The TREND *in Engineering*

THE UNIVERSITY OF WASHINGTON COLLEGE OF ENGINEERING NEWSLETTER SPRING 2014

The new Clean Energy Institute wants to revolutionize our energy system at every scale

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July will mark one year since I arrived at the UW as the new dean of the College of Engineering. I'm often asked what's impressed me as I've gotten to know the college, and an element that quickly comes to mind is the uniform strength and quality of the faculty and research. The level and activity of research per faculty in the College of Engineering is equivalent to that of the best public institutions. The competitiveness of faculty recruitment, the quality of our hires and the productivity of our faculty stands head-to-head with nationally recognized engineering leaders.

Our faculty lead the nation in many areas of research including big data, clean energy, and engineering education. This is demonstrated by partnerships that have resulted in significant investments by national foundations. In November, the UW, the University of California, Berkeley, and New York University received a five-year, $37.8 million grant from the Gordon and Betty Moore Foundation and the Alfred P. Sloan Foundation. The grant will expand our team of data scientists and fund postdoctoral fellows pursuing interdisciplinary data-science research, among other new additions. This initiative builds upon the university's eScience Institute and will have marvelous benefits for students as well.

In December, we welcomed Washington Governor Jay Inslee to the university to help launch the new Clean Energy Institute. This institute advances our research in solar energy and electrical energy storage, plus brings new faculty members to the UW. I hope you'll take a moment to learn more about the CEI in this edition's featured article (see pages 4-5).

And in March, our Center for Engineering Learning & Teaching received a $4.4 million grant from the Leona M. and Harry B. Helmsley Charitable Trust to develop and promote teaching practices that help undergraduate engineering students reflect on their experiences. The award focuses on first- and second-year undergraduates who want to be engineers, especially those from underrepresented populations. The goal is to enhance their ability to learn, help a greater percentage complete their degrees and ultimately foster a larger and better prepared engineering workforce required by the global economy. The UW-led consortium will involve a group of 12 higher education institutions, including community colleges, four-year colleges and research universities.

All of these initiatives bring us back to our core mission – to develop outstanding engineers and ideas that change the world. Excellent faculty and robust research programs provide a world of opportunity to our students, further preparing them to develop solutions for the challenges our society faces.

Mike Bragg
Frank & Julie Jungers Dean of Engineering

James Riley elected to the National Academy of Engineering

James Riley, the PACCAR Professor of Engineering in the Department of Mechanical Engineering, was among 67 new members and 11 foreign associates elected to the NAE this year. Election to the academy is among the highest professional distinctions accorded an engineer.

In electing Riley, the academy cited his "contributions in analysis, modeling, and computations of transitioning and turbulent phenomena." His research is primarily in fluid dynamics, where he has led in the development of modeling and numerical simulation of various transitioning and turbulent flows. Riley is a member of the Washington State Academy of Sciences and a fellow of the American Physical Society, among other honors.

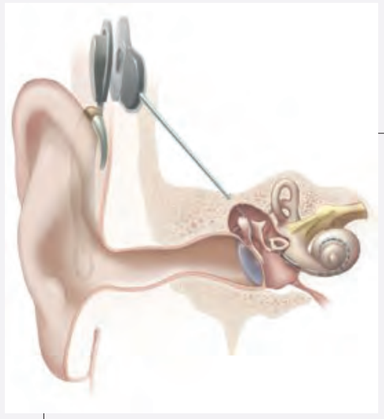
François Baneyx: new chair of UW chemical engineering

François Baneyx, the Charles W.H. Matthaei Professor in Chemical Engineering, has been appointed Chair of the Department of Chemical Engineering. François has held many leadership positions, including directing the UW Center for Nanotechnology, NSF National Nanotechnology Infrastructure Network, and NSF Genetically Engineered Materials Science and Engineering Center (co-director). Dean Mike Bragg describes François as an exceptional scholar whose many awards include his 2013 election as a fellow in the AAAS. He takes over from Dan Schwartz who is the new director of the Clean Energy Institute.

New strategy lets cochlear implant users hear music

For many, music is a universal language that unites people when words cannot. But for those with cochlear implants – technology that allows deaf and hard of hearing people to comprehend speech – hearing music remains extremely challenging. A cochlear implant works by directly stimulating the auditory nerve, bypassing damaged portions of the ear. The implant's signals are sent to the brain, which recognizes the signals as sounds.

UW engineers have developed a new way of processing the signals in cochlear implants to help users hear music better. The technique lets users perceive differences between musical instruments, a significant improvement from what standard cochlear implants can offer, said lead researcher Les Atlas, a UW professor of electrical engineering.



Atlas and collaborator Jay Rubinstein, a UW professor of otolaryngology and of bioengineering, tested their new processing technique on cochlear-implant users by playing common melodies with the rhythms removed. They found their new coding strategy lets cochlear-implant users distinguish between musical instruments much more accurately than with the standard devices.

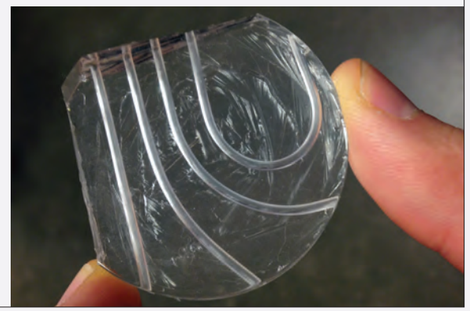
Credit card-sized device could analyze biopsy, help diagnose pancreatic cancer in minutes

Pancreatic cancer is a particularly devastating disease. At least 94 percent of diagnosed patients will die within five years, and in 2013 it was ranked as one of the top 10 deadliest cancers.

UW engineers are developing a low-cost device that could help pathologists diagnose pancreatic cancer earlier and faster. The prototype can perform the basic steps for processing a biopsy, relying on fluid transport instead of human hands to process the tissue. The team, led by Eric Seibel, a UW research professor of mechanical engineering, recently filed a patent for this first-generation device and future technology advancements.

The new instrumentation would essentially automate and streamline the manual, time-consuming process a pathology lab uses to diagnose cancer. Currently, a pathologist takes a biopsy tissue sample, then sends it to the lab where it's cut into thin slices, stained and put on slides, then analyzed optically in 2-D for abnormalities.

The research team is building a thick, credit card-sized diagnostic device out of silicon. It allows a piece of tissue to pass through tiny channels and undergo a series of processes that replicate what happens on a larger scale in a pathology lab. The device harnesses the properties of microfluidics, which allows tissue to move and stop with ease through small channels without needing to apply a lot of external force.



The UW's tech nology would process and analyze whole tissue biopsies for 3-D imaging, which offers a more complete picture of the cellular makeup of a tumor.

Yoga accessible for the blind with new Microsoft Kinect-based program

In a typical yoga class, students observe an instructor to properly learn how to hold a position. For people who are blind or can't see well, yoga can be a frustrating exercise.

Now, a team of UW engineers has created a software program that watches a user's movements and provides spoken feedback on what to change to accurately complete a yoga pose.

The program, called Eyes-Free Yoga, uses Microsoft Kinect software to track body movements and offer auditory feedback in real time for six yoga poses, including Warrior I and II, Tree and Chair poses.

Project leader Kyle Rector, a UW doctoral student in computer science and engineering, wrote the programming code that instructs the Kinect to read a user's body angles and then give verbal feedback. For example, the program might say: "Rotate your shoulders left," or "Lean sideways toward your left."

The result is an accessible yoga "exergame" – a video game used for exercise – that allows people without sight to interact verbally with a simulated yoga instructor

From Molecules to Miles

The new Clean Energy Institute wants to revolutionize our energy system at every scale.

By Jennifer Langston

To Alex Jen, Seattle's skyline represents a missed opportunity on a massive scale. The windows used in high-rises typically reflect up to 70 percent of sunlight that can make offices hot or fade carpets.

Jen, chief scientist for the University of Washington's Clean Energy Institute, and other researchers have been pioneering molecular innovations that could turn windows—along with roofs and other building materials—into large scale canvasses for collecting wasted sunlight and converting it to electricity.

The CEI, launched late last year with support from the state of Washington, has several key foci: improved solar technologies; energy storage devices; and hardware and software to integrate clean energy with the electric grid.

The first research strength cuts across multiple departments and spans different solar cell technologies, from organic polymers to perovskite hybrid cells to inorganic nanoparticles. The common innovation is that all start out as "inks" that can be printed on flexible plastic like cling wrap and used to coat a variety of surfaces.

"With solar power, you always think about the very bulky, very heavy silicon panels on your roof. But the next revolution is to make solar cells by printing, like you print a newspaper," said Jen, the Boeing-Johnson Chair of Materials Science & Engineering. "You can make it in large volumes and at low cost and you can make it flexible and portable so you can use it anywhere you want."

To meet state and worldwide goals to reduce greenhouse gas emissions, clean energy technologies must become ubiquitous. That won't happen until they become more efficient, reliable, and cost-competitive than polluting fossil fuels.

The Washington State Legislature, with strong support from Governor Jay Inslee, approved a $6 million, two-year appropriation to launch the CEI and bring new clean energy technologies to scale. Those state funds have already catalyzed an additional doubling of research support from federal and philanthropic organizations.

The CEI builds on the state's existing strengths in photovoltaics, solar inks, and "smart grid" technology at the UW and other collaborating institutions such as the Pacific Northwest National Laboratory. The new influx of state, federal, and private funds is fast transforming the campus' ability to move the needle in clean energy. Funds will support new instruments that will be shared among campus researchers, processing facilities to begin scaling up and manufacturing printable solar technologies, 26 new student fellows in the sciences and engineering, a planned postdoctoral fellowship program, support staff to enhance productivity, and a faculty cluster hiring campaign.

Rethinking our energy system requires work on wildly different scales, from molecules that can capture and store energy to miles of distribution lines that deliver it. That's why the CEI is organized around two research thrusts – Advanced Materials for Energy and Energy Systems and Integration.

The goal? To build a dream team of interdisciplinary researchers and devise solutions that fit together across our entire energy system.

"Advances in materials only get you part of the way to a solution for society," said Daniel Schwartz, director of the CEI and the Boeing-Sutter Professor of Chemical Engineering. "The other part is how do you get the electronics that you make in a solar cell onto the grid and use them when the sun goes down and make it as reliable as we expect when we flick a switch?"

Today's electric grid was built around dirty fossil fuel plants that could be turned on and off or ramped up and down to follow energy demand. Renewable energy doesn't work that way – the sun doesn't shine at night when everyone comes home from work, and the wind doesn't always blow on cold days when people want heat. That's why new technologies are necessary to store and effectively distribute clean energy.

To address that problem, CEI researchers such as Guozhong Cao, the Boeing-Steiner Professor of Materials Science & Engineering, are working on a next generation of powerful, reliable, and affordable batteries. "If you want to develop clean energy, you have to have the ways to store and carry it with you," Cao said.

Cao, for instance, has spent a decade working on lithium ion batteries, including a vanadium-oxide nanostructure material that could enable them to store more energy. His team has overcome many of the material's stability issues, and they are now working on making it compatible with real-world products and manufacturing lines.

Even with more powerful batteries, electric grid operators will still need better software and hardware to monitor that energy storage and connect it with real-time market demands. And before public and private utilities decide to invest in large-scale battery storage, they want to know it will pencil out.

"Those batteries have a pretty high investment cost, and all of them degrade in different ways," said Daniel Kirschen, the Donald W. and Ruth Mary Close Professor of Electrical Engineering. "We are working hard to figure out the value of energy storage and how much money could be saved by putting battery energy storage into the grid."

Investments in the new CEI Exploratory Fellowship program, which gives Ph.D. researchers six months to work with advisors on seeding new ideas and moving research out of the lab, have already begun to pay off.

One CEI graduate fellow working with Hugh Hillhouse, Rehnberg Chair of Chemical Engineering, hit upon a plausible strategy for combining hybrid perovskite and inorganic solar ink technologies. If the idea proves out, it could catapult the efficiency of printable solar cells past 30 percent, crushing the 12 percent to 20 percent efficiencies of photovoltaics on the market today.

State funding will also seed critical investments in processing facilities to begin producing solar and battery ink technologies on a more commercial scale.

CEI Advisory Council member Denis Hayes recently oversaw the construction of what is widely considered one of the world's greenest buildings. As president of the Bullitt Foundation, he sees plenty of room for leapfrog technologies to revolutionize the energy sphere in the same way that mobile phones fundamentally changed the way we communicate.

"Some of these exist now at the size of a fingernail, but we need them to be the size of a whole building," Hayes said. "With this state investment in the CEI, we are adding to the intellectual capacity of some very smart people to figure that out."

Dan Schwartz, CEI Director

Students Connect with Alumni on "Speed Dating" Exploration Night

By M. Sharon Baker

When Clara Monheit Berman entered the University of Washington three years ago, she only had a vague notion of applying engineering concepts to medicine.

She didn't know where that interest would lead or what profession the combination equaled. Like many of her peers, she initially struggled to connect that interest to a professional path. Many students think they know what engineering is, but making the connection to a job is difficult.

Attending the past several Engineering Exploration Nights helped Berman, who is now a junior focused on biomaterials, connect her interests to a career path.

"Engineering Exploration Night opened my eyes to a professional world. After learning the alumni's stories and meeting interesting people in fields that I was passionate about, I felt empowered with a new sense of purpose," she said. "The event helped to connect my classroom activities to a possible, and very exciting professional future."

More than 30 alumni shared their stories and answered questions at the fourth annual Engineering Exploration Night, which was created by the College of Engineering's Student Academic Services. About 100 students gained exposure to the field and learned about different disciplines after talking to alumni in three speed-dating-like sessions.

Alumni came from Amazon, Microsoft, and Tableau Software; Boeing; biotech firms including Presage Biosciences, Pacific Bioscience Labs, Amgen, and CMC Biologics; Aerojet Rocketdyne, mPanion, Inc. and Hydroacoustic Technology, Inc., among many others. Students had the rare opportunity to talk to chief executive officers to chief technical officers, senior scientists to civil and electrical engineers.

For alumna Sabra Rossman, (BS '97 in math and MS '01 in CSE), attending Exploration Night is a chance to promote computer science and let students, particularly women, know there are many career options available. "I have a successful career," she said. "I like to tell students that you can go out and have fun and be an engineer, too."

Rossman entered UW thinking she'd conduct drug research and go into pharmaceutics, but wound up studying computer science and becoming a software engineer. Today, she is a technical architect at Cadence Design Systems with two patents to her credit.

"I landed an internship in design automation and (back then) the tendency was to get a job in what you had an internship in," Rossman said. "When you are just starting out in engineering, you start with courses that aren't as interesting and you don't have a good idea of what problems you might get the opportunity to solve."

Freshman Steven Bell knows how competitive it is to get into the mechanical engineering department, so he gave up a few hours of mid-term study time to learn about other engineering opportunities.

"I know what I want to do but it all depends upon what I get accepted into," said Bell, who would like to land a coveted spot in the Department of Mechanical Engineering, join the UW's Formula 1 race team and eventually work for an automobile company like Tesla Motors.

Attending Engineering Exploration Night and speaking with alumni helped him formulate a backup plan and realize that he doesn't have to land his engineering dream job right out of college.

"It really solidified my feelings about engineering," said Bell, who spoke to a mechanical engineer, an aerospace engineer and a chief engineer of astronautics. "I had the great chance to find out more about what I'll be doing in the future."

Bobak Ferdowsi

The Unintentional Ambassador

Bobak Ferdowsi (BSAA '01), is a NASA flight engineer, whose mohawk hairstyle became an unexpected icon of the historic Mars Curiosity Rover landing in 2012. He visited campus this spring to speak to UW aeronautics and astronautics students and shared advice for students, reflections on his newfound fame, and thoughts about the future of space exploration.

When did you know you wanted to become an engineer?

I always wanted to be involved in something technical, either physics or engineering. The defining moment for me was the 1997 NASA Pathfinder landing. Although it certainly wasn't the same way as the Apollo missions were for a previous generation, for me, it was the first time seeing that as a species, we put an unmanned vehicle on another planet.

Tell us about your current role at NASA's Jet Propulsion Laboratory.

My job consists of two things, continuing operations of the rover – now that we are on the surface – and working on the development of the Europa mission. Europa is the moon of Jupiter, roughly the size of our moon, with an icy surface. We think there's a liquid ocean underneath that ice and we want to learn if there is potential for habitability. I'll start all over in project development and in 10 years we'll be on our way there. It's fun because each day is different, what you did yesterday isn't what you'll do tomorrow.

What is the discovery value in space exploration?

Often times the greatest inventions are made while working on something else. Not everything that we do is going to have a direct impact, but hopefully we come across something that is going to change the way we live. It's amazing to be a part of something so much bigger than yourself.

What advice would you give to students who are interested in space?

I would say "definitely do it." It's a lot of fun and you can take pride in your work. There are few places where you get that unique sense of camaraderie. And, you get to do things that are universally considered cool. There is something very special about working with the type of people who choose this field – people who are hard-working, motivated, and smart.

What opportunities are available in space exploration?

It's a great time to be in this field. It will expand more than we anticipated. A lot of people think that without the shuttle program, NASA's gone away, which is far from the truth. We're building new capability for manned flight and working with commercial industry to develop an opportunity for people to travel in space. This lowers the cost for all of us interested in space travel. New markets are being realized including mining of asteroids and space tourism. The balance may shift from being NASA-driven to NASA being able to take advantage of these commercial developments.

You were essentially thrust into the limelight and now you're viewed as a spokesperson. Does this impact your future plans?

Definitely, I've always wanted to be a positive influence and to leave the world a better place. Now that I have a louder voice, I want to encourage a younger generation to go into science and engineering. I fundamentally believe that the great challenges we face in the next 20 years will require a generation of scientists and engineers to face those challenges and find solutions. I want people to go into those fields and realize that it's really important and satisfying work. I'd also like to encourage greater scientific discourse in this country.

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DIAMOND AWARDS NINTH ANNUAL DINNER

Diamond Awards

Ninth Annual Dinner
Thursday, June 5, 2014, 6-9 PM
Husky Union Building (HUB) Lyceum, UW Campus

Please join the College of Engineering as we honor these five eminent engineers with 2014 Diamond Awards for their outstanding professional and community achievements.

Eric Denton, P.E., *'51 BS & MS Chemical Engineering*
Distinguished Achievement in Industry

A remarkable engineer who brought the sawmill industry into the computer age. He pioneered and patented computer-automation in sawmill centers which reduced waste and massively increased yield and productivity.

Simon Sze, *'60 MS Electrical Engineering*
Distinguished Achievement in Academia

As co-inventor of the nonvolatile semiconductor memory (NVSM) popular in today's consumer electronics, his contributions to semiconductor physics revolutionized the development of modern electronic systems.

Randy Kurosky, *'88 BS Ceramic Engineering*
Entrepreneurial Excellence

The co-inventor of two ceramic oxide powder processes and engineer of over 3,000 different metallic oxide compositions, he is responsible for turning Seattle Specialty Ceramics, a technology transfer startup, into a successful business – Praxair Specialty Ceramics.

Daniel J. Evans, *'48 BS, '49 MS Civil Engineering*
Distinguished Service

The citizens of Washington State have benefited from the thread of service that runs through his varied career. A tireless advocate, he has devoted over sixty years of service to his community, both in and out of political office.

Brad Fitzpatrick, *'02 BS, Computer Science & Engineering*
Early Career

The creator of LiveJournal, an internet tool that helped popularize blogging. His Memcached technology is used today by all major-scale web services including YouTube, Facebook, Wikipedia, and Twitter.

Learn more about the honorees and the dinner at www.engr.uw.edu/da