The Trend in ENGINEERING

UNIVERSITY OF WASHINGTON COLLEGE OF ENGINEERING NEWSLETTER / **SPRING 2022**

Improving sidewalk accessibility

PAGES 6-8

FROM THE **DEAN**

As we are on a path to managing and living with COVID-19, I would like to express my thanks for our UW Engineering community's resilience, determination and grace. As you'll read in this issue, our faculty and staff have supported our students through difficult times, adapted research and teaching, integrated new technologies and systems, expanded conversations and practices around equity and inclusion, and navigated pivots and shifts as we returned to campus. This is truly something to celebrate.

Another community effort is our work together to transform engineering education. Last fall we launched the College's ambitious five-year strategic plan, "Engineering Excellence for the Public Good," which focuses on four areas: creating a healthier and more just world through our work; embracing the power of diversity, equity and inclusion (DEI); translating innovation into impact; and investing strategically in our future. Just recently we unveiled a detailed plan for implementation, defining the goals, strategies and timelines that will guide our way forward. I invite you to read more about it at **engr.uw.edu/about/strategic-plan**

In addition, we're moving full steam ahead with our new Interdisciplinary Engineering Building (IEB). We are committed to making it a building for all students — especially those who are underrepresented — and we look forward to breaking ground in September. Thanks goes to the Washington State Legislature that has dedicated over $50 million to the design and construction of this facility. And, in the most recent Legislative supplemental session, we received $2 million for the Paul G. Allen School of Computer Science & Engineering to expand degree capacity among underrepresented students, along with an additional $455,000 for the Allen School Startup Program.

Thank you for being a part of our UW Engineering community. I am proud to work alongside such an incredible group of people committed to engineering excellence for the greater good.

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

2022 DIAMOND AWARDS

The College of Engineering honors seven alumni and friends for their outstanding achievements.

DEAN'S AWARD

Basel Alomair, '11 Ph.D.
Electrical Engineering
Professor and Founding Director, National Center for Cybersecurity Technologies, King Abdulaziz City for Science & Technology (KACST)

DISTINGUISHED ACHIEVEMENT IN INDUSTRY

Phil Spencer, '90 B.S. Human Centered Design & Engineering
CEO, Microsoft Gaming

DISTINGUISHED ACHIEVEMENT IN ACADEMIA

Stefan Savage, '02 Ph.D.
Computer Science & Engineering
Professor, Computer Science & Engineering, University of California, San Diego

ENTREPRENEURIAL EXCELLENCE

Victor Wong, '89 B.S.
Electrical Engineering
Founder, vfxNova Digital Productions Ltd.

DISTINGUISHED SERVICE

Rao Varanasi, '68 Ph.D.
Aeronautics & Astronautics
Chief Engineer, Structures Engineering, The Boeing Company (ret.)

Usha Varanasi, '68 Ph.D. Chemistry
Director, Northwest Fisheries Science Center, NOAA (ret.)

EARLY CAREER

Justine Sherry, '10 B.S.
Computer Science
Assistant Professor, Computer Science, Carnegie Mellon University

Learn more about the 2022 Diamond Award winners at engr.uw.edu/da

Heather Hoeksema to serve as Executive Director, Strategy & External Relations

In April, Heather Hoeksema was appointed as the College's Executive Director, Strategy & External Relations. Since 2020, Hoeksema has co-led the College's strategic planning process. In her new role, she will oversee strategic plan implementation and engagement and will work to expand integrated advancement — an alignment of fundraising, alumni relations, marketing and communications, recruitment and admissions — within the College.

Hoeksema continues to direct the College's Marketing & Communications team, aligning communications efforts to meet strategic objectives. Over the last six years, she has collaborated with the UW's External Relations team to secure state funding for engineering enrollment expansion and the Interdisciplinary Engineering Building. She will continue to expand work in this area and further integrate the communications portfolio to support student communication, College branding, community outreach and diversity, equity and inclusion initiatives.

Dave Iyall named Associate Dean for Advancement

Dave Iyall joined us in February as the College's new Associate Dean for Advancement. He brings more than 20 years of experience to this role, with deep knowledge of both individual giving and corporate support, team leadership and development, an innovative spirit, and a commitment to elevating the UW's impact on issues that matter.

Iyall most recently served as Senior Director for Advancement in the UW College of the Environment and as Interim Assistant Dean for Advancement in the College of Education. Prior to these roles, he was the College of Engineering's Senior Director of Corporate & Foundations Relations.

Iyall's philosophy as a leader, colleague and fundraiser is one of service. He is committed to anti-racism, equity and inclusion work and believes UW Engineering is positioned to respond to societal challenges with innovation, a solution-focused mindset and an inclusive multi-disciplinary approach.

Cassady Glass Hastings appointed Director of New Programs & Innovation

We've recently welcomed Cassady Glass Hastings as Director of New Programs & Innovation. In this new role, she will work closely with internal and external constituents to grow and develop graduate programs, including Professional Masters Programs, short courses, online courses and certificates.

In her fifteen years at the UW, Glass Hastings has created and implemented comprehensive and forward-thinking strategic initiatives, particularly those at the intersection of academic and community/industry partnerships. She specializes in building new programs, new teams and new processes in pursuit of strategic goals. Most recently, she served as Senior Director of Academic Partnerships in the UW Continuum College and as a strategic adviser in UW Undergraduate Academic Affairs. Prior to those roles, she co-created the UW's Education, Communities & Organization program and served as a lecturer and strategic adviser in the UW College of Education.

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SCIENCE Hub

The UW and Amazon are partnering to launch the Science Hub, an effort to advance innovation in core robotics and artificial intelligence technologies and their applications.

The UW and Amazon have announced the Science Hub, an effort that deepens the relationship between the two organizations and advances innovation in core robotics, artificial intelligence (AI) technologies and their applications.

Amazon's initial investment of $1.9 million will support a broad set of programs, including fellowships for doctoral students, collaboration among researchers and support for research events. Housed in the College of Engineering, the hub is expected to expand over time and tackle additional challenges at the intersection of technology, industry and society.

"These kinds of real-world challenges and problems are increasingly a scarce strategic resource for researchers in robotics and AI," says hub inaugural director Joshua Smith, who is a professor in the Paul G. Allen School of Computer Science & Engineering and is the Milton and Delia Zeutschel Professor in Entrepreneurial Excellence in Electrical & Computer Engineering (ECE). "The hub will allow our students and faculty to advance the state of the art in some of the most challenging open research problems in robotics and AI. And that's just the start of the mission."

Michael Wolf, an Amazon Robotics AI principal scientist who will serve as the UW research liaison, says the hub will launch with an initial focus on robotics as a collaboration between Amazon Robotics AI and the College of Engineering.

"Addressing challenges in autonomy, computer vision and machine learning is important to both Amazon and the robotics community at large," Wolf says. "We've already built great momentum in defining flagship programs in robotic manipulation and 3D perception at UW, and we look forward to expanding our engagement with UW and building a joint community of researchers here in Seattle."

Amazon and the UW have worked closely since the 1990s, leveraging their proximity to one another. Amazon has provided learning opportunities for students through project funds and fellowships, support for faculty through professorships and research funding and new spaces for learning and collaboration through capital support. Thousands of UW alumni work at Amazon, many serving in executive-leadership positions. Dozens of Amazon professionals have served in volunteer roles at the UW over the years, as advisors on UW boards and committees.

Many UW professors also are Amazon Scholars, a program designed for academics from universities around the globe who want to apply research methods in practice and help the company solve technical challenges without leaving their academic institutions.

"The research hub aligns with our strategic vision to advance engineering excellence for the public good. We're thrilled to further deepen our relationship with Amazon and to leverage our research strengths to address these types of challenges and develop solutions that will benefit all," says Nancy Allbritton, Frank & Julie Jungers Dean of Engineering.

Learn more at
engr.uw.edu/science-hub

Allen School and ECE Professor Joshua Smith serves as the inaugural director of the UW and Amazon's Science Hub.

The IEB takes shape

The new Interdisciplinary Engineering Building (IEB) is set to break ground in September.

Design for the IEB has entered its final stages, with thoughtful consideration reflected in all elements, from its central location across from the HUB, to how existing trees are incorporated into the landscape ecology, to the building's art that will reflect a diverse student body. Applying feedback from stakeholders — particularly students — architects are designing spaces that promote diversity, equity and inclusivity. Space is being allocated for students to collaborate on projects, socialize and study, and find academic support.

The IEB will enable the College to increase access to a UW engineering degree by providing more space to educate students and will relieve pressure on the College's departmental buildings. It will also provide a portal to industry through spaces for capstone projects and house the College's new AI Education Institute, which will transform research and education in fundamental artificial intelligence and machine learning theory, algorithms, and applications for learning and control of complex dynamic systems.

Rendering courtesy of KieranTimberlake

For undergraduate engineering students, the IEB will serve as a home base. For the College, the building will change engineering education at the UW by providing a modern learning environment that prioritizes interdisciplinary collaboration and prepares students for industry and entrepreneurship.

Learn more about the IEB and how you can help transform engineering education at engr.uw.edu/ieb

Engineering faculty elected to NAE

Membership to the National Academy of Engineering is one of the highest professional distinctions in engineering.

Samson Jenekhe, a professor of chemistry and the Boeing-Martin Professor of Chemical Engineering, and Anna Karlin, a professor in the Paul G. Allen School of Computer Science & Engineering, have been elected to the National Academy of Engineering. They are among 111 new members across the U.S. who are honored for contributions to engineering research, practice or education.

Jenekhe studies the fundamental physical and chemical properties of semiconductor materials, as well as their practical applications. Research topics have included organic and flexible electronics, the use of organic light-emitting diodes for lighting and displays, energy storage and conversion systems, semiconducting polymers and polymer-based photovoltaic systems.

Samson Jenekhe, left, and Anna Karlin, right.

Karlin, who holds the Bill and Melinda Gates Chair in the Allen School, is a member of the school's Theory of Computation group. Her research centers on designing and analyzing certain types of algorithms — such as probabilistic algorithms, which incorporate a degree of chance or randomness, and online algorithms, which can handle input delivered in a step-by-step manner. Karlin also works in algorithmic game theory, a field that merges algorithm design with considerations of strategic behavior. In addition, her studies have intersected other disciplines, including economics and data mining.

Sidewalk EQUITY

By Sarah DeWeerdt

ENGINEERING AND COMPUTER SCIENCE RESEARCHERS SEEK TO MAKE DIGITAL WAYFINDING MORE EQUITABLE AND ACCESSIBLE TO MORE PEOPLE.

Nearly every journey in a city, whether by bus, bike, car, on foot, or using a wheelchair, at some point depends on a crucial yet often overlooked bit of urban infrastructure: the sidewalk.

"Sidewalks are at the heart of every community," says Anat Caspi, director of the Taskar Center for Accessible Technology in the Paul G. Allen School of Computer Science & Engineering. "They represent the fabric that connects all other modes of transportation, any access to recreation, to financial opportunities, to schools, to health opportunities."

Yet the digital maps and transportation apps that have revolutionized urban navigation over the last two decades contain little information about sidewalks or other pedestrian infrastructure.

That poses a particular problem for people with mobility-limiting disabilities, for whom a cracked or uneven sidewalk or a missing curb ramp can be an insurmountable barrier.

"Sidewalk accessibility is really important," says Allen School Ph.D. student Ather Sharif, who uses a motorized wheelchair. "Otherwise, how are we going to get around?"

Sharif and Caspi are among a growing group of UW engineering and computer science researchers who are making digital wayfinding more equitable and accessible to a broader segment of the population via a series of projects focused on sidewalks.

The results will not only make cities friendlier to those with mobility limitations, but will also benefit other groups, including seniors, pregnant people, caregivers of young children who use strollers, first responders, and even perhaps delivery robots one day.

"The availability of this information does serve everybody," says Mark Hallenbeck, director of the Washington State Transportation Center in Civil & Environmental Engineering.

ACCESSMAP AND OPENSIDEWALKS

Caspi, whose background is in bioengineering, became interested in sidewalk accessibility after moving to Seattle and struggling to navigate the city's steep hills with her daughter, who uses a wheelchair. That experience sparked AccessMap, the first city-scale pedestrian customized wayfinding application.

"The idea was to provide an app that foregrounded the sidewalk environment," Caspi says. Sidewalks are highlighted; streets and buildings fade into the background.

AccessMap uses green-yellow-red color-coding to indicate the difficulty of traversing a given length of sidewalk, similar to the way car-centric maps color-code the heaviness of vehicle traffic. Users can also specify their individual mobility needs and the program will identify customized routes through the city.

The tool currently covers three Western Washington cities: Seattle, Mount Vernon and Bellingham. The team released a mobile application last December, and is now focused on expanding to other cities in the United States and Latin America.

AccessMap is based on data on sidewalk and curb ramp location provided by city transportation departments — data that tend to be spotty and inconsistent.

"As we tried to expand AccessMap in more areas, we were running into a lot of non-standard data formats," says Nick Bolten, a Taskar Center postdoctoral researcher.

That situation gave rise to OpenSidewalks, an effort to develop data standards and tools for sidewalk data. If all cities collected and reported sidewalk data in the same way, it would be much easier to add more cities to AccessMap or other wayfinding tools. Such standards and tools would also prompt more cities to collect sidewalk data and keep it updated, Caspi argues.

OpenSidewalks is active in 11 cities, with teams in each city collecting and stewarding the data. This helps bring to the fore local idiosyncrasies of the pedestrian network, such as the way wheelchair users rely on elevators in certain buildings to traverse hilly Seattle, or the importance of enclosed, elevated walkways in snowy Minneapolis and St. Paul, Minnesota.

PROJECT SIDEWALK AND SIDEWALK EVOLUTION

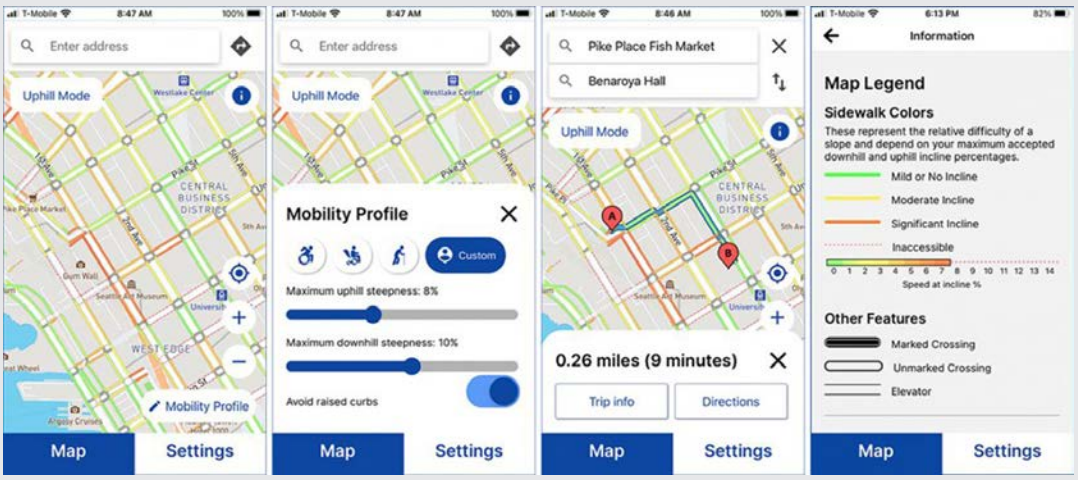
Even when cities do collect data on sidewalks, they typically don't record information about sidewalk condition or other obstacles — such as tree roots, uplift, cracks or substandard curb ramps — that can pose a major barrier to mobility.

Enter Project Sidewalk, an online crowdsourcing game that virtually immerses volunteers into Google Streetview to evaluate sections of sidewalk in detail.

"It gives you missions and that's how it scaffolds the experience, and also tries to make it fun and engaging," says project lead and Allen School Associate Professor Jon Froehlich.

Project Sidewalk launched in 2012 in Washington, D.C., and is active in seven cities, including Seattle. Volunteers have collected 600,000 data points so far, which Froehlich's team is using to train computer vision algorithms to evaluate sidewalk condition.

"Assigning this task to AI would transform how we're able to compare accessibility across cities," Froehlich says. He envisions using Project Sidewalk to perform quick, initial accessibility audits for cities around the world. The data could also be incorporated into other sidewalk-oriented apps and tools, such as AccessMap.



AccessMap enables users to select from preset pedestrian profiles or customize their own to obtain directions following an accessible route between Point A and Point B. The different colors shown on the map allow users to determine accessible sidewalk routes at a glance.

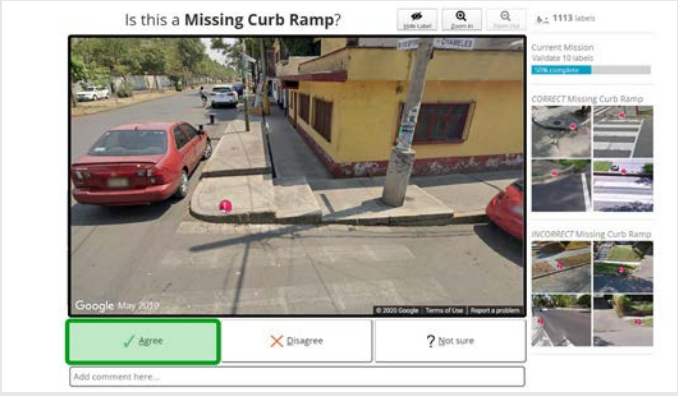
Sidewalk Evolution aims to apply computer vision to images to track changes in curb ramps over time, as seen here in images taken of the same intersection from 2011 and 2015.

A related effort in Froehlich's lab, Sidewalk Evolution, aims to apply computer vision to images to track changes in curb ramps over time. The approach could then be applied to tracking temporal changes in other kinds of images, explains Sharif, who is working on the project.

But it's not just a matter of academic interest.

"Advocates in the disability world could use that data to make the case for better accessibility," Sharif says. Data from this and other sidewalk accessibility projects could spark conversations around the equitableness of accessibility, and point out which neighborhoods and populations lack access to good pedestrian infrastructure, he and other researchers say.

Project Sidewalk uses online map imagery and remote crowdsourcing for collecting and validating data about sidewalk conditions. Volunteers are given missions to explore and correct data, such as identifying missing curb ramps or pathway obstructions as shown here.



EXPANDING TRANSPORTATION EQUITY

Sidewalk accessibility data also needs to be linked to the broader transportation network. One effort to do that is the Transportation Data Equity Initiative (TDEI), supported by an $11.45-million, multiyear grant from the U.S. Department of Transportation.

TDEI aims to develop data standards for three elements of the transportation system: sidewalks (that is, it represents the next iteration of OpenSidewalks); navigating transit centers; and paratransit, which includes on-demand shuttles and community transit on Native American reservations.

The initiative will finalize draft data standards in all three areas, as well as develop procedures to collect, store, upgrade, and publish these data as a feed.

"There's a lot of work to be done," says Hallenbeck, who co-leads the initiative with Caspi.

Similarly, an unrelated project led by Sharif, UnlockedMaps, visualizes the accessibility of urban rail transit, highlighting features such as accessible restrooms and restaurants. It also tracks real-time elevator outages at transit stations — data often missing from digital maps.

Following the principle of "nothing about us without us," Sharif and his team have been seeking input from users with mobility disabilities to guide the next phase of the project.

"After seeing elevator outage information on the map, I realized it is an important feature since it impacts a lot of people," says computer science undergraduate Luna Chen, who is conducting user experience research for Unlocked Maps. She adds that working on UnlockedMaps has sparked her interest in other accessibility-related projects.

It's an energy that many members of the UW Engineering community share.

"There's so much potential in this space, because it's so underserved," Bolten says. "And there's always a million directions that we envision going."

LEARNING outcomes

In Winter 2020, the UW pivoted to the virtual environment nearly overnight. Though the shift presented major challenges for teaching and learning, it also introduced new technologies and methods of communication, asked instructors to rethink pedagogy and shed light on ways to expand accessibility and equity. Here four UW Engineering instructors share what they learned from more than a year of remote teaching and what they've been integrating into their classes back on campus.

A student transfers melted aluminum from an oven to complete an investment casting procedure during a materials science and engineering lab taught by Luna Yue Huang. Photo by Mark Stone

MEETING STUDENTS **WHERE THEY ARE**

Even though in-person classes resumed this school year, Mechanical Engineering (ME) Associate Professor Brian Polagye is teaching his undergraduate thermodynamics courses in a hybrid format. He lectures in-person and online simultaneously, writes on a digital tablet records the lectures using Zoom. Students can revisit the material whenever — and from wherever — is best for them.

"During the pandemic, we realized how necessary it was to give students more flexibility and more sense of control," he says. "That need has continued through this school year."

While teaching remotely, Polagye involved students in making decisions about course structure, homework policies, even exams. Back on campus, he's continued this practice. Students decide whether to attend in-person or online. This year they requested both in-person and virtual office hours to meet with the teaching team. With student input, the team also revised lab report assignments and established new exam guidelines.

Polagye and fellow ME instructors Lucas Meza and Julia Jones have been experimenting with different types of homework extension policies. The data they've collected indicate that being flexible leads to better learning outcomes.

"Some instructors were worried that if students were given too much flexibility, they'd take advantage of it or not rise to their potential, but we're actually seeing the opposite," he says.

Polagye's team has also been allowing students to take exams on or off campus and to use books, notes and calculators.

"We've built in trip wires to catch anyone taking advantage of these allowances, but so far none have been tripped. Instead, we're seeing better understanding and less stressed-out students," he says.

Polagye admits that implementing these changes and teaching to hybrid audiences hasn't been easy, but it's been worth it.

"Students really want to do well, and the level of commitment we've seen from them has been wonderful," he says.

Polagye lectures in-person and online simultaneously, writes on a digital tablet and records the lectures using Zoom.

Undergraduates in Huang's lab conduct materials processing and property characterization experiments.

FOCUSING ON **FOUNDATIONS** AND **GROWING NEEDS**

"The pandemic pushed many instructors to rethink a lot of what we do as teachers," says Materials Science & Engineering (MSE) Assistant Teaching Professor Luna Yue Huang, whose labs on materials processing and property characterization are required for all MSE undergraduates.

During the pandemic, her teaching team faced major challenges in shifting hands-on lab experiments to the virtual environment. But, she says, it's just that kind of problem-solving that engineers do — "true engineering," she calls it.

With safety and costs in mind, her team identified materials and equipment for students to use at home. They created series of video demonstrations and set clear expectations for outcomes. Eventually, Huang asked students to design their own experiments using at-home tools and materials.

"True engineering requires critical thinking and creativity, so we built that into the assignments," she explains. And the outcomes were impressive: students' spirits and confidence soared — so much so that Huang is requiring students to design at-home experiments even after labs have resumed on campus.

"They can do this in the lab or in their garage, residence halls, kitchens or bathrooms," she says. "It's up to the students."

Huang also launched a new data science course series. "This is a growing area in industry and something students are really interested in," she says.

MSE offered the first course during the pandemic. More than 100 students signed up immediately.

"Because we were virtual, we could accommodate everyone. Had we been on campus we would have had to turn away students due to classroom size," Huang says. "Being online also made it easy to host speakers from industry."

This year Huang has been teaching the data science courses in-person but says that students' learning was better online.

"Some learning is best achieved in-person and some remotely. Online is much better for this course. As instructors, it's our job to investigate this — to better understand limitations as well as opportunities," she says.

INTEGRATING **TEACHING TECHNIQUES**

Once the UW went remote, Jon Froehlich developed an interactive digital textbook to support his classes. An associate professor in the Paul G. Allen School of Computer Science & Engineering, Froehlich teaches physical computing and electronic maker courses, which depend on hands-on resources and learning experiences. While his teaching team mailed hardware kits to students, Froehlich filled his textbook with tutorials and videos created from his home office-turned-virtual teaching studio.

He asked students to use the interactive textbook to complete online lessons before attending virtual discussions. Now back on campus, the professor continues to assign the digital textbook in concert with in-person lectures and activities.

Like other instructors, Froehlich uses the "flipped classroom" teaching strategy to engage students with information outside of class in order to use class time for discussion and analysis.

"Interacting with the materials before class helps students build their mental models of the physics of computing," he explains.

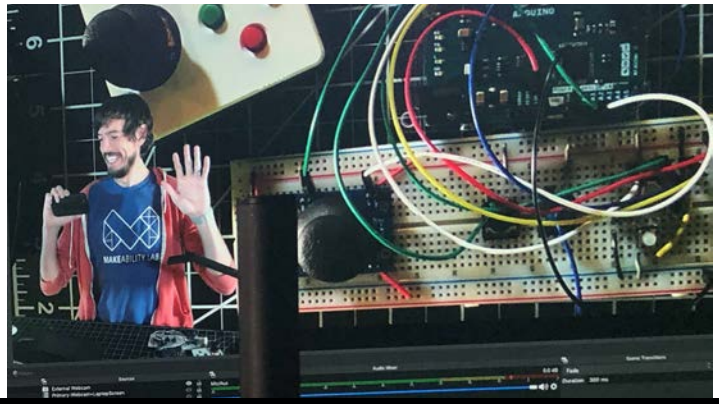
Incorporating hybrid learning elements may require more experimentation with technology and tools, but it may also lead to better learning outcomes. Froehlich has found that digital tools encourage students who might otherwise feel reluctant to speak up during class. For example, the online chat function gives all students the opportunity to ask and respond to real-time questions, resulting in potentially richer and more inclusive discourse. And online breakout rooms tend to create space for more discussion among students.

"The online chat feature in virtual classrooms afforded different types of questions and discussions without interrupting the flow of the lecture," he says. "This often led to greater peer engagement as students could answer each other's questions before the instructor weighed in."

This year, he's been thinking a lot about how to replicate the experience of hearing all the voices.

"We need to redesign classrooms to draw on both the strengths of in-person teaching and online learning, with additional channels for discussion," he says.

Froehlich used his at-home teaching studio to create tutorials and videos for the interactive digital textbook he developed to accompany his class.



RETHINKING **ACCESSIBILITY** AND **ENGAGEMENT**

When the UW went remote, inequity issues immediately presented themselves. Many students struggled with challenges ranging from securing reliable study and teaching space, access to technology and stable internet to balancing home and family obligations with school commitments.

"This became evident when students needed space to set up engineering projects at home," says Human Centered Design & Engineering Assistant Professor Nadya Peek, who developed an innovative curriculum to help students learn computer-aided design and 3D printing skills from home during the pandemic.

On campus, Peek's courses on digital fabrication meet in UW makerspaces, where students can access 3D printers, laser cutters, CNC mills, CAD software and other tools. A core objective of her course is for students to understand machine workflows, equipping them with skills for rapid physical prototyping. While remote, Peek got creative and designed toolkits, including small 3D printers, so that students could set up at-home makerspaces. She worked with her department to help manage costs for students.

Peek's students used their 3D printers to create objects for personal use in addition to coursework. They shared items they were making with each other on Discord, encouraging and inspiring each other to take on engineering and design challenges. Peek saw her students engage deeply in learning, design, testing, iteration and peer support. She also found that students gained much more experience with machine maintenance and tuning than they did when using 3D printers in campus makerspaces, which had valuable learning outcomes.

Since returning to campus, she's continued to require students to own tools while working with her department to develop more equity-minded approaches for managing materials-based classes.

"Having ownership of tools has made my students more confident with machines and more willing to experiment," she says.

She adds that their communication and collaboration has grown as students help each other with documentation, analysis and even equipment sharing.

"Students helping each other has led to good learning outcomes," Peek says. "That's a positive thing."

Introducing the Harmony COVID-19 TEST

The new low-cost, rapid test can detect COVID-19 virus's genome without need for PCR, providing results in less than 20 minutes.

By James Urton | Photo by Mark Stone

UW researchers have developed a new test for COVID-19 that combines the speed of over-the-counter antigen tests with the accuracy of PCR tests that are processed in labs and hospitals.

The Harmony COVID-19 test is a diagnostic test that, like PCR tests for COVID-19, detects genetic material from the SARS-CoV-2 virus. But whereas conventional PCR tests can take several hours, the Harmony kit can provide results in less than 20 minutes for some samples and with similar accuracy.

"We designed the test to be low-cost and simple enough that it could be used anywhere," says Barry Lutz, an associate professor of bioengineering and investigator with the Brotman Baty Institute for Precision Medicine. "We hope that the low cost will make high-performance testing more accessible locally and around the world."

The test uses a "PCR-like" method to detect the presence of the SARS-CoV-2 RNA genome in a nasal swab sample with the aid of a small detector also designed by Lutz's group. A smartphone is used to operate the detector and read the results.

The accuracy of COVID-19 tests has been a pressing matter. Many at-home antigen kits for COVID-19, which detect pieces of the proteins the virus creates instead of its genetic material, are 80-85% accurate, though accuracy may drop with variants that harbor more mutations not found in other strains. PCR tests are generally 95% accurate or better — a key FDA benchmark — but require expensive equipment and a long wait for results.

Initial results show that the Harmony kit is 97% accurate for nasal swabs. The Harmony kit detects three different regions of the virus' genome. If a new variant has many mutations in one region, the new test can still detect the other two.

Lutz and two colleagues spun out a new company from the UW, Anavasi Diagnostics, which last year was supported by $300,000 from WE-REACH and later received $14.9 million in grants from the National Institutes of Health to develop the Harmony prototype kit into a product and scale up manufacturing to help address the ongoing shortage of COVID-19 diagnostic tests.

The team hopes the kits will be available first for use in clinics, workplaces and schools. Later, they would like to adapt the test for home use.

"For a long time, the options have been either a PCR test that is expensive and typically takes a day or more to get a result, or a rapid antigen test that gives fast results and is low cost, but typically has lower accuracy than a lab PCR test," says Lutz. "From the first day, we designed our test to be manufacturable at low cost and high volume, while delivering fast results with PCR-like performance."

An app for blood clots

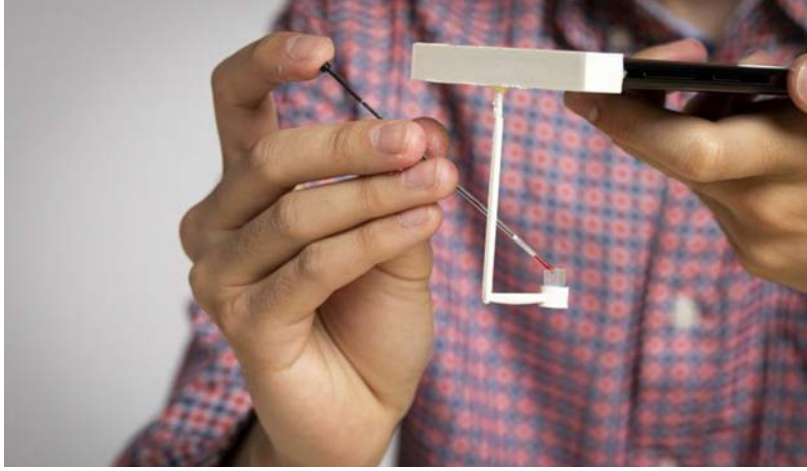
The new test requires only a single drop of blood and a smartphone.

By Sarah McQuate

Blood clots form to stop bleeding when someone is injured. But blood clots in patients with medical issues, such as mechanical heart valves or other heart conditions, can lead to a stroke or heart attack. That's why millions of Americans take blood-thinning medications that make it harder for their blood to clot.

Some of these medications require patients to be tested to ensure their blood is in the correct range — blood that clots too easily could still lead to a stroke or a heart attack while blood that doesn't clot can lead to extended bleeding. Currently, patients must go to a clinic laboratory or use a costly at-home testing system.

A UW research team led by Allen School Professor Shyam Gollakota has developed a new blood-clotting test that uses only a single drop of blood and a smartphone vibration motor and camera. The system includes a plastic attachment that holds a tiny cup beneath the phone's camera.



The test uses a drop of blood and a smartphone with a plastic attachment that holds a tiny cup beneath the phone's camera. Note: This photo simulates how this system works, and the "blood" shown here is not real. Photo by Mark Stone

A person adds a drop of blood to the cup, which contains a small copper particle and a chemical that starts the blood-clotting process. Then the phone's vibration motor shakes the cup while the camera monitors the movement of the particle, which eventually stops moving as the clot forms. The researchers showed that this method falls within the accuracy range of the standard instruments of the field.

While this device is still in a proof-of-concept stage, the researchers have publicly released the code and are exploring further testing and commercialization opportunities.

Housing discrimination
AND AIR POLLUTION

Researchers have found that housing discrimination practices dating from the 1930s still drive air pollution disparities in hundreds of U.S. cities today.

Despite air quality improvements over the past 50 years, people of color at every income level in the United States are exposed to higher-than-average levels of air pollution. This disparity has been widely documented; now researchers are examining links between air pollution and historic patterns of racially segregated planning.

A new study by UW and UC Berkeley researchers has found that housing discrimination practices from the 1930s still drive air pollution disparities in hundreds of American cities today. In this study — the first to do a national-level analysis of modern urban air pollution and historical redlining — the team examined more than 200 cities and found a strong correlation between present-day air pollution levels and historical patterns of redlining.

Redlining — a widespread federally backed discriminatory mortgage appraisal practice in the 1930s — color-coded city areas red if they included high concentrations of Black, Asian, immigrant or working-class residents, deeming these areas hazardous and risky for investment. Historically redlined

areas have been cumulatively affected by a low prevalence of home ownership, uneven economic development, displacement of residents, community disintegration and lack of access to education and economic opportunities.

"Racism from the 1930s, and racist actions by people who are no longer alive, are still influencing inequality in air pollution exposure today," says Julian Marshall, a professor of civil and environmental engineering. "The problems underlying environmental inequality by race are larger than any one city or political administration. We need solutions that match the scale of the problem."

Sensors inspired by dandelion seeds

TAKING A CUE FROM NATURE, A UW TEAM HAS DEVELOPED A TINY SENSOR-CARRYING DEVICE THAT CAN BE BLOWN BY THE WIND AS IT TUMBLES TOWARD THE GROUND.

By Sarah McQuate | Photo by Mark Stone

Wireless sensors can monitor how temperature, humidity or other environmental conditions vary across large swaths of land, and provide insights for applications from digital agriculture to monitoring climate change. Currently, however, it is time consuming and expensive to physically place hundreds of sensors across a large area.

Inspired by how dandelions use the wind to distribute their seeds, a UW team has developed a tiny sensor-carrying device that can be blown by the wind as it tumbles toward the ground. This system is about 30 times as heavy as a 1 milligram dandelion seed but can travel up to 100 meters in a moderate breeze from where it was released by a drone. On the ground, the device uses solar panels to power its onboard electronics and can share sensor data up to 60 meters away.

"Our prototype suggests that you could use a drone to release thousands of these devices in a single drop. They'll all be carried by the wind a little differently, and basically you can create a 1,000-device network with this one drop," says Allen School Professor Shyam Gollakota.

Because the devices have electronics on board, it's challenging to make the whole system as light as an actual dandelion seed. The first step was to develop a shape that would allow the system to take its time falling to the ground.

"The way dandelion seed structures work is that they have a central point and these little bristles sticking out to slow down their fall. We took a 2D projection of that to create the base design for our structures," says Allen School Assistant Professor Vikram Iyer.

The devices use backscatter, a method that involves sending information by reflecting transmitted signals, to wirelessly send sensor data to the researchers.

To keep things light, the team used solar panels instead of a heavy battery to power the electronics. The devices landed with the solar panels facing upright 95% of the time. Their shape and structure allow them to flip over and fall in a consistently upright orientation similar to a dandelion seed.

One issue with solar panels is that the system stops working after the sun goes down. And without battery, the devices can't store a charge. The team added a capacitor, which allows the electronics to hold some charge overnight. That way, the sensors can resume collecting data when the devices turn themselves back on in the morning.

A benefit of the battery-free system is that there's nothing on this device that will run out of juice. One drawback to this is that electronics will be scattered across the ecosystem of interest. The researchers are studying how to make these systems more biodegradable.

CAVITY PREVENTION

A new dental prototype can measure the acidity built up in plaque that leads to cavities.

By Jake Ellison

We have many tools and techniques for stopping cavities, but detecting the chemical conditions that can lead to cavities and preventing them from ever getting started is much harder. Enter the O-pH system, a dental tool created by UW researchers to measure the acidity built up by the bacteria in plaque that leads to cavities.

"Plaque has a lot of bacteria that produce acid when they interact with the sugar in our food," says electrical and computer engineering doctoral student Manuja Sharma. "This acid is what causes the corrosion of the tooth surface and eventually cavities. So, if we can capture information about the acidic activity, we can get an idea of how bacteria are growing in the dental biofilm, or plaque."

The researchers' prototype emits an LED light and measures the reactions of that light, the fluorescence, with an FDA-approved chemical dye applied to teeth. The O-pH then produces a numerical reading of the acidity of the plaque covering those teeth, which can tell dentists and patients what area of a tooth is most at risk of developing a cavity.

The researchers, who are iterating on their device, envision this test could one day be added as part of a patient's preliminary dental exam alongside teeth cleaning: When a patient first sits in the dental chair, the dentist could optically scan their teeth and identify high acid areas.

A new UW dental tool uses a low-power light system to monitor reactions with a florescent dye solution to find where teeth enamel is most at risk from the acidity of plaque. University of Washington and IEEE Xplore/Creative Commons

BREAKTHROUGHS

Novel nanoparticle for treating breast cancer

UW researchers have developed a targeted nanoparticle that kills cancer cells by simultaneously delivering chemotherapeutic drugs and activating the immune system, limiting harmful side effects. They've reported that their multifunctional nanoparticle can inhibit tumor growth and spread, also known as metastasis, in models of triple negative breast cancer, an exceptionally aggressive form of breast cancer with limited treatment options.

Harnessing noise in optical computing for AI

A UW-led team, which has been developing faster, more energy efficient optical computing hardware for AI and machine learning and has engineered an optical computing system using laser light, has achieved another first: They've demonstrated an optical computing system that not only mitigates noise from stray light particles but uses it to help enhance the creative output of the artificial neural network within the system.

Precision-engineered vascular grafts for healing

UW researchers have presented the first biomaterial designed for vascular grafts, which are used to replace diseased blood vessels. The researchers engineered their flexible graft to match the mechanical properties of native blood vessels and heal in place like a natural artery. Because it looks more like a natural blood vessel to the body, the immune system reacts favorably, leading to more healing and less scar tissue.

Greater understanding about the transition from foster care

A new study by UW researchers seeks to support the transition out of foster care by understanding what former foster youth connect about online. Examining Reddit communities, the researchers have found topics that social workers already focus on, but they've also discovered missing topics — including how youth in foster care are represented in the media, how they spend time during the holidays, and their interpersonal relationships.

Read more research news at **engr.uw.edu/news**

SPACE MATTERS

By Chelsea Yates

SPARC SETS THE COURSE FOR SPACE RESEARCH AND POLICY PARTNERSHIPS IN THE PACIFIC NORTHWEST.

With all the global challenges we face here on Earth, why invest time, energy and money in space?

"I would say look around you. A good part of your way of living is somehow, somewhere, running in and through space," says Saadia Pekkanen, the Job and Gertrud Tamaki Endowed Professor in the Henry M. Jackson School of International Studies. "Thanks to space research advancements, we are building an ever more precise understanding of life on Earth — environmental, economic and political."

"So many technologies designed for space — new materials, data connectivity, satellite networks, accountable energy use and much more — have huge implications for many of the societal problems we face on this planet," adds Kristi Morgansen, professor and chair of the William E. Boeing Department of Aeronautics & Astronautics. "When done with the greater good in mind, investing in space can truly advance a more just world."

Learn more about SPARC at sparc.uw.edu

On this planet, it's an interesting time for space research. Today, more and more emerging commercial entities and private ventures are entering the "new space race" to propel space technology, taking the reins from government agencies and established aerospace companies that have traditionally led these efforts. This brings up questions of equity, power, ethics and privilege. How can industry, governments and academic institutions work together to unpack the challenges of human presence and endeavors in space? What is the relationship between space policy, research and innovation? How can we advance space efforts for social good?

At the UW, Morgansen and Pekkanen co-direct the Space Policy and Research Center (SPARC), which they launched in 2018 to bring together researchers, policymakers and industry professionals to explore these questions and more.

A NEED FOR COLLABORATION

SPARC's efforts on campus extend across an array of academic disciplines: engineering, law, global studies, business, astrobiology, computer science, environmental science, medicine, math and more. The complexity of space challenges deepens the need for cross-disciplinary collaboration.

"The different parts of the problems that need to be solved touch on so many different disciplines, and we need to make sure all voices are represented," Morgansen says. "After all, research has shown that the more diverse a group of people you have working on a problem, the better the outcome will be."

In addition to connecting academic researchers with each other, SPARC builds bridges for them to work with policymakers and industry professionals.

"All issues related to outer space activities crisscross technology, law and policy, and more so today because space is democratized in unprecedented ways," Pekkanen explains.

The directors believe that universities are uniquely positioned to play a significant role in working across governments in competition with one another to be a global space leader as well as by helping private companies connect with each other.

"It's a different landscape today than even just 20 years ago," says Morgansen. "It's important that private companies engage not just with academic researchers but with those government entities and established, well-known companies that laid the groundwork for technology advancements. SPARC provides the platform for these exchanges to take place."

AT HOME IN THE PACIFIC NORTHWEST

According to the directors, having SPARC situated at the UW and in the Pacific Northwest is critical.

"In addition to being home to a top engineering program with advances in space systems, computer science and data science and at the forefront of space policy and law, the UW has leading faculty and researchers in physics, math, environment and life sciences who contribute to our understanding of the universe and our potential reach in space," they say.


SPARC directors Kristi Morgansen, left, and Saadia Pekkanen, right.

The region is home to spacecraft and aerospace companies and is powering new technologies, from reusable rocketry and satellite manufacturing to innovative systems for deployment and mission management. The aerospace industry alone provides jobs for tens of thousands in Washington.

Academia can help address workforce development needs and employee training for the Pacific Northwest. SPARC is in the early stages of developing professional education and training programs, and the directors look forward to building these out in partnership with regional organizations such as the Pacific Northwest National Laboratory. Such opportunities could include collaborative research and knowledge dissemination, joint publication, student internships, short courses, tutorials and other forms of continuing education.

LOOKING INTO THE FUTURE

SPARC hopes to position itself as the premier resource for innovative space technology and policy. Each autumn since it launched, the center hosts an annual space symposium, convening approximately 450 people every year to discuss topics ranging from autonomous operations and security to sustainable built environments and workforce development. For students, the directors envision an interdisciplinary space studies curriculum in technology, law and policy, bringing together STEM, social sciences and humanities in the common enterprise of preserving peaceful prospects in space.

They're also connecting SPARC to the Institute for Space Law, Data and Policy (SDLP) that Pekkanen is developing with support from the UW School of Law. SDLP is the world's first interdisciplinary institute focused on space law, data and policy in a global context and will be a dedicated platform for education, training and public outreach.

"Thanks to our colleagues, we have built up a technology and policy platform through SPARC that we think can be a useful interdisciplinary model for academia," Pekkanen says.

A NON-ENGINEER'S JOURNEY INTO MOLECULAR ENGINEERING

Ayumi Pottenger never planned to study engineering. Here, the third-year molecular engineering (MolE) Ph.D. student reflects on what drew her to the program and where she's headed next.

Interview by Renske Dyedov

What brought you to MolE from a non-engineering background?

I got my undergraduate degree in molecular and cellular biology at the University of Arizona. I knew that in graduate school I wanted to study infectious diseases and apply what I had learned in my undergraduate studies to build better platforms and technologies. By chance, I met my adviser Pat Stayton at my UW campus visit. He's a bioengineering professor who directs the Molecular Engineering & Sciences Institute, and he told me about a new drug delivery system his lab was developing to treat malaria. It combined everything I love: biology, chemistry and infectious disease research. I knew then that UW was where I wanted to be.

The MolE program encourages students without engineering backgrounds to apply so I decided to go for it. To my surprise, I got in! There was a lot to learn, but the key was asking for help. I leaned on my professors and other students in my cohort — molecular engineering draws on so many disciplines that each of us is knowledgeable in slightly different areas.

Tell us about your research and your plans after graduate school.

I'm working on the development of polymeric prodrugs — drugs designed to remain inactive until they reach their target tissue — to treat malaria. My research focuses on the parasite *Plasmodium vivax*, or *P.vivax*, one of five species that can cause malaria in humans. *P.vivax* is unique in that it can lie dormant in the liver for weeks, months or even years before reactivating to cause another episode of malaria. Although *p.vivax* is not the deadliest of all of the malaria species, it does cause widespread disease.

After graduating, I hope to work at the U.S. Army Medical Research Institute of Infectious Disease. They have a number of awesome labs focusing on treatments for diseases like malaria. It would be a great opportunity to build on the work I am doing now and expand my expertise.

You've worked with other students to launch a Diversity, Equity & Inclusion (DEI) committee for MolE. Tell us about this work.

We have three goals: increasing program accessibility, providing inclusive mentorship opportunities and educating our community about inequity in STEM.

We've organized several activities to advance those goals. Last fall we held a virtual event to help prospective students, especially those from historically Black colleges and universities and local community colleges, learn how to apply and what to expect in grad school. We also piloted a mentorship program to help connect MolE students with faculty outside of their committees to advise on navigating

grad school. We started a book club for students and faculty to discuss difficult topics without putting the burden of teaching on those from underrepresented groups.

I'm proud to be part of a program that values diversity of lived experiences and backgrounds, recognizing how diversity leads to better science and the thoughtful application of that science.

Has graduate school been what you expected?

Given that I started in fall 2019, the majority of my time as a graduate student has been during the pandemic. I certainly was not expecting that! The pandemic made my first year especially challenging between quarantine and virtual classes, but it was such a trying time for everyone and people were really understanding and accommodating. It was, however, an interesting time to be an infectious disease researcher, as our lab pivoted to apply our polymeric prodrug design to COVID treatments.

Overall, I'm having a lot more fun in graduate school than I thought I would. It's been the most challenging but exciting and enjoyable time I've ever had in school.

Tell us about your blog, "A Tale of 2 PhDs."

Phuong Nguyen (also a third-year MolE PhD student) and I started a blog in March 2020 to document our journey through grad school. We post about everything: tips for picking rotations, lessons from taking our preliminary exams, self-care, and racism in academia. We also have some posts for undergrads interested in pursuing grad school, such as how to choose a grad school and questions to ask during grad school interviews. Writing for the blog has been a great outlet and a nice way to reflect. If we help another student or two along the way, even better!

Read the blog at
ataleoftwophds.com

ENGINEERING UNDERGRAD **COMPETES ON 'JEOPARDY!'**

Aeronautics and astronautics junior Kaden Lee represented the UW at this year's "Jeopardy! National College Championship." The tournament took place in February, bringing together undergraduates from 36 U.S. colleges and universities.

Lee has been playing competitive trivia since high school, where they won the state Knowledge Bowl tournament with their high school team. They now compete on the UW's team for Quiz Bowl, which Lee describes as "definitely a little more on the academic side" than "Jeopardy!"

Lee appeared on Feb. 11, and came in second place during the semi-finals. They didn't walk away empty-handed, however; each student contestant took home $10,000 just for playing.

HEALTH INNOVATION **WINS**

Engineering student teams swept the Holloman Health Innovation Challenge hosted by the UW Foster School's Buerk Center for Entrepreneurship this spring, taking home first, second and third place prizes. Team inSTENT Connection won the grand prize for its medical device idea that lowers the chance of complications and mortality for patients needing surgery in their gastrointestinal tract. The team of biochemistry, mechanical, and chemical engineering students is developing a new kind of stent they hope will be able to help hospitals and surgical clinics soon.

Second place went to CathConnect for its novel breakaway catheter mechanism that improves upon a commonly used tool. The mechanical engineering student team hopes to reduce trauma risk for patients being treated for urinary retention.

Team EquinOx won third place for its pulse oximeter sensor that corrects skin-tone inaccuracies in real-time. The team of mechanical, electrical, and computer engineering students seeks to make health care more equitable and ethical by solving the oximeter problem affecting patients with darker skin tones that statistically leads to a greater number of medical mistakes.

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Introducing Portage Bay Crossing

Plans are underway for a new facility on the west side of the Seattle campus, which will bring together engineers, scientists and students to advance clean energy and health innovation.

The UW Board of Regents has approved development plans for the first major project in the UW's newly named Portage Bay Crossing area. The site sits just south of NE 40th Street and is bounded by University Way NE to the east, Brooklyn Avenue NE to the west, and the Burke-Gilman Trail and NE Pacific Street to the south. The Regents authorized a ground lease of the property to Wexford Science + Technology, a developer of academic facilities that specialize in the sciences, and a lease of building space by the University.

Wexford will develop and manage an 11-story building with 340,000 rentable square feet of lab, office, collaboration and retail space. The UW's Clean Energy Institute (CEI), Brotman Baty Institute, and Institute for Protein Design are slated to occupy a significant amount of the space. A key component of the new facility will be the Washington Clean Energy Testbeds, created by the CEI to scale up technologies in solar harvesting, energy storage and systems integration.

"In recent years, the Washington Clean Energy Testbeds have attracted about 600 facility users from the UW and other research organizations across the state and nation who work side by side with a group of roughly 60 companies," says Daniel Schwartz, CEI director and professor of chemical engineering.

"The dynamic environment in this new space will unleash Washington students, faculty and companies to create home-grown technologies that can scale solutions to address the climate crisis."

The vision for Portage Bay Crossing is to create a place where student and faculty across multiple fields — engineering, public health, life sciences, social work, public policy, the humanities, physical sciences and environmental studies — can partner with business, government, nonprofit organizations and the Seattle community to solve critical challenges.

Rendering courtesy of Wexford Science + Technology