The TREND in Engineering

THE UNIVERSITY OF WASHINGTON COLLEGE OF ENGINEERING NEWSLETTER AUTUMN 2011

The Mind-Machine Interface

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DEAN'S MESSAGE »

I am excited to announce that the National Science Foundation has awarded an $18.5 million, five-year grant to establish a new Engineering Research Center (ERC) focused on neural engineering at the UW. This center complements our science and technology center (STC) in optoelectronic materials and devices and is the second major NSF center in the college. The UW can now claim a substantial percentage of the roughly 40 NSF-sponsored ERC/STC centers currently operating around the country.

The Center for Sensorimotor Neural Engineering will develop robotic devices that interact with, assist, and understand the nervous system. This is a true campus-wide collaboration, involving a diverse group of faculty and students from Engineering, Arts and Sciences, and UW Medicine; we highlight a few in the cover story. Yoky Matsuoka, associate professor of computer science and engineering, will direct the center. Additional partners include MIT, San Diego State University, Spelman College, Morehouse College, the University of British Columbia, and the University of Tokyo.

The new center will bring together university and industry researchers to establish Seattle as an education, research and commercial hub for "neurobotics." A vibrant set of companies involved in this field will interact closely with the center. I like to think of this network as a well-functioning neural engineering system, rich in dendritic connections. We expect this center to spur major advances in the field of prosthetics and neural engineering.

On another note, I'm very pleased to welcome Michael Young, the UW's new president. He comes with high accolades from the University of Utah where, during his tenure as president, the budget increased from $1.6 billion to $2.6 billion. We are particularly excited about his role in technology transfer: in his five years at the University of Utah, the campus led the nation in the total number of company spinoffs. We look forward to working with him to advance tech transfer and overall commercialization of technology in UW Engineering, building on the momentum we've gained over the past few years.

"The new center will bring together university and industry researchers to establish Seattle as an education, research and commercial hub for 'neurobotics.'"

Matt O'Donnell

Frank & Julie Jungers
Dean of Engineering

A New Class of Innovators

Nine exceptional new faculty members join the College this academic year. We highlight two here.

Meet all nine at www.engr.uw.edu/facresearch/newfaculty2011.html

Daniel Kirschen

Close Professor of Electrical Engineering

Daniel Kirschen joins UW from Great Britain's University of Manchester where he led the electrical energy and power systems research group. Prior to joining academia, he worked in industry on advanced application software for electric utilities. Kirschen's research focuses on the development of techniques in electrical energy that achieve optimal balance between cost, reliability, and sustainability. He explores how resources such as demand-side participation, energy storage, and agile generating units should be deployed and operated – the essence of the "smart grid." Kirschen holds the Donald W. and Ruth Mary Close Professorship.

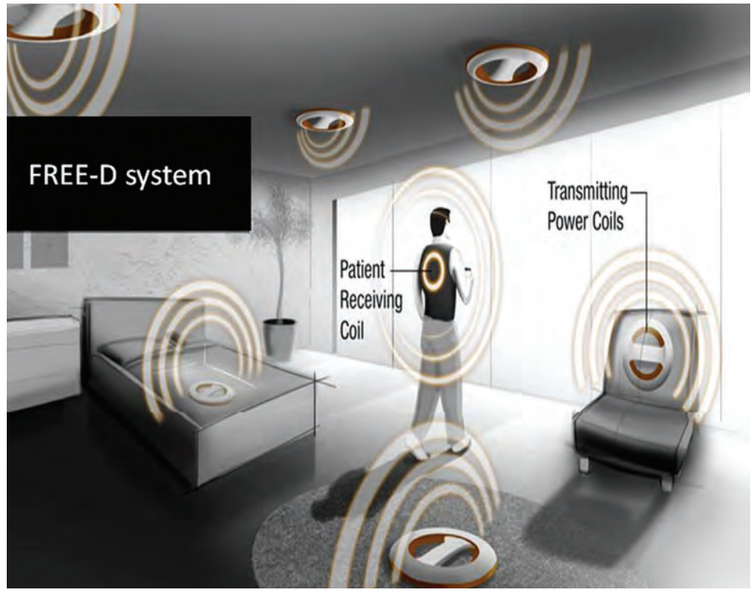
Rebecca Neumann

Civil & Environmental Engineering

Rebecca Neumann comes to the UW from Harvard University where she has been a NOAA Climate and Global Change postdoctoral fellow. She earned her doctorate from MIT with a thesis project on arsenic-contaminated groundwater, one of the major human health problems in Bangladesh.

Neumann's research seeks to understand how land-surface modifications and management decisions affect human and environmental health by altering the fluxes of water, nutrients, carbon, and contaminants in underlying soils. Her work recognizes that soils are the critical interface between the atmosphere, land surface, and subsurface, and that soil fluxes often control the quality of food and water resources.

NEWS SPOTLIGHT »



Wireless Power Could Cut Cord for Patients with Implanted Heart Pumps

Mechanical pumps to give failing hearts a boost were originally developed as temporary measures for patients awaiting a heart transplant. As the technology has improved, these ventricular assist devices commonly operate in patients for years. Prolonged use, however, has its own problems. The power cord that protrudes through the patient's belly is cumbersome and prone to infection. Infections occur in nearly 40 percent of patients, are the leading cause of rehospitalization, and can be fatal.

Researchers at the University of Washington and the University of Pittsburgh Medical Center (UPMC) are testing a wireless power system for ventricular assist devices in an attempt to put an end to troublesome cords.

The research team is led by Joshua Smith, a UW associate professor of computer science and engineering and electrical engineering, along with UPMC heart surgeon Pramod Bonde. The concept is a variation on inductive power, in which a transmitting coil sends out electromagnetic waves at a certain frequency and a receiving coil absorbs the energy and uses it to charge a battery. "Most people's intuition about wireless power is that as the receiver gets further away, you get less power," Smith said, "but with this technique the efficiency doesn't change with distance."

The team envisions a future in which patients install transmission coils in their homes and workplaces to create zones where the implant would receive uninterrupted power. A small receiver coil implanted under the patient's skin connects to a battery that holds enough power for approximately two hours. The patient could then be completely free for short periods of time to take a bath or go for a swim (current users of heart pumps cannot do either). Longer term, the researchers imagine additional power transmitters placed under a patient's bed or chair, allowing patients to move unencumbered.

The potential for wireless power goes far beyond powering artificial hearts. It could be used to power other types of implants or to recharge consumer electronics or underwater ocean instruments.

Visionary Innovator wins MacArthur "Genius" Award

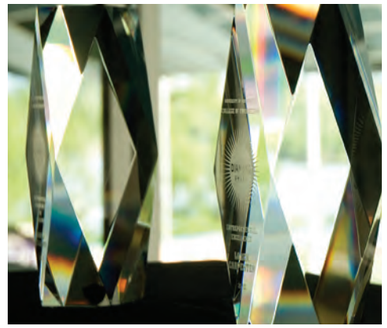
Shwetak Patel, assistant professor of computer science and engineering and electrical engineering has been named one of this year's MacArthur Foundation Fellows.

Patel is one of 22 people honored with the $500,000 no-strings-attached prizes that are often referred to as the "genius" awards. "It feels like winning an intellectual lottery," Patel said.

Patel's most recent research has been in building a new class of low-cost and easy-to-deploy sensing systems for the home which leverages existing utility infrastructures. In addition to the resource conservation applications of his sensor systems, Patel is also exploring their potential for home security or elder care.

Patel showed humor when discussing the award. He expects "genius" jokes from his students starting the school year. "My wife is already making those," he explained.

▶ **Read more at www.engr.uw.edu/news**



Nominate an Exceptional Engineer for a Diamond Award

The Diamond Awards honor outstanding alumni and friends who have made significant contributions to the field of engineering. If you know an engineer who deserves recognition, we want to hear from you! Take time to nominate an engineer to join the distinguished ranks of Diamond Award honorees.

▶ **Deadline for nominations is Friday, October 14. www.engr.uw.edu/da**

A Global Hub *for Neural Engineering*

Planes, software, and coffee have put Seattle on the global map. A decade or two from now, the region and the University of Washington might be just as well known for human–machine interfaces that will improve the health and well-being of millions of people.

Smart chips and sensors promise to give amputees, people with spinal cord injuries, and those with neuromuscular disorders far better control of prosthetic limbs and assistive devices, and to revolutionize therapy for many debilitating conditions. These goals are driving research at the new multi-university Engineering Research Center for Sensorimotor Neural Engineering (CSNE) led by the UW and funded with $18.5 million, five-year grant from the National Science Foundation, with potential for a five-year renewal.

Associate Professor Yoky Matsuoka

"The center will take recent progress in prosthetic design and chips that interface with the neural system to the next level by integrating engineering and neuroscience with the analytic power of computational analysis," said Yoky Matsuoka, associate professor of computer science and engineering. She directs the new center with Tom Daniel, UW professor of biology. "People were excited by the human–machine ideas in *Star Wars*. We decided: 'Let's go for it.'"

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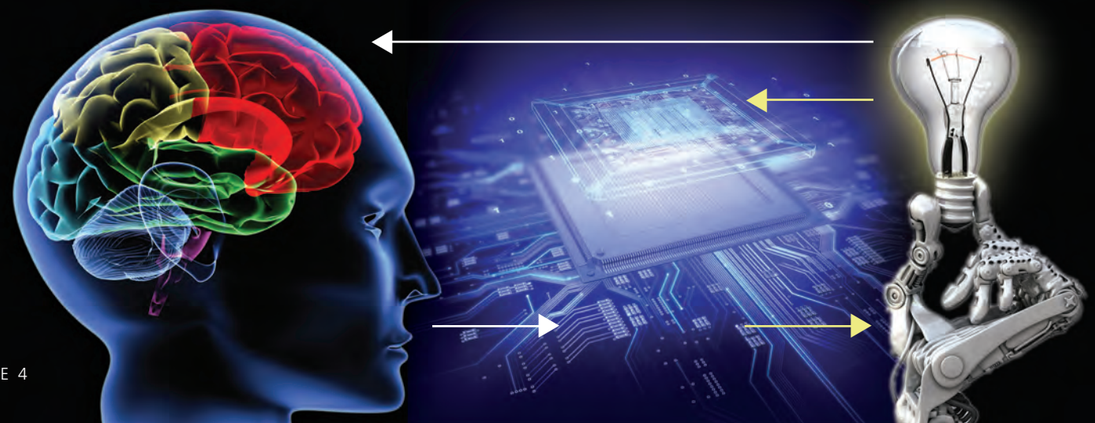
High-Powered Network

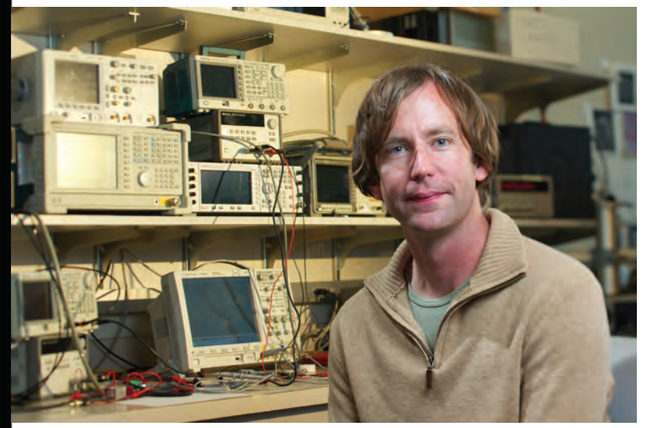
Under UW leadership, the center unites more than 60 faculty researchers across five core academic institutions including the Massachusetts Institute of Technology and San Diego State University, with the University of British Columbia and University of Tokyo as international partners. Lead industrial partners are Intel, Microsoft, and Lockheed Martin, which contribute resources and participate in center governance. Some 30 other affiliated partners include biotech and venture capital companies, research institutions, hospitals, and secondary schools.

"Neural engineering is exceptionally interdisciplinary, and to accomplish our goals we needed to reach out and collaborate nationally and internationally, particularly to tap deep expertise in microelectronic and robotic technology," Matsuoka said.



Power and Promise of Ultra-Small Sensors

One promising device with early potential impact is a tiny, low-power, wireless sensor that monitors muscle and brain signals. Brian Otis, associate professor of electrical engineering, is collaborating with UW faculty in rehabilitation medicine to develop a NeuroGame Therapy system for clinical and home-based rehabilitation for conditions such as stroke, traumatic brain injury (TBI), and cerebral palsy (CP). A sensor placed on the skin transmits electrical activity from impaired muscles, allowing a system user to improve coordination by controlling the movements of computer games. The user benefits from instant feedback of neural activity, and fun exercises that encourage adherence to a therapy plan.



Associate Professor Brian Otis

"We have seen substantial improvements in movement for children with CP and several adults recovering from stroke and TBI," said Chet Moritz, assistant professor of rehabilitation medicine, physiology and biophysics. "A recent test of wireless electrodes for clinical use gives us confidence that we may be able to deploy this system to rehabilitation programs within a few years."

"The concepts behind neural engineering are simple, but the science and technology would have been impossible a decade ago because we didn't have the tools," Otis said. He points to the infrastructure and effort required to develop smart phones. "The economic push needed to develop smart phone technology was huge. The power of our NSF center is the broad, concerted effort that will advance the state of the art in neural engineering. A single research lab or grant can't do it alone, and our industry partners are critical to developing the market."

Blue Sky Vision, No Longer Science Fiction

Longer-term developments include wireless sensors and chips to control a lifelike robotic hand, and perhaps even biocompatible sensors for implant directly on the surface of the brain or in a paralyzed extremity. Matsuoka and computer science and engineering faculty members Emo Todorov, director of CSE's Movement Control Laboratory, and Rajesh Rao, director of CSE's Neural Systems Laboratory, are collaborating in this work with UW neurosurgeon Jeffrey Ojemann.

Enabling someone to use thoughts to control a prosthetic device or wheelchair is another intriguing possibility. The mere thought of moving a missing hand or paralyzed arm generates a strong signal that neuroscientists and engineers are trying to harness. Studies have shown that noninvasive electrodes recording from the scalp allow a person to direct thought to move a computer cursor.

"It's similar to learning any new motor skill in which you first need to think about the individual steps and then it becomes automatic. Many study subjects move into this automatic mode in just a few minutes," Ojemann said. "We can do a lot with a reliable signal from the brain even when the neuromuscular system is not being used."

That's why the work of computer scientists such as Rao and Todorov is essential for decoding neural signals and developing computational models for brain and neuromuscular function and algorithms for controlling external devices and brain-computer interfaces.

"With good electronics and signal processing we can truly harness the power of the mind to control external devices," Ojemann says. "It's no longer science fiction. We are developing the tools to understand the neuroscience and the engineering. Only our own imagination limits us."

Funding the Education Mission

Most of the NSF grant funding supports graduate and undergraduate student research at the UW and collaborating institutions, which also include affiliate research partners Morehouse College and Spelman College in Atlanta, and Southwestern College in Chula Vista, Calif. A primary center mission is to integrate research with education and the broader community, including working with school districts in Seattle, Boston and San Diego.

UW faculty are enthusiastic about offering their students more interdisciplinary research opportunities and reaching out to students from middle school through college undergrads, especially to widen and diversify the pipeline for students from underrepresented populations. Faculty will develop new undergraduate courses, a minor in neural engineering, and a graduate certificate program.

With first-class engineering and medical programs, and imagination aplenty, the University of Washington has taken the first big step to become a global hub of neural engineering. An evolving Seattle-based industry could someday provide more of a brain boost than caffeine, and like airplanes, increase human mobility.

▶ **Learn more about the center at bit.ly/uwtrendaut2011erc**

Capstone Support *Launches* Students *into Real-World Engineering*

Eight students lurched, tumbled, and floated through an unforgettable final lab project. Participants in NASA's Microgravity University in Houston spent the last week of their undergraduate careers carrying out an experiment they designed for a reduced-gravity environment.

This was the second year UW undergraduates have participated in the program. Student teams carry out an experiment aboard an airplane that provides brief experiences of a weightless environment. Each project must address a current problem in space science and be of possible use to NASA. The UW students built a spinning drum to store and transfer fuel in zero gravity and were among a dozen undergraduate teams chosen to participate.

Though it was serious engineering, this wasn't a typical lab class. This year's welcome meeting was cut short by a chance to meet the recently returned crew of the *Endeavor* space shuttle. The week-long trip included tours of full-scale replicas of the space shuttle and the International Space Station. Students also visited Mission Control sites for the shuttle, space station, and historic Apollo missions.

A two-hour flight aboard the *Weightless Wonder* was the highlight. The aircraft flies in reserved air space over the Gulf of Mexico doing a series of parabolic arcs. With each arc the plane flies up at a 45-degree angle for 90 seconds during which gravity feels twice as strong as on Earth, then drops in freefall for about 30 seconds in which passengers experience weightlessness. At the beginning of each parabola students gather their composure to set the experimental parameters and flip a switch to begin recording data. And yes, the flight did live up to the airplane's unsavory nickname, the "Vomit Comet."

Students are responsible for all aspects of the project, including designing and building the experiment, conducting outreach activities, and raising funds for equipment, travel, and medical exams. To cover some of the costs, the students applied for and received support from the College of Engineering's Capstone Fund. Capstone design projects are a UW Engineering rite of passage for seniors. The Capstone Fund was developed to support students' pursuit of their professional interests and to allow them to tackle real-world engineering problems. Gifts from alumni and friends provided critical support for the microgravity capstone project and many others.

- **Learn more about this capstone project at www.bit.ly/UWCapstone**
- **Or, watch a video about a recent tidal turbine capstone project at www.engr.uw.edu/giving/capstone.html**

- **MAKE AN IMMEDIATE IMPACT – do your part to support the capstone learning experience. Give today at www.uwfoundation.org/engineeringcapstone**

What Works is Work at the Summer Math Academy

The rigor of pre-engineering coursework can be a harsh reality for incoming college freshmen. Students who thought they were well prepared for college sometimes struggle to keep up in math classes. All kinds of students fall into the gap.

This summer 32 high school students spent four weeks on campus participating in the Math Academy, a program designed by UW Engineering to help high-achieving students develop the math and problem-solving skills necessary to succeed in engineering. Applications are open to students entering the senior year of high school, the program targets groups underrepresented in engineering, including African American, Latino, Native American, Pacific Islander, female, and first-generation students.

Math Academy is in its third year and was designed by Dave Prince, lead instructor for the program. His math-teaching philosophy is simple: "What works is work." If students are willing to work hard, he's willing to be there with them. But it's not all work as the students experience life on a college campus. Each day is packed with learning, activities, and some down-time in the dorm. Students also have opportunities to explore a wide-range of engineering careers through lab tours, research projects, site visits and professional networking events with alumni.

In Math Academy what works is indeed work. Ten students from the 2009 class are now students at the UW and ten from the 2010 class will enter UW this fall making the case for a summer vacation well spent.

- **Learn more about Math Academy at www.uwmathacademy.org**
- **Consider supporting a student at next year's Math Academy. Visit www.bit.ly/MathAcademy to make a gift.**

Five Faculty Members Elected to the Washington State Academy of Sciences

Among 24 new members elected to the Washington State Academy of Sciences in recognition of their distinguished and continuing scientific achievement, five have ties to the College of Engineering. Hank Levy, chairman and Wissner-Slivka Chair of CSE; Lee Huntsman, BioE professor and UW president emeritus; Alex K-Y Jen, chairman and Boeing/Johnson Chair of MSE; Shaoyi Jiang, Boeing-Roundhill Professor of ChemE; and Mary Lidstrom, UW vice provost for research, and Frank Jungers Chair of Engineering and professor of ChemE.

Materials Scientist John W. Cahn to Receive 27th Annual Kyoto Prize for Lifetime Achievement in "Advanced Technology"

John W. Cahn, a UW affiliate professor of materials science and engineering, will receive the Kyoto Prize. The award recognizes Dr. Cahn's outstanding contributions to alloy materials engineering through his theory of spinodal decomposition. The theory has found universal application in creating alloy materials with unique properties such as extreme strength or heat resistance.

Alex Jen and Buddy Ratner Elected Fellows of the American Chemical Society

Alex Jen, the Boeing/Johnson Chair of MSE, and Buddy Ratner, the Michael L. and Myrna Darland Endowed Chair in Technology Commercialization and professor of BioE, have been elected 2011 Fellows of the American Chemical Society (ACS). The Fellows program recognizes members of ACS for outstanding achievements in and contributions to science, the profession, and the society.

Shwetak Patel Named Microsoft Research Faculty Fellow

Microsoft Research annually honors a small number of the world's most innovative young faculty members as Microsoft Research Faculty Fellows. Shwetak Patel, an assistant professor of computer science and engineering and electrical engineering, was named a 2011 Fellow. His research focuses on the development of easy-to-deploy sensing technologies and approaches for activity recognition and energy monitoring applications.

David Allstot Receives the 2011 Mac Van Valkenburg Award

The IEEE Circuits and Systems Society recognized electrical engineering professor David Allstot with the 2011 Mac Van Valkenburg Award for his "contributions to mixed-signal and RF integrated systems." This is the top award of the IEEE Circuits and Systems Society and is based on the quality and significance of contribution as well as continuity of technical leadership.

Human Centered Design & Engineering and Corporate Affiliate Team Shine in National Software Competition

Priority Contact™ was awarded honorable mention in the national SMART Health App Challenge intended to foster new health information applications built on a common platform of electronic patient records. Priority Contact,™ developed in HCDE, reduces non-productive physician time by managing contact with patients about their test results.

Learn more at www.hcde.washington.edu/news/priority-contact

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2011 Engineering Lecture Series Re-Engineering Aerospace Flying Cleaner, Greener, Smarter

Shrinking the Aerospace Carbon Footprint

Wednesday, October 26, 2011

Mary Armstrong '79
Vice President – Environment, Health and Safety,
The Boeing Company

Boeing is designing new aircraft to be fuel efficient, quieter, and more recyclable. On the ground, manufacturing facilities are reducing use of energy, water, and hazardous materials. Chemical engineering alumna Mary Armstrong reveals how engineering innovations are shrinking Boeing's domestic carbon footprint by 25% and leading worldwide industry efforts to enable zero carbon growth for air travel.

Repowering the Military with Alternative Energy

Wednesday, November 9, 2011

Tim Vinopal '91
Director – Environment, Health and Safety Engineering,
Boeing Defense, Space and Security

The U.S. military aims to dramatically reduce dependence on imported oil to power ships and aircraft. Alumnus Tim Vinopal explains how Boeing is developing hydrogen- and solar-powered unmanned aircraft, producing the world's most-efficient solar cells, testing sustainable fuels for tactical aircraft, and designing smart-grid electrical systems for government facilities.

Flying Smart with Autonomous Vehicles

Wednesday, November 16, 2011

Mehran Mesbahi
Professor, Aeronautics & Astronautics, and Principal Investigator, Distributed Space Systems Lab

Awed by the precision flying of the Blue Angels pilots? Imagine autonomous drones performing complex group maneuvers with no human intervention, or satellites orbiting together around the sun, jointly searching for exoplanets. Mehran Mesbahi offers insights from engineering and biology to reveal how networked "smart" vehicles will take on challenging aerospace missions.

All lectures will be held at: 7pm, Kane Hall 130, UW Seattle Campus

Lectures are free! Registration required, online at UWalum.com or by calling (206) 543-0540

Presented by the College of Engineering in partnership with UW Alumni Association