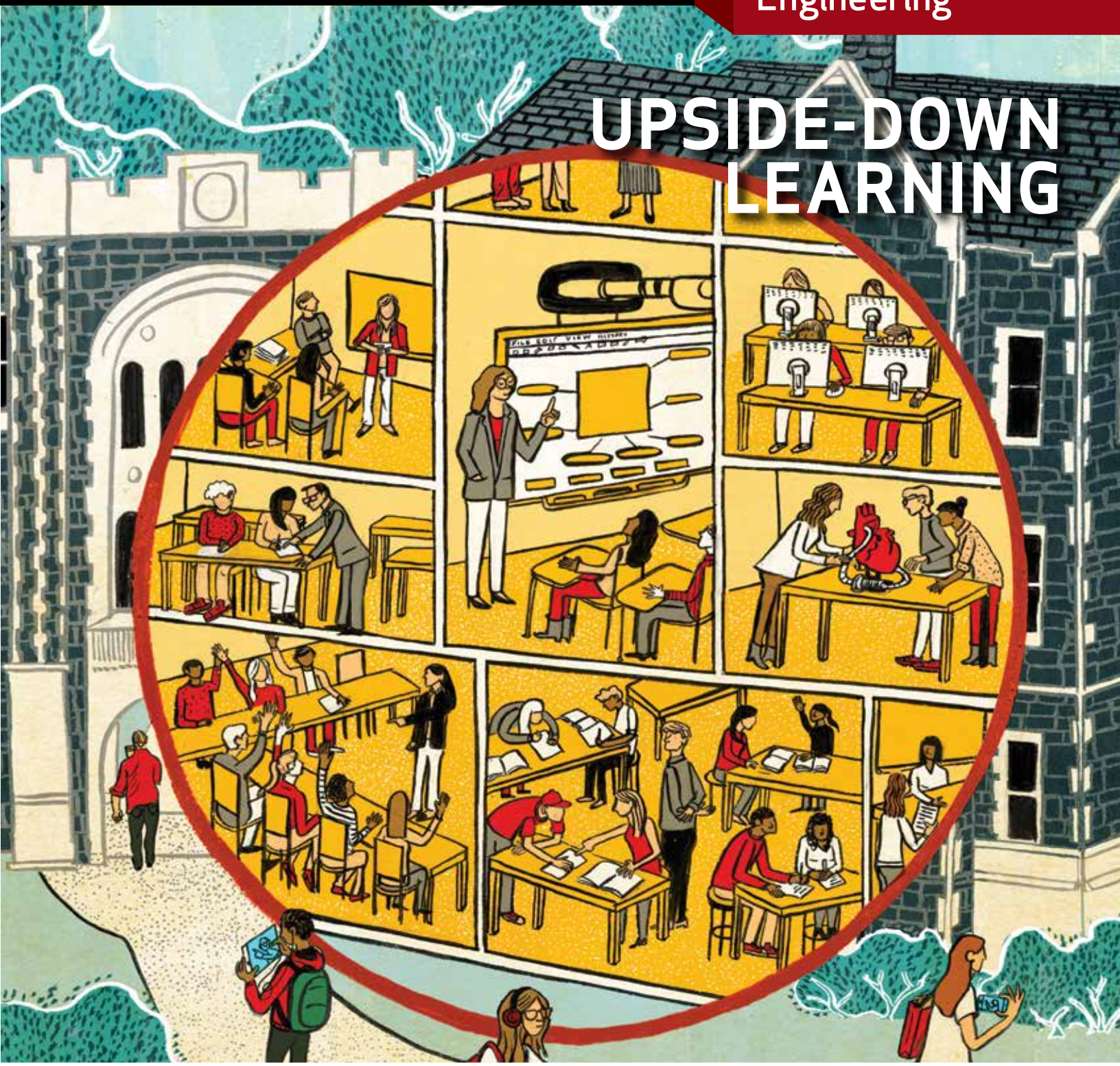
ACROSS DISCIPLINES. ACROSS THE WORLD.™

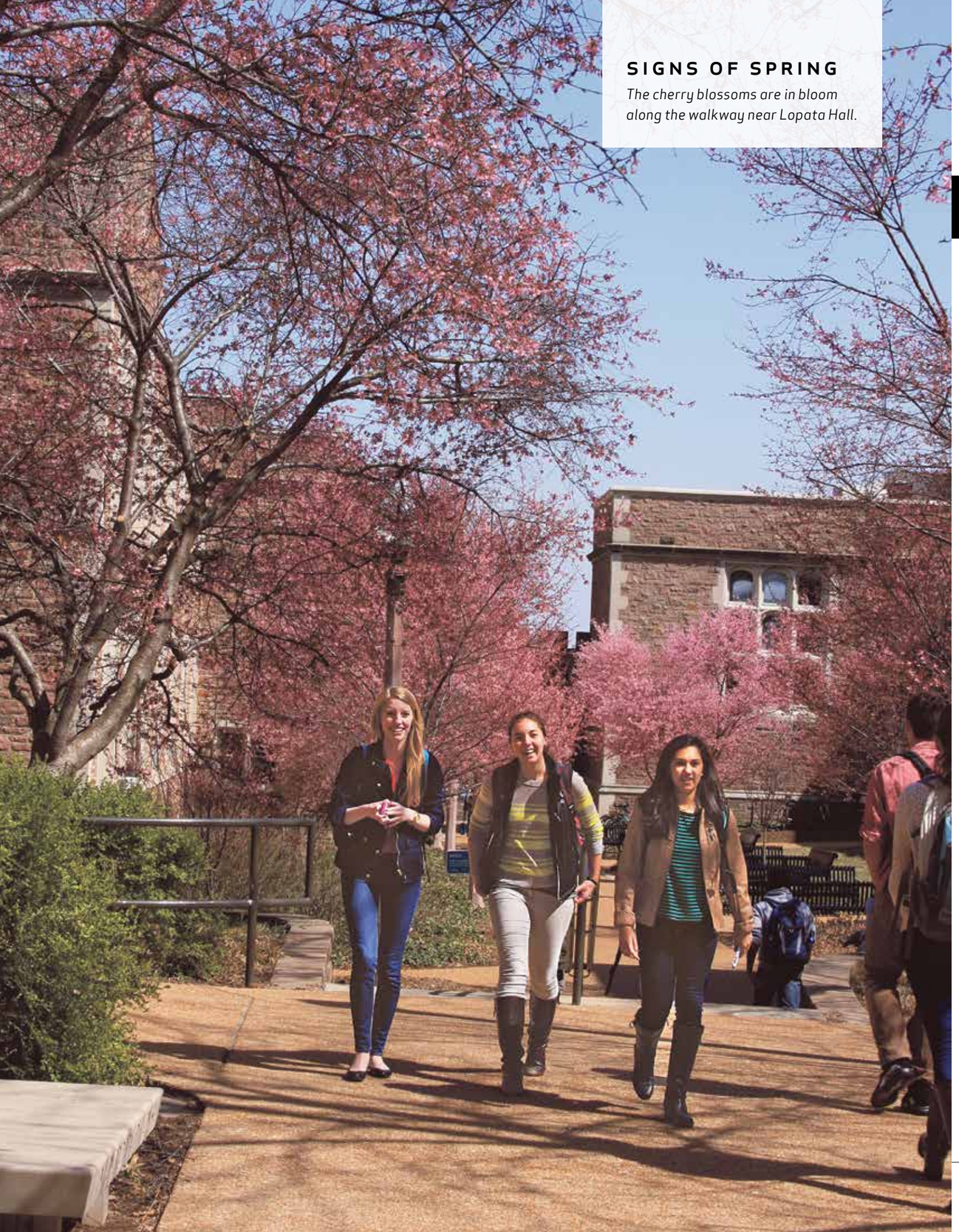
Washington University in St. Louis

Engineering



UPSIDE-DOWN LEARNING

inside ›› Q&A with new BME chair ›› Robert Pless ›› Engineered to serve ›› John C. Sommerer



SIGNS OF SPRING

The cherry blossoms are in bloom along the walkway near Lopata Hall.

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Washington University in St. Louis

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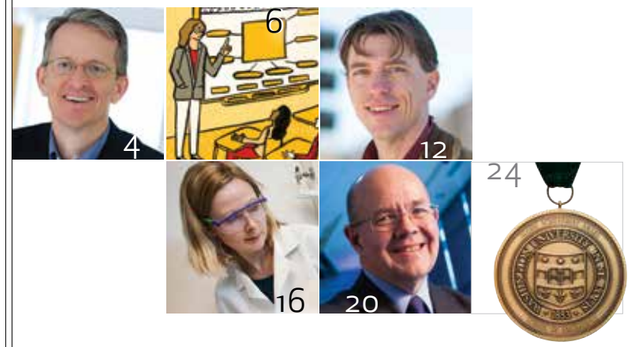

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WUSTL PHOTO

Dean Quatrano with Hui-Fen Kuo, PhD, of the Agricultural Biotechnology Research Center, Academia Sinica, at the International Advisory Council for Asia (IACA) meeting in February in Taipei, Taiwan. The IACA assists university leaders in expanding the university's global presence and is composed of alumni, parents and friends, including prominent educators and business leaders throughout Asia.

Dear friends,

With a rapidly growing and developing human population around the world, our global society needs engineers to contribute toward solving many of the world's most significant health, environmental and security challenges. From using science and technology to save lives, to alleviate the shortage of clean water and to improve air quality to addressing the increasing demand for energy while protecting the environment, our faculty and students are at the forefront of work worldwide because of our global partnerships.

Building on the principle that our students, faculty and staff understand they are citizens of a global society, our strategic plan calls for expanding engineering education and outreach globally through study-abroad programs, student organizations, faculty research and relationships with McDonnell Academy partners. Our work through Engineers Without Borders, for example, recognizes that "borders" extend to North St. Louis, to Ethiopia, to China, to India and beyond. We continue to increase our efforts to recruit international students because we believe they bring new and more diverse opportunities for contributions, including expanding our global reach through those who return to their home countries after receiving their education.

In this magazine, we highlight just a few of our many global activities, but you can read more about at our global outreach at engineering.wustl.edu. I am extremely proud of all that our school is doing to improve quality of life, and I appreciate the efforts of many students, faculty, staff, alumni and friends who are giving back to our local, regional, national and global communities.

Sincerely,

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

Taipei, Taiwan

social media buzz

POSTED JAN. 26, 2014

#1 popular post:

Wash U. Racing at the St. Louis Auto Show

POSTED JAN. 31, 2014

Alumni blogs:

Q&A with David Karandish, founder and CEO of Answers.com

"You learn entrepreneurship by doing. The first seven businesses I tried — failed. The experience I received from trying and failing allowed me to learn the pros and cons of various business models, how to strike partnerships and how to market a product. We have a philosophy at Answers that any one person rarely knows the answer for how to make an experience great, but through lots of experimentation, you can 'course correct' and get there."

POSTED FEB. 20, 2014

#ThrowbackThursday

Engineering students are held with duct tape to a column in Lopata Gallery at Cheap Lunch during Engineers Week 2008.

POSTED FEB. 3, 2014

Students win $50,000

A team of WUSTL students won the $50,000 first prize in the GlobalHack hackathon at Union Station in St. Louis.

PUBLISHED MARCH 6, 2014

Techli TV interviews Professors Igor Efimov and Roger Chamberlain

Watch the full interview at youtube.com/techlitv

POSTED FEB. 20, 2014

EnWeek

Mindlin Memorial Lecture featuring Mark Barteau, PhD, director, Energy Institute, University of Michigan

#wustlengineers

Q&A

with new BME Chair

STEVEN GEORGE

Written by **BETH MILLER**

Q What attracted you to Washington University?

A. I became very interested in Washington University because of my experience in building biomedical engineering programs. I've become aware of what pieces of the puzzle you need to build a program that will have an impact. Part of that is having a School of Engineering and other engineering departments, but a big part of biomedical engineering is having a broad and deep medical school.

There are really very few places in the country that rival what Washington University has here.

The medical school is internationally renowned, and it provides opportunities in which the department has already been building but also brand new opportunities. As the department continues to expand and build, you need partnerships with the medical school that are very research active, and that was the main draw to Washington University.

Q What is your research focus?

A. My research program is really focused on tissue engineering. It started by engineering tissues that you would implant to replace a tissue that might have worn out or was diseased. When induced pluripotent stem cells were created, that became a really interesting opportunity for tissue engineers. You could take cells from a person, create stem cells from them, and from that, create a new tissue. Now we're using this new type of stem cell to create cells in tissues that have applications in the cardiovascular area. I'm working on a project where we're trying to create a small version of a tumor and the human heart, and we're trying to put them on a small device you can hold in your hand. We want to create new anticancer drugs that would have no or minimal side effects. It's really fun! There is so much creativity you can have as an engineer. Most people think creativity is in the arts or music. Engineers survive or fail based on how creative they are.

Q What do you see as the strengths of this department, and where do you envision growth?

A. This department has built itself in three or four areas: cardiovascular, neural engineering imaging, tissue engineering and biomaterials, but they don't do a lot of device work. I think that's an area we'll certainly be thinking about for growth. We're going to be hiring new faculty, so we'll think about whether we'll go into a brand new area or augment existing areas. I think there is an opportunity in biomedical devices, and there is a lot of interest from clinicians working with patients.

Q How will you integrate medicine and health into the school pillars?

A. The easiest one to think about is entrepreneurship. One feature that is strong at the university I'm coming from is the private sector and biomedical device arena. It's one of the strongest in the country, if not the world. Because of that, when we were building the program there, we really tried to align the faculty interest and student training with what was going on in the private sector. I thought a lot about how to train engineers to think about problems that might become startup companies. You have to have an environment around you where you have an ecosystem to create young companies. You have an enormous amount of intellectual property coming out of Wash U., in the medical school but also in Engineering, and there may be parts of the ecosystem that need to be bolstered.

Q Why did you choose chemical engineering and medicine?

A. I was always interested in medical school. I met my wife, Sharon, when I was a senior at Northwestern (University), and she was going to medical school. We decided to go to medical school together at the University of Missouri. I really enjoyed all of the basic sciences in the first two years and the clinical rotations in my third year, but I had this constant draw back to research. I found myself thinking about research problems as opposed to clinical problems. I decided that I really wanted to run a research lab at a research university and teach undergraduates and train doctoral students. And to do that, I needed a PhD. Chemical engineering had a certain skill set that would be really useful, and I had so much biomedical training in med school. I use my engineering language as I approach problems, so it's a great marriage of the two.

Steven George, MD, PhD, will begin as chair of the Washington University Department of Biomedical Engineering July 1.

George is professor of biomedical engineering and of chemical engineering & materials science at the University of California, Irvine. In addition, he is the Edwards Lifesciences Professor and director of the Edwards Lifesciences Center for Advanced Cardiovascular Technology. Previously, he was the founding William J. Link Professor and chair of the Department of Biomedical Engineering at UC-Irvine from 2002-09. He joined its faculty in July 1995.

RON KLEIN

"I still use the med school training to this day — I wouldn't trade that for anything. It taught me how clinicians think, how they speak, what the culture of medicine is. It makes creating collaborations easier. I feel like I have an understanding of what clinicians' priorities are."

Watch an interview with Steven George: youtube.com/WUSTLEngineering

Illustrations by **VIDHYA NAGARAJAN**

For the past few years, higher education institutions have been changing the traditional lecture format in classes to improve the quality of education and appeal to different learning styles. The "flipped classroom" approach has students watch a videotaped lecture prior to class then discuss it during class time. In engineering, this includes working on problems or homework during the classroom time with the instructor available to answer questions. While this approach puts the onus of learning on the individual student, it allows for more interaction among students and a window into how they are learning and understanding the material.

UPSIDE-DOWN LEARNING

Written by **BETH MILLER**

The art of teaching has remained the same for millennia: a teacher stands in front of the class and lectures, while students sit and listen, then show what they have learned through exams and papers. But today's students, who have grown up with the Internet, email, mobile phones and multitasking, are not as responsive to this method as previous generations. This has led faculty at the School of Engineering & Applied Science to develop innovative teaching methods to keep students engaged and successful in the classroom.

Blackboards have been replaced with white boards or SMART Boards, lecture times have been shortened while in-class activities have increased, and interactive teaching tools have been integrated to gauge students' understanding of the concepts without them having to raise their hands.

In a traditional classroom format, students are focused on taking notes in preparation for what might be on an exam rather than absorbing what the instructor is saying. In large lecture classes, asking questions during a lecture may not be possible. If students don't understand the concepts, it is their responsibility to follow up with the instructor or teaching assistant or fellow classmates.

To improve the quality of education and appeal to different learning styles, many universities and colleges have been implementing the "flipped classroom" approach, in which students watch a videotaped lecture prior to class, then discuss it during class time. In engineering, this includes working on problems or homework during the classroom time, with the instructor available to answer questions.

Washington University Engineering faculty have implemented a variety of flipped-classroom-style approaches that have resulted in a better understanding of the course material by students and better grades as a result. While this approach puts the onus of learning on the individual student and may create more work for the instructor, it allows for more interaction among students and a window into how they are learning and understanding the material.

Since the flipped classroom approach is only about seven years old, hard data showing its benefits is limited. However, some researchers say that informing students about concepts and procedures before completing problems in class undermines the type of learning needed for understanding, according to an editorial in *Science*. In addition, students may not attend class if they can view the lecture online, thereby missing the value of the activities done during class time, or may come to class unprepared with the background to complete the activities.

Click, click, click

As you might expect, faculty members in Computer Science & Engineering are making the most of the newest technology to keep students engaged.

Roger Chamberlain, DSc, associate department chair and professor, has been using different class formats in several courses, including Computer Science I and II, Introduction to Digital Logic and Computer Design, and Introduction to Systems Software, which cover freshmen, sophomores and juniors. Chamberlain began the experiment through the six-year CPATH-T grant, funded by the National Science Foundation in 2007 and led by former professor Kenneth Goldman, PhD.

About 1,400 clickers are being used this semester across the STEM fields.

Chamberlain tried a variety of approaches to active learning, including a flipped classroom approach in Introduction to Systems Software, in which students were assigned to watch recorded lectures ahead of class. Chamberlain began the class with questions about the lectures, then allowed students to work on problems during class in small groups.

"At the end of the semester, we compared project and test scores with those of the course two years' prior, which was taught in the traditional method, and we saw a good standard deviation improvement in the new format," Chamberlain says.

Chamberlain has also incorporated a new technology into his classes called the i>clicker, a hand-held device similar to a remote control that allows students to answer an instructor's multiple choice questions electronically. The clickers are particularly useful in large classes, Chamberlain says.

"It's a way to get students to tell me what they are understanding and not understanding without them having to raise their hands and speak in front of everyone," he says. "If a lot of students give the wrong answer, then I know where the problem is, and we talk about it."

"In a large class, I don't want students to feel intimidated about asking questions, so this lowers the threshold."

— RON CYTRON, PHD

Chamberlain's course is included in a variety of projects, funded by a grant from the Association of American Universities (AAU), in which active-learning strategies are integrated into introductory science, technology, engineering and mathematics (STEM) courses. Students may check out an i>clicker from the John M. Olin Library. The device has five buttons that can correspond to multiple-choice answers A-E or 1-5. While responses are anonymous, each device has a serial number, so instructors can give participation credit to students who answer questions.

Bryn Lutes, PhD, assistant director, academic services, in The Teaching Center, said about 1,400 clickers are being used this semester across the STEM fields.

"Instructors are really interested in assessing how their students are doing with the content before they give an exam," Lutes says.

Ron Cytron, PhD, professor of computer science & engineering, took the idea a step further and developed his own interactive system using students' own cell phones and Twitter. Cytron and a former student, Ben Murray, and current student Hunter LaTourette developed the WUTexter app, which allows students to use Twitter to send direct messages to the app. Their answers and any other questions they have appear on Cytron's computer screen.

Cytron has been using WUTexter in Computer Science I, a freshman course with about 200 students, with good feedback.

"What I observed is that near the beginning of the class, students use that as a way to ask me simple questions," Cytron says.

DEVON HILL

Roger Chamberlain, PhD

Click click click!

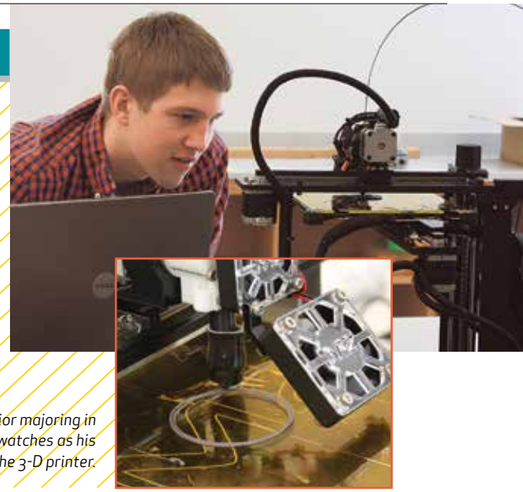
DEVON HILL

Interactive learning

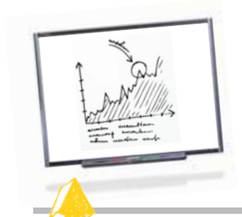
Engineering students often ask for more hands-on learning experiences amid courses with heavy theory and problem sets. Donald Elbert, PhD, associate professor of biomedical engineering, implemented hands-on learning while teaching Design of Artificial Organs in Fall 2013, in which students had to design a left ventricular assist device (LVAD).

Previously, students created a computer model of the device using computer-aided design and computational fluid dynamics. However, last fall, Elbert worked with Patricia Widder, lecturer in biomedical engineering, to allow students to create a model of their design using a 3-D printer. Then, each student could connect his or her 3-D-printed LVAD to a motor and pump water to simulate blood flow. That allowed them to see if the devices were working and what needed to be redesigned.

"The students really crave the hands-on experience and to have new techniques to put on their resumes," Elbert says.



Tyler Perez, a senior majoring in biomedical engineering, watches as his device prints on the 3-D printer.



A SMART Board is a large, interactive, touch-response computer monitor that shows the professor's presentation, but also allows the instructor to write on it like a chalkboard.

Watch Biswas' lecture: itunes.apple.com/us/course/id691280850

SMART Boards & iTunes

Pratim Biswas, PhD, the Lucy & Stanley Lopata Professor and chair of the Department of Energy, Environmental & Chemical Engineering, used a hybrid flipped classroom approach in his Fall 2013 graduate-level course, Aerosol Science & Technology. The course uses a lot of equations, and students often wanted to go back to the lecture to see how the equations were derived and used. Previously, the lectures were videotaped for students to review after class via Blackboard. However, the videos showed only the chalkboard and did not show what Biswas was doing in real time. This year, Biswas and his teaching assistant, Tandeep Chadha, used SMART Board technology, which records the writing and long derivations. The students could later watch the recording with the ability to pause, rewind or slow the replay and observe detailed steps of the derivations. At Chadha's suggestion, the lectures were made available on iTunes U, which allows educators to design complete courses with audio, video and other content and distribute them through the iTunes U app, which is free and available to anyone.

Biswas and Chadha worked with Ted Chaffin and Steven Vance of Washington University Libraries Instructional Support Services department inside the Arc Technology Center at the Olin Library, which has SMART Boards available for use. The library's SMART Board was modified to actively capture Biswas' voice and presentation slides, while also recording his live lecture and demonstrations of equations.

Biswas got an unexpected response to the iTunes content: Without any publicity, about 800 users downloaded the content. In addition, five engineers working for a company in Chicago found the content and audited the class through the publicly available lectures.

Chadha; Yang Wang, the other teaching assistant; and Biswas worked with Gina Frey, PhD, executive director of the Teaching Center, to do some experiments. They pre-recorded their class on a SMART Board, made it available to students before class and used a flipped approach for discussion. In another test, they showed the pre-recorded lecture during class, with and without Biswas present. After students and Frey evaluated these models, the instructors received valuable feedback that would enable improved learning of content that was difficult to understand. For their efforts, Chadha and Wang were selected by the students to receive the 2014 Department of Energy, Environmental & Chemical Engineering Teaching Assistant Award.

In Mechanical Engineering & Materials Science (MEMS), several faculty who have changed the format of their classes have seen positive results in students.

Shaun Sellers, lecturer in MEMS, teaches Engineering Mechanics II. He introduced a flipped-classroom approach a few years ago when he realized students weren't responding well to the straight lecture format.

Sellers tried a few different blends of lecture and in-class problem solving. Ultimately, the students told him they wanted a 15-minute lecture at the beginning of the class to summarize the material they had read before class, then to use the remainder of the class time to apply those ideas to problems.

"The response I got was really positive," Sellers says. "Attendance was nearly perfect, and students had a really positive attitude in class. The lecture was immediately relevant to what they were doing, so they paid attention and asked questions."

"I have found that in an interactive class setting, I am able to pay attention better. I feel more free to ask questions, and students learn to help each other."

— KENNA MIDDLETON

Sellers says the students worked together well in and outside of class.

"When the class was over, about half of them stayed in it to continue working on problems," he says. "Next semester, I've scheduled the room for another hour after class so the room is available if students want to continue working. I'll also stay in the room to answer questions."

Kenna Middleton, a junior majoring in mechanical engineering and a student in Sellers' course, says she felt like she learned more from the class because of the format.

"Because of the 'team effort' feel, students would collaborate on the same problem and share ideas back and forth," Middleton says. "By doing this, I was able to delve deeper into why I was doing a certain method versus another. This allowed me to learn the overall concepts deeper than I would have with a teacher lecturing at me. Also, because of this class setting, I was able to move freely about the classroom, which allowed me to concentrate better."

Mary Malast, DSc, adjunct instructor, has successfully integrated a flipped classroom approach in the Engineering Economy course in the University of Missouri–St. Louis/WUSTL Joint Undergraduate Engineering Program. The course meets one evening a week for three hours.

"What I found was going over the lecture material didn't help them a lot in class because they are already tired when they come into the classroom," she says. "I changed the format so a big part of their assignment is to go through the resources provided with the textbook — PowerPoint slides, video lecture and interactive online tools — then come to class with questions."

Malast splits the class period in half, with half of the time spent in the classroom and the other half in the computer lab. While students work in small groups, she can work with each group.

The approach has been successful: Malast says no student got lower than a C in the course last fall.

Next fall, Malast plans to hold the class entirely in the computer lab to better accommodate the needs of the students in the Joint Program.

"These are place-bound students who work during the day," she says. "The flipped classroom helps them a lot."

Mary Malast talking to UMSL/WUSTL Joint Program students

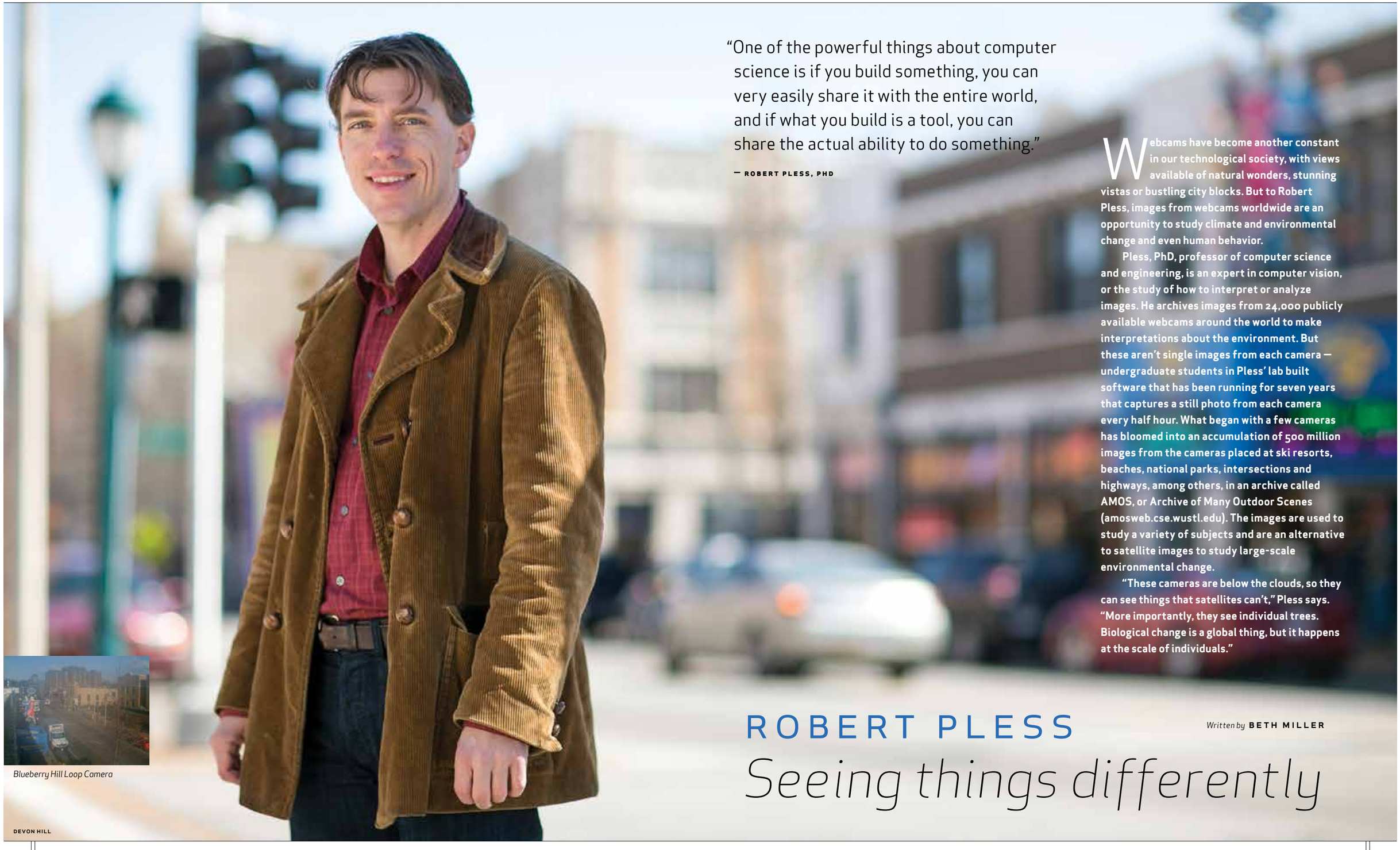
In 2013, Washington University was one of eight AAV member campuses selected to serve as project sites for an initiative to improve the quality of undergraduate education in the STEM fields. The School of Engineering & Applied Science, the College of Arts & Sciences, The Teaching Center and the Center for Integrative Research on Cognition, Learning, and Education (CIRCLE) are leading the charge for Washington University, which is using the $500,000 in seed money from the three-year grant to explore and implement active-learning techniques.

Washington University proposed to incorporate active learning into lower-level STEM courses and identify active-learning best practices.

Kurt Thoroughman, PhD, associate professor and associate chair for undergraduate studies in biomedical engineering, is one of the four Washington University investigators on the AAU STEM Initiative. Thoroughman, who also is director of undergraduate studies for the School of Engineering & Applied Science, has initiated Engineering Virtual Studio, a pilot intervention program for freshmen and sophomore Engineering students designed to connect their foundational courses with "the real world."

Engineering Virtual Studio, required for biomedical engineering students, is a four-semester, one-credit, pass-fail course in which students work with peer mentors, professionals working in the field, the WUSTL Career Center and the Writing Center. The first group of students to complete the program will finish at the end of Spring 2014.

"Freshmen and sophomore students are asked to focus on individual foundational courses and are told that it will all make sense later when they are juniors and seniors," Thoroughman says. "I want to make the experience one where integrative thought and attention to how the individual student understands how they fit into these bigger pictures begin with day one of the curriculum and persists through their first four semesters rather than offput until the junior and senior years."



"One of the powerful things about computer science is if you build something, you can very easily share it with the entire world, and if what you build is a tool, you can share the actual ability to do something."

— ROBERT PLESS, PHD

Blueberry Hill Loop Camera

DEVON HILL

ROBERT PLESS
Seeing things differently

Written by **BETH MILLER**

Webcams have become another constant in our technological society, with views available of natural wonders, stunning vistas or bustling city blocks. But to Robert Pless, images from webcams worldwide are an opportunity to study climate and environmental change and even human behavior.

Pless, PhD, professor of computer science and engineering, is an expert in computer vision, or the study of how to interpret or analyze images. He archives images from 24,000 publicly available webcams around the world to make interpretations about the environment. But these aren't single images from each camera — undergraduate students in Pless' lab built software that has been running for seven years that captures a still photo from each camera every half hour. What began with a few cameras has bloomed into an accumulation of 500 million images from the cameras placed at ski resorts, beaches, national parks, intersections and highways, among others, in an archive called AMOS, or Archive of Many Outdoor Scenes (amosweb.cse.wustl.edu). The images are used to study a variety of subjects and are an alternative to satellite images to study large-scale environmental change.

"These cameras are below the clouds, so they can see things that satellites can't," Pless says. "More importantly, they see individual trees. Biological change is a global thing, but it happens at the scale of individuals."

> "As public health researchers, we have to go out and observe how people are using spaces. If I were to go to a park and tally what types of activities people are doing, they might change their behavior if they see me sitting there with a clipboard. With the cameras, people know they are there, but they aren't changing their behavior because of them."
>
> — J. AARON HIPP, PHD

amos.cse.wustl.edu

More than 5 million outdoor webcam images archived from 24,000 webcams

Baltimore webcam

Hometown
Baltimore

Education
BS, Computer Science, Cornell University, 1994

PhD, Computer Science, University of Maryland, 2000

Patents held: 2

Research funding: $3.5 million

Number of published articles: 106

Satellites take an average of what they see and can't differentiate the green leaves of a group of trees from the green grass in the summer. So Pless and his collaborators are working to organize all public webcams as ground-level sensors to study phenology, or the annual life cycles of plants and animals, to get better and more accurate estimates of changes in those cycles. They exclusively use images from cameras other people have installed and whose images are already available through their own websites.

This method, which Pless calls passive vision, relies on the interpretation of these series of images over time. Looking at images taken from a webcam over the course of a year or several years shows many changes in the environment. To study this idea, Pless received a prestigious CAREER Award from the National Science Foundation in 2006.

"We can see every day how much snow is in a particular location and correlate the growth of a tree to how much snow is there, or how long it took the snow to melt, or how wet the field is or the drainage off of the streets," he says. "The idea of taking all of these webcams that are out there and put up by random people for random purposes and organizing them into a resource that can be used for other things excites me," Pless says.

He can also determine where a camera is in the world by watching the images over time and interpreting the time the sun rises, the length of the day and from which direction the sun shines. By studying the pattern of brightness and darkness during the day, Pless can make 3-D models of the scene.

Pless also is working with J. Aaron Hipp, PhD, assistant professor of social work in the Brown School, on a project seeking to understand how people use public spaces and built environments, such as parks, sidewalks, crosswalks or bike lanes.

A mutual friend who knew of Hipp's and Pless' research interests introduced them after a volleyball game in Forest Park. Hipp was interested in what the AMOS data could reveal about how people use public spaces.

In the fall of 2011, Pless and Hipp received a $25,000 University Research Strategic Alliance (URSA) grant to integrate Pless' AMOS database images with Hipp's interest in how people use public spaces. They looked back at six years' worth of images of six intersections in Washington, D.C., where a bike lane or painted crosswalks had been added during that time frame. They focused on the number of people using the intersections for a month before the crosswalk or bike lane was added and for a month after to determine if activity increased. Analysis of the data showed there was a significant increase in walking and cycling after the crosswalks and bike lanes were added, Hipp says.

Building on that research, the researchers received a two-year, $275,000 grant from the National Cancer Institute that started Jan. 1, 2014, that will allow them to continue using the images from AMOS to study public health.

"Public health is about populations and thinking at a larger scale," Hipp says. "Robert thinks at a much larger scale — instead of thinking about six cameras in D.C., he says that's like thinking about six trees in a forest. He is good at challenging me to think big."

Pless also works on a project called rePhoto (projectrephoto.com), an app that allows people to take repeated photographs of something over time. For example, a user could take a photo of one of many trees lining Melville Avenue near the Danforth Campus. A week later, that same person, or someone else, could take another photo of the same tree from exactly the same perspective as a previous image. The rePhoto app shows the previous picture transparently in half of the screen so that a new picture can be accurately aligned. The photos are uploaded to a database, where they can be analyzed for changes.

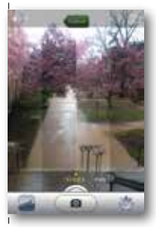
In another application of computer vision, Pless and members of his lab used their techniques to help with a cold crime case in 2013. An unidentified young girl was murdered in 1983 and was buried in a local cemetery in an unmarked grave. To find the body, Abby Stylianou, a research associate in Pless' lab, took old newspaper photos taken at the girl's funeral and compared them with current aerial images from the U.S. Geological Survey.

Using items in the newspaper photos, such as a tree near the gravesite and a billboard that no longer stands, the team used algorithms developed in Pless' lab to find points in the photos and match them to points currently at the cemetery, then made a model to determine from where the original photos were taken in the cemetery. Based on their modeling, the St. Louis Medical Examiner found the grave 8 inches from where Stylianou said it would be.

"Building tools to let other people take advantage of their creativity leads to endpoints you'd never think of," Pless says.

RON KLEIN

Pless' other university positions include director of the doctoral program and of graduate admissions, Computer Science & Engineering; Computer Science faculty representative to the Graduate Council; Engineering representative to the Undergraduate Council.



projectrephoto.com

When Hipp presents his collaborative research with Pless, he shows an image of the volleyball scene from the 1980s movie "Top Gun" to illustrate how he and Pless were introduced. "I claim to be Maverick because he is better looking and active, and I'm a public health professor, and Robert is Goose, because he's a computer scientist and kind of a dork."

Pless plays in local ultimate Frisbee leagues and for a St. Louis team called Brick City that travels in tournaments. He has been playing at least twice a week for 13 years. He reached his goal of going to the national championships last summer "because I aged into the grand master's category."

MARK KATZMAN

ENGINEERED *to* SERVE

A woman in India prepares a meal using a traditional wood-burning cookstove in her home while her children are nearby. The photo is from Gautam Yadama's book "Fires, Fuel, and the Fate of 3 Billion: Portraits of the Energy Impoverished" published by Oxford University Press. Yadama, PhD, is professor and director of international programs at The Brown School.

Written by **BETH MILLER**

Michael Liu and Victoria Wang, both seniors, have been good friends since they met their freshman year. During the spring of that year, they pledged Alpha Phi Omega, a national, co-ed service fraternity with a large, active chapter at Washington University. The organization, founded on the principles of leadership, friendship and service, provides members with the opportunity to develop leadership skills as they volunteer on their campuses, in their communities and for their nation. Each member is required to do 15 hours of service each semester.

The WUSTL chapter cooks meals for families staying at the Ronald McDonald House, works in greenhouses and cleans up trash for Brightside St. Louis, plays with children at the St. Louis Crisis Nursery, directs spectators at Busch Stadium to recycle food and drink containers, and works on campus at Dance Marathon and Relay for Life, among many other opportunities.

"If I can't give back, I should try to give forward."

— MICHAEL LIU

"It's probably been one of the most valuable experiences I've had in college because it uses the passion for service to motivate you to think about how you are a leader and how you effect change in the community," says Wang, who is majoring in biomedical engineering. "Without this opportunity, I wouldn't have any of the subsequent opportunities I've had in college. The leadership courses and being able to spend time understanding how the organizations work and seeing how nonprofits work in St. Louis have been invaluable. In some ways, it's a responsibility we have as Wash U. students to understand what happens outside the bubble."

For both Liu and Wang, service is part of their very nature.

"My parents taught me that if I can't give back, I should try to give forward," says Liu, who is majoring in computer science with a minor in psychology. "Coming to Wash U. is a great opportunity for me to not only become better educated, but having this opportunity to give is a great way that I can help shape the future."

Liu and Wang are just two of the hundreds of students in the School of Engineering & Applied Science who devote at least a few hours a week from their already busy schedules to community service. From tutoring children in the community and their peers on campus, to walking dogs for Stray Rescue of St. Louis, to going to Africa to help a school for blind children, Engineering students think beyond their immediate needs in consideration of how to help others. Through these opportunities, they can apply the skills and experience they are learning through their coursework, as well as serve society — either locally or across the globe.

"Our students have the ability and want to do more than only engineering," says Melanie Osborn, assistant dean in Engineering Student Services. "The engineering is a great help, because they can not only go someplace and help someone, they can go there and repair the equipment, instruct others, and be involved in a deeper way. They have a lot of added value that they bring. Instead of just a pair of hands, they are the people who can figure out what everybody's pair of hands should do."

Osborn says students entering the School of Engineering & Applied Science are coming in with service experience from high school and they want to continue that through their college years.

Instilling a love for STEM

In high school, William Padovano was involved in a Lego Robotics program, which uses a sophisticated Lego set called Lego Mindstorms that includes the gears, sensors, motors and other parts needed to build moving robots and cars. Now a junior majoring in biomedical engineering, Padovano wanted to use that experience to share with others his love for STEM.

He teamed with his friend, David Kim, also a junior majoring in biomedical engineering, who had been volunteering at the St. Louis Juvenile Detention Center. In early February, the two started a Lego Robotics program at the detention center where the youth built and raced cars, based on Padovano's high school program. In fact, Padovano's Lego Robotics adviser from high school donated an old Lego Mindstorms for them to use.

"We didn't want to make it a traditional classroom with lectures and homework," Padovano says. "Our goal is to make science and engineering fun so they will learn a lot and not actually know that they are learning.

"One week, instead of an assigned car, we had a free build where they were asked to make a car that goes as fast as possible," Padovano says. "We gave them instructions and a model. One team independently came up with a better design and won the competition. It's really impressive how easily they grasped the concepts and surprising how excited they are."

Connie Shao, a senior in biomedical engineering, has been external vice president for Student Union since 2010 and co-founded the Journal Club for Undergraduates in Biological Engineering in 2011. A John B. Ervin Scholar, Shao has done research in the lab of Igor Efimov, PhD; at the School of Medicine; and in industry. On top of her academic course load and preparing for medical school next year, she volunteers with patients at St. Louis Children's Hospital; with Math Circle, which creates fun projects with math for local middle school students; and with Cadence with Care, in which volunteers play musical instruments for patients at the Siteman Cancer Center.

"Math Circle is something I care a lot about and is important to me because I grew up loving math," Shao says. "It's one of the things I found refuge in as a kid. What I really enjoy about Math Circle is working with middle school, high school and elementary kids to help them develop that passion for math."

Anna Leavey, PhD, and Sameer Patel test an improved cookstove.

Improving air quality and safety

While Engineering students are involved in their own city, many also are drawn to global issues. Anna Leavey, PhD, a postdoctoral researcher, and Sameer Patel, a doctoral student, both work in the lab of Pratim Biswas, PhD, chair and the Lucy & Stanley Lopata Professor of Energy, Environmental & Chemical Engineering, measuring emissions from traditional and improved cookstoves relied upon by 3 billion people in developing countries worldwide, including India.

They are part of a larger university group working on a variety of aspects of cookstoves.

In these developing countries, many families in rural villages have no access to electricity, so the women cook meals on and heat their homes with a traditional indoor cookstove, a small, freestanding unit fueled by any materials they can find — wood, sticks, scavenged coal or dried animal dung. The rooms are small with little ventilation, so the smoke from the burning fuel and cooking food stays inside the home, where it is inhaled by everyone inside.

Leavey went with the team to rural Udiapur, India, in 2012 to measure the emissions from these traditional cookstoves.

"I'd read about it a lot, but you don't realize how harsh it is until you're actually standing there," Leavey says. "The air would fill with smoke. It was incredible — your eyes would water. And they did this two to three times a day, and often their children were with them.

Each year, 2 million people worldwide die from cookstove-related illnesses, primarily women and children.

"It also creates environmental issues with the depletion of biomass, as well as security issues: when women have to walk further from home to find fuel, the risk of violence against them increases when they leave their villages," Leavey says.

In addition to studying the composition and effects of the emissions from the traditional cookstoves, the team is studying the use of improved cookstoves that have been distributed by nongovernmental organizations across India and other countries. One of the most common improved cookstoves has an integrated fan, but it requires electricity, so many stop using it.

Engineers Without Borders addresses many needs

Through the Washington University chapter of Engineers Without Borders (EWB), a national organization that supports community development projects worldwide, Engineering undergraduate students are involved in a variety of local and international projects.

Locally, a group of EWB members is working with a church community and another group in the Hyde Park neighborhood of north St. Louis to design a bioretention basin in an empty lot. The basin is a type of rain garden used as a filtration system to reduce rainwater runoff into sewers, says team leader Lucy Cheadle, a junior majoring in chemical engineering with a minor in environmental engineering and energy engineering.

The Hyde Park project team consists of WUSTL undergraduates as well as students in the UMSL/Wash U. Joint Engineering Program, which brings strength in all areas of engineering, as well as a group focused on local projects, Cheadle says.

"I think it's important to stay local," she says. "St. Louis has a lot of nice areas, but it also has a lot of areas that need help."

Another EWB team is developing medical devices that could be used in developing countries. The team, headed by sophomore Huy Lam, who is majoring in biomedical engineering, has four teams of students this year working on projects including transdermal patches that would deliver antibiotics or zinc, a device that would help keep vaccinations from freezing, and a device that would be a portable tool to assist dentists avoid hitting nerve endings in dental surgery.

"From day one, we go to the World Health Organization to see what the world needs," he says. "In a sense, this design team is a simulation of what entrepreneurship will be like. Our team is very problem-oriented: many people on the team are not interested in making a for-profit company."

Left: Michael Liu (center) and Victoria Wang (right) help protect a home from cold weather on an Alpha Phi Omega service project.

Below, left: Carolyn Arden, left, and Morgan Carlile at Roosevelt Hospital in Guatemala

Below: Maeve Woeltje works on the electrical system at the Mekele Blind School in Ethiopia.

Carolyn Arden, a sophomore majoring in systems science and engineering and Spanish, heads another team under the EWB umbrella, the Washington University Guatemala Initiative (WU-GI). Last year, Arden worked with BJC HealthCare staff learning how to repair an older model ventilator in use at Roosevelt Hospital in Guatemala City, Guatemala. She visited the hospital in the summer of 2013 with the School of Medicine's Global Health Scholars to meet with doctors, surgeons, medical residents and hospital staff. While there, she "caught the bug."

"I said to myself, 'I can't just leave and forget about this,'" she says. "This was not a project that we finish and forget about, because then, how can we ensure our impact is sustainable?"

When she returned from the trip, she started WU-GI, which has about 15 student members who are working with BJC staff to learn how to repair medical equipment used by Roosevelt Hospital so they can repair it on service trips. The team is learning to repair ventilators, patient monitor displays and infant warmers, as well as building ECG simulators for the hospital to use in its emergency room and shock room in preparation for a trip this July.

"When I was in Guatemala, I took inventory of all the broken equipment, what needed to be repaired and things we could work on," she says. "I'm also working to translate repair manuals from English into Spanish, so if some of their equipment is broken, they can read how to fix it."

Arden says WU-GI has become a big part of her life. "Being down there changed my perspective," she says. "I just felt really empowered to do something. I could have left and said, 'That was a great experience,' and put it my resume, but for me, it turned into something more. Here at Wash U. I'm given the tools and am fortunate enough to have the experience and the education to make a difference and impact, and I felt responsible to make something out of that experience and to continue it."

The other international travel arm of Engineers Without Borders is a team's work with the Mekele Blind School in Ethiopia. A group of WUSTL EWB students has made the trip to Ethiopia for several years. Most recently, the team spent two weeks at the school, upgrading the electrical system to improve the cooking methods and adding outdoor lighting for safety and security.

Maeve Woeltje, a junior majoring in biomedical engineering and one of the co-leaders of the trip, said the residential school, which serves about 100 students, was using just two stoves to cook 200 pieces of injera bread every day because they did not have enough power to operate a third stove. In addition, they were unable to use two additional cooking stoves for other foods because they did not have enough electricity for them, so they were using wood-burning stoves indoors, creating unhealthy air quality. In addition to installing new circuit breakers, the team made plans for a new electric meter to be installed that will provide enough power for all of the electric cooking stoves.

This was Woeltje's first trip to Ethiopia.

"I have been involved with EWB for two years, so I was invested in the community," she says. "It was a good way to learn applicable things about engineering and implement them and also travel and explore a new culture."

Watch an interview with Carolyn Arden: youtube.com/WUSTLEngineering

JOHN C. SOMMERER

Connecting physics & space

Written by **RICK SKWIOT**

Key technological advances in missile defense, homeland security and information security that affect all Americans — along with ongoing solar system exploration — have burgeoned under the leadership and guidance of Engineering alumnus John C. Sommerer, PhD.

At the Johns Hopkins Applied Physics Laboratory (APL), which he joined in 1980 and where he headed both its Research Center and later its Space Department, Sommerer oversaw advances in the physics of submarine detection, the MESSENGER Mission to Mercury, the New Horizons Mission to Pluto and the Missile Defense Agency's Precision Tracking Space System.

APL, organized in 1942 to develop critical World War II technology and located near Washington, D.C., works to solve vital national security problems and to advance space science. Sommerer recently led APL's development of NASA's Van Allen Probes and a team of some 700 technical experts.

"At the dawn of the Space Age, James Van Allen discovered that the Earth is surrounded by two belts of pretty intense radiation," says Sommerer, who earned bachelor's and master's degrees in systems science mathematics from WUSTL in 1979. "The International Space Station lives below these belts, which can damage satellites. We built a pair of spacecraft at APL that are up there now to help us understand how the belts change with time" — knowledge that could help satellite operators.

He also was lately involved in a NASA mission, slated for a 2018 launch, that would "send a probe into the sun's outer atmosphere, its corona, where the temperature is millions of degrees," Sommerer says.

Previously, as head of APL research, he led a team working to figure out materials to protect a spacecraft in that environment.

"(The material) is 8 inches thick," he says. "When the front side is 2,700 degrees Fahrenheit, the backside, where the instruments are, is room temperature."

Sommerer, who in January stepped down from his job leading the Space Department, was most recently APL Senior Fellow for National Space Policy before his April 4 retirement. He recently headed a technical panel for a congressionally mandated National Academy of Sciences study on the U.S. human

John C. Sommerer, PhD, who recently retired as senior fellow for National Space Policy at the renowned Johns Hopkins Applied Physics Laboratory, has headed its Research Center and Space Department, overseeing tremendous advances in homeland security, information security and defense.

ED WHITMAN, JHUAPL

Sommerer with NASA Administrator Charles F. Bolden Jr. at the APL

spaceflight program. While unable to reveal the study's results (slated for early summer release), he personally questions the emphasis on manned spaceflight, which now consumes half of NASA's budget.

"We could maybe get people to Mars in the next 50 years at the cost of half a trillion dollars or, thanks to the explosion of robotic capabilities, send 100 top robotic spacecraft to explore the entire solar system."

During Sommerer's tenure, APL experienced significant growth, with its Milton S. Eisenhower Research Center quadrupling in size when he headed it. Additionally, in the early, post-Cold War '90s, he led a committee challenged to protect APL's future. The result was a three-pronged plan focused on missile defense,

John and his wife, Suzette Jacques, at Naranjo de Bulnes, a mountain in the Picos de Europa, North Spain.

This year, the Sommerers are planning several adventures, including diving in Alaska, a foot safari in Zambia, a trip to ride with the Kazakhs as they hunt with their golden eagles in Mongolia and the Advent markets in Prague.

- Elected to the International Academy of Astronautics in 2011
- Adviser to the Howard County, Md., new business incubator, NeoTech
- Maryland's Distinguished Young Scientist in 1994
- Named the inaugural Daniel Coit Gilman Scholar by JHU
- Director, Jim Rouse Entrepreneurial Fund

homeland security ("called counter-proliferation in pre 9/11 days," he says) and national security concerns in the information sphere.

"This led to a substantial period of growth in which APL doubled in size," he says.

Sommerer, who earned a master's in applied physics from The Johns Hopkins University and a doctorate in physics from the University of Maryland, also has produced notable personal work in the field of nonlinear dynamics. His 1993 discovery of why one sometimes finds fractal patterns in fluid flows was featured on the cover of the journal *Science*.

He came to Washington University from Milwaukee to major in chemical engineering. But a freshman elective course on mathematical modeling taught by Ervin Rodin, PhD, changed everything.

"It completely opened my eyes to the power of the concept to capture properties of complicated systems mathematically," Sommerer says.

He changed his major to what was then called systems science mathematics and has been a champion of the program ever since, continuing to serve as an external adviser to Arye Nehorai, PhD, chair of the Department of Electrical & Systems Engineering, and contributing to a scholarship fund named for Rodin, now senior professor.

"I'm a real booster," Sommerer says. "It is an absolutely unique curriculum you could not get anywhere else in the country. It really prepared me to approach problems from a different perspective: When you find things that don't correspond to your governing model, you check your assumptions. I apply that same schema to manage projects and organizations and to improve organizational performance. And at APL, I've had a chance to do a great number of things in one organization."

Yet none of his noted successes may have happened without the financial aid Sommerer received via a Langsdorf Scholarship.

"I couldn't have gone to Washington University if I hadn't had that deal," he says. "It meant everything to me."

That includes "the most important thing" that happened to him at Washington University, meeting his wife of 35 years, Suzette Jacques, who earned a bachelor's in chemical engineering at WUSTL in 1979.

Sommerer gives back to Washington University by serving as a member of the external advisory board for the Department of Electrical & Systems Engineering.

As to Sommerer's future work, he says, "There are more interesting things to do than there is time to do them."

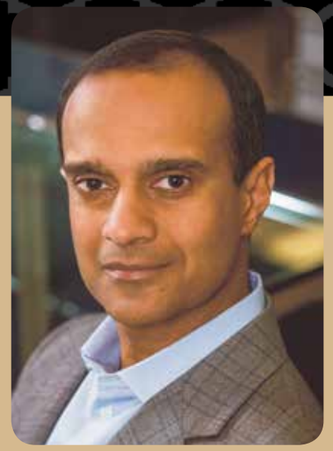
Recently, at the urging of the Acting Deputy Secretary of Defense, he joined a National Academy of Sciences study to make recommendations on the future governance of National Nuclear Security Administration laboratories "so they can better serve the Department of Energy, Department of Defense, Department of Homeland Security and the U.S. intelligence community," he says.

Alumni Achievement Awards 2014

The Alumni Achievement Awards are presented to alumni whose achievement has been truly outstanding. Because alumni are found in such a wide variety of careers, consideration is not restricted to alumni who have followed a traditional engineering career path. In addition to career achievement, consideration is given to contributions to education, civic causes, professional societies and public service.

Harold Barron, MD, is president of research & development for Calico, Google's new anti-aging startup, aimed at tackling aging and illness.

Barron combines this role with a part-time commitment at Roche, where he has served as chief medical officer and head of global product development. He also is a member of the Genentech Board of Directors. From 2004 to 2013, Barron was chief medical officer and executive vice president of global development at Genentech. A Langsdorf Scholar at Washington University, Barron earned a bachelor of science degree in engineering physics in 1985 and a medical degree from Yale University in 1989.



Gaurav Garg co-founded Wing Ventures in 2013. Wing's first fund is $160 million, focused on about 15 early stage technology companies with products and services directed at businesses in cloud computing, mobile and big data.

The firm's goal is to build enduring public companies. Garg was a partner at Sequoia Capital, Silicon Valley's most prominent venture capital firm, from 2001 to 2012. Garg earned bachelor of science degrees in computer science and electrical engineering in 1988 and a master's degree in electrical engineering in 1990 from Washington University.

Peter Leemputte is executive vice president and chief financial officer for Mead Johnson Nutrition, the leading global manufacturer of pediatric nutrition products.

He led the launch of Mead Johnson as a public company in one of the most successful IPOs in 2009. Prior to joining Mead Johnson, Leemputte served as an executive officer and CFO of Brunswick Corp. and Chicago Title Corp. He earned a bachelor's degree in chemical engineering in 1979 from Washington University and an MBA from the University of Chicago in 1983.

Christine Lorenz, PhD, is vice president, research and clinical collaborations, molecular imaging, at Siemens Healthcare, with responsibility for innovation and intellectual property strategies in molecular imaging.

Lorenz has held several faculty positions in radiology, cardiology and biomedical engineering at Vanderbilt University and at Washington University, where she was granted tenure. At Washington University, Lorenz was a Langsdorf Scholar, earning a bachelor's of science degree in mechanical engineering in 1986. Lorenz earned a master's degree and doctorate from Vanderbilt University and an MBA from the European School of Management and Technology.

Stephen Sands is vice chairman of U.S. Investment Banking and global co-head of the Healthcare Group at Lazard.

He has been with the firm since 1994, providing strategic and financial advice to senior executives and boards of directors at leading health-care and life sciences companies globally. Sands earned, through the Engineering 3-2 dual degree program, a bachelor's and a master's degree in chemical engineering from Washington University in 1979, along with a bachelor's from Oberlin College in 1977. He earned an MBA from New York University in 1986.

>> Watch a short video of each awardee:
engineering.wustl.edu/alumniawards

Turner, former CSE chair and National Academy of Engineering member, to retire

Turner has been a leading researcher in the field of computer networking and is well known for his work on scalable switching systems. He has many widely cited publications and has been awarded 30 patents. With his collaborators at Washington University, he built a series of novel network systems in order to demonstrate innovative research ideas. He is a fellow of the Institute for Electrical and Electronics Engineering, a fellow of the Association for Computing Machinery and a member of the National Academy of Engineering. His 1986 paper, "New Directions in Communications," was reprinted as a landmark article in the 50th anniversary issue of IEEE Communications Magazine.

Jonathan Turner, PhD, the Barbara J. and Jerome R. Cox, Jr. Professor of Computer Science, is retiring from Washington University Aug. 31 after 21 years on the faculty. He will remain a senior professor following his retirement.

Turner first joined the WUSTL community in the 1970s as one of the school's first 3-2 dual degree graduates, earning bachelor's degrees in computer science and electrical engineering in 1977. Over his academic career, he was chair of the Department of Computer Science & Engineering from 1992-97 and again from 2007-08. He teamed up with colleagues Jerry Cox and Guru Parulkar to found WUSTL's Applied Research Laboratory, which he directed until 2012. The trio also founded the startup Growth Networks, which developed high-performance switching components for Internet routers and was acquired by Cisco Systems in 2000.

Recently, Turner's research has centered on how to enable new network services by constructing Internet-scale overlay networks using cloud-computing infrastructures. These systems use modern multicore computer servers as overlay routers and are designed to support applications with demanding real-time performance requirements, such as large-scale virtual worlds.

In 2006, he was named to the Cox Professorship in what he says is the proudest moment of his career. Washington University also has awarded him three of its highest honors: the Chancellor's Award for Innovation and Entrepreneurship, the Founder's Day Distinguished Faculty Award and the Arthur Holly Compton Faculty Achievement Award. He also won an Engineering Alumni Achievement Award in 2007 and the Dean's Award in March 2014.

WUSTL PHOTO

Engineering student wins national championship race

WUSTL freshman Michael Lagieski set a meet and school record on his way to winning the national championship in the men's 100 breaststroke to highlight five All-America finishes March 21 on the third day of the 2014 NCAA Division III Swimming & Diving Championships at the Indiana University Natatorium.

In fourth place after the first 50 yards, Lagieski closed the final 50 yards 0.2 of a second faster than the runner-up finisher to set an NCAA Division III Championship meet record with a time of 54.10. Lagieski is the fourth men's swimmer at WUSTL to win a national championship.

Lagieski's individual title helped move the Washington U. men into 14th in the team standings heading into the final day of competition.

Stan Musial Veterans Memorial Bridge under construction

COURTESY PHOTO

UMSL/WUSTL Joint Student creates documentary about Stan Musial Memorial Bridge

DOUG HOWELL/KSDK

Upon turning 40 a few years ago, Jim Tuxbury started re-evaluating his life.

"I started thinking about whether or not I was leaving the kind of mark I wanted to leave," said Tuxbury, who earned a bachelor's in speech communication in 1988 at UMSL. "In my case it lead me back to school."

Tuxbury has been a successful photojournalist at KSDK (Channel 5) since 1990, but the introspection made him realize he wanted to return to school and study engineering.

"I have always thought the first degree I earned at UMSL served me very well," he said. "The engineering program has always been in the back of my mind as something that I wanted to pursue, but my kids were young and I had all sorts of family obligations. I was eyeballing the program in my 30s but felt I couldn't go back. When I turned 40, I made it my goal to work toward the program."

Tuxbury is a senior majoring in electrical engineering in the UMSL/WUSTL Joint Undergraduate Engineering Program. And for the past several years, his work life and school life have merged in an amazing way, and the fruit of that effort aired March 20 on KSDK.

For the past four years he's been working on a documentary about the making of the Stan Musial Veterans Memorial Bridge, which opened to the public Feb. 9. He's followed the project from construction through completion.

By Myra Lopez, UMSL Daily

Watch the documentary at ksdk.com; search "Stan Musial Bridge"

Gruev, Weinberger promoted effective July 1

Viktor Gruev, PhD, and Kilian Weinberger, PhD, both in Computer Science & Engineering, were promoted to associate professor and granted tenure at the Board of Trustees' spring meeting. All appointments are effective July 1.

VIKTOR GRUEV

Gruev, who joined the faculty in 2008, studies low-power integrated sensory systems. His lab is developing a new generation of optical sensors capable of capturing the three properties of light with low power, low noise and high-resolution imaging sensors.

Gruev earned a doctorate from Johns Hopkins University in 2004, then completed postdoctoral research at the University of Pennsylvania.

KILIAN WEINBERGER

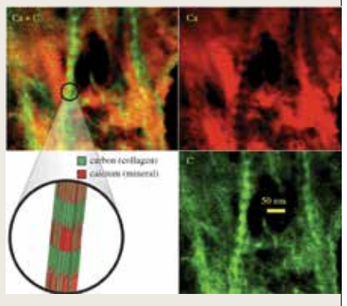
Weinberger, who joined the faculty in 2010, focuses his research on machine learning, high-dimensional data analytics, machine-learned web-search ranking, and resource-efficient and metric learning settings. In 2012, he received a prestigious National Science Foundation CAREER Award.

Previously, Weinberger was a research scientist at Yahoo! in Santa Clara, Calif. His work on supervised and unsupervised metric learning has won several outstanding paper awards. He earned a doctorate from the University of Pennsylvania in 2007.

Researchers blend orthopedics, engineering to better repair torn rotator cuffs

With a five-year, $3.1 million grant from the National Institutes of Health, orthopedic researchers and engineers at Washington University are working to discover a better way to improve the outcome of surgical repairs by studying the natural attachment of tendon to bone. This understanding could lead to the engineering of new tissues that could enhance cuff repair.

"Every motion you make is related to the attachment of tendon to bone," says Guy Genin, PhD, professor of mechanical engineering in the School of Engineering & Applied Science. "The muscle is attached to the tendon, and the tendon is attached to the bone. Any break in the linkage will prevent motion, so this attachment is vital to the way the body works."



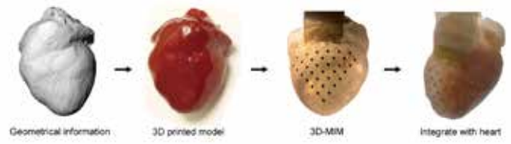
"The natural attachment system is not regenerated during healing, even following surgical repair," says Stavros Thomopoulous, PhD, associate professor of orthopaedic surgery in the School of Medicine. "The healing process leads to scar-tissue formation at the healing tendon-to-bone interface, and the resulting attachment is prone to re-injury."

engineering.wustl.edu/rotatorcuffs

3-D printer creates transformative device for heart treatment


WUSTL PHOTO

Using an inexpensive 3-D printer, biomedical engineers have developed a custom-fitted, implantable device with embedded sensors that could transform treatment and prediction of cardiac disorders.



Igor Efimov, PhD, at the School of Engineering & Applied Science at Washington University and an international team of biomedical engineers and materials scientists have created a 3-D elastic membrane made of a soft, flexible, silicon material that is precisely shaped to match the heart's epicardium, or the outer layer of the wall of the heart. Current technology is two-dimensional and cannot cover the full surface of the epicardium or maintain reliable contact for continual use without sutures or adhesives.

The team can then print tiny sensors onto the membrane that can precisely measure temperature, mechanical strain and pH, among other markers, or deliver a pulse of electricity in cases of arrhythmia. Those sensors could assist physicians with determining the health of the heart, deliver treatment or predict an impending heart attack before a patient exhibits any physical signs.

"Each heart is a different shape, and current devices are one-size-fits-all and don't at all conform to the geometry of a patient's heart," says Efimov, the Lucy & Stanley Lopata Distinguished Professor of Biomedical Engineering. "With this application, we image the patient's heart through MRI or CT scan, then computationally extract the image to build a 3-D model that we can print on a 3-D printer. We then mold the shape of the membrane that will constitute the base of the device deployed on the surface of the heart."

Ultimately, the membrane could be used to treat diseases of the ventricles in the lower chambers of the heart or could be inserted inside the heart to treat a variety of disorders, including atrial fibrillation, which affects 3 million to 5 million patients in the United States.

engineering.wustl.edu/3Dheart

Jain receives Qatar National Research Fund grant


RAJ JAIN

Raj Jain, PhD, professor of computer science & engineering, has received a grant in collaboration with Qatar University to study application delivery in cloud-based application deployment environments.

The three-year, $1.05 million grant provides $315,000 for Jain's work in collaboration with Mohammed Samaka, PhD, associate professor of computer science at Qatar University, who is the lead principal investigator. Jain will co-manage a postdoctoral researcher in Qatar and a graduate student at WUSTL.

Their research will focus on the separate middlebox infrastructure that provides application delivery services such as security, performance and scaling in modern enterprise and Internet-based application environments. There is no clear support for middleboxes in the original Internet design, so data center administrators must accommodate middleboxes through ad-hoc and error-prone network configuration techniques.

The researchers suggest that most businesses need to use a globally distributed application-level routing infrastructure to intelligently route application traffic to the right cloud data center. For example, Google and Microsoft have their own worldwide network for their traffic. But since such an infrastructure would be extremely hard to own and manage, it is best to design a shared solution where application-level routing could be provided as a service by a third-party global provider, such as an Internet service provider.

Klyachko receives Distinguished Investigator Award


VITALY KLYACHIKO

Vitaly A. Klyachko, PhD, assistant professor of biomedical engineering, received a Distinguished Investigator Award Jan. 29 at the School of Medicine.

Klyachko, also assistant professor of cell biology and physiology and of neurobiology at the School of Medicine, was among 18 faculty who received Distinguished Faculty Awards for their dedication, talent and wide-ranging achievements.

Klyachko was recognized for his influential research on synaptic function and its defects in Fragile X syndrome, the leading inherited cause of mental disability and autism.

Fragile X syndrome is caused by a loss of a single protein, called FMRP. Klyachko's work elucidates the role of FMRP in regulating signal transmissions between neurons in the brain. Unlike nearly all other researchers in this area, who focus on the mechanisms of receiving nerve signals, Klyachko studies the process of sending signals.

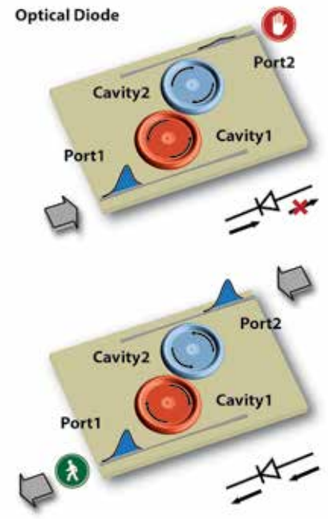
Groundbreaking optical device could enhance computers, lasers

At St. Paul's Cathedral in London, a section of the dome called the Whispering Gallery makes a whisper audible from the other side of the dome as a result of the way sound waves travel around the curved surface. Engineers at Washington University in St. Louis have used the same phenomenon with an optical device that may lead to new and more powerful computers that run faster and cooler.

Lan Yang, PhD, the Das Family Career Development Associate Professor of electrical and systems engineering, and her collaborators have developed an essential component of these new computers that would run on light. Their work brings predictions from recently formulated theoretical physics into real-world applications.

The results of their research appeared in *Nature Physics* advance online publication April 6.

Yang's group has created an optical diode by coupling tiny doughnut-shaped optical resonators — one with gain and one with loss — on a silicon chip.



In an optical diode, the light input in one direction is transmitted while the light input in the opposite direction is blocked. The new optical diode is made from parity-time (PT) symmetric microresonators in which loss of one of the resonators is balanced by the gain in the other.

"We believe that our discovery will benefit many other fields involving electronics, acoustics, plasmonics and meta-materials," says Yang, who received the Presidential Early Career Awards for Scientists and Engineers (PECASE) for her innovative work with these devices in 2011. "Coupling of so-called loss and gain devices using PT (parity-time) symmetry could enable such advances as cloaking devices, stronger lasers that need less input power and perhaps a detectors that could 'see' a single atom."

engineering.wustl.edu/optical

Julie Margenthaler, MD, a WUSTL breast surgeon at the Siteman Cancer Center

Special glasses help surgeons 'see' cancer

High-tech glasses developed at Washington University School of Medicine in St. Louis may help surgeons visualize cancer cells, which glow blue when viewed through the eyewear.

The technology, developed by a team led by Samuel Achilefu, PhD, professor of radiology and biomedical engineering at Washington University, incorporates custom video technology, a head-mounted display and a targeted molecular agent that attaches to cancer cells, making them glow when viewed with the glasses.

Cancer cells are notoriously difficult to see, even under high-powered magnification. The glasses are designed to make it easier for surgeons to distinguish cancer cells from healthy cells, helping to ensure that no stray tumor cells are left behind during surgery.

"We're in the early stages of this technology, and more development and testing will be done, but we're certainly encouraged by the potential benefits to patients," said breast surgeon Julie Margenthaler, MD, an associate professor of surgery at Washington University, who performed a recent operation. "Imagine what it would mean if these glasses eliminated the need for follow-up surgery and the associated pain, inconvenience and anxiety."

Current standard of care requires surgeons to remove the tumor and some neighboring tissue that may or may not include cancer cells. The samples are sent to a pathology lab and viewed under a microscope. If cancer cells are found in neighboring tissue, a second surgery often is recommended to remove additional tissue that also is checked for the presence of cancer.

The glasses could reduce the need for additional surgical procedures and subsequent stress on patients, as well as time and expense.

"This technology has great potential for patients and health-care professionals," Achilefu said. "Our goal is to make sure no cancer is left behind."

Viktor Gruev, PhD, assistant professor of engineering at WUSTL, and Ron Liang, PhD, of the University of Arizona, assisted with development of the glasses. WUSTL graduate students Suman Mondal, Shengkui Gao and Yang Liu and postdoctoral fellow Nan Zhu also played key roles.

» **engineering.wustl.edu/seecancer**

Engineers provide free code to help build better batteries

Lithium-ion batteries, such as those used in electric vehicles, are in high demand, with a global market value expected to reach $33.1 billion in 2019. But their high price and short life need to be addressed before they can be used in more consumer, energy and medical products.

Venkat Subramanian, PhD, associate professor of energy, environmental & chemical engineering, and his team have developed a way for lithium-ion battery developers to determine in early stages

whether a new material for the batteries will work. The team developed a freely available code that battery developers can use as a model to determine the optimal profile needed to charge a lithium-ion battery as well as any stresses that might be put on the materials used.

"This is a back-of-the-envelope calculation," said Subramanian, an expert in lithium-ion batteries. "Before you invest millions of dollars to go into manufacturing full time, you can develop models and codes similar to this and look at this initial data to extrapolate and predict how it will work."

The research was recently published in *Physical Chemistry Chemical Physics*.

The code, designed for a Windows platform, is available for free download.

Subramanian said software development such as this code is an important part of developing new lithium-ion batteries.

» **www.maple.eece.wustl.edu**

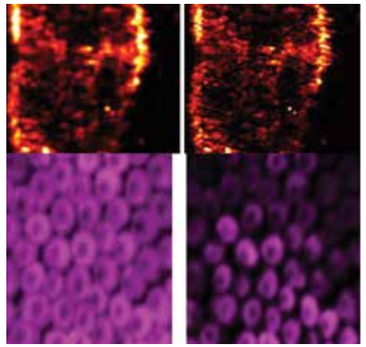
Unwanted side effect becomes advantage in photoacoustic imaging

Biomedical engineer Lihong Wang, PhD, and researchers in his lab work with lasers used in photoacoustic imaging for early cancer detection and a close look at biological tissue. But sometimes there are limitations to what they can do, and as engineers, they work to find a way around those limitations.

Wang, the Gene K. Beare Distinguished Professor of Biomedical Engineering, and Junjie Yao, PhD, a postdoctoral research associate in Wang's lab, found a unique and novel way to use an otherwise unwanted side effect of the lasers they use — the photo-bleaching effect — to their advantage.

The results were published online Jan. 10 in *Physical Review Letters*.

The researchers use an optical microscopy method called photoacoustic microscopy to take an intensely close look at tissues. The laser beam is a mere 200 nanometers wide. However, the center of the laser beam is so strong that it bleaches the center of the tissue sample.



When researchers pulse the laser beam on the tissue, the molecules no longer give signals packed with information.

"Previously when a molecule was prone to bleaching, researchers didn't want to use it because they couldn't get enough information from it," Yao says. "Now for us, that is good news."

After each area of the sample is scanned, the researchers create an image. With previous photoacoustic microscopy imaging, the microspheres on the image were blurry. However, with the new photo-imprint photoacoustic microscopy, the resulting image is clear and sharp.

Joint faculty member publishes thriller novel 'Red Devil 4'

Eric Leuthardt, MD, associate professor of neurosurgery and of biomedical engineering at Washington University School of Medicine, is working to develop brain implants known as neuroprosthetics that detect brain signals and relay them to a computer. He hopes to use the technology to restore movement, speech and other functions in people suffering from stroke.

On the literary front, Leuthardt, director of the Center for Innovation in Neuroscience and Technology, is publishing a novel — his first — that extrapolates from his knowledge of and experience with computers and the brain to create a techno-thriller set four decades in the future. The novel, "RedDevil 4," envisions a world in which brain implants permeate every level of personal and social interaction as cellphones do today. One of the protagonists, Dr. Hagan Maerici, is a St. Louis neurosurgeon on the verge of creating the world's first artificial intelligence. He becomes entangled in a series of brutal murders committed by prominent citizens with no discernible motive for their violent actions.

Agarwal receives engineering education award

RAMESH AGARWAL

Ramesh K. Agarwal, PhD, the William Palm Professor of Engineering in the Department of Mechanical Engineering, has been selected to receive the 2014 Society of Automotive Engineers (SAE) Excellence in Engineering Education (Triple E) Award.

Agarwal received the award because of his long-standing participation and support of SAE's engineering education initiatives. The award recognizes outstanding contributions made to activities related to the SAE Education Board. He will receive the award at the 2014 SAE World Congress in April in Detroit.

"We're really fortunate that Ramesh, an internationally recognized expert in computational fluid mechanics, is also such a dedicated and effective teacher," says Phil Bayly, PhD, department chair and the Lilyan and E. Lisle Hughes Professor of Mechanical Engineering. "It's nice to see him receive this well-deserved recognition."

Agarwal has been on the Washington University Engineering faculty since 2001, bringing with him two decades of industry experience at McDonnell Douglas Research Laboratories (now Boeing Co.), NASA Ames Research Center and National Institute for Aviation Research. His research focuses on flow control, bio-fluid dynamics, computational fluid dynamics and electromagnetics. He also focuses on nanotechnology, carbon capture and sequestration and renewable energy systems.

LEADING *Together*

The Campaign for Washington University

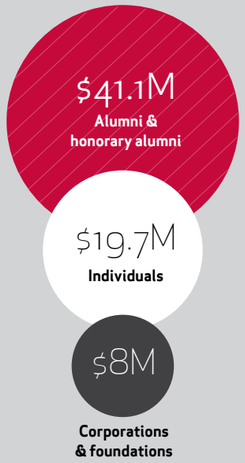
We are committed to becoming one of the world's premier engineering schools. With the continued dedication, hard work and generous support of our engineering alumni, friends and partners, we will achieve our vision to serve society — to improve the quality of life for the greater good. Together, we will lead to ensure a bright, secure future for generations to come. We invite you to join us.

together.wustl.edu

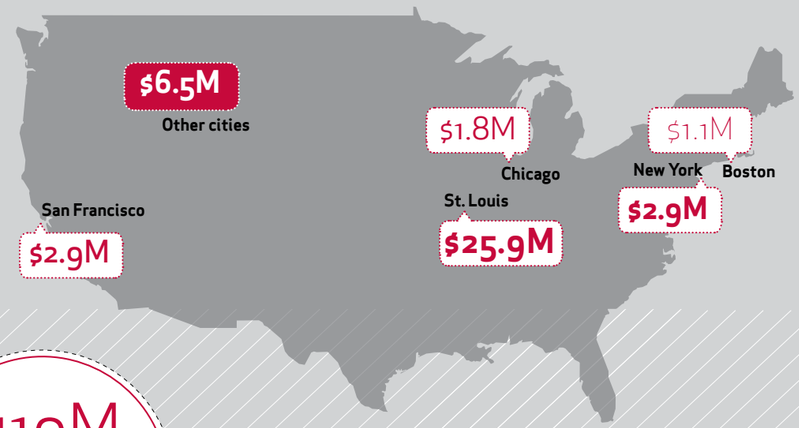
The goal of the Leading Together Campaign is to secure $2.2 billion in private gifts by June 30, 2018. As of March 31, 2014, the university has raised $1.478 billion, or 67 percent of the goal!

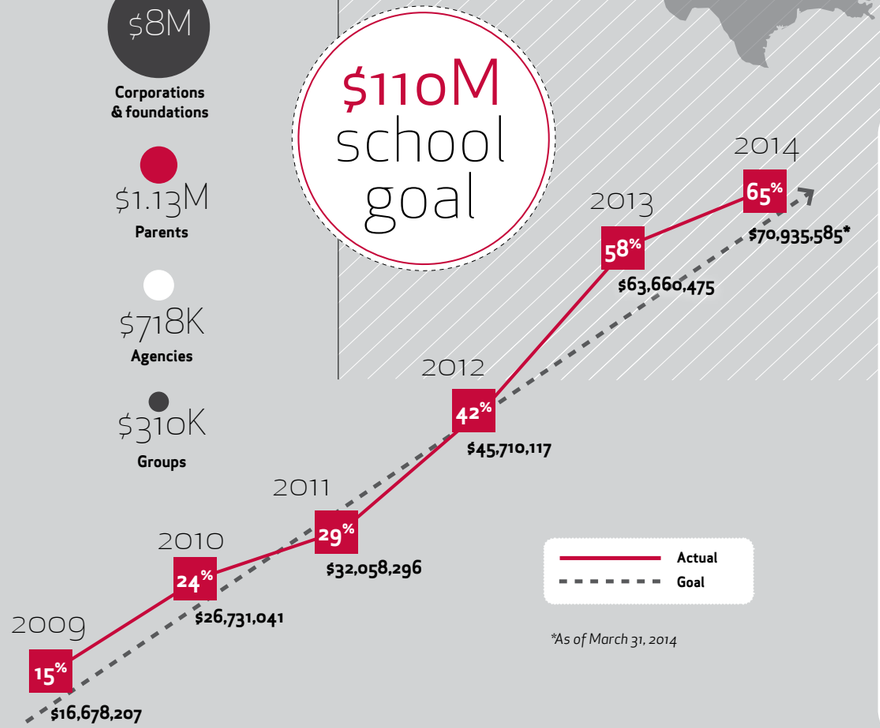
School of Engineering & Applied Science Campaign progress

Campaign giving by donor group



Alumni giving by city





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THE LAST WORD:

service

"The servant-leader is servant first… It begins with the natural feeling that one wants to serve, to serve first. Then conscious choice brings one to aspire to lead."

— Robert K. Greenleaf in *The Servant as Leader*

Lending a helping hand, doing a favor for someone or even holding the door open for the next person are small acts of service we do daily without a thought. These acts of service don't require much time or commitment. But many Washington University in St. Louis Engineering students take those small acts much further, investing their time and thought and ultimately becoming leaders from their service.

By sharing their knowledge, time and experience with local children, families in need or with blind children in Ethiopia, students are building their own leadership skills and learning to become good citizens — both in their communities and of the world.

There are opportunities for everyone to serve their communities by feeding the hungry, tutoring at-risk children or simply offering a helping hand. For local opportunities visit **gephardtinstitute.wustl.edu** *and* **communityservice.wustl.edu**, *or find opportunities nationwide at* **www.volunteer.gov**.

RAY MARKLIN

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