

The TREND *in Engineering*

THE UNIVERSITY OF WASHINGTON COLLEGE OF ENGINEERING NEWSLETTER **AUTUMN 2012**

Launching the Molecular Engineering Revolution

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A Farewell Celebration

THIS IS MY LAST *Trend* message — after six plus great years as dean, I will shift focus back to bioengineering research and return to teaching in January 2013.

It has been a privilege to partner with many people across the UW and Seattle communities to advance key initiatives focused on the student experience, faculty development, educational outreach, research and commercialization. As you'll see, even in challenging times we were able to grow many important programs.

The Student Experience

All of our departments now directly admit freshmen — growing programs and access for the state's top high school graduates. We've grown undergraduate enrollment by 27% and degrees by 12% and have aggressive plans to grow our capacity further. Graduate enrollment grew by 22% and degrees by 34%. More than 35% of our undergraduates participate in research, giving them a leg up as they go into the workforce.

Faculty Development

Outstanding education and research happen because of the right people. Twenty-six percent of our faculty

are new hires within the last six years, representing both replacements for retirees and growth. More important than the number is the sheer quality of these individuals. Most often we are competing with the top five engineering schools in the country, and the large majority of candidates choose the UW.

Educational Outreach

As is our tradition, we serve industry in part through the development of continuing education programs. Professional master's degrees are now offered in a majority of our disciplines, in partnership with UW Professional & Continuing Education.

Research Expenditures & Commercialization

The UW is an amazing economic engine, and engineering is a major player. Our research expenditures have grown by 21% from \$92.5 million to \$113 million — a credit to our entrepreneurial faculty. Last year the college comprised 38% of the UW's commercialization activities with only about 6% of total UW faculty.

This fall we will celebrate the opening of the Molecular Engineering and Sciences building. It will house some of our best and brightest faculty and students working to make important advances in energy and medical applications.

I am extremely bullish on the future of engineering education and research at the UW. The college has strong leadership in place, remarkable faculty, an excellent student base and an amazing group of supporters in you, our alumni. We will continue to provide a quality research and educational experience to equip the next generation of Husky Engineers.

Matt O'Donnell

*Frank & Julie Jungers
Dean of Engineering*

Banner Year for Faculty Recruitment

Eleven exceptional new faculty members will join the college this year. We highlight two below. Meet them all at: www.engr.uw.edu/newfac2012.

Carlos Guestrin

Computer Science & Engineering
Amazon Professor of Machine Learning



Considered one of the world's leading researchers in machine learning, Carlos Guestrin joins us this fall from Carnegie Mellon University. He is the recipient of a Sloan Research Fellowship and a Presidential Early Career Award for Scientists and

Engineers, and was named one of the 2008 "Brilliant 10" by *Popular Science* magazine. He is one of four game-changing new hires in the computer science and engineering fields of "big data" and machine learning.

Kate Starbird

Human Centered Design & Engineering



Former WNBA star Kate Starbird returns to Seattle in a new role — assistant professor. Her research focuses on the use of social media during crises and mass emergencies, and specifically examines how digital volunteers and members of the

connected crowd help to organize information during disaster. She is the recipient of an NSF Graduate Research Fellowship.

Lehman & Notkin Assume College Leadership Roles

Dawn Lehman, associate professor of civil and environmental engineering, has been named associate dean of infrastructure where she will guide the development of new research and computational facilities for the college.

David Notkin, professor of computer science & engineering, will serve as acting associate dean of research and graduate studies for one year. He will foster multidisciplinary collaborations, develop research programs, and strengthen recruitment and mentoring programs for graduate students.



Plasma startup creates high-energy light to make smaller microchips

By Hannah Hickey

A UW lab has been working for over a decade on fusion energy, harnessing the energy-generating mechanism of the sun. But in a twist of scientific discovery, along the way the researchers found a potential solution to a looming problem in the electronics industry. To bring their solution to market, UW engineers have launched a startup, Zplasma, which aims to produce high-energy light to etch the next generation of microchips.

"In order to get smaller feature sizes on silicon, the industry has to go to shorter wavelength light," said Uri Shumlak, professor of aeronautics and astronautics. "We're able to produce that light with enough power that it can be used to manufacture microchips."

For over forty years the technology industry has kept up with Moore's Law, a prediction that the number of transistors on a computer chip will double every two years, allowing ever-smaller, faster, and less energy-intensive electronics. But it's hit a roadblock: the 193-nanometer ultraviolet light now being used cannot etch circuits any smaller.



PLASMA

More extreme ultraviolet light comes from plasmas – high-temperature, electrically charged gases in which electrons are stripped from their nuclei. Fusion scientists, it turns out, are plasma experts. The

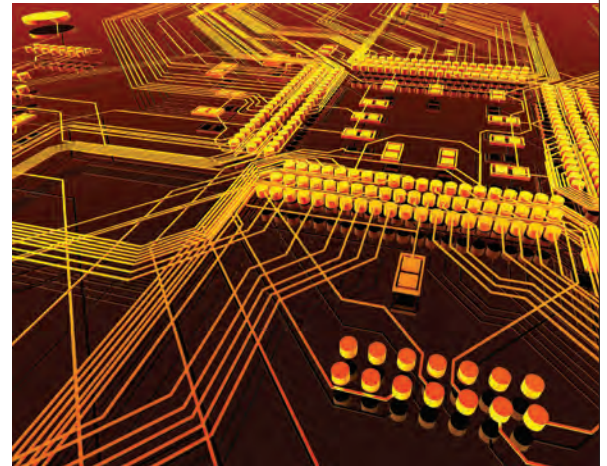
hydrogen plasma in the sun is so hot that hydrogen nuclei fuse together and release energy. Fusion scientists around the world are working to replicate this on Earth to generate clean energy.

The UW's specialty is a lower-cost reactor that uses electrical currents, rather than giant magnets, to contain the million-degree plasma. The plasma is stable, long-lived and intense. The first time the team triggered the experiment in 1999, an engineer said, "That was really bright!" That's when the proverbial light bulb went on and the team began to explore applications for bright, high-energy light.

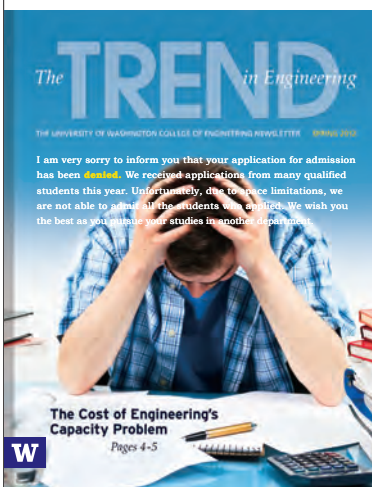
The team may have found that application in the microchip industry. Techniques now being considered generate a spark that lasts just 20 to 50 nanoseconds. Zplasma's light beam lasts 20 to 50 millionths of a second, about 1,000 times longer.

A gift from the Washington Research Foundation helped the team shrink the equipment from the size of a broomstick to the size of a pin, which can produce a sharp beam. The company is seeking "smart money" from investors who can integrate the new technology with existing processes.

"I hope this gets implemented into industry and has an impact," Shumlak said.




Progress on the Capacity Problem



The last issue of *Trend* reported on the college's capacity problem. The feature story generated great interest and feedback. Thank you for taking the time to share your concerns and thoughts. Since the last publication, the college has received a \$3.8 million state-mandated distribution to increase admission to all engineering departments. These funds allow the college to increase enrollments by 425 students in the next few years, resulting in an additional 190 engineering degrees per year, with the majority of the distribution allocated to undergraduate admissions. At this time, half of this money has been distributed throughout the departments and the other half will be distributed based on progress. This funding comes at a critical time and helps the college

begin to address the backlog of students seeking an engineering education. Applications are up again this year and unfortunately, well-qualified students are still being turned away. The college will continue to work with UW and state leadership to find creative solutions to meet the demand for engineers.



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 Monday, October 15.

► www.engr.uw.edu/da



Launching the Molecular Engineering

Could the University of Washington be at the center of the next digital revolution? College of Engineering Dean Matt O'Donnell thinks so, a conviction that's behind the recent launch of the university's Molecular Engineering and Sciences (MoES) Institute, one of the first such programs in the country.

Molecular engineering is such a new field that each of its practitioners defines it in a slightly different way. But what they all have in common is an emphasis on designing new molecules to do useful things, and building materials from the molecule up.

In the coming years, manufacturing at the molecular scale "will affect increasingly large sectors of the economy," O'Donnell predicts.

But this isn't just about commerce. The rise of molecular engineering also represents an intellectual revolution, a new way of thinking about the physical world in the same way that the digital revolution transformed our thinking about information.

And, just like the digital revolution, molecular engineering could profoundly transform and improve our everyday lives.

"We have a grand challenge model at the MoES Institute that envision teams of top faculty working together on solutions to major societal challenges," says institute director Patrick Stayton. Specifically, researchers will pursue new ways to diagnose disease earlier and treat it more precisely, and develop inexpensive and practical methods to harness clean sources of energy.

Why focus on these two areas, "biotech" and "cleantech" in MoES Institute shorthand? Simple: "The people," says O'Donnell.

That is, the UW already had faculty members contributing important discoveries on these topics. But, says Stayton, "We felt these efforts were scattered." Bringing researchers together to work across disciplines could multiply their efforts—and their achievements.

But the challenges will be grand indeed. "The easy problems have been sorted out by now," says professor of chemical engineering Hugh Hillhouse. "These things take big efforts, they take collaboration," Hillhouse adds, and he knows firsthand—his work is aimed at developing cheap, efficient solar cells, a problem that has flummoxed researchers for over half a century.

Currently, the usual approach to manufacturing solar cells involves growing giant crystals of silicon or other materials, a manufacturing process fraught with expense and technical difficulty. Instead, Hillhouse hopes to write a new solar story in ink—literally.

The ink is a black solution composed of nanocrystals made from copper, tin, zinc, and sulfur. These abundant, readily available elements could someday support manufacturing at a large scale. And that manufacturing process would be considerably simpler than the current one.

In a solar cell, efficient energy conversion depends on a flawless crystal, and it's much easier to make flawless nanocrystals than it is to make flawless giant ones. Turning nanocrystal ink into a solar cell is also quite

straightforward: "Spread it on a substrate, heat it up, and that's the active layer of the solar cell," Hillhouse summarizes.

Of course, it's not quite that simple. "We've made ink-based solar cells that are 12 percent efficient," Hillhouse says—that is, they convert 12 percent of the sun's energy that hits them directly into electricity. That's not good enough. The average silicon solar panel is about 15 percent efficient, and getting better all the time.

So Hillhouse's next step, in collaboration with the other solar-energy researchers who inhabit the first floor of the MoES building (see insert), will be to improve the efficiency of those solar cells bit by bit, testing out tens of thousands of new molecular combinations using high-throughput techniques.

"If we get to 20%," he predicts, "they will be everywhere." That's far from certain. But it's just possible enough to keep Hillhouse going.

Research on the biotech side of MoES is equally audacious. Bioengineering professor Suzie Pun gives one example: "Our challenge is, how can we get drugs into the place that our body wants to protect most?" she says.

That place is the central nervous system—the brain and spinal cord. The membranes that protect these vital structures prevent most drugs from passing from the bloodstream into the central nervous system. As a result, devastating neurological diseases like Lou Gehrig's Disease and Alzheimer's "are really not treatable at this point," Pun says.

But Pun and her collaborators aim to change that by building molecular vehicles to help transport drugs across the blood-brain barrier. They're taking clues from pathogens like polio and tetanus that affect the central nervous system, and engineering molecular systems that can mimic the way those pathogens get inside.

Pun and others are applying a similar approach to a dizzying array of biomedical problems. Another project in Pun's lab aims to identify cancer earlier than is currently possible—much earlier.

A cell in the process of turning cancerous "starts to make molecular changes very early on, but it still looks like a normal cell to the eye," Pun explains. The changes are too small to see with current imaging methods like ultrasound and CT scan.



Suzie Pun

REVOLUTION

By Sarah DeWeerd

So to make these changes visible, Pun is working with talented chemists to combine fluorescent molecules with other molecules that specifically recognize cancerous or precancerous cells. "We're trying to find markers, and light them up," she says. Next, Pun's group will collaborate with UW professor of gastroenterology Joo Ha Hwang to test their approach using human tissue samples.

The MoES Institute is more than just research. It will also offer graduate-level education programs, including a track program for students in related disciplines and, perhaps, a dedicated Ph.D. program that could begin as early as Fall Quarter 2013.

In many interdisciplinary courses, "The first problem students have is just to talk to each other," observes René Overney, professor of chemical engineering and director of education for the MoES Institute. That's because underlying scientific concepts and, especially, vocabulary differ so much across various fields.

As a result, it's not enough to just bring people from different disciplines together. Instead, MoES will train students in a way that helps them understand across disciplines so that they can better work together.

"They cannot be experts in everything, that's not the point," says Overney, who draws on his success as director of the interdisciplinary Nanoscience and Molecular Engineering program for undergraduates. But a chemist working on molecular synthesis should have a sense of what a molecular modeler does, and vice versa. Core MoES courses will be designed to create these foundations of common knowledge.

To O'Donnell, the MoES Institute's educational impact—formal program participation as well as students working in associated researchers' labs—will be a key measure of its overall success.

"I want to see huge student involvement," he says.



WiSE Beyond Their Years: Women *in* Science *and* Engineering

By Deanna Duff



Elise Groves is proud to continue her family's engineering legacy – with a twist. Upon graduating from the UW in 2014, she will become a third-generation engineer. Following in her father's and grandfather's footsteps is rewarding, but it has also been a journey to find equal footing. As the first woman in her family to pursue engineering, she couldn't always look to them for role models.

"Engineering is a male-dominated field and sometimes it's a struggle to attend class and realize you're the only female. In the back of your mind, you wonder if choosing another field would be easier," says the 21-year-old. "It's programs like WiSE that made me realize female engineers really do exist."

Women in Science and Engineering (WiSE) is a nationwide program that endeavors to recruit and retain female engineering and science students. UW WiSE is one of many successful programs in the College of Engineering Student Academic Services (SAS) focused on increasing the number of female engineering students. And WiSE is working. "Women who participate in WiSE are three times more likely to be admitted to the departments of the UW College of Engineering," says Eve Riskin, associate dean of academic affairs.

Creating equal gender opportunities benefits the sciences and engineering. "We bring our own, unique perspectives and when you combine women and men, it creates a fuller, whole picture," says Groves.

Anne Goodchild, assistant professor of civil and environmental engineering, understands firsthand the impact of WiSE. For her, the seed to pursue engineering was partially planted when a WiSE group presented at her California high school.

"In hindsight, it was really powerful. Even for upper-middle class students like me, the exposure made an impact," says Goodchild. "There are so many messages sent to girls that they should do other things and it undermines their confidence. WiSE makes a difference in helping counteract that."

UW Leading the Nation in Women in Engineering

The UW's efforts with a variety of programs to increase the number of female students have yielded solid results. According to the National Center for Education, in 1988 only 15.4% of engineering graduates nationally were women. Over 20 years later, the American Society for Engineering Education (ASEE) reported that the UW's 24% undergraduate rate in 2011 was well ahead of the 18% national average. While parity has yet to be reached across the board, some engineering disciplines demonstrate particular progress. According to ASEE, for the 2010-2011 academic year, 48% in UW industrial and systems engineering graduates were women, 41% in bioengineering and 37% in chemical engineering.

"Every one of those fields is known to have strong, positive social impacts. Women tend to choose engineering areas where they see more social benefit," says Suzanne Brainard, current executive director for the Center for Workforce Development.

Brainard, who designed and implemented the Women in Engineering Initiative and formerly oversaw WiSE, believes that reframing the discussion was essential to making progress.

"This isn't an issue of 'fixing' women. Research showed that women don't decide against engineering or drop out of programs because of personal failure. Their grades are often better than the men," says Brainard. "We had to work towards institutional change. How can we (the education system) be more supportive and emphasize these fields as available options to young women?"

Impressive progress has been made in the last 20 years, but there is also much that remains to be accomplished. "It's labor-intensive to run these programs and takes a lot of people power and financial support," says Brainard. To safeguard the progress already made and to continue moving forward, ongoing and vigilant advocacy is essential.

Engaging Students Early

A major way that WiSE helps the UW achieve that mission is through early outreach. "The transition from high school to college and the first two years at university are crucial in encouraging young women to pursue disciplines such as engineering," says Cathryne Jordan, WiSE program manager.

Many female students are not overtly or intentionally discouraged. Rather, they are deterred by feelings of isolation and the lack of role models.

"Some people don't mind being in the minority, but it can be overwhelming to come from a typical high school where the classes are about (gender) even to be one of only a few girls in a class of 100. No one really has to say anything (negative) for it to feel intimidating," says Alexandra Gramling. Gramling served as a WiSE board member and graduated this year with



Alexandra Gramling

a mechanical engineering degree. She will pursue her engineering master's degree at the UW this fall.

In addition to providing students opportunities to connect with their peers, having female, academic role models is equally important. Anne Goodchild specifically chose to come to the UW as a faculty member because of its welcoming environment. "Our department has hired a lot of really talented young women. I think in the long-term, we (female professors) support the younger generation by obtaining positions of leadership and influence and that filters through," says Goodchild.

A Community of Support

WiSE offers several events and partners with the Society of Women Engineers and Phi Sigma Rho, a sorority of women engineers, to provide ongoing, community support. WiSE receives some university funding, but is largely supported by industry contributions, individual gifts and volunteers. Students and alumni serve on the advisory board planning and overseeing projects.

To fully connect the various communities, the annual WiSE conference is the program's flagship event hosting high school students, current and pre-engineering college students, faculty, alumni and industry leaders. Held every winter, a few hundred attendees network and attend lectures and workshops. This not only creates a sense of community, but also encourages long-term consideration of how to eventually integrate into the workforce.

For major industry leaders like Microsoft, Boeing, BP, CISCO and Intel (among the many WiSE corporate sponsors), cultivating exceptional women engineers is mutually beneficial.

"There aren't many companies today that aren't building worldwide products. Any aspect of diversity that you can bring to the team, including women, is critically important. The more collective knowledge, the better the product in the end," says Debra Dove, a 1998 UW computer engineering graduate. Dove works at Microsoft and, as an alumna, has repeatedly participated in WiSE events.

The current generation of students who have benefited from WiSE are already doing their part. They have learned the value of not only being great engineers, but good citizens who want to inspire future generations.

"When I have kids, whether they're boys or girls, I hope they'll be engineers!" says Gramling.

Interested in WiSE? Consider these opportunities:

WiSE/LSAMP Coffee

A quarterly session where you can mentor aspiring female engineers.

WiE Speaks Lecture Series

Share your expertise with female engineering students as a presenter.

WiSE Conference – March 2, 2013

Volunteer as a speaker, mentor, or participant in this annual event.

Contact Joseph Sherman at shermjp@uw.edu if you are interested in any of the above volunteer opportunities.

Give to the Suzanne G. Brainard Scholarship for Diversity in STEM

This fund awards an annual scholarship to an exceptional student who impacts STEM diversity. Visit www.engr.uw.edu/brainard.html to learn more about this giving opportunity.

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2012 Engineering Lecture Series Engineering Molecules: *Tiny Solutions for Big Problems*

Launching the Molecular Engineering Revolution

Tuesday, October 16

Matt O'Donnell, Frank & Julie Jungers Dean of Engineering

In the future, molecular engineering will reshape the economy, education, and our very relationship with the physical world. Though the field is still in its infancy, it's predicted to eventually yield tools that could spark a revolution as far-reaching as the recent digital revolution. The UW is harnessing its existing strengths in cleantech and biotech to position itself at the leading edge of this revolution.

Here Comes the Sun: Engineering New Solar Technologies at the Molecular Scale

Thursday, November 1

Hugh Hillhouse, Rehnberg Chair Professor, Chemical Engineering
Christine Luscombe, Associate Professor, Materials Science & Engineering

The sun is an almost limitless source of clean energy — if only we could capture that energy effectively. Though solar cells have been around for over 50 years, so far no one has been able to make them cheaply and efficient enough for truly widespread use. But by starting small, using either nanocrystals or organic polymers, UW engineers hope to make solar cell manufacturing simpler and more reliable while adhering to green manufacturing methods to position itself at the leading edge of this revolution.

Into the Body: Molecular Systems for Healing

Thursday, November 8

Suzie Pun, Robert F. Rushmer Associate Professor, Bioengineering
Patrick Stayton, Director, Molecular Engineering & Sciences Institute,
Washington Research Foundation Endowed Professor, Bioengineering

Imagine delivering cancer drugs directly to tumor cells, without harming the healthy cells that surround them. Hear how UW molecular engineers are devising ways to deliver drugs to cells more precisely, offering hope far beyond cancer diagnosis and treatment. The methods they are pioneering may also lead to breakthroughs for allergies, asthma and autoimmune disease, and neurodegenerative diseases like Alzheimer's that are largely untreatable today.

All lectures are at 7pm, Kane Hall, UW Campus – FREE!
Registration required, online at:
UWalum.com/engineering or call (206) 543-0450.

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UW Alumni Association*