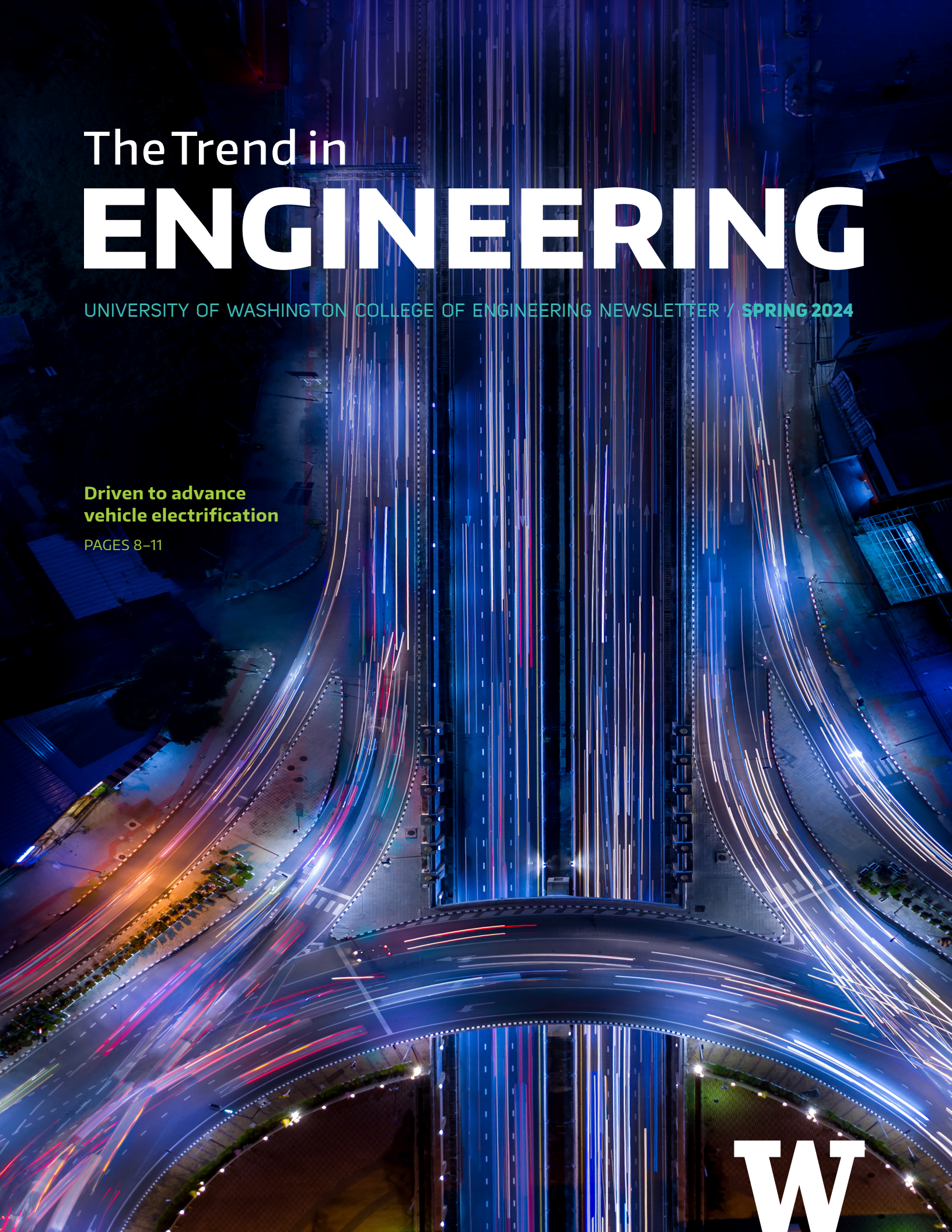


The Trend in ENGINEERING

UNIVERSITY OF WASHINGTON COLLEGE OF ENGINEERING NEWSLETTER / **SPRING 2024**

Driven to advance vehicle electrification

PAGES 8–11

FROM THE **DEAN**

This has been an exciting spring in the College of Engineering. In early April I was honored to attend a signing ceremony in Washington, D.C., celebrating our new cross-Pacific AI partnership. Later that month the UW hosted a convergence of UPWARDS for the Future, a landmark initiative focused on addressing the shortage of skilled workers and researchers in semiconductor and microchip production. Both endeavors represent not just significant academic and industry partnership but also collaboration across nations — they show what's possible when a diverse coalition shares a vision for a better future.

I'm pleased to report that interest in engineering and computer science is soaring, with a 52% increase in undergraduate applications to the UW in these areas over the past five years.

This year, we welcomed over 1,000 Direct-to-College students and 21 new faculty, with approval to hire 60 more. Our Interdisciplinary Engineering Building (IEB) is nearing completion and will open in 2025, addressing crucial infrastructure needs. However, as Washington's premier engineering educator, we recognize the need for more and better space to support collaborative engineering education. We're currently working on a space assessment and academic facilities plan, focusing on the renewal of severely outdated spaces.

Finally, we are thrilled that this spring marked the return of Discovery Days! Prior to the pandemic, this outreach event had been held for over 100 years. This year's registration filled within six minutes! I cannot express how wonderful it was to once again host elementary and middle school students on campus as an introduction to the incredible world of engineering.

We all know that engineers are problem-solvers, but engineers are so much more. Our community knows the importance of teamwork, collaboration, precision, trial and error, and that working together makes us stronger. Thank you for all you do to advance engineering excellence for the public good.

Nancy Allbritton, M.D., Ph.D.
Frank & Julie Jungers Dean of Engineering

2024 DIAMOND AWARDS

The College of Engineering honors five alumni and friends for their outstanding achievements and contributions in the following areas:

DIAMOND AWARDS

EMBRACING THE POWER OF DIVERSITY, EQUITY AND INCLUSION

Hakim Weatherspoon, B.S. '99 Computer Engineering
Professor and Associate Director, Cornell Institute for Digital Agriculture, Cornell University; Co-Founder and Chief Scientist, Exostellar, Inc.

CREATING A HEALTHIER AND MORE JUST WORLD

Stephanie Bostwick, B.S. '05, M.S. '07 Aeronautics & Astronautics
Engineering Department Chair, Northwest Indian College

TRANSLATING INNOVATION INTO IMPACT

Shivang Dave, Ph.D. '11 Bioengineering and Nanotechnology
CEO and Co-Founder, PlenOptika, Inc.

DEAN'S AWARD

Paul Bao-Ho Liao, Ph.D. '72 Civil & Environmental Engineering
Chairman and CEO (past), KCM Inc.

Mei-Yea Chiou Liao
Community leader

Learn more about the 2024 Diamond Award winners at engr.uw.edu/da

Remembering alumnus Frank Jungers

From navigating turbulent times in the Middle East to supporting educational institutions, mechanical engineering alumnus Frank Jungers, '47, was committed to progress. At the age of 97, Jungers passed away in fall 2023.

A longtime supporter of the College of Engineering, Jungers helped advance the future of engineering through his philanthropic support, thought leadership and time. In addition to being a founding member of the UW Foundation Board of Directors, he served on several College committees. Together with his wife, he established the Frank & Julie Jungers Deanship and the Jungers Endowed Chair, both of which support excellence in leadership.

During a 31-year career at the Arabian-American Oil Company (now Saudi Aramco), Jungers became chair and CEO. While based in Saudi Arabia, Jungers managed critical operations and played a pivotal role during the 1973 OPEC embargo. He met with CEOs around the globe, spoke with President Nixon at the White House and was interviewed on 60 Minutes. Following the transfer of Aramco to the Saudi government, Jungers was praised for his problem-solving and diplomacy with U.S. and Saudi workers, the Saudi royal family, government and corporations.

"I am so grateful for the lasting legacy Frank and Julie have made in the College of Engineering, which will benefit students, faculty and the engineering profession in perpetuity," says Nancy Allbritton, Frank & Julie Jungers Dean of Engineering.

The College is honored to carry on Jungers' legacy through both the deanship and Jungers Endowed Chair, held by Samson Jenekhe, professor of chemical engineering and of chemistry.

UW joins landmark $110 million cross-Pacific effort to advance artificial intelligence

By Jackson Holtz

This spring the UW and the University of Tsukuba entered a partnership with NVIDIA and Amazon to advance artificial intelligence (AI) research, entrepreneurship and workforce development. The collaboration is part of a $110 million effort to foster innovation and technological breakthroughs in AI between the U.S. and Japan.

Announced on April 9 during Japanese Prime Minister Kishida Fumio's visit to the U.S., the agreement involves two new AI research partnerships between the UW and University of Tsukuba, and between Carnegie Mellon University and Keio University. These partnerships are backed by $110 million from NVIDIA, Amazon, Arm, Microsoft and nine Japanese firms, with Amazon and NVIDIA each contributing $25 million.

At the invitation of U.S. Ambassador to Japan Rahm Emanuel, the UW has been building connections with the University of Tsukuba over the past year. Tsukuba is a city known for scientific research and innovation, mirroring Seattle's reputation as a tech innovation hub.

The College of Engineering will lead interdisciplinary efforts at the UW, and the partnership will support research, post-doctoral and doctoral students, an undergraduate research program, and an entrepreneurship boot camp.

It marks the third strategic university-corporate initiative between American and Japanese institutions since May 2022, following President Biden and Prime Minister Kishida's commitment to U.S.-Japan science cooperation. Additionally, the UW leads UPWARDS, a program for semiconductor workforce development supported by Micron, Tokyo Electron Limited and the National Science Foundation.

A new innovation partnership between the UW and the University of Tsukuba is announced in Washington, D.C. From left: U.S. Secretary of Commerce Gina Raimondo, Amazon Senior Vice President David Zapolsky, UW Provost Tricia Serio, University of Tsukuba President Dr. Kyosuke Nagata, NVIDIA Vice President Ned Finkle, and Japanese Minister of Education, Culture, Sports, Science & Technology Moriyama Masahito.

Nancy Allbritton elected to National Academy of Engineering

Nancy Allbritton, the Frank & Julie Jungers Dean of the College of Engineering and a professor of bioengineering, was elected to the National Academy of Engineering in February. Election to the Academy is one of the highest honors given to an engineer. Allbritton was selected "for innovation and commercialization of single-cell, analytical, and gut-on-chip technologies for drug screening and for engineering education."

Drawing from the fields of engineering, chemistry, physics and materials science, Allbritton's research develops technologies and platforms for biomedical research and clinical care, including the study and analysis of single cells for the treatment of a variety of diseases such as cancer, macular degeneration and HIV. She is an international expert on multiplexed single-cell assays, microfabricated platforms for high-content cytometry combined with cell sorting, and microengineered stem-cell-based systems for recapitulating human organ-level function.

Allbritton's work has resulted in more than 250 publications and patents and led to 15 commercial products. In addition, five companies have been formed based on her research discoveries: Protein Simple (acquired by Bio-Techne in 2014), Intellego, Cell Microsystems, Altis Biosystems and Piccolo Biosystems. She has been nationally recognized for her research and is a fellow of the American Association for the Advancement of Science, the American Institute for Medical & Biological Engineering, the National Academy of Inventors and the Washington State Academy of Sciences.

Rising Star Award for inclusive excellence

Celebrating individuals and institutions for their contributions to inclusive excellence in higher education, the National Association of Diversity Officers in Higher Education recently announced its 2024 Inclusive Excellence Award winners. Among 11 honorees was Karen Thomas-Brown, associate dean of diversity, equity and inclusion in the College of Engineering, who received the Rising Star Award. Since 2021, Thomas-Brown has led the College's ongoing efforts to be an accessible, welcoming and inclusive community.

USA Today Woman of the Year

In recognition of her advocacy for women in STEM, Merrill Keating, a senior in mechanical engineering, was one of 60 women across the country to be named a USA Today 2024 Woman of the Year. Among her many activities aimed at empowering young women, Keating founded a nonprofit known as Girls Ignited, which inspires change by spotlighting young women leaders, and established a collective giving organization called The Power of 100 Girls. Each of the 100 members invests $100 annually to fund scholarships.

From the top: Nancy Allbritton, the dean of the College of Engineering; Karen Thomas-Brown, associate dean of diversity, equity and inclusion; and Merrill Keating, a senior in mechanical engineering.

UPWARDS for the Future

The UW leads an initiative to address the shortage of skilled workers and researchers in semiconductor production.

Modern technology relies on semiconductors, yet the U.S. manufactures about only 12% of the world's supply. Recognizing the economic and national security risks this poses, U.S. policymakers passed the Creating Helpful Incentives to Produce Semiconductors (CHIPS) & Science Act in 2022 to strengthen the U.S. semiconductor ecosystem.

In April, the UW — as the lead institution of the U.S.-Japan University Partnership for Workforce Advancement and Research & Development in Semiconductors (UPWARDS) for the Future — convened government representatives, industry representatives, faculty and researchers on campus to develop strategies to propel the semiconductor industry forward.

"Our nation's success in advanced technologies depends on having a strong workforce. The University of Washington will help establish the Pacific Northwest as a leader by training the more than 90,000 students, faculty, and skilled professionals needed to build the most advanced chips right here in the United States," says U.S. Senator Maria Cantwell of Washington, who was instrumental in passing the landmark CHIPS & Science bill. "If we want to lead the world tomorrow, we must invest in worker training today."

Micron Technology and Tokyo Electron Limited, as founding industry partners, together with the National Science Foundation (NSF) and universities, are investing over $60 million for the five-year project. In addition to the UW, the partnership includes five U.S. institutions — Boise State, Purdue, Rensselaer Polytechnic Institute, Rochester Institute of Technology and Virginia Tech — and five Japanese universities: Hiroshima University, Kyushu University, Nagoya University, Tohoku University and Tokyo Institute of Technology.

At the spring event, the 11 institutions partnered to establish plans for student exchange, curriculum sharing and standardization, and research collaboration.

UPWARDS for the Future workshop attendees. Photo by Matt Hagen

CHIPS UPDATES

Developing a laser printer for photonic chips

A UW-led research team has invented a rapid, cost-effective printer for photonic chips. These microchips, which use particles of light to process information, have the potential to drastically reduce costs and enhance speed of a range of electronic devices. Similar in size to a desktop laser printer, the technology could enable researchers to produce photonic chips from almost anywhere.

Scientists reveal superconductor with on/off switches

As industrial computing grows, its hardware size and energy consumption must keep up. Superconducting materials, which reduce energy consumption exponentially, offer a possible solution. Recently, a team of clean energy researchers and physicists discovered a superconducting material with properties that can be enhanced or suppressed at will. This finding could potentially revolutionize industrial-scale computing and advance technologies like quantum computing.

Creating a new chip for wireless communication

As more devices compete for airwaves, engineers are exploring how to improve wireless communication, and reduce congestion, by using the same frequencies for talking and listening. But they face challenges like signal noise, especially for far-reaching mobile devices. A UW team has designed a new chip to handle this, improving data speed and reliability.

Want more CHIPS?

College of Engineering Dean Nancy Allbritton explains what the CHIPS & Science Act means for the UW and the state of Washington at engr.uw.edu/news/chips

A MISSION TO MITIGATE methane

By Brooke Fisher | *Photos by Dennis Wise*

For 16 years, Mary Lidstrom, Professor Emeritus of chemical engineering and microbiology, advocated for researchers across the University of Washington while serving as Vice Provost for Research. And now, she's returned full-time to her lab, eager to advocate for a promising project that aims to address climate change.

"The big impetus for me was so that I could focus 100% on this new research thrust," says Lidstrom about stepping down from the leadership position in 2021 and also retiring from her departments shortly thereafter. "My whole career is coming together for this, that's how I feel about it. And I have the luxury of time now."

While the project is breaking ground in many respects, and isn't without challenges, Lidstrom is full of optimism for what her team aims to accomplish — reducing methane in the atmosphere on a global scale. To do so, she plans to utilize bacteria that can consume the greenhouse gas, which accounts for 30% of global warming emissions. Spearheading the effort, Lidstrom's lab is joined by collaborators from the University of Utah, Northwestern University, Auburn University and Michigan Technological University. Funding comes from the National Science Foundation and the Carbon Technology Research Foundation.

Top: Professor Emeritus Mary Lidstrom discusses the research with undergraduate Mia Grayson. Left: A close-up of a bioreactor in the lab. The cellulose beads provide a support structure for the bacteria to grow.

"What this takes to make it successful is both microbiology and engineering. Since I can combine the two, and have 50 years of experience in this field, I felt that if I really wanted to do something about climate change, this was what I could do," says Lidstrom, who celebrated her half-century research milestone this past fall.

A bacteria breakthrough

For nearly three years, Lidstrom's lab has been working to address two primary challenges associated with harnessing bacteria for methane mitigation. The first of these was to find the right methane-eating bacteria, known as methanotrophs, for the job.

"The bacteria use methane as their main source of food and have specialized metabolic pathways to do this that we've studied for decades. They are very unique in their capabilities," Lidstrom explains. "So the idea is that we need bacteria that are really good at doing this, and we need an engineered system, a bioreactor, that can be deployed out in the field to remove methane."

Turning to the extensive bacteria collection in her lab, Lidstrom started screening strains, looking for an ideal candidate that could consume methane at low concentrations. While she'd assumed that the "workhorse" strain commonly used in her lab wouldn't be suitable, that wasn't the case.

"It really surprised me," says Lidstrom about the pivotal finding. "I thought that because the strain grows well at high methane, it wouldn't grow well at low. That wasn't true — It is the champion."

Compared to the majority of bacteria that are well-nourished when methane concentrations are around 5,000 parts per million (ppm), the strain that the researchers identified, *Methylotuvimicrobium buryatense*, can remove methane extremely well at concentrations as low as 200 ppm. Below 1,000 ppm is when most bacteria feel starved.

"You can think about it in the same way that if people have a diet of 5,000 calories a day, it's not a starvation problem. But if you try and cut back to 1,000 calories and below, they don't do very well. It's roughly in the same ballpark," Lidstrom says.

Optimizing the bacteria

While the strain of bacteria that the researchers identified is capable of growing in low methane environments, it needs to consume methane more quickly for the process to be effective on a large scale. This is where the second big challenge comes in.

Surprisingly, even at higher output methane sites where the technology is anticipated to be located — such as landfills, agricultural lands, manure piles, oil and gas wells, coal mines and wetlands — the gas still supplies only a moderate level of nourishment to the bacteria.

"Around these sites that are leaking methane into the atmosphere, the methane is higher than in the air we breathe. It's still hard for the bacteria, but they are ok, especially this really good strain we have," Lidstrom says. "Whereas in the air we breathe, they can't make a living off of it, it's way too low."

Since they'll be sustained by a modest amount of food even at the elevated methane sites, the bacteria will operate at a slow pace. Therefore, the plan is to genetically modify the bacteria to enable them to work faster.

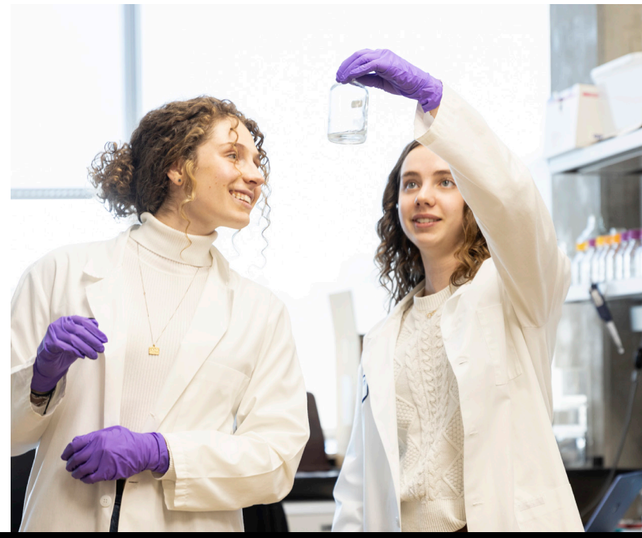
Applying lessons from leadership

Big picture thinking and team building are skills that Lidstrom honed during her tenure as Vice Provost for Research. As a result of this strategic mindset, she's already considering how to best commercialize the technology and conduct community outreach.

"Even if you develop this amazing technology and get it ready to go, people may not want it sitting in their community. It's important to understand what people care about and to work with community leaders — you have to get engagement," explains Lidstrom.

Preliminary designs depict the bioreactor, which would house the methane-consuming bacteria, as a shipping container-like structure. To slow global warming by 2050, Lidstrom's goal is to deploy the technology by 2030, with scale-up projections showing it will take approximately 20 years to reduce methane emissions.

"I'll be working on this until I can't — it builds on my whole career," Lidstrom says.



Undergraduates Mia Grayson and Naomi Kern, from left, look at a bottle filled with the methanotrophic bacterium Methylotuvimicrobium buryatense.

DRIVEN TO advance VEHICLE ELECTRIFICATION

Engineering research leads the next wave of electric vehicle technologies

By Brooke Fisher

Photos by Dennis Wise

When it comes to developing the next generation electric vehicle (EV) technologies, UW engineering researchers are unstoppable. Their collective research, together with initiatives underway throughout the state, positions Washington to be a leader in this truly electrifying area.

"The goal is for Washington state to be a leader in EV technologies and battery manufacturing and research," says Jihui Yang, vice dean of the College of Engineering. "Our UW researchers are working on everything from identifying new battery materials and chemistries to improving power transfer and workforce development."

UW engineering research, along with newly established manufacturing facilities and raw materials available in Washington, enables the state to be a hub — especially for next-generation battery development. Two new EV battery manufacturing facilities, Sila and Group14 Technologies, are establishing factories in Moses Lake, funded with $100 million each from the U.S. Department of Energy. In addition, Washington is one of the richest states in biomass, a promising and sustainable material for EV battery production.

Here, we highlight four research projects that are advancing EV innovation.

1 Leading the charge to enhance power transfer

Imagine rolling into a parking spot and your EV automatically begins to charge, quickly and without cables, thanks to a compact charging station on the ground. Jungwon Choi, an assistant professor of electrical and computer engineering, can do more than envision it — she's developing the technology.

"Charging time is a barrier for people buying EVs," Choi says. "I'm interested in how we can make more efficient power circuits to charge the battery in electric vehicles."

In addition to advancing the design of spiral coils for high-frequency wireless charging, Choi's primary research focuses on designing power circuits that can receive electrical currents at high frequencies from a charging source and transfer the energy to the battery.

"We want to have high efficiency," Choi explains. "When we have 100% power at input and the battery receives only 80% power, energy is lost."

Inset: Discussing the power circuit on the workbench in front of them are electrical and computer engineering graduate student Manas Palmal, Assistant Professor Jungwon Choi, and graduate student Ghovindo Surya, from left.

2 Plugging in to prospective consumers

There's one potential roadblock to EV ownership that civil and environmental engineering researchers are exploring: the unreliability of public charging stations.

"The number one problem now is not lack of charging stations, but reliable stations," says Don MacKenzie, an associate professor of civil and environmental engineering who holds the Allan & Inger Osberg Endowed Professorship. "Sometimes the hardware is broken, vandalized or switched off, and payment systems commonly fail."

To better understand the preferences of people who don't yet own EVs, the UW researchers recently distributed a nationwide survey. The project informs the work of the ChargeX consortium, tasked with improving public charging infrastructure in the country by 2025.

"We will ask people to imagine different experiences, such as a world where public chargers are terrible and don't work, and then a world where public chargers work perfectly," explains graduate student Rubina Singh.

Inset: Civil and environmental engineering graduate student Rubina Singh stands next to an EV charging station.

3 A healthy plan for battery maintenance

Developing a roadmap for how to best manage and enhance the health of EV batteries is the objective of a team of mechanical engineering researchers.

"Battery health is an important concept that relates to the long-term costs of batteries and their safety," explains Shijing Sun, an assistant professor of mechanical engineering who was a senior research scientist at the Toyota Research Institute before joining the UW last year.

In addition to planning ahead for the replacement of aged batteries, managing the overall battery health can also help extend the life of the battery. To develop highly predictive models, Sun's research employs artificial intelligence to process large and complex datasets. Together with students, she conducts tests at the Washington Clean Energy Testbeds, part of the Clean Energy Institute. They analyze battery charge and discharge behavior to investigate factors that affect performance, such as the frequency of charging, the environment and human behavior.

"Better understanding how the battery behaves today and identifying limitations will also guide us to explore new ideas for the next generation of batteries," Sun explains.

Below: Assistant Professor Shijing Sun and students discuss their work to analyze battery behavior.

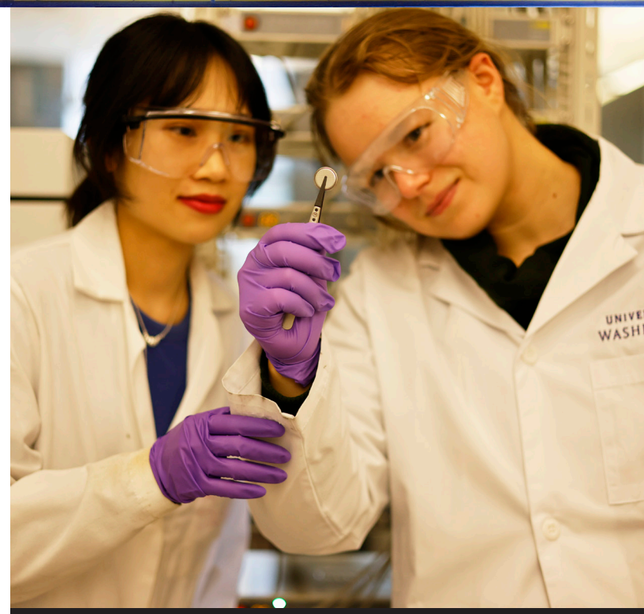
4 Next up: The next generation battery

An EV battery that needs to be charged much less frequently than stopping at a gas station is one goal of UW engineering faculty who are collectively working toward developing the next generation battery materials and technologies.

UW researchers Corie Cobb, a professor of mechanical engineering, and Jun Liu, a professor of materials science and engineering and of chemical engineering, are investigating how to extend the cycle life of lithium-ion batteries used in EVs. The researchers — both Washington Research Foundation Innovation Professors in Clean Energy — are working with Pacific Northwest National Laboratory's (PNNL) Cathode-Electrolyte Interphase Consortium, supported by the U.S. Department of Energy's (DOE) Vehicle Technologies Office.

UW researchers also play an important role in the Innovation Center for Battery500 Consortium by advancing a type of battery that shows great promise: lithium-metal batteries. Led by PNNL and joined by Brookhaven National Laboratory, Idaho National Laboratory, SLAC National Accelerator Laboratory, General Motors, UW and eight other universities, Battery500 Consortium is supported by the DOE Vehicle Technologies Office.

"Our goal is to deliver a real battery to industry," says Liu, who directs the Battery500 Consortium.



Above: Graduate students Bella Wu and Julia White, from left, look at a lithium metal coin cell. Below: The Battery500 quarterly meeting held at UW in September 2023.

Developing the workforce

UW Engineering is committed to ensuring the next generation of engineers is up to speed on the latest EV technologies.

Clubs and teams: Students are converting a diesel truck from PACCAR into a battery electric truck with UW E-Truck, and designing and building both a zero-emission motorcycle with Washington Superbike and electric race cars with Formula Motorsports.

Industry capstone projects: Last year, Ford Motor Company sponsored a project that tasked students with creating the ideal EV charging experience. This year, a team of students is working to reduce the cost of infrastructure for charging stations in a project funded by McKinstry.

Training programs: In addition to developing courses and internships with national labs and industry, faculty are working to design battery certificate programs and hands-on classes on clean energy.

Q&A: UW researchers answer common questions about language models like ChatGPT

Often called "artificial intelligence," language models have dominated the news for the past year. However, many people struggle to find accurate, comprehensible information on what these language models — which underlie chatbots like ChatGPT and Google Gemini — are and how they work. Here, Noah A. Smith, a professor in the Paul G. Allen School of Computer Science & Engineering, and Allen School graduate students Sofia Serrano and Zander Brumbaugh answer a few common questions.

By Stefan Milne

What are language models and how do they work?

Serrano: A language model is essentially a next-word predictor. It looks at a lot of text and notices which words tend to follow after which sequences of other words. Typically, when we're talking about a language model, we're talking about a large machine learning model, which contains a lot of different numbers called parameters. Those numbers are tweaked with each new bit of textual data that the model is trained on. The result is a giant mathematical function that overall is pretty good at predicting which words come next.

How may language models be perceived as intelligent?

Smith: If you tell a model "I'm having a bad day" and its response sounds like a therapist, it has likely read a bunch of articles online that coach people on empathy. But if it starts feeding on your sadness and telling you you're awful, it's probably latching on to some other source of text. It can reproduce the various qualities of human intelligence and behavior that we see online. So if a model behaves in a way that seems intelligent, you should first ask, "What did it see in the training data that looks like this conversation?"

Brumbaugh: We need to keep separating language models from notions of intelligence. These models are imperfect. They can sound very fluent, but they're prone to hallucinations — which is when they generate erroneous or fictional information. They're not databases or Google search.

Where would you like to see these models go?

Smith: Big tech companies have no reason to make a tool that works really well for me or you, so the models have to be democratized. Some organizations are building language models that are open, where the parameters, code and data are shared. I work part-time for one of those organizations, the Allen Institute for Artificial Intelligence. Meta has put out models, without the data, but that's still better than nothing. These models are still often quite expensive to run, so we need more investment in research to make them more efficient.

Read the full interview: engr.uw.edu/news/language-model-qa

Supporting tribal-led salmon monitoring using computer vision

By Amy Sprague

Climate change not only negatively affects Chinook salmon populations, it also makes it harder to monitor those effects. UW researchers are working on a solution that will make monitoring salmon easier and more accurate, while also giving the Sauk-Suiattle Indian Tribe more power to manage their salmon stock.

The Sauk-Suiattle harvest Chinook salmon in the Skagit River system for commercial, subsistence and ceremonial benefits through treaty-protected fisheries. Management of the fishery, with the State of Washington, includes setting harvest guidelines and recovery planning. Historically, helicopter surveys have estimated population numbers, but these are expensive and the effects of climate change on the river systems have altered river runoff, creating more silt in the water and obscuring views.

To develop a new cost-effective and accurate monitoring system utilizing drones and AI-based computer vision, Andrew Berdahl, assistant professor in the School of Aquatic and Fishery Sciences and Karen Leung, assistant professor of aeronautics and astronautics, are partnering with the Sauk-Suiattle's fish program manager to identify and count salmon nests, or redds, to estimate population sizes. The research is funded by a UW EarthLab Innovation Grant.

"Researchers won't be booking an expensive helicopter in advance for what turns out to be a low-visibility day. We can fly drones opportunistically based on daily river conditions. Also, because of the lower cost and convenience, we can survey more frequently throughout the season for higher precision monitoring," Leung explains.

A female Chinook salmon stands guard on her redd at McAllister Springs in Lacey, Washington. Photo credit: USFWS – Pacific Region

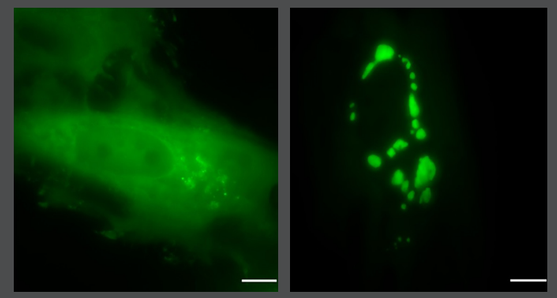
Tunable hydrogels that can form both inside and outside of cells

By Sarah McQuate

When researchers want to study how diseases such as Alzheimer's work, one approach is to look at what's happening inside individual cells. Researchers sometimes grow the cells in a 3D scaffold called a "hydrogel." This network of proteins or molecules mimics the environment the cells would live in inside the body.

Research led by the UW demonstrates a new class of hydrogels that can form not just outside cells, but also inside of them, providing a new tool to group proteins together inside of cells.

"In the past 10 years, there's been a shift in the world of cell biology," says Cole DeForest, an associate professor of chemical engineering and of bioengineering. "Classically, folks have attributed much of the cell's interior organization to membrane-bound organelles, such as mitochondria or the nucleus. But now scientists are realizing that the cell actually has other ways to locally concentrate certain molecules or proteins without using membranes, for example, by protein-protein interactions."



Made visible with green fluorescence, the cell on the right contains hydrogels (green blobs). With green spread throughout, the cell on the left does not contain hydrogels. Photo credit: Mout et al./PNAS

"We have good mechanical control of our hydrogels — even when they are made inside human cells," DeForest adds. "This means we can tune them to essentially function as a synthetic version of whatever sequestering phenomenon we want to study, such as how protein aggregation can lead to Alzheimer's."

Smart earrings can monitor a person's temperature

By Stefan Milne

Smart accessories are increasingly common. Rings and watches track vitals, while Ray-Bans now come with cameras and microphones. Wearable tech has even broached brooches.

Recently, UW researchers introduced the Thermal Earring, a wireless wearable that continuously monitors a user's earlobe temperature. In a study of six users, the earring outperformed a smartwatch at sensing skin temperature during periods of rest. It also showed promise for monitoring signs of stress, eating, exercise and ovulation.

The smart earring prototype is about the size and weight of a small paperclip and has a 28-day battery life. A magnetic clip attaches one temperature sensor to a wearer's ear, while another sensor dangles about an inch below it for estimating room temperature.

"I wear a smartwatch to track my personal health, but I've found that a lot of people think smartwatches are unfashionable or bulky and uncomfortable," says Qiuyue (Shirley) Xue, a doctoral student in the Paul G. Allen School of Computer Science & Engineering. "I also like to wear earrings, so we started thinking about what unique things we can get from the earlobe. We found that sensing the skin temperature on the lobe, instead of a hand or wrist, was much more accurate."

The device is not currently commercially available. For future iterations of the device, Xue is working to integrate heart rate and activity monitoring.

The Thermal Earring, a wireless wearable that continuously monitors a user's earlobe temperature. Photo by Raymond Smith

Treating individuals with multiple organ failures

By Lyra Fontaine

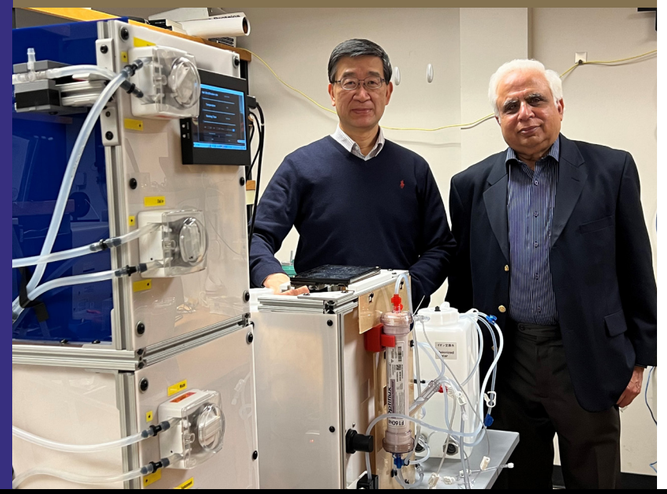
Vital organs can fail during conditions such as sepsis and due to genetic or environmental reasons. If it's not treated in a timely manner, a single-organ failure can quickly trigger dysfunction in other organs. Multi-organ failure is a significant cause of mortality for intensive care patients, says Dayong Gao, Origincell Endowed Professor of Mechanical Engineering.

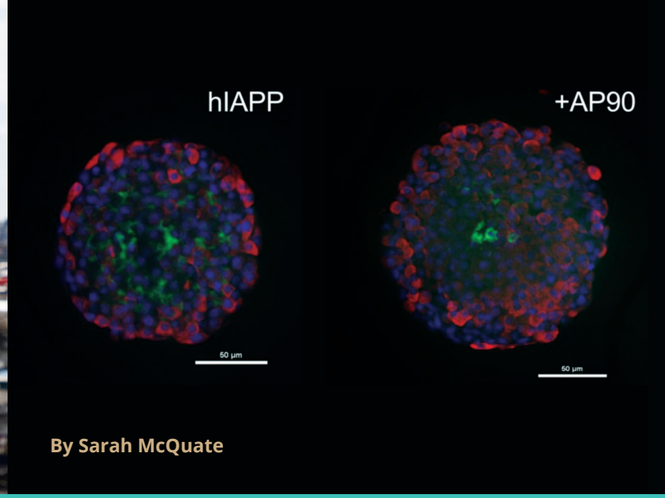
"This urgent medical need is the major driving force for our team to develop a machine that can replace multiple vital organs' functions," says Gao, who co-founded the Artificial Multi-Organ Replacement (AMOR) system with Dr. Suhail Ahmad, a UW Medicine professor.

AMOR treats organ failure by removing toxins in patients' blood. If the organs can't be repaired, the system keeps patients alive while they wait for a transplant. The system supports several organs at the same time, focusing primarily on liver and kidney function. Unlike dialysis machines, AMOR is able to remove sufficient protein-bound toxins, as well as excess fluids from outside the bloodstream that can lead to swelling, pressure on organs and injury.

Results from a clinical trial detail how AMOR successfully treated individuals with multiorgan failure. In 10 patients, treatment with AMOR enabled them to regain enough health to be relisted for transplant. UW CoMotion has filed international patents on the technology.

AMOR co-founders Dayong Gao, professor of mechanical engineering, and Dr. Suhail Ahmad, a UW Medicine professor, from left.





By Sarah McQuate

Q&A: How a potential treatment for Alzheimer's disease may work for Type 2 diabetes

Of the 38 million Americans who have diabetes at least 90% have Type 2, according to the Centers for Disease Control and Prevention. Type 2 diabetes occurs over time and is characterized by a loss of the cells in the pancreas that make the hormone insulin, which helps the body manage sugar.

These cells make another protein, called islet amyloid polypeptide or IAPP, which has been found clumped together in many Type 2 diabetes patients. The formation of IAPP clusters is comparable to the signature plaques associated with Alzheimer's disease.

UW researchers have demonstrated that a synthetic peptide can block the formation of small toxic protein clusters in Alzheimer's — and more recently — in Type 2 diabetes. Valerie Daggett, a professor of bioengineering and faculty member in the UW Molecular Engineering & Sciences Institute, discusses protein aggregation and how synthetic peptides may be a promising solution.

Alzheimer's and Type 2 diabetes are part of a family of amyloid diseases that are characterized by having proteins that cluster together. What's happening?

There are over 50 amyloid diseases, and they start out with their respective proteins in biologically active forms. But then the proteins start changing structure and globbing together. Early in the process there are smaller clusters, which are toxic, and they set off all kinds of problems. Over time, the toxic clusters combine to form non-toxic structures: longer strands and finally large deposits, such as the Alzheimer's plaques.

What role does protein aggregation play in neurodegenerative disease?

In the case of Alzheimer's, these toxic protein clusters are running around the brain attacking neurons and over time there's enough damage that we start to see symptoms. By the time the clusters have combined to form the non-toxic plaques, there's already been a lot of damage. It becomes similar to trying to treat stage 4 cancer. That's why we want to get in early. With Type 2 diabetes, this happens in the pancreas instead of the brain.

In a recent paper, you showed that a synthetic peptide was able to bind and neutralize the toxic IAPP clusters. How does it work?

Previously, we designed synthetic peptides to bind to the toxic protein clusters in Alzheimer's disease. The idea is for the peptides to take the clusters out of commission before they can wreak havoc on the cells. Our peptides bind really tightly to the clusters, and we're currently studying what happens to the clusters after it binds. In this paper, we showed that our synthetic peptides also work against the toxic IAPP clusters, which means this could be a potential therapeutic in the future.

Top left: Valerie Daggett, professor of bioengineering. Right: Microscopy image of cells in the pancreas, called beta cells, making IAPP (left) and IAPP plus one of the team's synthetic peptides (right). The synthetic peptides bind to the small toxic IAPP clusters to take them out of commission before they can wreak havoc on the cells. Hsu et al./Protein Science

powering PROGRESS

As the demand for engineers skyrockets, so does the need for academic and industry partnerships. Collaborations between the UW and organizations large and small fuel the expansion of the engineering workforce, propel discoveries forward and drive innovation into impact.

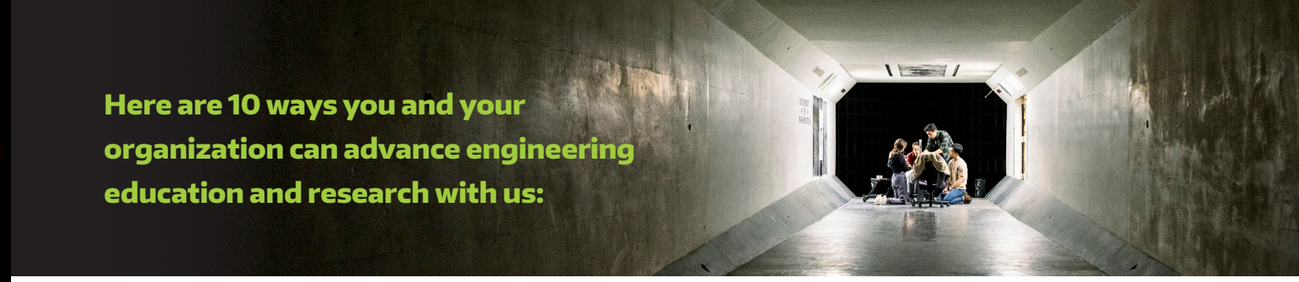
"The demand for engineers in the U.S. is reaching critical levels," says Jihui Yang, vice dean of the College of Engineering. "We're facing an unprecedented shortage of engineering talent across multiple sectors — from the semiconductor industry and artificial intelligence to the automotive sector's seismic shift toward electric vehicle manufacturing, as well as in infrastructure and health care."

This shortage could significantly impact the nation's economic future. Take, for example, the surge projected in the semiconductor industry, which was catalyzed by 2022's CHIPS & Science Act. With $250 billion earmarked by the federal government and industry, this initiative seeks to bolster domestic microchip technology research, manufacturing and workforce development. However, a considerable gap remains in workforce size and diversity. Washington state alone anticipates a shortfall of 60,000 STEM-trained workers by 2026 to meet the demand for chips.

"The U.S. once led the charge in computer chip production but now relies heavily on outside manufacturers," Yang says. "This dependence poses a significant economic and national security risk, as recognized by the government. While funding is paving the way for new chip manufacturing facilities, the actual shortage of qualified engineers remains a pressing concern. Recently, U.S. Secretary of Commerce Gina Raimondo issued a call to universities to triple the number of graduates in semiconductor-related fields, including engineering."

Deepening partnerships with industry is a critical step. The college has recently launched several research centers in partnership with industry leaders. These centers, such as the Boeing Advanced Research Collaboration, the Advanced Composite Center and the UW + Amazon Science Hub, cover topics including aerospace, robotics, artificial intelligence, manufacturing and data science.

"It's crucial for our partners to contribute to shaping the skillsets engineers need," Yang says. "This applies not only to chips manufacturing, but extends across all industry sectors. Companies bring invaluable insights and resources to engineering research and education: entrepreneurial acumen, idea generation, mentorship, financial support, technology transfer expertise and more."



Here are 10 ways you and your organization can advance engineering education and research with us:

1. Sponsor a student capstone project

Through our Industry Capstone Program, engineering students work alongside professionals to tackle real-world workplace engineering challenges. Students and faculty provide a fresh look and then partner with your team to develop a solution. For organizations that sponsor projects, the program is a great way to build brand recognition and skills among up-and-coming engineers.

2. Collaborate with UW researchers

Your company can leverage our researchers' expertise by sponsoring a customized project. Our team can help facilitate the commercialization of innovations by managing intellectual property. Companies can also support UW research through philanthropic gifts, in-kind equipment and software donations, and product discounts.

3. Encourage your employees to further their education

We offer more than 20 professional programs, including flexible master's and certificate programs for professionals in all engineering disciplines, to help your employees upskill. We're also launching stackable master's programs, which allow students to "stack" certificate programs and complete a capstone project to earn a master's degree.

4. Help us create programs to meet emerging needs

We partner with companies to develop programs in response to industry trends. Your team can learn directly from our expert faculty in online or in-person workshops, and we can learn from you! Let us know what academic programs you'd like to see to address engineering's biggest challenges.

5. Hire interns and recruit talent

Partner with our Career Center @ Engineering to post internship and full-time job openings. Our staff can help your company build recruiting plans and host site visits and networking nights. By participating in one of our many career fairs, your organization's recruiters can meet students and advertise your open positions.

6. Volunteer as a speaker or board member

Professional partners regularly serve as guest lecturers for engineering seminars, conferences, workshops and lecture series. Partners can also volunteer on our departmental and program advisory boards, which provide counsel, leadership, advocacy and vital connections to industry.

7. Support student clubs and teams

Engineering clubs and teams like Formula Motorsports, Husky Satellite Club and Steel Bridge help students gain teamwork, leadership and project management skills alongside hands-on engineering experience. These groups rely heavily on community support to fund their projects. Companies can sponsor teams through financial gifts, materials and equipment donations, professional advising and more.

8. Participate in a mentorship program

Share your insights with future engineers through programs like Engineering Exploration Night and Huskies@Work! These programs bring together professionals and students to discuss career journeys, job experiences and more. Students benefit from your expertise and advice, and you can help inspire the next generation of UW engineers.

9. Use our facilities

Did you know that many of our research labs and facilities can be made available for your company to use? Businesses can access state-of-the-art research and development facilities at the Washington Clean Energy Testbeds. And the Washington Nanofabrication Facility and Molecular Analysis Facility offer open access to cutting-edge micro- and nanofabrication processing and equipment.

10. Stay connected and advocate

One of the simplest ways to partner with us? Keep reading The Trend in Engineering and follow us on social media. Share our stories and news with your peers and colleagues. Help spread the word about UW Engineering!

Ready to partner?
Learn more and connect with us: engr.uw.edu/industry

Opposite page: A materials science and engineering student at work. This page: Aeronautical research testing at the Kirsten Wind Tunnel is available for customers outside of the UW. Photos by Dennis Wise

Lessons in LEADERSHIP

The Emerging Leaders in Engineering program empowers undergraduates with advanced leadership skills to help shape the future of engineering.

By Brooke Fisher

When civil and environmental engineering senior Jake Eko interviews for jobs, there's one thing that prospective employers are eager to learn more about: the Emerging Leaders in Engineering (ELE) program.

"Employers love to ask questions about it," Eko says. "It's a unique program in the sense that I had a role in both teaching and leading — and a unique skillset that's born because of that. I see it as an asset and employers do, too."

Since it was founded six years ago, the ELE program has equipped hundreds of undergraduate engineering students with advanced leadership skills that complement their technical coursework. While some ELE students coordinate recruitment and outreach events to inspire the next generation of engineers, others teach makerspace workshops or mentor first-year engineering students.

"If they're trained in leadership and trained as an engineer, students can go on to lead tomorrow's companies," says Dan Ratner, associate dean of academic affairs in the College of Engineering. "We see students come out of their shells. The ELE students become empowered and feel like they can answer questions, serve as an example and be looked up to."

From founding to flourishing

The program has more than doubled in size since its launch. This year, 100 engineering students were selected from a record-breaking 318 applicants. Participating students, who receive scholarships and course credit, are spread across three sub-programs: Engineering Ambassadors (EAs), Engineering Design Coaches (EDCs) and Engineering Peer Educators (EPEs).

The ELE program helps support the Direct-to-College admission process, which admits first-year students directly to the College of Engineering with guaranteed access to an engineering major. Since incoming students — of which there are more than 1,000 — have one year before ranking their preferred engineering majors, the EPEs help guide them through an exploration process. Meanwhile, the EDCs provide hands-on technical instruction and the EAs ensure that prospective students and families understand the admissions process.

"The ELE students are hungry for this kind of experience and leadership opportunity," says Shanai Lechtenberg, the college's senior director for student academic services. "Many of the students share that this is the most impactful thing they've ever done at UW."

Shaping a skillset

Considering what type of leader they want to be is an important first step for ELE students. A training course culminates with students writing a leadership philosophy. They also receive specialized instruction geared toward their specific sub-program. Together, the cohort learns high-level leadership skills such as facilitation, creating inclusive learning environments and public speaking.

The program utilizes expertise both within the college and across campus. The college's Office of Inclusive Excellence offers diversity, equity and inclusion training, while speech coaching is provided by the Communication Department's Center for Speech & Debate. One of the most frequent comments from ELE students is that they have greater confidence when addressing a large audience.

"We would have group presentations in engineering classes, but no one teaches you how to do them," explains bioengineering senior Aditi Prabhala, who has participated in the program for three years. "I've become a better public speaker and can effectively present information."

Top left: An Engineering Design Coach teaches an intro to milling workshop. Top right: At a college fair, an Engineering Ambassador talks to prospective students.

Another key set of skills is curriculum building and lesson planning. As an EPE, Eko facilitated a course as part of an Engineering First-Year Interest Group (E-FIG), with lessons geared toward exploring the 11 engineering majors and interdisciplinary career pathways.

"I learned a teaching skillset where I can go into groups and have a work-together mindset," explains Eko. "In terms of engineering being a very technical field, this exposes soft skills — I can say I worked with 25 freshmen and taught a course. It's one of the experiences that will have the most meaningful impact on my future."

In addition, Prabhala and Eko list a variety of other essential leadership skills that they've honed — from accountability to active listening to leading outreach activities.

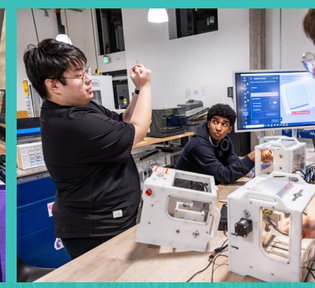
"As an engineering ambassador, we did a lot of outreach, such as workshops for transfer students and hosting elementary schools on campus for tours," says Prabhala. "A lot of people depended on us."

Applying mentorship to management

Employed at Boeing, mechanical engineering alumnus Derek Wei, '20, started as a test engineer and is now an acting manager. The mentoring skills he developed as an EPE have been particularly helpful in advancing his career in a short amount of time, he says.

"I've been able to mentor folks on the team and help direct reports with removing roadblocks and overcoming challenges," says Wei, who was awarded the 2020 Outstanding EPE of the Year award. "Being a peer educator helped me do that, especially having experience connecting with individuals, figuring out how to relate to them, and being a helping hand."

Jake Eko, a senior in civil and environmental engineering (front right), poses with first-year engineering students he taught as an Engineering Peer Educator.



ELE student sub-groups

Engineering Ambassadors

Students connect with elementary, middle and high school students, as well as transfer students, through outreach and recruitment events to inspire interest in engineering. In 2022-23, they engaged with 4,000 students during 18 events.

Engineering Design Coaches

Students design and lead hands-on workshops in makerspaces for undergraduates. In 2022-23, they taught 23 workshops to 247 students.

Engineering Peer Educators

Students mentor first-year engineering students by leading a course within students' E-FIGs. In 2022-23, they supported more than 1,000 incoming students.

Support tomorrow's leaders

The ELE program provides students with scholarships, which are possible thanks to donor support. Learn how to make a gift: engr.uw.edu/give/ELE

Top: To reach youth who may not be familiar with engineering, Engineering Ambassadors lead activities for 10th grade students at Evergreen High School. Top left: During UW Family Weekend, Engineering Ambassadors answer questions and provide information to prospective students. Top right: Engineering Design Coach Sky Song, who is a senior in mechanical engineering, teaches an intro to milling workshop at The MILL Makerspace.

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Rediscovering Discovery Days

Engineering Discovery Days returned this spring! The College of Engineering's signature outreach event relaunched May 2–3 after a few years' hiatus. Held annually for more than 100 years prior to the pandemic, the two-day event continued the tradition of sharing the excitement of engineering with youth, teachers and families. This year, more than 7,400 elementary and middle school students visited campus to participate in hands-on activities and experiments led by engineering students and faculty.