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ENGINEERING



INNOVATIVE ENGINEERING

ENGINEERING ENTREPRENEURS

Wielding a fiber-optic laser, bioengineer Chao Huang is illuminating heart tissue from a laboratory rat. A fourth-year graduate student at the University of Utah Cardiovascular Research Training Institute, Huang is developing a new technique that allows real-time imaging of tissue in 3-D with confocal microscopy.

Using FDA-approved fluorescent dyes on the tip of the fiber-optic cable, Huang can closely examine certain types of tissue while avoiding others. By delivering dye across a tissue sample—“like a marker tip that gives you real-time information,” says Huang—this technique can help surgeons pinpoint tissue related to defects instead of tissue associated with the conduction system of the heart. Currently, surgeons use anatomical landmarks to guide a procedure.

“The motivation of this work is to reduce trauma during pediatric heart surgery by avoiding incidences while suturing or blunt force trauma. We’re hoping to have clinicians use this system while they are doing surgeries,” said Huang.

Under the supervision of his thesis advisor Frank Sachse, a U bioengineering associate professor, Huang has submitted a National Institutes of Health grant to continue their efforts. The next step is to continue imaging studies in larger animals for safety and efficacy, and to define features beneath the heart’s surface such as blood vessels, Huang says.

He hopes to pursue this technology further after graduate school based on his one-of-a-kind training at the University of Utah.

“We offer our students a unique, clinically immersive, educational experience due to our closely knit relationship with our hospitals and clinics,” says Patrick Tresco, chair of the Department of Bioengineering. “This proximity enhances our students’ ability to be innovative in a very practical way.”

In the same spirit, undergraduate mechanical engineers Scott Ho, Jessica Kuhlman and Andy Thompson have updated a squirm-inducing technique by creating a device to improve post-surgical treatment.

Leeches have been commonly used since the Middle Ages to relieve swelling and are still used today to drain blood from swollen body parts after reconstructive surgery. However, leech therapy is not ideal—these “suckers” cannot control blood flow in a reliable fashion and trigger adverse reactions in some patients.

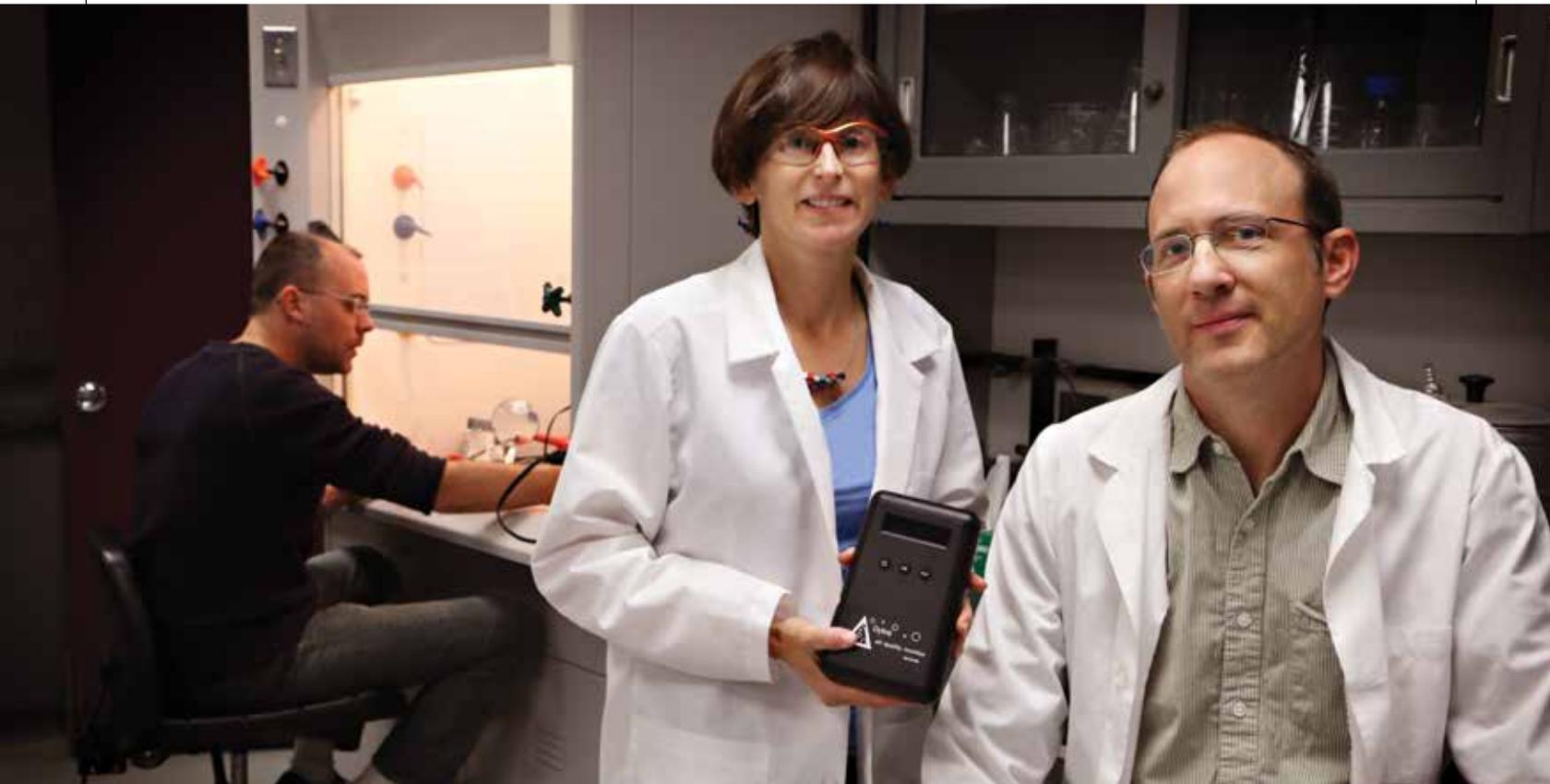
Ho, Kuhlman and Thompson developed a mechanical leech that serves the same functions as their biological counterparts while providing control and consistent performance. The mechanical leech is a one-inch-diameter device containing tiny hypodermic needles on both sides: exterior needles remove bodily fluids while interior needles deliver anti-coagulants to prevent clots.

The team formed BioMime Innovations, LLC in January 2014 and published a utility patent (pending) in April 2014 based on their device. Despite their busy school and work schedules, Ho says the group is pushing forward and seeking additional funding sources from government grants and private investors.

“The thing I enjoy most about my entrepreneurship experience is being able to wear so many different hats,” says Ho, who is now a master’s student in mechanical engineering at the U. “My undergraduate education here at the University of Utah has helped me develop a solid technical toolbox and experiences that taught me how to work in professional settings.”



BUILDING A BETTER SENSOR



Every Salt Lake resident knows what happens in the valley each winter — a ghastly haze of muck blankets the county as a meteorological inversion traps pollution. For those with respiratory problems, it can be much tougher to get through the day.

University of Utah chemical engineers Kerry Kelly and Tony Butterfield are working toward solutions to address air quality in the Salt Lake Valley. Kelly, a research associate with the chemical engineering department, and Butterfield, a chemical engineering assistant professor (lecturing), have taken over research to design and build portable air quality sensors that can measure the particulate matter in the air. They have since built more than 20 of the portable sensors and are now putting them through their paces in a series of studies to test their accuracy and sensitivity.

“It’s important,” Kelly says of the research. “The limited numbers of monitoring stations in the Salt Lake Valley do not give you an accurate picture of pollutant concentrations.”

Thanks to Butterfield’s love of tinkering with sensors, they have built air-quality instruments that

can analyze fine and coarse particulate matter in the air as well as temperature and humidity. What’s unique about the devices Butterfield and Kelly have developed is they can be manufactured for much less than the cost of other portable air quality sensors, and they can take the readings and wirelessly transmit the data to a central database. By deploying a larger number of the instruments throughout the valley, they can get a better overall picture of the air quality throughout the county.

“The end goal is not to have just one number that represents the valley but a pollution map,” Butterfield says.

Currently, these sensors are undergoing a validation study with the Rocky Mountain Center for Occupational Medicine, and then they will be used in a university study this winter with patients suffering from idiopathic pulmonary fibrosis to see how badly the pollution affects their illness. Afterward, Butterfield will begin deploying the sensors in middle and high schools to get more readings and also to help educate kids about science and especially air quality.

COMMUNICATING COMPUTER SCIENCE



Matthew Might is not just a computer scientist. He is a science communicator.

The University of Utah computer science associate professor loves to relay the importance of science and technology to the public. That's why he has a popular blog about his work that gets two to three million hits a year. He also tweets daily to his more than 6,000 Twitter followers. And when he's not interacting with his readers, he's engrossed in his university research, which includes a method to create perfect, bug-free software with airtight security.

"I enjoy communicating science as much as I enjoy doing it," he said.

His community engagement is just one of the reasons Might was named the first Presidential Scholar for the College of Engineering, a new campus-wide honor bestowed by U President David Pershing on early to mid-career faculty who distinguish themselves in research, education and outreach. The six recipients each were

nominated by department chairs and deans and then selected over the summer by a review committee.

Might's blog at matt.might.net/articles/ has grown a loyal readership with posts that range anywhere from tips for iPhone users to a how-to guide on building muscle and strength. He says his most popular post, however, is a simple illustrated guide explaining what a Ph.D. is that has been translated into dozens of languages and has been reposted tens of thousands of times. That post is just one of many in which he tries to explain what he does for a living.

"I started to realize that there is a real need for science communication when you look at the general public's understanding of science," he said. "I feel like every professor has a responsibility to be a champion for their science."

But communication is only half of Might's mission. As an expert on computer security, he also has been researching software that can perform an audit on new computer code to assure that it is completely bug free and impervious to hackers and viruses before it is shipped. He says software today is "well beyond the nightmare-crisis level. Every piece of software is vulnerable and every piece of software is capable of being attacked."

So, he adds, "Why don't we write software that doesn't make mistakes? Can we make perfect software? The answer is, yes we can."

Might became interested in computers while in the sixth grade when his father gave him the old family 286 PC. Since then, he learned how to write computer code while attending the Georgia Institute of Technology in Atlanta where he received his bachelor's, master's and doctorate degrees in computer science. At the U, he also is researching programming languages, high-performance computing and has written security-auditing software for Android apps for the military's advanced research projects agency, DARPA.

"Programming is like playing with LEGOS except you have an infinite number of LEGOS," he said of his love of programming. "You can build anything you want, and your imagination is your only limit."

GRETCHEN McCLAIN

In her highly successful career as a global executive business leader, Gretchen McClain has impacted technologies ranging from cell phone interconnects to robotics for spacecraft. The University of Utah Alumni Association will honor McClain as a Distinguished Alumna at the annual Founder's Day celebration on February 24, 2015.

Inspired by her father, a Penn State engineering graduate, McClain was surrounded by science and engineering from a young age. Her journey began at the University of Utah, where she earned a degree in mechanical engineering. She was among family: McClain's husband, brother and sister are all College of Engineering graduates, and her nephew is currently studying mechanical engineering at the U.

She also cites U distinguished professor of mechanical engineering Larry DeVries with sparking her enthusiasm for her chosen profession. "He was so influential in keeping me interested in engineering and showing me the bigger picture. As an instructor, he was just phenomenal," McClain says.

After graduating from the U, McClain rose quickly through engineering positions in design, program management and structural dynamics before achieving her lifelong dream of working for NASA. As deputy associate administrator for space development, she was responsible for the successful development and launch of the International Space Station. This role gave her "a unique viewpoint, where I could connect pieces across systems," she says.

"It taught me the most important principle of my career, which is the value of teamwork. You can't do it all yourself, but you can be the best at the piece you are responsible for. If there's a weak link in the armor, you have to drop what you are doing and help someone else. Together, we were able to make the launch happen," McClain says.

Fluctuating financial support from the government also led to some unusual teamwork experiences: not only was NASA working with the European Space Agency, but Russia became a partner in the program



as well. This turn of events brought new challenges, McClain says, but once the team got past residual competitiveness and language barriers, they were able to learn a great deal from one another. She received the NASA Distinguished Service Medal for her service.

Motivated to make an impact in the private sector, McClain left NASA for Allied Signal (now Honeywell International), which broadened her horizons even further beyond engineering. As chief technology officer, she managed Honeywell's portfolio of aviation-related businesses and learned about their commercial aspects. In 2011, these diverse leadership experiences led to her role as president and CEO of Xylem, Inc., a leading global water technology company dedicated to solving the world's most challenging water issues. She left Xylem in 2013 and has since served as a member of the boards of both AMETEK and Booz Allen Hamilton.

As a role model for women in engineering, McClain says she has been fortunate to have a strong network of peers and mentors and a supportive family. McClain met her husband in her strength of materials class at the U, and says that throughout her career he has been both her "biggest support and biggest critic—he's always proud of me, but knows I can do more."

"Listening, learning and recognizing what you can apply from your previous experiences is critical—you can never stop learning," McClain says. "At the same time, you need to have confidence in the talents you have. Women are often more critical of themselves, but we have to remember we are at the table because we are good at what we do."

IN BRIEF

SCHLUMBERGER DONATES SOFTWARE

Thanks to a donation from Schlumberger, a leading provider of technology and information systems for the oil and gas industries, University of Utah engineering students and faculty have free access to multi-million-dollar simulation software that can help researchers better analyze oil reservoirs and figure out where they might be located.

The generous donation is worth \$105 million in software, technical support and training and includes multiple licenses for Schlumberger's three main software packages for oil production and geology simulations. Software donated includes ECLIPSE, an industry-reference series of modules of simulation programs for modeling reservoirs; Petrel E&P software platform, which integrates data from multiple disciplines, allowing experts to combine their knowledge in a unified environment; and PetroMod petroleum modeling software that predicts if, and how, a reservoir has been charged with hydrocarbon. The university can use the software free of charge for three years, and it is available for classroom use and for faculty and students doing research on oil and gas systems.

"It opens up a whole new world for our students when we teach courses," said Milind Deo, chair of the University of Utah's chemical engineering department. "For our students who are doing research in these areas, it helps benchmark their work. We now have state-of-the-art software."

The donation to the university was possible in part because the U is a "Schlumberger Ambassador University," a designation bestowed by the company to establish a collaboration between the company and a college. It also highlights the strength of that school's research and education program in oil and gas exploration. The U is the only Utah university and one of only 60 colleges in the world with this designation.

Below, from left: Arnis Judzis, General Manager, Terra Tek and Vice President, Schlumberger; Jeff Spath, Vice President of Industry Affairs for Schlumberger Limited, based in Houston, Texas; Richard B. Brown, Dean of the College of Engineering; Milind Deo, Chair of Chemical Engineering.



MEYER WINS NSF CAREER AWARD

Miriah Meyer, University of Utah assistant professor of computer science, has received the National Science Foundation's (NSF) prestigious Faculty Early Career Development (CAREER) award.

"I am extremely grateful for this grant as it will allow me to pursue a new area of research, as well as to establish several new collaborations with faculty across campus," says Meyer.

This five-year, \$400,000 award will support development of widely-applicable techniques for visualizing and interacting with multivariate graphs, which involve many distinct, though not usually independent, random variables. This research will focus on applying these techniques to cancer biology, urban transportation and particle physics.

BEST ENGINEERING DAY EVER

On Saturday, Oct. 11, about 500 high school students and their parents arrived at the University of Utah to learn how the College of Engineering can take their education to new heights. For Engineering Day 2014, which was sponsored by Rio Tinto, local students were invited to come talk to engineering faculty, view fascinating demonstrations in science and technology, and get a taste of what it's like to pursue an engineering degree at the University of Utah. It was the largest turnout for Engineering Day ever, said Richard Brown, dean of the U's College of Engineering.

NEW FACULTY

Three new faculty members joined the College this winter, for a total of 22 new engineering faculty in 2014.

ROBERT D. BOWLES

Assistant Professor, Bioengineering

Ph.D., biomedical engineering, Cornell University

Research interests: biomechanics, tissue engineering, back pain, CRISPR, regenerative medicine



DANIEL J. FAGNANT

Assistant Professor, Civil and Environmental Engineering

Ph.D. civil engineering, The University of Texas at Austin

Research interests: automated (autonomous, self-driving) vehicles, transportation safety, operations, project planning and evaluation, pedestrians, cyclists, motorcycles



AZAREE LINTEREUR

Assistant Professor, Civil and Environmental Engineering

Ph.D. biomedical engineering, University of Florida

Research interests: coincidence and multiplicity counting, nondestructive assay techniques, novel radiation detection materials, detector design with MCNPX, radiation detector development



ARCS Foundation Utah Chapter has announced that University of Utah bioengineering graduate student Amanda Reynolds is the first recipient of the new Roche/ARCS Foundation Scholar Award Program in the Life Sciences, a unique program that supports graduate students in the life sciences. Other 2014-2015 ARCS Foundation Utah Chapter scholars are: computer science Ph.D. student Phillip Erickson, materials science and engineering graduate student Alex Szendrei, and Eileen Hwang, who has joined the ophthalmology residency program at the U's Moran Eye Center.



STUDENT LIFE

DISCOVERING BIOENGINEERING



Laura Tatham was in a conundrum. While a student at Century High School in Pocatello, Idaho, she discovered she loved biology, math and physics, but wondered how she would combine all of these interests into her education.

So she got on her computer and started to search for engineering majors on Google. That's when she found her answer: bioengineering.

"As soon as I found out that it was a combination of biology with design, I realized I didn't have to give up any of my passions. It was a combination of everything I was passionate about," Tatham said.

The next step was easy. She learned about the University of Utah's bioengineering department, traveled to Salt Lake City to tour the campus, and the advisors told her about the vast opportunities waiting for her in the program.

"It just seemed like a really good fit," said the 22-year-old senior. "I thought the bioengineering program looked great, and I loved the mountains, so I decided to come."

She has never regretted her decision since. In her three-and-a-half years at the U, Tatham has been immersed in fascinating research, she says, that she hopes will one day impact the lives of many suffering from heart disease.

She has been interning with Salt Lake City-based Bard Access Systems, which designs and produces vascular access devices such as catheters, and has been doing her thesis project on biodegradable polymers. In particular, she is investigating a polymer called PLGA or poly(lactic-co-glycolic acid). It is a type of material that can coat drug-eluting stents — wire meshes that widen arteries for patients with cardiovascular disease that can slowly release a drug such as aspirin.

Research hasn't been Tatham's only mission while attending the U. Recently, she worked on outreach with the University of Utah's chapter of the Society of Women Engineers and also was the chapter's social chair. Meanwhile, she is the president of Cru for the University of Utah, an inter-denominational Christian group for students.

After graduation, Tatham will move to Germany to be with her boyfriend and to pursue a master's degree in engineering. She says she's grateful the U has given her the chance to follow all of her academic passions through one engineering department.

"It has been academically challenging in a way that has motivated me to pursue my interests," she said. "I have had a lot of encouragement from professors and also from my classmates."