Dear alumni and friends,

After a decade of dedicated leadership as dean of our college, Candis Claiborn has returned to the faculty ranks and resumed her teaching and research in environmental engineering. We are thankful for Candis’ leadership and passion for WSU. During her tenure, the college had dramatic growth in student enrollment, faculty, and research. Our programs expanded throughout the state, our college was renamed, and this year we opened the impressive PACCAR Environmental Technology Building. With continuing high demand for our graduates, the Voiland College is playing an increasingly central role as an engine for economic growth.

A national search for our next dean was launched this summer. During the one year search period, I am serving as interim dean of the Voiland College. I am a professor of civil engineering and director of the Composite Materials & Engineering Center. I am honored and excited to take on the new challenge of interim dean, and to build on our successful programs.

Our undergraduate engineering and design programs are the best in the region, with hands-on learning, industry connections, international experiences, student clubs, research experiences, direct contact with professors, and high paying, exciting jobs upon graduation. Our research targets important topics such as energy, natural resources, health, and infrastructure with impacts on the quality of life and economic development. As the land-grant university of Washington state, we also have a unique mission to reach out to our citizens and industry to educate and transfer technology.

We are pleased to welcome WSU President Kirk Schulz and his wife, Noel Schulz, to campus. Kirk is a chemical engineer by training, and Noel is now part of our power engineering faculty in the School of Electrical Engineering and Computer Science. With their engineering backgrounds, they are very familiar with the important role that our graduates play in the state and national economy, as well as the challenges we face in meeting industry demands. We look forward to working with the Schulzes in the years ahead.

This issue of Innovation is dedicated to addressing national grand challenges. In the Voiland College, we educate our students to be problem solvers. Our students, faculty, and alumni are well suited to solve our nation’s biggest challenges in health, sustainable resources, national security, and smart systems. I hope you enjoy reading their inspiring stories.

Thank you for your continued support of the Voiland College. Go Cougs!

Don Bender

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Meet WSU’s new first family

Kirk and Noel Schulz

The new president of WSU, Kirk H. Schulz, set out to be a medical doctor, even though aptitude tests all told him to go into engineering. He began his chemistry degree at Old Dominion University but transferred to Virginia Tech once he realized that chemical engineering was more his forte. That move changed his life.

Schulz completed his undergraduate degree and then his doctoral program at Virginia Tech, but he aspired to leadership. His research advisor said Schulz had told him at Virginia Tech that he hoped to be a university president.

His life changed significantly at a Baptist Student Union volleyball game as well. There he met a freshman from Blacksburg, Virginia, named Noel Nunnally. They hit it off, and eventually started dating.

Noel grew up around engineering with an electrical engineering professor father at Virginia Tech. She excelled in math and science, and loved the field. “I even had resistor earrings,” she says. She received her electrical engineering degree at Virginia Tech, and later her doctorate at the University of Minnesota. Kirk and Noel got married and had two sons, Tim and Andrew.

Attending Virginia Tech infused the Schulzes with an understanding and appreciation of the land-grant mission. Like WSU, Virginia Tech has well-established engineering, veterinary medicine, and agriculture programs.

“I love the importance of land-grant universities to states, the idea that a lot of land-grants are easy to get into and hard to get out of. We’ll give you a shot; you’ll have to come and work really hard,” says Kirk.

He started his teaching career in chemical engineering at the University of North Dakota, followed by several years at Michigan Tech. He says his time as a professor was crucial to his future role as a president.

“I felt it was really important that I become a good faculty member before I become a good administrator,” he says. “It’s very difficult to lead an institution if you haven’t been in the trenches.”

He moved into administration at Mississippi State University, another land-grant institution, where he went from director of their chemical engineering program to dean and finally to vice president for research and economic development. Kirk spent eight years there before reaching his next destination in 2009: president of Kansas State University.

Over seven years, he led Kansas State to record enrollment, large increases in private giving, and a heightened research profile.

During their time from North Dakota to WSU, Noel became an internationally recognized expert in power systems, publishing 160 papers and bringing in more than $10 million in external research funding to Kansas State. She garnered more than 20 years of teaching experience at those universities.

Noel learned about WSU because of its strong power engineering program. “The power program is in the top five in the country, with Anjan Bose, a world leader in electric power, Chen-Ching Liu, and others,” she says. “It was a great match for me.”

She also collaborated with Schweitzer Engineering Laboratories and power systems pioneer Edmund O. Schweitzer III ’77 Ph.D.

In addition to faculty work, Noel took leadership roles in professional organizations, becoming president of the Power and Energy Society in the Institute of Electrical and Electronics Engineers. She was only the second woman to hold that seat in 130 years.

Noel diligently pursued ways to mentor and bring more women faculty and students into engineering and science. “We’re not going to have enough engineers unless we recruit women and minorities. I want to see how I can complement what’s being done at WSU,” she says.

Another passion is rural electrification around the world, particularly in Ethiopia where Noel has worked to bring power to the country.

That project fits with one of her research areas: microgrids. When Kirk accepted the WSU presidency, Noel saw parallels of WSU research with her own interests in the intersection of computer science and power engineering.

For Kirk Schulz, the draw of WSU was accessibility for students, a new medical school, and the state’s commitment to the land-grant ideal. He aims to get WSU into the top 25 research universities in the country.

He and Noel both believe in communication, too. Avid Twitter users, they want to have an active conversation with WSU faculty, alumni, students, and supporters. That might include a photo or two of camping, too; the Schulzes have a 25-foot Airstream for touring national parks.

vceawsu.edu

Learn more, follow Kirk and Noel Schulz on Twitter, and sign up for regular news at president.wsu.edu.
Washington State University research is uniting the best minds across disciplines and addressing ambitious goals known as the Grand Challenges.

The Grand Challenges came out of a University-wide effort to encourage faculty and academic leaders to identify and think about how we might help solve our society’s biggest problems. The five broad inspirational research themes, which include sustainable resources, smart systems, sustaining health, national security, and opportunity and equity, aim to focus University priorities and encourage collaboration and multidisciplinary work across the University.

They team WSU and Voiland College of Engineering and Architecture researchers with scholars around the world—as well as with federal and state agencies, national laboratories, business and civic leaders, and philanthropists—to target critical national and global problems.

The commitment to the Grand Challenges grows out of WSU’s land-grant mission, which makes service to society a top University priority. Our research strengthens communities across the state and around the world while enabling students to see firsthand how to advance knowledge.

Two research projects are getting underway in the Voiland College with support from Washington State University’s Grand Challenges research initiative: one in community health analytics (page 11) and the other in developing smarter cities (page 10). University officials expect the research proposals will stimulate enhanced federal funding, as well as increased commercialization opportunities and faculty recruiting.
Supplying food, energy, and water for future generations

The challenge
By the year 2050, the world population will hit 9 billion people—2 billion more than today. Farmers will need to grow more food than what has been produced in the previous 10,000-year history of agriculture. People will need fresh water for farming, drinking, and other uses. They will also need more energy.
Reliable production, storage, and transmission of clean energy will be fundamental to sustaining our way of life.

Harnessing technology to improve quality of life

The challenge
The “Internet of Things” is coming of age. This network of objects embedded with sensors, electronics, software, and connectivity promises to generate mountains of data. New approaches in data science and analytics will be needed to convert the data into actionable information.
When it comes to using that information to improve quality of life, the possibilities are endless. Digital devices working together as smart systems can sense, act upon, and communicate about a situation. They can recognize patterns, make predictions, and support human decision-making. Smart systems can optimize the use of dwindling natural resources. They can enable self-sufficiency for those who need extra assistance in their daily lives. They can provide energy security across the nation.

The uncompromising pursuit of health for people and communities

The challenge
Scientific discoveries in the past century have enabled an unprecedented increase in human longevity. But along with advances have come the challenges of chronic health problems and skyrocketing health care costs.

Fundamental research to protect America

The challenge
The 2015 U.S. National Security Strategy presents a vision for protecting United States’ interests in an insecure world. Notable elements include preventing the spread of weapons of mass destruction, strengthening critical infrastructure (energy systems, roads, bridges, water systems, and more), and reducing hunger.

Promoting an informed and equitable society, expanding individual opportunity, and advancing social justice

The challenge
A skilled workforce is key to economic prosperity. But not every worker in America has the opportunity to rise to his or her full career potential. Opportunity inequality persists in employment, education, and health care. It erects barriers to personal growth and squanders priceless human capital.
Building tours, a reception, and music from the WSU Cougar Marching Band were part of the recent dedication of the new PACCAR Environmental Technology Building at Washington State University.

Designed and built by LMN Architects and Skanska, the 96,000-square-foot facility is one of WSU’s greenest buildings on its Pullman campus. The U.S. Green Building Council’s Leadership in Energy and Environmental Design (LEED) certification program awarded the building its second-highest level of certification—gold—for sustainable and energy-efficient design.

The building, named in recognition of PACCAR’s major donation, is constructed using renewable materials and technologies developed at WSU, including wood composites, recycled concrete, and pervious pavement. It incorporates features such as water capture and reuse, heat recovery, individual control of air quality factors, maximized daylighting, and optimal siting, making it a technological showcase for minimizing the carbon footprint of the built environment.

“We are pleased to provide one of the important building blocks to Washington State University in the development of its interdisciplinary environmental technology initiative that will benefit students and the region for many years,” said Mark Pigott, executive chairman of PACCAR Inc. “PACCAR has recruited excellent employees from WSU for many decades, and this investment will provide another strong link in our robust relationship.”

The building houses five of WSU’s longstanding research centers dedicated to tackling multifaceted environmental issues through interdisciplinary collaboration. Focus areas include sustainable design and construction, water quality, and atmospheric sciences.
Aiming for the Sun

WSU vies for solar home prize

Washington State University students have begun designing a solar home for the U.S. Department of Energy’s Solar Decathlon competition. The contest, set for fall of 2017 in Denver, Colorado, will award $2 million in prize money.

WSU is one of 14 universities from across the world chosen to participate in the competition, which aims to increase public awareness of solar energy and inspire innovative solutions in ecological design. Darrin Griechen, an architecture professor in the School of Design and Construction, is leading the effort for WSU.

“This is a once in a lifetime opportunity for students to apply the skills and knowledge they are learning toward a real project,” said Griechen.

Students are designing and building the home and will transport it to Denver in fall 2017 where it will be on public display and compete with other universities in 10 categories: architecture, engineering, innovation, communication, health and comfort, market potential, appliances, energy balance, water, and home life. The teams must commute with an electric vehicle using energy from their solar-powered home.

“Our students will be working on our most critical challenges in smart and sustainable living while also gaining tremendous hands-on experience at designing and building for the future,” said Phil Gruen, director of the school. “WSU remains focused on our land-grant mission of training our students to solve these most important and real problems for the world.”

“We are perfectly positioned to design, engineer, and build a home within this smart paradigm,” said Griechen.

WSU students from a wide variety of disciplines—including architecture, interior design, landscape architecture, construction management, mechanical engineering, civil engineering, electrical engineering, computer science, communications, business, and English—are participating in the project.
NEW CATALYST FOR BIO-BASED PLASTICS

Washington State University researchers have developed a catalyst that easily converts bio-based ethanol to a widely used industrial chemical, paving the way for more environmentally friendly, bio-based plastics and products. The researchers published a paper online describing the catalyst in the *Journal of the American Chemical Society* and have been granted a U.S. patent.

The chemical industry is interested in moving away from fossil fuels to bio-based products to reduce environmental impacts and meet new regulations for sustainability, said Yong Wang, Voiland Distinguished Professor in the Gene and Linda Voiland School of Chemical Engineering and Bioengineering. The catalyst works on bio-based ethanol to create isobutene used in plastics and other products.

The industry has traditionally made a widely used chemical called isobutene—used in everything from plastic soda bottles to rubber tires—by superheating crude oil. But in collaboration with the Archer Daniels Midland (ADM) Company, Wang and his colleagues developed a catalyst to convert bio-based ethanol, which is made from corn or other biomass, to isobutene in one easy production step.

The researchers examined the costs and lifetime of their catalyst to determine its practicality for the marketplace and determined that it could be used for other closely related feedstocks. They also discovered just how their catalyst works, knowledge that could be used to design more efficient catalysts for a wide range of applications. In addition to ADM, the work was supported by a grant from the Department of Energy.

Recycling carbon fiber to permeable pavement

Improving water quality through better permeable pavement is the focus of a research and development collaboration between The Boeing Company, Washington State University, and the Washington Stormwater Center.

The U.S. Environmental Protection Agency has identified improved permeable pavement as a positive step to mitigating stormwater issues in Washington state. In addition, the state requires low-impact development wherever feasible in western Washington, and permeable pavement is one way to achieve that.

The porous concrete or asphalt, which allows stormwater to seep into the ground instead of running off to waterways, improves water quality by reducing flow, filtering pollutants, and returning water to the water table.

The project will take a two-pronged approach to improving permeable pavement. First, scientists will recycle scrap carbon fiber composites to strengthen and reinforce porous pavement material, which is used in parking lots and side roads but is too soft to be used on heavily traveled roadways. Second, the team will examine the composite material for toxicity to validate that it does not add pollutants to the soil or impact water quality.

“This is a tremendous waste reduction opportunity for the aerospace industry,” said Karl Englund, associate research professor in the Department of Civil and Environmental Engineering. “Developing new, cost-effective uses for scrap carbon fiber could have tremendous environmental benefits.”

Boeing is supporting the Washington Stormwater Center, a collaboration between WSU and the University of Washington, through a $212,000 research grant and donation of cured carbon fiber composite material. The material will be recycled to develop stronger permeable pavement. The grant will support research programs at the WSU Research and Extension Center in Puyallup and on the WSU Pullman campus.
Key Improvement Made in Solar Cell Voltage Technology

A critical milestone in solar cell fabrication will help pave the way for solar energy to directly compete with electricity generated by conventional energy sources. Researchers improved the maximum voltage available from a cadmium telluride (CdTe) solar cell, overcoming a practical limit that has been pursued for six decades and is key to improving efficiency. The work was published in Nature Energy.

The effort was led by the U.S. Department of Energy’s National Renewable Energy Laboratory (NREL) in collaboration with Washington State University and the University of Tennessee.

Silicon solar cells represent 90 percent of the solar cell market, but it will be difficult to significantly reduce their manufacturing costs. CdTe solar cells offer a low-cost alternative. They have the lowest carbon footprint in solar technology and perform better than silicon in real-world conditions, including in hot, humid weather and under low light. However, until recently, CdTe cells haven’t been as efficient as silicon cells.

One key area where CdTe has underperformed is the maximum voltage available from the solar cell, called open-circuit voltage. Limited by the quality of CdTe materials, researchers for the past 60 years were not able to get more than 900 millivolts out of the material, which was considered its practical limit.

The research team improved cell voltage by shifting from a standard processing step using cadmium chloride. Instead, they placed a small number of phosphorus atoms on tellurium lattice sites and then carefully formed ideal interfaces between materials with different atomic spacing to complete the solar cell. This approach improved both the CdTe conductivity and carrier lifetime by orders of magnitude, enabling fabrication of CdTe solar cells with an open-circuit voltage breaking the one-volt barrier for the first time. The innovation establishes new research paths for solar cells to become more efficient and provide electricity at a lower cost than fossil fuels.

The research was funded by the Energy Department’s SunShot Initiative, which aims to make solar energy cost competitive with traditional energy sources. The work also was supported in part by Oak Ridge National Laboratory’s Center for Nanophase Materials Sciences.

Silicon solar cells represent 90 percent of the solar cell market.
Washington State University is a partner in a grant to research, develop, and demonstrate technologies to create “smart” buildings, campuses, and cities to better manage energy use.

Once buildings and devices are smarter—managing energy resources optimally on their own—they also can be more responsive to the needs of the power grid.

WSU researchers in the Energy Systems Innovation Center are installing photovoltaic modules on the Pullman campus and integrating them into Pullman’s “smart city” test bed and WSU’s microgrid system.

Experiments will be designed to show how campus power generation can power critical city infrastructure in the event of a power outage. WSU will also develop strategies for sharing energy between its smart buildings and solar modules.

The U.S. Department of Energy (DOE) is matching a $2.25 million Clean Energy Fund grant from the Washington Department of Commerce to support the work.

In what the DOE is calling a pioneering regional partnership for grid modernization, Washington will host a three-campus demonstration of transaction-based energy management. This is the first time researchers will test the use of transactive controls at this scale involving multiple buildings and devices.

The idea is that equipment will make decisions and automatically adjust energy loads based on predetermined criteria related to energy prices, essential services, comfort levels, time of day, etc. The project is developing the mechanisms to make that happen with minimal human direction.

WSU, DOE’s Pacific Northwest National Laboratory, and the University of Washington are teaming on the effort, which builds on their involvement in the recently completed Pacific Northwest Smart Grid Demonstration Project.

The state is funding infrastructure for the project to establish an enduring test bed that will enable subsequent research. Once perfected, load flexibility available from smart buildings will help to better integrate nontraditional energy sources like wind and stationary battery power into the grid.

SEL and WSU build strong partnership

When legislators, such as Washington Governor Jay Inslee, U.S. Senator Maria Cantwell, or Representative Cathy McMorris Rogers, come to Pullman, they often make just two stops: one at WSU’s Energy Systems Innovation Center and the other at Schweitzer Engineering Laboratory (SEL) to learn about smart electric power grid innovation.

Aligned from SEL’s earliest days, WSU and SEL have collaborated closely over the years, and their success has brought attention from local, national, and international policy and industry leaders. They have supported each other as they have grown in stature, developing state-of-the-art power grid technologies for the country and training next-generation power industry leaders.

“SEL began in Pullman because of WSU,” said Edmund O. Schweitzer III, SEL founder and president, who was attracted to WSU’s famed power engineering program to study for his Ph.D. “WSU has a recognized electrical engineering program that has educated so many students who have gone on to serve us in all kinds of disciplines, including electric power.”

SEL has provided years of support to WSU’s programs. “We’ve enjoyed a long and close relationship through SEL’s support of labs, our research, and scholarship,” said Behrooz Shirazi, Huie-Rogers chair professor and director of the School of Electrical Engineering and Computer Science. “We look forward to
continuing this valuable collaboration and supporting each other in future years.”

After completing his doctorate at WSU in 1977, Schweitzer came back as a faculty member to WSU. Based on the research that he conducted while a student at WSU, Schweitzer started his business in the basement of his Pullman home. In 1982, he left the University to devote his efforts full-time to the company, which is headquartered in Pullman.

Schweitzer invented the first digital protective relay that went on to largely replace the electro-mechanical relays traditionally used in the power industry for monitoring and controlling electric power systems. The digital methods he developed and commercialized help to prevent, locate, and limit power outages more quickly and provide detailed reports that help users improve the system. Nearly every utility in North America uses SEL products, which can also be found in industrial and commercial power applications, and Schweitzer’s work to develop computer-based protection and control technology has led to safer and more reliable generation, transmission, and distribution for the electric power grid.

SEL is one of the largest employers on the Palouse and contributes significantly to its economy. The company employs nearly 4,000 people and sells products in 148 countries.

Meanwhile, EECS has also seen dramatic growth in the past few years. Research expenditures in the school have more than doubled to $7.6 million in the past six years, with about $4 million of that in power engineering research. Enrollment in EECS has also doubled to more than 1,000 undergraduates and nearly 200 graduate students.

EECS anticipated the growing interest in energy and strategically expanded the already strong power engineering program to 12 faculty members. That resulted in doubling the number of undergraduate and graduate students who go to work for the energy industry.

The relationship between WSU and SEL remains close. In the past two years, SEL has hired more than 10 percent of EECS graduates—more than any other company. More than 200 WSU alumni work at SEL, and the company provides internship learning opportunities for many WSU students. Every year, the company also supports student senior design projects.

“So many of us at SEL enjoy working with WSU students on their design projects, serving on advisory boards, and teaching an occasional class,” said Schweitzer. “I love what WSU offers,” he added. “It has never lost its roots of a land-grant institution advancing science, agriculture, and technology.”

Schweitzer fondly remembers the support he received at WSU. In the past couple of years, he and his wife, Beatriz, and SEL have provided significant scholarship support in the name of former professors Clifford Mosher and Al Flechsig, and a street entrance into SEL was named Mosher Drive. Mosher was Schweitzer’s WSU academic advisor and introduced him to protective relays and to the University. Schweitzer has said that SEL wouldn’t have been created without Mosher’s support.

SEL is also very generous with equipment donations, said Anjan Bose, regents professor in the School of EECS. A few years ago, for instance, the company provided students with an electric car for a senior design project and had them retrofit it as a solar-powered car. After the student project was completed, the company donated the car back to WSU for use in a renewable energy course.

“The whole idea of an undergraduate lab is to provide hands-on experience, and by having the latest and best equipment from SEL, we can teach them better,” he said.

The company also supports the work of WSU researchers and graduate students in power engineering in areas such as health monitoring of substations and critical infrastructure protection. SEL supports a graduate student fellowship, which the school uses to attract top graduate students.

“So many of us at SEL enjoy working with WSU students on their design projects, serving on advisory boards, and teaching an occasional class.”

—Edmund O. Schweitzer III

SEL and WSU have a great industry/university relationship.”

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A STEP TOWARD EARLY GLAUCOMA DETECTION

Washington State University researchers have developed a way to analyze a person’s gait with sensors, an innovation that could lead to reduced falls and injuries in people with glaucoma, the second leading cause of blindness in the United States.

Led by Hassan Ghasemzadeh, assistant professor in the School of Electrical Engineering and Computer Science, and graduate student Yuchao Ma, the researchers recently presented their gait analysis study results at the Wireless Health Conference.

Working with a group from the University of California, Los Angeles, they have begun clinical trials.

“Glaucoma is usually diagnosed late,” Ma said. “But earlier detection of gait disturbances could make a difference.”

Previous studies have shown that glaucoma patients fall more often as their visual deterioration progresses. They walk more slowly, sway, bump into obstacles, and have unequal step placement of their feet. However, most patients aren’t diagnosed until they suffer from ocular discomfort, which usually occurs at a later stage of the disease when it’s less treatable.

The researchers developed a sensing platform worn on special shoes to measure, filter, and analyze gait information. The research team can detect and examine specific features of gait, such as step length, equity between feet, and evenness of step. The researchers hope to use the technology someday to diagnose the disease earlier and outside laboratory settings, adding to the current practice of imaging or a visual field test.

HOLISTIC APPROACH TO DEVELOPING SMARTER CITIES

Researchers in the Voiland College of Engineering and Architecture are leading a five-year, $1.5 million initiative to develop a framework to monitor, predict, and control energy and air quality in an urban environment, and record resulting health impacts in Spokane’s University District.

Supported by WSU, the multidisciplinary initiative is part of WSU’s Grand Challenges in smart systems to harness technology to improve quality of life. The initiative will link researchers in WSU’s Energy Systems Innovation Center, the Laboratory for Atmospheric Research, and the Institute for Sustainable Design with Spokane’s Smart City Accelerator and its public and private sector partners.

The University also recently signed a memorandum of understanding to begin working with the city of Spokane, Avista Utilities, and other public and industry partners to develop smart systems in the district, which is located north of I-90 and east of Division Street. The area is being transformed by private, state, and federal investments, including WSU’s new Elson S. Floyd College of Medicine and an iconic new University District Gateway Bridge across the Spokane River.

WSU has a long history of work in smart environments. As part of a national effort to test new smart grid technologies, a group of WSU researchers worked with Avista Utilities on a five-year-long demonstration project to make Pullman the region’s first smart grid community. Researchers in the Energy Systems Innovation Center are also partnering with Pacific Northwest National Laboratory and the University of Washington on a project to research, develop, and demonstrate technologies to create “smart” buildings, campuses, and cities to better manage energy use. The WSU team is installing photovoltaic modules on the Pullman campus and integrating them into WSU’s smart city test bed.

In the past year, students in the School of Design and Construction also developed smart city design ideas for Spokane’s University District, including ideas for interactive environments and data-driven decision making.

The new planning project furthers these efforts, aiming to establish WSU as a center for research and analytics in the design, engineering, and application of smart systems that will serve and ensure healthy, resilient communities, said Anjan Bose, regents professor in the School of Electrical Engineering and Computer Science and a project coleader. The global smart cities initiative aims to create cities that use less resources while increasing their livability and economic viability.

“There are more and more people on the planet relying on urban infrastructure,” he said. “We can’t tear out and replace all of our infrastructure, but we have to increase its capability and make the most of the resources we have.”
**New alternative to antibiotics**

Washington State University researchers for the first time have discovered how electrical stimulation works for the treatment of bacterial infections, paving the way for a viable alternative to medicinal antibiotics.

The researchers passed an electric current over a film of bacteria and in 24 hours killed almost all of a multidrug resistant bacterium that is often present in difficult-to-treat infections. The remaining bacterial population was 1/10,000 of its original size.

The researchers also tested the method on pig tissue, where it killed most of the bacteria and did not damage surrounding tissue. The research appears in *Nature Scientific Reports*, an open-access online journal from the publishers of *Nature*.

Antibiotics have been the preferred and most effective treatment for infections, but their widespread use has led to drug-resistant strains.

Electrical stimulation has had mixed results against bacteria, but this is probably due in part because people didn’t have a clear understanding of how it works electrochemically, said Haluk Beyenal, coauthor of the paper and a professor in WSU’s Gene and Linda Voiland School of Chemical Engineering and Bioengineering.

The researchers, for the first time, demonstrated the electrochemical reaction produces hydrogen peroxide, an effective disinfectant, at the electrode surface.

“We have been doing fundamental research on this for many years, and finally we are able to transfer it to technology,” said Beyenal. “It’s really exciting.”

The researchers optimized the reaction and developed an “e-scaffold,” a sort of electronic Band-Aid made out of conductive carbon fabric. By running electrical current through the fabric, they produced a low and constant concentration of hydrogen peroxide to kill the bugs. The bacteria are unable to develop resistance to such an electrochemical treatment.

The researchers have applied for a patent and are now testing it with a variety of bacterial species.

The work was led by Sujala T. Sultana, a graduate student in the Voiland School, and included other researchers from the Voiland School, the WSU Department of Veterinary Microbiology and Pathology, the Washington Animal Disease Diagnostic Laboratory, and WSU’s Paul G. Allen School for Global Animal Health.

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**Strategic funding leads to community health analytics research institute**

For most of the twentieth century, people didn’t worry about an illness like strep throat or an infected cut because they could go to the doctor for a quick dose of antibiotics, which was invariably followed by a quick recovery.

Slowly, however, microbes developed resistance to the miracle drugs, and in the United States, at least two million infections and 23,000 deaths are attributable to antibiotic-resistant bacteria each year, according to the Centers for Disease Control and Prevention.

Researchers in the Voiland College of Engineering and Architecture are leading a five-year, $4.9 million initiative to look at social determinants of antimicrobial resistance in human and animal populations. The initiative, called the Community Health Analytics Initiative (CHAI), will boost WSU’s ability to analyze extensive datasets known as “big data” and to promote information-based health care research. Supported by WSU, the multidisciplinary initiative, in partnership with the College of...
Community Health Analytics (Cont’d from page 11)

Veterinary Medicine, the College of Medicine, and the College of Arts and Sciences, tackles grand challenges in health as well as equity and opportunity. The initiative, slated to become a University research institute, includes the establishment of a new graduate degree program in health analytics.

“Data science has been of great interest to the University, and this project is a natural outgrowth of that interest,” said Behrooz Shirazi, Huie-Rogers chair professor and director in the School of Electrical Engineering and Computer Science, who is leading the initiative. “The planned research institute brings together researchers in math and computing with the School of Global Animal Health and the new College of Medicine to begin making sense of data that health care researchers have been and will be collecting.”

Medical science has traditionally been done by looking at a patient’s symptoms, giving standard tests based on those symptoms, and then prescribing a standard dose of medicine. In addition, medical studies are often controlled experiments, which are limited, expensive, and time consuming, he said. Community-based analytics, on the other hand, allow researchers to find patient-specific information that would be very difficult to spot with traditional research methods in a large community and region—and oftentimes more quickly and cost effectively.

“We need to move away from the cookie cutter solutions we now have in medicine,” he said. “We want to get a lot more precise about patient data in the context of community information and develop more proactive public health solutions.”

The initiative will initially focus on antimicrobial resistance in eastern Washington. The region provides an opportunity for a fresh way of looking at the problem since many studies have been focused in urban areas near academic medical centers. The researchers don’t know what they are going to find.

“Eastern Washington has many people who work with and around livestock who may be exposed to antibiotics and antibiotic-resistant pathogens. How much microbial resistance occurs in eastern Washington? How much might those people interact with others in their community to spread pathogens?

“Those are questions we don’t know for a population like ours, and these issues haven’t really been looked at in a rural area,” said Eric Lofgren, an assistant professor in the School of Global Animal Health who is part of the CHAI project. What they learn will be applicable to eastern Washington as well as to other parts of the country. Collaborating across disciplines will help the computer science researchers better understand and verify their data.

“Faculty in the Elson S. Floyd College of Medicine are already involved in big data projects across different levels of analysis,” said John Roll, vice dean for research in the Elson S. Floyd College of Medicine. “This is one facet in our developing research portfolio that has tremendous potential for development over time. The partnerships that CHAI will cultivate will greatly enhance this development.”

The researchers will be able to use health analytics and computer science to model how communities interact with pathogens, building a virtual version of eastern Washington. They might model how an emerging pathogen might spread, develop preexisting theories, and come up with potential solutions before such a scenario actually occurs.

“The computer scientists let us get to the big questions in a way that traditional public health tools struggle with,” said Lofgren. “If you can get a broad outline of what might happen, you’ve got at least a little knowledge built up and can react quickly.”

“We need to move away from the cookie cutter solutions we now have in medicine.”
—Behrooz Shirazi
Researchers study climate change impacts on air quality

Washington State University researchers have received a U.S. Environmental Protection Agency grant to better understand the impact of climate change on air pollution.

Led by Brian Lamb, regents professor in the Department of Civil and Environmental Engineering, the researchers will use new modeling techniques to study how pollution levels might change in the western United States as the climate warms.

The study will focus on predictions of air pollution in the years 2030 and 2050, when global change is expected to have large impacts on air quality. The researchers will look at some factors that impact air quality and are expected to change in the future, such as pollution from distant sources, wildfire emissions, and land cover changes.

They will use a new, fast computer model that can follow air masses and monitor one area at a time throughout a day. Most air quality computer models use a grid, which requires more computation. The complex computer model will allow the researchers to take into account a full range of contributing climate change and human activity factors.

The researchers will check their model’s accuracy by comparing its predictions with air quality measurements taken in recent field campaigns in the Northwest and California. Results from the simulations eventually will be provided to regional air quality managers.

Little is known about climate change’s effects on air pollution, especially on small particulate matter—particles that are less than 2.5 microns in size. Small particles, which are present in soot, smoke, or car exhaust, have dramatic impacts on health because, unlike larger particles, they are inhaled directly into the lungs. They are a factor in diseases such as asthma, heart disease, and lung cancer.

“Particulate matter is the most serious air quality issue in regards to human health,” said Lamb.

The WSU researchers are collaborating with University of California, Irvine, and the U.S. Department of Energy’s Pacific Northwest National Laboratory.

A better way to treat cancer

Washington State University researchers have developed a unique, tiny protein cage to deliver chemotherapy chemicals directly to cancer cells. Direct delivery could improve treatment and lessen what can be horrendous side effects from toxic drugs.

In their study, published in *Biomaterials Science*, the researchers built a drug delivery system using apoferritin, the same ball of natural proteins that carries iron around in blood without letting the iron leak out. Apoferritin is made of 24 pieces that can conveniently open and close depending on surrounding acidity. While some research has been done on using apoferritin for drug delivery, this is the first time it was used to target lung cancer cells.

Led by Yuehe Lin, professor in Voiland College’s School of Mechanical and Materials Engineering, the researchers inserted the anticancer drug daunomycin into the cage. They modified the cage’s exterior with a ligand, a signal-triggering molecule, making the cage particularly attractive to a common cancer cell receptor.

With the addition of a small amount of acid, adjusting the pH to below neutral, the protein cage slightly opened and let the drug jump inside, where it stayed until it came to the cancer cell. When the ball of drugs entered the acidic environment of the cancer cell, the cage opened and delivered the drug directly to its foe.

Testing the system with lung cancer cells, the researchers showed that the ligand-guided protein cages selectively penetrated and killed more than 70 percent of the cancer cells. Unlike with the typical methods for drug delivery used in chemotherapy, the system did not attack healthy lung cells.

Although the work is still preliminary, the system was shown to work nearly as well as—or in some cases better than—when the drug was freely moving, the type of scenario that causes the commonly experienced cancer treatment side effects.

“Our efficiency in killing the cancer cell was very high with no toxicity to normal cells,” said Lin. “At the cell level, we were able to demonstrate it was very effective.”
Students engage to save lives

Washington State University engineering students Emily Willard and Katherine Brandenstein are hoping to save lives someday with a product they developed to make injections safer in the developing world.

The bioengineering students in the Gene and Linda Voiland School of Chemical Engineering and Bioengineering won a total of $35,000 for their idea in three separate, regional competitions. They called their company Engage, which stands for Engineering Accessible Global Equipment.

Willard and Brandenstein devoted their senior year to doing a capstone project with social impact. As they scouted potential projects, they learned that contaminated injections are a huge problem in developing countries and a leading cause of death. Injections of antibiotics, vitamins, and vaccines are commonly given at doctors’ offices, but nearly half, or seven billion injections each year, are done with contaminated equipment.

“Syringes and needles are usually just rinsed with water and then used with different patients,” said Willard.

The students designed a nonremovable cap that attaches to the top of multidose vials of medicine. The cap holds a layer of liquid to sterilize the needle each time it passes through. The liquid could stop the spread of contaminants commonly found on a reused needle, such as Hepatitis B, Hepatitis C, and HIV.

Entrepreneurship program starts at WSU

Washington State University has received a National Science Foundation grant to teach its faculty and students how to come up with the “next big thing” and become better entrepreneurs.

The three-year Innovation Corps (I-Corps) grant will support the launch of a LEAN Accelerator program—an advanced eight-week course designed to increase student and faculty participation in entrepreneurial endeavors. WSU has grown its entrepreneurship efforts significantly in the past five years by cultivating and training student business development teams.

“WSU I-Corps will help our aspiring entrepreneurs better determine whether their ideas will work before they try to launch a startup business,” said Travis Woodland, the WSU I-Corps site director and director of business development in the Voiland College of Engineering and Architecture.

For more information and to get involved, visit vcea.wsu.edu/icorps.
Out the hack door

Simulating cyber attacks to protect the smart grid

by Larry Clark ’94

Hackers had a banner year in 2014. They stole hundreds of millions of passwords and other pieces of confidential information from banks, retailers, credit card companies, even film company Sony Pictures. A record number of computer breaches affected more than half of all American adults, costing businesses up to $500 billion, and fueling increased attention to the security of Internet interactions. But the financial consequences of those attacks pale in comparison to the possibility of intrusion and disruption of the electric power system.

From hospitals’ life support machines to nuclear reactors to home heating during bitter cold winters, keeping the power flowing can be a matter of survival. Increasingly the power grid is a smart one, an interconnected system of electric power generation, distribution, advanced home meters and appliances, and computer control centers. The system can increase efficiency, reduce outages, and possibly lower costs. But with more and faster communication across the system comes greater vulnerability.

At Washington State University, a combination of power engineers, computer scientists, and their industry partners simulate holes and weaknesses in the smart grid, then work out ways to manage the risk of hackers interrupting and subverting the electric power system.

Their key to successfully securing the grid is understanding that the threats are both cyber and physical.

“What is the nightmare scenario of an attack on the power grid? If you’re an IT manager alone, you can’t imagine that,” says Chen-Ching Liu, electrical engineering professor and director of WSU’s Energy Systems Innovation Center (ESIC). “We have to bring the two sides together, much like our group of computer scientists and engineers. You have to know enough about the power grid to see what kind of cyber attack would take control and do enough damage to the grid to create that nightmare scenario.”

Liu says a successful attack could cause not just a power outage, but create a tremendous expense for utilities as they replace blown transformers worth millions of dollars each. The threat is not just theoretical; in 2007, Idaho National Laboratory ran an experiment where a cyber attack physically destroyed its Aurora generator, causing it to explode after rapidly opening and closing circuits.

Even President Barack Obama and Congress agree that cybersecurity is a national priority. “No foreign nation, no hacker, should be able to shut down our networks, steal our trade secrets, or invade the privacy of American families,” said Obama in his 2015 State of the Union, to rare bipartisan applause.

Liu explains that their software looks at computer traffic and spots oddities. “When you find unusual things, you try to figure out what to do with that. Hopefully
you kick out the intruder early enough that there’s no impact on the grid,” he says.

The control simulator, called a smart city test bed, is a valuable asset and one part of the strategy to safeguard a smart grid’s integrity. “Cybersecurity is very hard to study on just paper. We know the power grid so we can simulate that, but the computer side is very complex,” says Liu. “Unless you have a realistic environment, much like industry has, it’ll be hard for you to do your research.”

Pullman, wired up as a smart city, is part of the test bed, too. Its data will be used for simulating attacks, but not in real time, says Liu with a chuckle. “We can’t play with a live system.”

Smart meters, which send usage information to the Avista utility to increase efficiency, are part of the project in Pullman. On the consumer side, Liu recognizes the need for diligence on privacy issues for the devices, since around 60 million smart meters are expected to be deployed around the United States by 2019. There’s a strong interest in securing smart meters because unauthorized access could not only lead to infiltration of the power grid, but a criminal might see that no one is home if there’s less electricity use, says Liu.

Because of privacy and other societal and policy implications of the smart grid and cybersecurity, Liu brought WSU psychologists, sociologists, economists, and political scientists into the ESIC group. They work in concert with the engineers to address privacy and other human factors connected to electric power systems. Liu also headed up smart grid implementation for the European Union before coming to WSU, which shared many of the same concerns.

Up a couple of floors from the smart city control test bed, electrical engineer Anurag Srivastava leads the team in another smart grid demonstration and research lab, where stacks of electric relays, sensors, and controllers connect to real-time simulators. This is the physical side of the system, connected to its own smart grid simulation and acting as a complement to the smart city test bed.

The sensor helps in monitoring the simulated power grid using the same hardware as a substation, says assistant professor Srivastava. He explains that this WSU test bed emulates the way data flow from real equipment to control centers, and how different actions such as cyber attacks may impact the physical system. It also helps in analyzing advanced communication technologies in a smart grid.

“In the past, you used to get snapshots of the grid, like a picture which would come every four seconds. Now you’re looking at more like a video of the grid with fast sensors,” he says. That immediacy means more control ability to isolate problems and maneuverability to bring back the power system in case of trouble.

Srivastava says the test bed can help analyze responses to both hackers and damage from storms, accidents, or direct physical attacks by humans.

“A big concern is how to survive big storms like Hurricane Sandy. Turns out some of the techniques you need to survive cyber attacks are the same kinds of technology and processes,” says Bose.

2019. There’s a strong interest in securing smart meters because unauthorized access could not only lead to infiltration of the power grid, but a criminal might see that no one is home if there’s less electricity use, says Liu.

Bake in the security

On the other side of Pullman, Dave Whitehead ’89, vice president of research for the electric power equipment manufacturer Schweitzer Engineering Laboratories (SEL), takes an engineer’s perspective on cybersecurity.

“We build systems to take into account temperature and other environmental factors. Cybersecurity is just another thing we need to do so we can make sure the system is robust and reliable,” he says.

Not that the sky is falling. It’s really preventive medicine. “Is Pullman a dangerous place? No, but I’m still locking the door on my house. It’s just prudent behavior.”

After he graduated from WSU, Whitehead worked on submarines in Connecticut, and then returned to Pullman and the expanding company in 1994.

Whitehead says security has always been built right into the company’s electric relays and other equipment. Edmund O. Schweitzer III ’77 Ph.D. started the company in his basement in 1982, with an industry-changing digital protective relay—a device that monitors power lines and systems for problems. Since Schweitzer, also a former WSU faculty member, had introduced the world’s first microprocessor-based relay, he recognized the potential for misuse through the increase in electronic...
communications. The relay was now passing more information than ever to an electric utility’s control centers through dialup modems. Even in the early 1980s, Schweitzer required two passwords to use the relays, one for technicians to evaluate problems and another for engineers to actually change settings.

It’s essentially the same as the two-part access at SEL’s offices, where a person might need both an electronic badge and a password. “We take data security we have in our headquarters and apply it to substations out in the middle of nowhere,” says Whitehead. “It’s a layered approach.”

He says there are advantages to securing the grid, as opposed to guarding strictly online transactions. When it comes to cybersecurity, the challenge for Target or banks is abstract; it is money, but it’s a handful of bytes in a computer, says Whitehead. “When you take the money from my account or give me a whole bunch, there’s no connection to the physical universe. I don’t all of a sudden have a million dollars sitting in my wallet.” For the electric power system, the cyber part really does connect back to some physical thing, whether it’s electrical current or an open circuit breaker.

“How can you defend against something you don’t know? You have to know what an attack is going to do before you can defend against it.” —Adam Hahn

Another advantage is that power systems are overmeasured, “so if somebody were able to spoof one location, we have another location that essentially measures the same thing,” he says. If something is wrong or values don’t match, the attack can be identified and isolated.

When they complete new products, Whitehead’s research team at SEL works in a similar way to the WSU scientists, and sometimes with them. “Our cybersecurity team has a test bed where they put in equipment, and then start poking holes in it or attacking it.”

Put on the hacker hat

Adam Hahn, a computer scientist at WSU, says researchers must consider the worst ways to break the power system if they want to mitigate attacks.

“How can you defend against something you don’t know? You have to know what an attack is going to do before you can defend against it,” says Hahn.

“In other engineering fields you try to design a system that meets some functional requirements. Here we try to figure out how we can violate whatever assumptions they made. Instead of making a system work, we’re trying to make a system fail.”

Hahn came to WSU in 2014 after working in the private sector on cybersecurity, primarily for the federal government. He says cybersecurity really came to the forefront after the 2010 revelation of Stuxnet, the powerful computer “worm” that could propagate and infect computers to control machinery and industrial processes.

Stuxnet was a magnitude of order worse than anyone imagined, says Hahn. It pushed into high gear the research into cybersecurity of physical systems like the power grid.

Hahn and WSU computer scientist Carl Hauser work with students to infuse the security mindset—in effect, to think like a hacker. Hauser says students will often come up with good security ideas, but don’t necessarily think about how their ideas might be circumvented.

“Having built this thing, it’s hard for some people to ask, ‘Where are the holes?’ You don’t want to admit there are holes,” says Hauser.

They teach the students partly through attack and defense games on the operational systems, called red team-blue team competitions. Hahn isn’t worried that they’re teaching students to be hackers. “You pretend you’re an adversary and attack the system. As a security person that’s what you really need to focus on,” says Hahn.

To Hauser, invasion is inevitable. Experience shows us that computer security will be breached, just not very

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Out the Hack Door  
(Cont’d from page 17)

often, he says. When there’s only one line of defense, it reduces planning for the attack that makes it through.

“That’s not helpful. It doesn’t lead you to doing the things you should be doing to make the system resilient,” says Hauser. Instead he recommends that people look at computer security as risk management. That makes it easier to talk about how to contain damage in the rare instances when attacks succeed.

Hauser has worked with power engineering faculty for over 10 years on how to secure the communications that take place in the power grid and understanding the risks associated with different types of cybersecurity failures.

In turn he and the other computer experts learn from engineers about how to build control systems that fail gracefully and rebound after problems, just like the power grid itself. Their collaboration doesn’t end with research. WSU’s graduate students take courses team-taught by the two disciplines, a unique combination that benefits both fields.

“This is a very rare group in terms of our combination of power engineers and computer scientists,” says Bose. “There are other parts of the country where power engineers work with computer scientists, but I think this is the only place where we have three computer scientists focusing 100 percent of their research on the power grid.”

In many ways, the struggle between good guys and bad never ends. It becomes an arms race over the security of computer systems, and new challenges continue to push engineers. One of the challenges is the growing amount of data and computer traffic. The smart grid, with its numerous advanced meters on homes and businesses, and complex control systems, will create a flood of new information.

It has become a scale problem, says Whitehead. “How do we secure all that data, as the data rates get faster and faster and the volumes get larger and larger?”

Hahn also points out that, unlike smartphones, home computers, and other short-lived products, power equipment lasts up to 30 years. That makes it tough to build computer security systems that can block out hackers of the future, perhaps even armed with the capabilities of ultrafast quantum computers.

Moreover, he says, the “Internet of Things,” with its interconnected devices from refrigerators to light bulbs to smart meters, can exacerbate security concerns when they get picked up quickly by consumers. “We don’t think about the risk before we do the adoption. From a security perspective, we’re always chasing the problem,” says Hahn.

Despite these challenges, the WSU engineers and industry researchers realize most people just want the electricity to work.

“My expectation when I go home is that I hit that light switch and the lights come on. I think it’s the same for all consumers,” says Whitehead.

Protecting power transmission and distribution from hackers or storms keeps the TV on and businesses running. This is something the smart grid can do well, as long as it’s secure.

Students partner with PNNL on nuclear safety

Pacific Northwest National Laboratory (PNNL) is partnering with Washington State University students to develop new instruments, tools, and methods to support nuclear nonproliferation and international safeguards.

Under PNNL mentorship, student teams design and develop prototype equipment to tackle real-world problems. Completed designs are eventually used to train personnel, conduct tests and experiments, and evaluate hypotheses to further international safeguards goals. The student teams last year worked with Professor Charles Pezeshki and PNNL mentors Leesa Duckworth, Patrick Valdez, and Mark Mitchell.

The students designed and developed a mechanical lift to improve ergonomics of moving a sample into a detection instrument system, modifications for detector enclosures to improve their sensitivity, and a portable cart and racking system to position detectors for field measurements. The program is supported by the National Nuclear Safety Administration’s Next Generation Safeguards Initiative.

WSU engineering student Matthew McDaniel demonstrates the lift fixture to move a sample into a detection instrument system.
OPPORTUNITY AND EQUITY

BRINGING MORE WOMEN TO COMPUTER SCIENCE

It’s no secret that while computer science offers great job prospects and interesting careers, attracting women to the field has been problematic. In fact, fewer women are entering computer science than a generation ago. Many women who initially have an interest in the field often become discouraged and quit.

With continuing industry demand, especially in the state of Washington, the School of Electrical Engineering and Computer Science is providing awards and scholarship opportunities for high school girls in computer science. The awards program has been shown to be successful in recruiting girls into the field. In part, it simply provides needed encouragement for young women to overcome prejudice and stereotypes that can keep them from pursuing the field. WSU focused its recruiting efforts for the awards program with Spokane County high schools this year and will expand to the Tri-Cities next year.

Once they get to WSU, the school is also making a concerted effort to keep women in computer science. The school, for instance, is working to provide a gathering room for women computer science students. Having a place set aside for women has been shown to help them stay in male-dominated programs. At the same time, students in the women’s WSU chapter of Association of Computing Machinery have begun mentoring all female students in the program. The club is one of two new groups in the school that are tailored specifically for women.

“The goal is to have junior and senior students help the incoming female students adjust to the program and help them to overcome the obstacles that they might experience during their first year,” said Sakire Arslan Ay, assistant director of the School of Electrical Engineering and Computer Science, who is leading retention efforts. “We hope that catching problems early on and providing help to solve them will help retain more females in the program.”

The school has also begun working with introductory programming course instructors to make classroom and lab environments more supportive for women by, for instance, bringing female students together in lab sessions. Usually, women drop out from computer science and engineering programs because of the lack of support around them, not because they can’t succeed in classes, said Arslan Ay.

“They often don’t feel like they will ever be able to fit in in a male-dominant field,” she said. “We are trying to establish this support circle for them, provide opportunities for them to get help, and encourage them to seek for help when they need to.”

“As a female computer scientist, I have experienced the same problems that today’s computer scientists have,” said Arslan Ay. “But we need women in computer science and engineering; I would like to help the new generation of women become aware of their qualities and not let anything stop them.”

Young women receive computing awards

Eight high school students from eastern Washington were honored for their interest and success in computing and technology at a ceremony and banquet this spring at Washington State University. The Award for Aspirations in Computing program was developed by the National Center for Women in Information and Technology and is administered regionally by WSU.
Reach for the STARS

The Washington State Academic RedShirt (STARS) program equips motivated first-year engineering students with the tools and community they need to be successful in engineering.

“My first interaction with STARS was during Alive! (orientation), and I knew right then and there that it was a ‘yes’ for me,” said Amie Browder, an electrical engineering student in the STARS program at Washington State University. “It means you have extra support for grades, social events, and financial support.”

The STARS program is based on the strategy of “redshirting,” which allows promising college athletes to sit out a season in preparation for four successful years of competition.

A select group of students receive intensive coaching, access to mentors and advisors, and scholarship support during their freshman year in engineering. The program aims to help more students succeed as they navigate what can be a tough first year of college.

“Our director, Katy Tetrick, is a big help,” said Abraham Podkranic, who is studying chemical engineering. “The first week of school I had all my classes messed up, and I contacted Katy and she helped me sort it out.”

Students meet as a group in a seminar-style study skills course, as well as attend tutoring sessions.

Students within the program also receive support from upperclassmen, including former STARS students. The students are part of a community right from the start of their college career, participating in movie nights, holiday parties, bowling events, and even glow-in-the-dark ultimate frisbee.

Having a strong community is one of the best ways to create student success and to make it to graduation, says Katy Tetrick, Voiland College STARS program director.

“The connections you make with the people in STARS are important,” said Browder. “They’re going to be with you in your classes for the next four years.”

The program, funded by the National Science Foundation and private donors, is part of a collaborative project between Washington State University and the University of Washington.
Out-of-this-world experience

Mars rover team finishes second at international competition
By Randy Bolerjack, WSU Everett

The rust-colored badlands of the Mars Desert Research Station in Hanksville, Utah, became a proving ground for aspiring engineers from around the world. And at the end of three days of competition, students from Washington State University North Puget Sound at Everett stood on the second-place podium at the University Rover Challenge.

The WSU team of nearly 20 mechanical engineers from the Voiland College of Engineering and Architecture spent more than a year designing and building their Mars rover with the guidance of clinical associate professor Xiaopeng Bi.

“I have never had a trophy mean so much to me,” said WSU team member and mechanical engineering major Blaine Liukko. Liukko served as president of the WSU Everett Engineering Club for the 2015-16 academic year.

“We started with a vision my junior year, and throughout my educational career I have put in well over 1,000 hours of blood, sweat, and tears to make that vision become a reality,” Liukko said. “My team came together, each person taking on different responsibilities, to build the best machine we could. Hard work does pay off and the emotions that came along with this accomplishment are second to none.”

A project of The Mars Society, the University Rover Challenge is considered the world’s premier robotics competition for college students. Held in the southern Utah desert for the past nine years, the competition challenges students to design and build the next generation of Mars rovers that are one day expected to work alongside human explorers on the surface of the Red Planet.

The project received support from several industry sponsors, including The Boeing Company, Janicki Industries, the WSU Foundation, Voiland College of Engineering and Architecture, and the Bruce and Barbara Wollstein Endowment in Engineering.

Walls made from trash

Voiland College of Engineering and Architecture students presented their energy-saving walls made from trash to as many as 30,000 people at the National Sustainable Design Expo in Washington, D.C., earlier this year.

TrashWall is a collaborative effort between WSU’s engineering and architecture students. Guided by Taiji Miyasaka, associate professor of architecture in the School of Design and Construction, and Bob Richards, professor in the School of Mechanical and Materials Engineering, the students use trash to create walls that sustain heat and improve energy efficiency.

Current energy efficiency technologies cater to the rich, said Richards. But low-income people—who might spend half of a paycheck paying for the winter energy bill—need the improvements most. At 10 cents per square foot, TrashWall could be an efficient, affordable alternative.

In constructing their prototypes, the students dug through trash to find usable items, taking excess out of the waste stream in addition to making efficient building materials. The students also incorporated fire-resistant materials into their designs. The walls are crafted creatively, making them works of art that happen to be made from trash.

“When we think about trash, we think about things in the garbage bin,” Miyasaka said. “But paper, when it is sitting on a table, is just paper. When it is thrown into a bin it becomes trash.”
**Program Expansion Continues**

The Voiland College of Engineering and Architecture continues to meet its land-grant mission and increase its offerings to students around the state, country, and world.

**WSU, Alaska agreement offers chemical engineering degree**

Washington State University is joining with the University of Alaska Anchorage and the University of Alaska Fairbanks to offer a chemical engineering degree for Alaska students. The program will allow students to fulfill the first two years of core requirements at the Alaska universities and the final two years at WSU’s Voiland School of Chemical Engineering and Bioengineering. Graduates of the program will receive a bachelor’s degree in chemical engineering from WSU’s ABET-accredited program.

**International agreement bolsters graduate education**

Yunsheng Ma, chairman of Shandong Chambroad Holding Co. Ltd., left, and WSU’s Chris Keane and Asif Chaudhry sign the agreement in China.

Washington State University has entered into an agreement with Shandong Chambroad Holding Co. Ltd., a private Chinese corporation, to educate WSU doctoral students to meet significant societal needs in energy and the environment. The corporation will provide up to $5 million to support five new students each year, up to a total of twenty students simultaneously, in chemical engineering, chemistry, or materials science and engineering. The Chambroad Distinguished Fellowship will provide graduate student and research support in the area of catalysis, a critical component of the manufacturing sector, especially in the production of high energy fuels and household chemicals.

**New degree programs**

With a dramatic need for engineers and computer scientists around the state and nation, Washington State University has established several new WSU degree programs in these technical fields. They include bachelor of science degrees in construction engineering, software engineering, as well a new master’s degree in software engineering. The degrees will be offered around the state, including at the Pullman, Everett, Global, and Vancouver campuses. A new bachelor’s degree in electrical engineering at Olympic College in Bremerton was also established.

**WSU receives in-kind software grant from Siemens PLM Software**

Washington State University has received an in-kind software grant from Siemens PLM Software.

The in-kind grant gives students access to the same technology that companies around the world depend on every day to develop innovative products in a wide variety of industries including automotive, aerospace, machinery, shipbuilding, high-tech electronics, and many more. Graduates with this type of software training are highly recruited candidates for advanced technology jobs.

WSU students in Pullman and Everett are using the software in their senior mechanical engineering capstone design courses and, in particular, as part of the AerosPACE, or Aerospace Partners for the Advancement of Collaborative Engineering, program. The Boeing Company started AerosPACE in 2013 to give students real-world collaboration practice before entering the job market. Students in the program work two semesters as part of a multidisciplinary team with students from several other universities, as well as with industry partners on designing, building, and flying an unmanned aerial vehicle. WSU’s Everett program is led by Professor Xiaopeng Bi.

This year, the students developed an unmanned surveillance aircraft for wildland firefighting. Effectively controlling tens of thousands of fires a year around the country requires tight coordination of personnel, vehicles, equipment, and time, according to Bi. Firefighters need to augment their information about wildfire growth affordably in real time. An unmanned surveillance aircraft can lower costs and provide a safer alternative to a manned aircraft. The students successfully tested and flew their plane.

“This partnership enables us to meet the needs of employers and prepare students for these significant high paying STEM careers,” said Bi.
“YOU CAN REVECTOR”

**Early Struggles Taught Valuable Lessons for Voiland Aerospace Alumna**

The most valuable thing that Iris Fujiura Bombelyn (’83) learned during her time at Washington State University was how to overcome mistakes.

“I learned how to fail here and I learned I wasn’t the best in the class,” she said. “It humbled me—a lot.”

Bombelyn, currently the vice president of protected communications at Lockheed Martin Space Systems Company, was the keynote speaker at the recent Joint Center for Aerospace Technology and Innovation’s annual symposium held in Spokane.

Growing up in Longview as the daughter of a longshoremen and a seamstress, she was a top student in high school and followed her older brother to WSU. During her freshman year she considered studying engineering or journalism. She was good at math and also liked to write.

**Engineers Eat**

“Well, kid, engineers eat,” her father said.

Inspired by her father's simple and practical advice that engineers make a good living, Bombelyn chose it as her major shortly thereafter. The engineering classes she took provided her with the fundamentals in power engineering design, communications theory, and control systems that gave Bombelyn a strong foundation for her career.

**A Challenging Environment**

She also found herself in a challenging and unfamiliar environment—and one of only a handful of women on campus who were studying engineering at the time.

Bombelyn was used to being in a culture that rewarded young women for following the rules, being quiet and well-behaved, and sitting on the sidelines. The young men in her classes, on the other hand, had often been rewarded for pushing the envelope, getting out there, and doing things—just the sort of skills that are needed in engineering.

“So when you enter into an engineering degree because you’re smart enough to do it, and you don’t have a lot of the other skills...that you need to become an engineer,” she said. “I struggled.”

And for the first time in her life, she also had to work hard. “This was the first time that I had been immersed in an environment where everyone was the smartest in the class,” she said. “I had to work, and I didn’t have the skills to do that.”

Bombelyn managed to get through those challenges and was lucky to get a good position in the aerospace industry soon after graduation. She began her career as an instrumentation engineer at Vandenberg Air Force Base in California. She later became a payload operations launch conductor and progressed through increasingly responsible positions, including launch operations manager at International Launch Services, Inc., and program director at Orbital Sciences Corporation.

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She later earned an MBA in leadership and global innovation from the Massachusetts Institute of Technology Sloan Fellows program before returning to Lockheed Martin as director of test systems.

She has received numerous honors for her work, including the Silicon Valley YWCA Tribute to Women in Industry award and the Asian American Executive of the Year. In 2012, she received WSU’s Alumni Achievement Award, the Alumni Association’s highest honor, where she was recognized for her leadership in global business and her accomplishments in the aerospace industry.

**Giving Back**

Today, Bombelyn likes to mentor young people starting their careers, particularly in her position on the board of the Harold Frank Engineering Entrepreneurship Institute.

Students often want to know how she became a vice president at Lockheed. She tells them that there is no perfect path to execute. There is plenty of room for missteps and direction changes, and each person’s journey is their own. Getting the engineering degree is the first priority, followed by getting a job that can pay the bills.

“With that degree, you have the foundation,” she says. “The degree provides you with a suite of opportunities until you find the right fit. The hardest thing in the world is to figure out what you want to do, actually. Along the way, it’s ok to make course corrections.”

“The punch line is, ‘try it,’” she says. “If you don’t like it, try something else. Life is long.”

And, sounding like a true aerospace engineer, she adds, “You can revector.”

While women often think of the disadvantages to being a woman in the field, Bombelyn also likes to point out at least one big advantage: you stand out.

“There’s an advantage to being the only person who looks like you—if you take it,” she said. “If you take your seat at the table, people will remember who you are and what you said.”

A lesson that Bombelyn learned early on during her studies at WSU remains with her today. The line between people who succeed and those who don’t is not based on how smart, talented, or good looking they are.

“It’s their perseverance,” she says. “It’s never giving up. That’s the measure of success.”

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**Alumni Achievement Award Recipients**

The WSU Alumni Achievement Award is the highest award bestowed by the WSU Alumni Association.

David S. Ensor (’79 BS ME) was recognized for his contributions to aerosol science that have helped protect workers and the public from potential air pollution hazards. Ensor’s career accomplishments have included: methods to characterize emissions from coal-fired power plants; technology to control ultra-fine airborne contaminants of semi-conductor chips; participation in government-private sector-academic efforts to detect and limit environmental threats; and innovative approaches to characterizing nanomaterials.

Armistead (Ted) G. Russell (’79 BS ME), an engineering researcher and professor at the Georgia Institute of Technology, was recognized for his work in air quality science tied to health, public policy, and sustainable development. Russell’s research has increased understanding of trace contaminants in the air, computational modeling, air quality engineering, and health. His particular contributions are based on his ability to integrate these areas and provide information that is used in managing air quality and developing national public policy.
LOOKING BACK, LOOKING FORWARD

Candis Claiborn, who led the college as dean for a decade and was one of just a few female engineering deans in the United States, returned to her faculty position in the Department of Civil and Environmental Engineering earlier this fall. Claiborn led the college through the budget challenges of the 2008 recession as well as through the unprecedented growth that followed.

SINCE 2009, RESEARCH EXPENDITURES HAVE GROWN BY 75 PERCENT. Research successes include a $40 million USDA grant to develop a supply chain for aviation biofuels; two prestigious National Science Foundation IGERT awards; a NSF ADVANCE grant to increase the advancement of faculty women in science, technology, engineering and mathematics; and more than ten NSF Career awards.

The college was renamed the Voiland College of Engineering and Architecture in 2014 to honor the lifetime contributions of Gene and Linda Voiland to the college, the University, and society.

THE NEW PACCAR ENVIRONMENTAL TECHNOLOGY BUILDING is a state-of-the-art research and learning facility that will support engineering faculty and interdisciplinary collaborators.

SINCE 2009, ENROLLMENT IN THE COLLEGE HAS INCREASED BY 65 PERCENT TO MORE THAN 4,300 STUDENTS. With support from industry and government leaders around the state, the college began engineering programs in Bremerton and Everett, and expanded online offerings to meet the needs of place-bound, and often nontraditional students.

The college exceeded its $125 MILLION fundraising goal as part of the successful Campaign for WSU.

THE COLLEGE EXPANDED ENTREPRENEURSHIP OPPORTUNITIES THROUGH THE HAROLD FRANK ENGINEERING ENTREPRENEURSHIP PROGRAM AND THE FRANK INNOVATION ZONE, A MAKER SPACE OPEN TO ALL STUDENTS.
AIMING FOR THE SUN
WSU VIES FOR SOLAR HOME PRIZE

Washington State University students have begun designing a solar home for the U.S. Department of Energy’s Solar Decathlon competition. WSU is one of 14 universities from across the world participating in the $2 million competition, which aims to increase public awareness of solar energy and inspire innovative solutions in ecological design. See story, p. 5.