THE BRIDGE

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Fighting fatalities with facts

Sensing technology from a new start-up is installed at Yakama Nation's most deadly intersection.

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CIVIL & ENVIRONMENTAL ENGINEERING
UNIVERSITY *of* WASHINGTON

Timber triumph

A 10-story mass timber building is designed to be sustainable and seismically resilient.

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MESSAGE FROM THE CHAIR

Welcome to the spring edition of *The Bridge*. One of my goals for my first year as CEE Chair was the completion of the department's strategic plan. I am excited to report that it was officially released in March. My predecessor as Chair, Professor Laura Lowes, started the strategic planning process in late 2021 and enlisted many in our community to participate in its development. At the center of the plan is our commitment to building a resilient and sustainable community. We have defined four Grand Challenges that CEE students and faculty will tackle together through research and coursework, preparing students to build a more resilient and sustainable world through their careers.

As I shared in my message in the autumn edition of *The Bridge*, rebuilding community and undergraduate recruitment are also priorities. We have increased efforts in both areas through more regular social engagements and focused recruitment efforts to first-year engineering students who have not yet decided on a major. While the job market for civil and environmental engineers remains excellent, one of our challenges is that first-year students often do not have a clear idea of the broad range of professions unlocked by a degree in civil or environmental engineering. Telling the story of what we do in a way that is compelling to incoming students is more important than ever. To help with this, Professor Faisal Hossain led an initiative to enrich the hallways of Wilcox and More Halls with photos that showcase the work of our students and faculty.

One of the pleasures of becoming Chair has been the opportunity to learn more about the work of our faculty, staff and students, and to celebrate their successes. In this edition of *The Bridge*, we feature research from across the department, including Professor Yinhai Wang's team that developed sensing technology to enhance roadway safety, Professor Jeffrey Berman and his Ph.D. student's work to demonstrate the earthquake resilience of tall wooden buildings, and research by Professor Alex Horner-Devine to investigate the movement of water where a river flows into the ocean, which resulted in photogenic pink waves.

Bart Nijssen
Chair & Allan & Inger Osberg Professor

Faculty awards

PEDRO ARDUINO NAMED PSEC 2023 ACADEMIC ENGINEER OF THE YEAR

Professor Pedro Arduino is the recipient of the 2023 Academic Engineer of the Year Award by the Puget Sound Engineering Council (PSEC), which honors his career as a geotechnical engineering educator and researcher. A pioneer in computational geomechanics, Arduino has advanced models used to examine soils subjected to earthquake ground motions, which has furthered the study of soil-structure interaction as well as granular soils subject to complex loading conditions. He is also a dedicated teacher and mentor to engineering students.

YINHAI WANG ELEVATED TO IEEE FELLOW AND HONORED BY ASCE

This year, Professor Yinhai Wang received three honors. Wang was elevated to the status of Institute of Electrical and Electronics Engineers (IEEE) Fellow, a distinction reserved for a small number of members. The honor recognizes Wang's contributions to traffic sensing, transportation data science and smart infrastructure systems. Wang is also the recipient of two honors from the American Society of Civil Engineers (ASCE): the 2023 Francis Turner Award and the title of Distinguished Member, Class of 2023, which is the highest honor bestowed by ASCE.

FAISAL HOSSAIN RECEIVES UW EXCELLENCE IN GLOBAL ENGAGEMENT AWARD

Professor Faisal Hossain is the recipient of the inaugural 2023 UW Excellence in Global Engagement Award in recognition of his leadership, mentorship and research undertaken in collaboration with communities around the world. Hossain has implemented sustainable and water efficient food production solutions for agricultural agencies in Pakistan, India and Bangladesh. He has also co-developed solutions for reservoir management in Cambodia, Laos, Vietnam, Egypt and Iraq. Recently, Hossain has engaged with tribal authorities to develop reservoir tools to improve fishery resource management for the Columbia River.






CEE strategic plan: 2023–2027

Building a resilient and sustainable society

The CEE Department officially has a North Star to guide activities, academics and research for the next five years — and to position the department to shine bright. Launched in early 2023, CEE's strategic plan is the culmination of a yearlong effort by students, faculty, staff, alumni, leadership and other partners. Through implementation of the plan, the department will lead the way in enhancing the well-being of our communities and preparing for a rapidly changing world.

Our plan framework: Four pillars

At the center of the strategic plan is a commitment to building a resilient and sustainable society. Four core pillars will guide our work:

1. **Grand Challenges and research**
2. **Culture and diversity, equity and inclusion**
3. **Education**
4. **Visibility and engagement**

Learn more and read the full plan:
ce.uw.edu/about/strategic-plan

Embarking on Grand Challenges

As part of the strategic plan, four Grand Challenges have been identified to encourage CEE students and faculty to design solutions for the future by addressing pressing societal needs. The themes build upon existing work underway in the department, while encouraging additional innovation and collaboration across disciplines.

- **Designing for a changing climate**
  Big data, adaptive design and other emerging theories and technologies will inform work to decarbonize engineering sectors, remove greenhouse gases from the atmosphere, and help communities mitigate and adapt to climate change impacts.
- **Creating resilience to natural hazards**
  Utilizing remote sensing, machine learning, artificial intelligence and other tools, researchers will enhance the resilience of communities in the wake of increasing natural disasters.
- **Engineering for socioeconomic and environmental justice**
  Through developing a diverse, collaborative and skilled workforce, the CEE community will create a more inclusive world and reverse existing societal and environmental inequities.
- **Building sustainable infrastructure**
  Advanced construction techniques, new materials and transformative technologies will enable researchers to create smart structures that withstand natural disasters and climatic events.

A TIMBER triumph

Seismically resilient and sustainable

Researchers test a 10-story mass timber building designed for Seattle

It may sound like a tall order: a seismically resilient and sustainable mid-rise building constructed entirely out of timber. But a team of researchers is proving that this is indeed feasible by testing the tallest structure to date, a 10-story building designed to withstand Seattle-area earthquakes.

"There's a need in urban areas like Seattle for mid-rise buildings, and similar things are happening in San Francisco, Los Angeles and Portland," says CEE Professor Jeffrey Berman, a principal investigator on the project. "We are trying to make these new developments more sustainable and seismically resilient."

The project is paving the way for more widespread use of mass timber — layers of wood bonded together — in taller structures, particularly in earthquake-prone regions.

The lowest segment of one of four rocking walls is lowered into the structure. Each rocking wall is divided into three segments that are 3-4 stories tall. Photo credit: ©Timberlab/FLOR Projects

Researchers from across the country gathered in early May to test the 10-story building at one of the world's largest shake tables at the University of California San Diego. The project breaks ground on numerous fronts. Not only is it the world's tallest building to be tested on a shake table, but the structure is crafted entirely out of timber, including a unique rocking wall system designed by the UW team.

"Mass timber is a new material, so we are testing it in a taller building as a proof of concept and to study if this is actually feasible — there aren't any buildings in the world that are 10 stories and have structural systems made entirely of timber," says CEE Ph.D. student Sarah Wichman.

Funded by the National Science Foundation, the Natural Hazards Engineering Research Infrastructure (NHERI) TallWood project is a collaborative effort between university researchers and engineering firms. The UW team includes Berman, Wichman

and master's student Davis Wright. They are collaborating with lead institution Colorado School of Mines, University of Nevada, Reno, Colorado State University, Washington State University, University of California San Diego, Oregon State University and Lehigh University. Local industry partners include KPFF Consulting Engineers and LEVER Architecture.

Designed for Seattle

Since the seismic performance of taller buildings crafted out of mass timber is not well understood, the building undergoing testing was designed to be located in the heart of Seattle — the Capitol Hill neighborhood. Seattle was selected due to the city's risk of significant, yet uncommon, seismic events. The project builds upon a successful test of a two-story timber building in 2017, which wasn't location-specific.

"We don't think much more is to be learned at four, five or six stories, but at 10 stories there's a lot to learn in how these systems behave," Berman explains. "And so we picked the location in Capitol Hill and did exactly what you need to do if designing a 10-story mass timber building in the city."

The researchers worked closely with both an architecture firm and structural engineers. Since specifications for this type of timber structure are not yet included in the building code, additional requirements included a site-specific hazard assessment. The resulting information — from soil types to fault lines — informed the building design.

"Based on findings from the two-story test, we think we've got a really good handle on how the 10-story building will perform," Wichman says. "We've used our models to validate the design — the damage should be minimal and predictable."

A sustainable stability system

The project is especially unique because the rocking wall system, which stabilizes the structure in the event of an earthquake, is also crafted out of timber. This type of lateral stability system is typically constructed from more traditional materials such as concrete or steel.

For taller buildings, a resilient lateral system becomes especially important due to increasing forces from a variety of sources, including earthquakes and even wind. Rather than prevent the building from moving, the rocking wall system is specially designed to rock back and forth during a seismic event. This enables the structure to snap back into its original position with minimal damage.

"That's contrary to what's common in earthquake engineering where we expect the structure to be damaged and it may even need to be torn down after a big earthquake," Berman says. "The rocking wall system is designed to be resilient even in large earthquakes. If there is damage, it will be easily repairable."

The researchers are evaluating the performance of two primary types of mass timber, cross laminated timber and mass plywood panels, which are relatively new to the building scene and

Table talk

The outdoor earthquake simulator at the University of California San Diego (UCSD) and the indoor E-Defense facility in Japan are the two largest shake tables in the world.

Tallest buildings tested: Prior to the 10-story structure, the tallest building tested at full-scale was six stories tall. Several buildings of this height have been tested at the E-Defense facility in Japan.

Upgraded UCSD simulator: The recently upgraded outdoor simulator is now able to reproduce the full 3D ground motions that occur during earthquakes, when the ground is moving in all six degrees of freedom. It is also capable of carrying and shaking structures weighing up to 4.5 million pounds.

A 10-story building constructed from mass timber and designed to withstand Seattle-area earthquakes is tested at one of the largest shake tables in San Diego. Photo credit: University of California San Diego

are slowly gaining popularity as a greener alternative. In the construction industry, concrete is one of the most widely used materials, the production of which is responsible for about 8% of global carbon dioxide (CO2) emissions.

"Trees are a renewable resource. Growing trees sustainably and using them is better than concrete and steel, which leave a lot of CO2 emissions," Wichman explains.

Earthquake simulations

During the monthlong testing process, a series of earthquakes will be simulated with increasing intensity. The final phase will include ground motions for the maximum earthquakes that buildings are designed for in Seattle. The city has two primary faults: The Seattle Fault that runs east-west through the middle of the city, capable of earthquakes up to 7.4 magnitude; and the Cascadia Subduction Zone along the coast, capable of a magnitude 9 earthquake.

More than 800 sensors were installed throughout the structure. The data will enable the UW researchers to refine their computer models, which they hope will be utilized by industry to predict the performance of similar buildings. The researchers also hope their findings will inform building code requirements for timber structures.

"We want people to be using mass timber everywhere," Berman says. "This is providing a demonstration and validation of this particular system and is aimed at higher seismic zones, largely along the West Coast, but many of the principles from the building itself can apply anywhere."

Fighting Fatalities with facts

A data-driven solution for Yakama Nation's most deadly intersection

In addition to the cherries, asparagus and hops that grow along a stretch of U.S. Highway 97 in the heart of Yakima Valley's agricultural corridor, something else has taken root in the community: a data-driven approach to improve traffic safety and save lives at Yakama Nation's deadliest intersection.

"With the agriculture comes farm vehicles, farm workers, freight and bigger trucks on roads that were built in the 1940s, '50s and '60s, so they are not to today's standards," explains HollyAnna Littlebull, the Traffic Safety Coordinator for Yakama Nation Department of Natural Resources Engineering. "There is often a line-of-sight issue — crops come right up to the intersection so sometimes you can't see if there's oncoming traffic."

Along the precarious highway corridor, where more than 430 serious injuries and 24 fatalities have occurred in the past 20 years, contributing factors include speeding, texting while driving and pedestrians walking along the highway shoulder. In her ongoing work to advocate for safety improvements, Littlebull often hasn't had enough data to make generalizations — but that is changing.

To provide real-time data about the nature of traffic collisions, as well as monitor traffic, roadway and environmental conditions, a Mobile Unit for Sensing Traffic (MUST) sensor was installed at the deadliest intersection on the reservation in November 2022. A partnership between Yakama Nation Department of Natural Resources, UW Smart Transportation Applications & Research (STAR) Lab researchers and associated spin-off company AIWaysion, the pilot project is funded by the Pacific Northwest Transportation Consortium (PacTrans).

"Facts are important — we are utilizing the data to tell us what the reality is that we are facing," Littlebull says. "So far, it's the best tool that we've ever had to give us current and up-to-date information. We want to make the best decisions possible to reduce fatalities and serious injuries."

From left: On-site interviews by local media during the installation of the first MUST device at the Highway 97 and Larue Road intersection in November 2022; Professor Yinhai Wang, who led the sensor development; the first MUST sensor installed on a utility pole; the AIWaysion team working on product performance testing and improvement; a map that shows the location of Yakama Nation in dark purple. Photos by Dennis Wise/University of Washington and Yakama Nation

A sensing solution

Since 2008, STAR Lab researchers have been working on iterations of the MUST sensor, which began as a Bluetooth sensing experiment. The current technology integrates several functions in one device: a camera, environmental sensors, communication functions and advanced analysis that incorporates multiple data sources and is capable of making decisions.

"Everything is done by the sensing device — it detects and processes information and decides what kind of warning information to send directly to the traffic center," says Professor Yinhai Wang, who has overseen the sensor development. "Our students do computer science, mechanical design and control theory, so we are using all these different technologies to break boundaries and optimize the solution."

Information captured by the sensor is sent to Yakama Nation's traffic management center, where traffic engineers can view the data in real-time on a dashboard and also via an app for after-hours monitoring. Thanks to edge computing capabilities, in which data is processed and stored locally on a device instead of via the cloud, the sensor works well in remote and rural areas with limited internet access.

"The sensor provides real-time information like vehicle volume and speed, road surface and weather conditions and the presence of pedestrians and semi-trucks. It also detects possible near-miss collision events," explains Wei Sun, the CEO of the spin-off company AIWaysion. "If certain events are happening, it can send out a warning message and traffic engineers can check it out."

Understanding a deadly intersection

Better understanding the nature of traffic collisions along Highway 97, specifically at the Larue Road intersection — where seven of 24 fatalities have occurred between the towns of Union Gap and Toppenish since 2001 — is a priority for Littlebull. Collision reports often don't include the direction of travel, and weather conditions are not specified.

"The fog here can be so thick that you can't see 200 feet. That's not in the report. I need to see the environmental and behavioral factors," explains Littlebull. "The other thing I don't get from the reports is the traffic volume and the speed cars are going. I know speeding is an issue, but if I can't prove it, that's a problem."

To help improve safety along the highway corridor, Washington State Department of Transportation is installing six roundabouts. While construction of a roundabout at Larue Road may be a few years out, the first installation at McDonald Road in 2021 has proven successful. More than six million vehicles have traveled through the roundabout with only a handful of minor collisions — and no fatalities.

An AIWaysion researcher works on a vehicle detection algorithm.

A related concern that Littlebull is also advocating for is improvements to first responder services. While two ambulance providers serve the reservation, the only one that has paramedics trained to handle severe trauma responds from Yakima.

"It's a huge issue. We are so remote, so spread out — there's no way people will receive advanced life support within the 10-minute bubble, or the 'golden hour,'" Littlebull explains. "I'm trying to paint that picture with as much data as I can get, to justify to people who hand out grants that this is why we need higher trained EMTs and safer roads for all."

Data developments

To enhance safety at the Larue Road intersection, the researchers are working to roll out more technology features. For example, if the sensor detects a traffic collision, it could be programmed to automatically alert emergency responders. Or, if unsafe driving conditions are detected, the sensor could prompt a warning message on an electronic reader board.

"The sensor could detect if black ice or snow is covering the road surface and issue a warning," Wang explains. "This would enable people to avoid the area or drive at a very low speed."

To expand the pilot project, AIWaysion and Yakama Nation are seeking funding to deploy additional sensors along the highway corridor. Although the pilot is intended to last up to 18 months, Littlebull hopes to utilize the technology much longer — perhaps indefinitely.

"When I lobby and talk to elected officials, I make it a story. I help them realize that these fatalities are not just dots on a map, these are human lives," Littlebull says. "I take the data, personalize it and hit them where it hurts — in the heart. That is what the UW is helping me do, they are helping me tell the stories."

Spin-off specifics

To commercialize the MUST sensor technology, AIWaysion launched in 2022. In addition to start-up support and mentorship from UW CoMotion, funding was also provided by a U.S. Department of Transportation Small Business Innovation Research Award. Orders are starting to stream in and the team hopes to sell 100 sensors by the coming summer. Learn more at **aiwaysion.com**.

Project to digitize the curb receives $2 million SMART grant

A delivery driver in downtown Seattle. Photo credit: Urban Freight Lab

Freight carriers often have trouble accessing loading zones when making deliveries in downtown Seattle. To help remedy this by "digitizing" the curb, a $2 million U.S. Department of Transportation Strengthening Mobility and Revolutionizing Transportation (SMART) program grant has been awarded to a multi-sector team led by the Seattle Department of Transportation in partnership with CEE's Urban Freight Lab and Open Mobility Foundation.

"The Urban Freight Lab is delighted to help deliver new digital tools and data-driven solutions to maximize access, safety, mobility and usage of the limited curb space in Seattle," says Urban Freight Lab Director and Professor Anne Goodchild. "Deploying new strategies and approaches is key to reducing congestion and emissions, and achieving Seattle's climate and economic goals."

Although there are more than 5,000 curbside loading zones within the city of Seattle, it can be difficult for delivery drivers to find parking, as spaces may be too small or are already occupied.

To streamline curb access and use, with the added benefit of reducing congestion, the project will implement new tools to create a digital representation of the city's loading zone spaces. This will allow the city to digitally manage commercial loading spaces, analyze activity and communicate with drivers. The strategy will be informed by targeted outreach to local businesses and freight carriers.

The researchers plan to conduct a pilot test in the Belltown and Denny Triangle business districts near downtown Seattle. The project is anticipated to start this summer and extend through early 2025.

PacTrans receives USDOT $15 million renewal award

To continue and expand its important work to improve the movement of people and goods throughout the region, the Pacific Northwest Transportation Consortium (PacTrans) has received another green light: a $15 million renewal grant over the course of five years from the U.S. Department of Transportation (USDOT).

Seattle skyline. Photo credit: UW Photography

Housed within CEE and directed by Professor Yinhai Wang, PacTrans is one of 10 regional University Transportation Centers (UTC) across the U.S. As the UTC for Federal Region 10, PacTrans represents Washington, Oregon, Idaho and Alaska. In partnership with regional universities, PacTrans supports a variety of transportation research related to advancing mobility, including technology transfer and education and workforce development. The four core university partners are Portland State University, University of Alaska Anchorage, University of Idaho and Washington State University. The Northwest Indian College, which has six campuses in Western Washington, will also serve as an education and outreach partner.

The center will continue to focus on mobility challenges related to the movement of people and goods throughout the region, with the addition of several strategic goals identified by USDOT. The center will work toward two overarching strategic goals: economic strength and global competitiveness. Secondary goals are equity, transformation and safety.

Founded in 2012, PacTrans received a $14 million award from USDOT in 2016. Much of the work of the center has come to fruition in recent years, with the launch of a workforce training program and the start-up company AIWaysion.

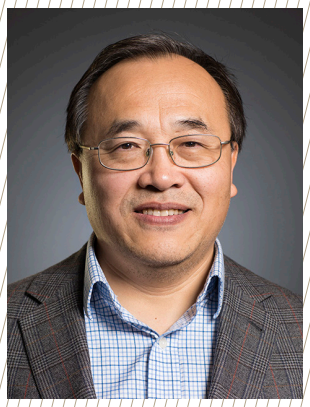
New NW TTAP Center launches, seeks assistant director

Housed within CEE, the Northwestern Tribal Technical Assistance Program (NW TTAP) Center launched in November 2022 in collaboration with Eastern Washington University (EWU). The center is one of seven national centers supported by the Federal Highway Administration's National Tribal Technical Assistance Program and joins an even wider network of 51 local program centers.

The regional centers serve as a local resource for tribal transportation training, technical assistance and technology transfer needs, and also assist with the maintenance, management and administration of transportation infrastructure and programs. The NW TTAP Center supports 45 Native American and Alaskan Native Tribes within the Northwestern Bureau of Indian Affairs Region 6.

Directed by CEE Professor Yinhai Wang in collaboration with Associate Director and EWU faculty Margo Hill, the center is supported by UW graduate students Ollie Wiesner and Olivia Potash. To carry out the day-to-day functions of the program, the center is looking to hire an assistant director. To learn more or apply, visit nwttap.org.

To understand the most pressing transportation needs and challenges associated with each tribe in the region, the center's leadership and students are in the beginning stages of meeting with each tribe. The center is also building relationships with subject matter experts across all transportation-related disciplines who may be interested in developing trainings or aiding in practical technical assistance. If interested, contact Wiesner at olw8@uw.edu.



Leading the NW TTAP Center are CEE Professor Yinhai Wang and Eastern Washington University faculty Margo Hill.

RAPID researchers deploy equipment in the Yellowstone River.

Following flooding, RAPID researchers gather data at Yellowstone

The historic flooding that hit Yellowstone National Park in summer 2022 prompted an urgent need to understand the impacts of the natural disaster on both the infrastructure and environment in the ecotourism-dependent community. The UW Natural Hazards Reconnaissance Facility (known as RAPID) responded with a two-phase approach, leveraging cutting-edge technology and expertise to investigate the intricate interdependencies between human-built infrastructure and the natural world.

During the first reconnaissance trip immediately following the flood, RAPID supported fieldwork undertaken by a Geotechnical Extreme Events Reconnaissance (GEER) team by providing laser scanners. These were used to capture structural damage and assess the extent of the flood's impact on the infrastructure and environment. In the second phase, RAPID researchers Michael Grilliot and Andrew Lyda joined the onsite efforts. They operated state-of-the-art equipment including a drone-mounted multispectral camera to investigate the source of deposited sediments and a hydrographic survey vessel to map the river bottom and measure erosion next to bridge foundations. This enabled the collection of high-resolution perishable data to better understand how sediment is carried away and deposited in new locations, particularly near affected infrastructure.

The insights gathered from the research will offer a deeper understanding of how the geometry of the river channel, flow conditions, presence and location of debris, and geotechnical properties influence engineered structures from bridges to buildings during extreme floods. The insights will be invaluable in updating infrastructure design and flood mitigation strategies across the United States.

A course of action

Four faculty share how they have incorporated DEI content into their classes

Julian Marshall, Professor

Created a course on CEE and equity

In spring 2021, Professor Julian Marshall introduced a new course that explores how engineering and equity are interrelated: CEE for Justice, Equity, Diversity and Inclusion. "In the class, we talk about the idea that engineering design often is not neutral, even if we might think it is," explains Marshall. "We discuss issues that are present today and also engineering design that happened decades earlier since infrastructure lasts a long time."

What do students learn about in the course?
Students learn how engineering design can reflect and reinforce existing norms, assumptions and power dynamics — and also how engineers can recognize and try to eliminate inequities. Some of the readings are recent; others are classics because the issues they describe are still relevant. For example, *Dumping in Dixie*, a book from 1990, documents how undesirable land uses like trash dumps and industries that pollute generally end up near communities with less political power. *Do Artifacts Have Politics?* explores how engineered systems can embody political goals and the assumptions of the designer. Overall, students learn what questions to ask to help improve the solutions they design.

How did the students respond to the course?
The students definitely feel that this is an important part of their education. The class is not about DEI in the workplace necessarily, such as how to interact with coworkers. It's more about how DEI relates to designing engineering solutions. Students are eager to reflect on that topic and include it in their future professional practice.

Anne Goodchild, Professor

Enhanced a transportation course with new content

While preparing to teach the transportation engineering course Planning for People and Freight for the second time, Professor Anne Goodchild realized that something was missing from the content: the differential impacts across communities. The course didn't touch on the varied experiences across groups — such as which communities bear the highest costs for road construction and how safety outcomes vary across age, gender and race.

How did you add differential impacts content to the course?
I added substantial new content in terms of the exercises and selected readings, which ranged from opinion pieces to scientific articles. During class discussions, I centered the conversation on differential impacts. For example, when covering pedestrian fatalities, I highlighted how these vary across neighborhoods and how transport planning can be improved to address these differences.

How did the students respond to the content?
The students were interested in the topics and engaged in discussions in a similar way to previous years. One student expressed dissatisfaction and I reached out to discuss their concerns. This helped me understand the need to explain the purpose and intent of some of the readings. The student stayed engaged and became one of the most frequent contributors to the class discussion. At the end of the course, I sent out a survey specifically about the focus on equity and found that students overwhelmingly appreciated the approach.

Many CEE faculty are embracing a learning opportunity when it comes to adding diversity, equity and inclusion (DEI) content to the curriculum. The past few years, they've been busy updating existing courses and developing new classes from scratch.

"It's an oversight that this material wasn't included in previous years," says Professor Anne Goodchild, who teaches transportation engineering courses. "This content will help train engineers who will build a better transport system for everyone, not just a few people."

Their work comes in light of a petition from students in 2020 that called for increasing the amount of class time spent discussing and exploring DEI topics as they relate to engineering. Given that courses often rely heavily on mathematical calculations, some of the new content has compelled students to approach their coursework assignments differently.

"Homework is often calculating something," explains Professor Jim Thomson. "This is encouraging engineering students to think more broadly about the effects of our work in society."

RESPONDING TO STUDENTS

In June 2020, 179 CEE students petitioned the department with specific requests, including the addition of DEI content to existing courses and the introduction of dedicated DEI courses. In 2021, the first new courses were rolled out: Professor Julian Marshall's course, as well as a class titled Environment, Engineering and Justice taught by Khalid Kadir, a lecturer from University of California, Berkeley.

Learn about the ongoing work of CEE's DEI committee: **ce.uw.edu/DEI**

Jim Thomson, Professor

Supplemented core curriculum with equity-focused research assignments

Although he initially wasn't sure where to start, Professor Jim Thomson felt compelled to add DEI content to two hydrodynamics courses he teaches. In one class, he decided to supplement the existing core content with mini equity-focused research assignments. "This allowed students to follow their own interests and we learned together," Thomson explains.

Tell us about the mini research assignments
In my Coastal Engineering course, students typically complete weekly assignments such as determining the wave forces on a piling at a ferry terminal. Instead of calculations, for one assignment I asked the students to report on a coastal engineering case study where there's a strong equity or social justice issue, or unintended consequences of design choices, such as reduced access to waterways. Students looked at topics first as engineers and then again with an eye toward social justice.

What topics did the students report on?
One student wrote a report about a waterway in Honolulu that had been a traditional passageway for native Hawaiians for transportation and fishing. As the city grew, the passageway was engineered until there was restricted access and the waterway no longer flowed into the ocean. Other students have written about "managed retreat" programs, in which the federal government buys private coastal land that is in danger of eroding — but only in wealthy neighborhoods.

Bethany Gordon, Assistant Professor

Introduced a new course on engineering policy and place-based equity

A new course, called Engineering Policy for Place-Based Equity and Justice, was introduced this spring by Assistant Professor Bethany Gordon, who joined the faculty last autumn. "Students in the class learn how to prepare themselves for collaborative work with diverse communities," Gordon explains.

What topics do students learn about in the class?
We explore positionality, which is the political and social context that creates our identity, through both a personal and a professional lens. Then, we move into unpacking the values inherent in engineering culture. This leads us to examine what we consider valuable knowledge and ways of gathering information that may elevate our understanding of complex problems. The discussion is situated in a conversation about the history of Seattle, with a focus on Indigenous history. One of the major assignments asks students to write science policy memos, which they are encouraged to submit to the *Journal of Science Policy and Governance.*

Why is this type of content important for future engineers?
Our work as civil and environmental engineers affects the daily lives of so many people, yet we often find it challenging to meaningfully include people in the problem-solving process. Moreover, there are communities that have been historically marginalized and intentionally excluded from the processes we use to make decisions. This has created a need for engineers to take a serious look at how we can work to create a built environment that truly works for everyone.

Alumnus **Alexander Ratcliff** returns as graduation keynote speaker

A desire planted during Alexander Ratcliff's (BSEnvE '19) undergraduate years has continued to grow and flourish in his early career — to create a more sustainable world. Ratcliff shared his story with the class of 2023 as this year's keynote speaker at the department graduation ceremony on June 3.

A lead engineer with PAE Consulting Engineers in Seattle, Ratcliff oversees the design of sustainable mechanical and plumbing systems for residential, commercial and institutional projects. He has contributed to the design of several campus buildings including the Hans Rosling Center for Population Health, the Health Sciences Education Building and the Interdisciplinary Engineering Building, currently under construction. Other notable projects include the Seattle Aquarium Ocean Pavilion (opening 2025) and the Concourse C Expansion at the Port of Seattle (opening 2027). With a focus on heat pump technology, thermal energy storage and biomimetic design inspired by nature, Ratcliff strives to engineer buildings that produce 80-90% fewer carbon emissions when compared to conventional infrastructure.

Ratcliff graduated magna cum laude with the inaugural cohort of the Bachelor of Science in Environmental Engineering (BSEnvE) program, earning departmental honors, Husky 100 recognition and the Dean's Medal from the College of Engineering. During his undergraduate career, he served as a project manager with the UW Solar student organization and was instrumental in the deployment of solar energy installations at three residence halls. He also worked to secure sustainable features for the new UW Life Sciences Building. In addition to spending one year in Associate Professor Rebecca Neumann's Hydro-biogeochemistry Research Group, Ratcliff collaborated with faculty Michael Brett and Mike Dodd on a theoretical water reclamation system to serve Drumheller Fountain.

Career connections: CEE hosts 17th annual career fair

Handshakes were back in style at the 17th annual CEE Career Fair, held in-person on February 16 after two years of remote events. Attended by more than 200 students, the annual event offered an opportunity to make career connections.

Held at the HUB Ballroom, representatives from 94 companies were on hand to discuss career opportunities and internships with both CEE undergraduate and graduate students. Founded in 2007, the CEE Career Fair connects employers with students who are seeking internships and full-time positions. Industry focuses range from general civil engineering to specialty areas such as construction, transportation, geotechnical, structural, water resources/hydrology/fluid mechanics and environmental engineering.

Industry representatives, many of whom are CEE alumni, enjoyed a post-fair reception with the department chair and faculty. Thank you to the many companies and organizations that continue to participate and support the CEE Career Fair.

Research with a SPLASH OF COLOR

The phrase "a splash of color" took on a very literal meaning for a research team stationed in San Diego. Using environmentally safe pink dye, they are investigating the movement of water within a coastal zone, specifically where a river flows into the ocean.

"It's bright pink — we need it to be that bright," CEE Professor Alex Horner-Devine says about the nontoxic dye. "We have to start with something concentrated so that we can see it get diluted for a long enough time to observe all the processes that mix it."

At the mouth of the Los Peñasquitos Lagoon estuary, where the freshwater river meets the ocean, the first of three dye releases kicked off on January 20. Although visible to the naked eye for only a few hours, smaller traces of dye can be detected with technology for up to 24 hours.

Until now, previous studies have primarily focused on investigating the dynamics of how freshwater from large rivers mixes with saline seawater. The Los Peñasquitos Lagoon was therefore selected as an example of a smaller river discharging into the ocean where it forms a plume — the resulting combined water mass.

Historically, river plumes have been studied by lowering instrumentation off the edge of boats, which isn't feasible this close to the shoreline. In addition to a variety of sensors installed at various ocean depths that measure everything from salinity to turbulence, the researchers employed specialized equipment: GPS-tracked drifting sensors that record the trajectory of the river water and drones equipped with hyperspectral sensing.

By investigating the water movement dynamics, the researchers hope to learn more about how various substances, especially pollutants, move from the nearshore area to outer waters. Following the data gathering, the researchers will undertake further analysis and refine their computer models — which they hope will one day help manage coastal areas and prevent pollution events through enhanced prediction of dilution rates and transportation processes.

"One of the intriguing things about this research is that it falls between two disciplinary groups. For decades, people studying rivers always ignored waves and the people studying waves ignored rivers," says Horner-Devine. "The intersection of the two is actually a new area. A lot is known about wave breaking and river plumes, but little is known about how they interact with each other."

Insert: CEE Professor Alex Horner-Devine steps out of the pink surf while tending to GPS drifters. Photo credit: Erik Jepsen/UC San Diego and UW researchers

BUILDING

Alumna Amy Leland (MSCE '99) builds bridges both literally and figuratively. In addition to overseeing more than 3,000 bridges throughout the state of Washington in her position as the new State Bridge Design Engineer — a role she assumed this past January — Leland is also the first woman to hold this position at the state agency.

After earning her master's degree, Leland embarked on a career with Washington State Department of Transportation (WSDOT) Bridge & Structures in 1999. During her 24-year tenure, Leland has designed many structures of varying degrees of complexity, giving her an extraordinary breadth and depth of technical experience and knowledge. Below, Leland shares highlights from her career and offers advice for women in the field.

When did you first become interested in bridges?

During my graduate school years, I interned at a few different agencies, which is when I was first drawn to bridges. At Harding Lawson Associates, I helped design part of a bridge for the city of Index, Washington. It was an alternate design, and wasn't selected to be built, but was a good experience. During an internship with CES Consulting Engineering Services, I was involved in load rating, which is when you check a structure to verify its ability to carry specific loads. I also helped inspect bridges for a county, which is typically done every two years.

What are the most memorable projects you've worked on?

Since I started at WSDOT, I've worked on dozens of bridges. Two memorable bridges are both steel girder bridges over the Snohomish River. The first one launched in 2013 on State Route 522, and the second one is on State Route 9 and will go out to bid later this year. For that project, I designed the upper structure, called the super structure. Similar to the first bridge, rather than use a crane to lower the structural elements, the bridge was designed to be pushed across the river. There are high power lines that we need to avoid and we also want to make it easier for the contractors when building across the river.

I also had the opportunity to design the Keller Ferry landings, which were constructed in 2019. Keller Ferry is the only WSDOT-operated ferry in Eastern Washington, located behind the Grand Coulee Dam and across Franklin D. Roosevelt Lake. The new ferry vessel didn't fit with the existing landings, so we designed new ones and also fixed operational issues. Unlike many ferry landings that are constructed on shore, these are floating structures since the water level fluctuates up to 80 feet. The landings move along the concrete approach ramps as the water level changes, sometimes several feet per day, and the design allows for up to 800 feet of movement. There are two landing locations on the north side — for high and low water. Twice a year, the ferry is used to push the landing to its new location. The design was definitely unique.

What role does research play in your engineering practice at the state level?

We have a research office at WSDOT. As a subject matter expert, I am involved in reviewing findings and working with researchers. Sometimes there are things we need to know more about so we can be more efficient in our design, and we also want to update our practices to match current trends and findings. One research area that has improved vastly over the years is our knowledge in earthquake design. If you look at a structure now

bridges

versus the early 1970s, it will have a much larger foundation. We often partner with universities for research. An example is the research that CEE faculty Dawn Lehman and Charles Roeder conducted on concrete-filled steel tube (CFST) frame systems. When the lateral forces on a foundation exceed the capacity of typical reinforced concrete drilled shafts, CFSTs provide a viable solution. Based off this research, CFSTs were eventually included in the state's bridge design manual. We also have current research projects underway with CEE faculty Marc Eberhard, Jeffrey Berman and John Stanton.

Any advice for women who are interested in leadership roles?

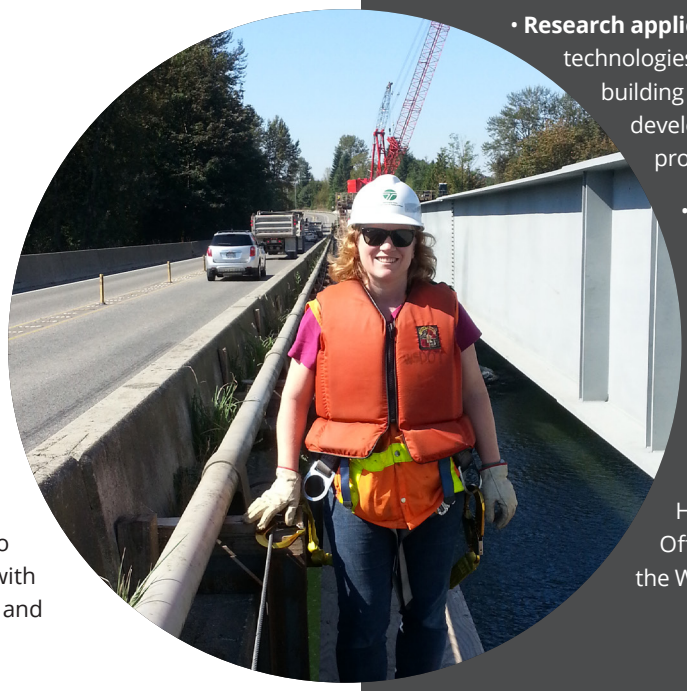
In one of my graduate school structures classes, it was halfway through the quarter before I realized I was the only female in the class. But I'm now seeing an increase in the number of women in the field, including those who are pursuing leadership roles. My advice is not to be intimidated to pursue new things. Whether men or women, we are respected for our knowledge and our ability to share that knowledge with others.

Above: The new Snohomish River Bridge, on the right, was designed by alumna Amy Leland. The new bridge carries westbound traffic. Photo credit: WSDOT

What does a state bridge design engineer do?

At WSDOT's Tumwater office, alumna Amy Leland is responsible for the structural design, and ensuring the safety and efficiency, of all bridges throughout Washington state. This includes structures such as movable bridges, floating bridges and even ferry terminals. Leland oversees a team of 55 engineers and other professionals who conduct the following:

- **Bridge design services:** When planning for new bridges, as well as retrofits and replacements, Leland's team offers bridge design and planning expertise, architecture guidance and troubleshooting for complex structural engineering issues.
- **Construction support:** Construction processes are either managed internally by Leland's team, or the team works with outside consultants to complete projects.
- **Research application:** To incorporate new technologies into bridge design and building methods, Leland's team both develops and reviews new research products and practices.
- **Upholding codes and standards:** To ensure safety standards and support the latest building practices, Leland's team provides direction for updating and implementing codes and policies, including the national American Association of State Highway and Transportation Officials design specifications and the WSDOT Bridge Design Manual.



Women in transportation leadership

In the transportation workforce, which boasts upwards of 15 million people, only 24% are women, according to the U.S. Bureau of Labor Statistics. Of this percentage, even fewer women are in leadership positions.

Insert: Alumna Amy Leland on the Snohomish River Bridge on State Route 522.

THE BRIDGE SPRING / 2023

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BURGES AND EVANS LECTURES

Steve and Sylvia Burges Endowed Lecture
February 2023

CEE Professor Dawn Lehman presented a talk titled "What Happened? Investigating the Champlain Towers South Collapse in Surfside, Florida." In the aftermath of the 2021 tragedy, Lehman provided expert commentary to various news outlets, including the Miami Herald, which received a Pulitzer Prize in Breaking News Reporting. Based on the timeline of the collapse, the building schematics and advanced earthquake simulation models, Lehman details what contributed to the disaster and practices to help prevent similar incidents in the future.

Daniel L. and Irma Evans Endowed Lecture
May 2023

Professor Rafael Bras from the Georgia Institute of Technology presented a talk titled "The Venice Gates: A Short History of a Long, Successful (but Controversial) Project." As a consultant, Bras helped oversee the construction of a multibillion-dollar project to protect Venice, Italy, from floods, which have increased dramatically during the past 100 years. Bras shares insights about the series of gates, considered an engineering marvel, that were constructed across the lagoon of Venice — and how the project's completion was threatened by political, social and management challenges.

Enjoy the Burges and Evans lecture videos at **ce.uw.edu/news/video**