THE BRIDGE

Clearing the air

Professor Tim Larson helps uncover the hazards of aircraft air pollution

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SPRING 2021

CIVIL & ENVIRONMENTAL ENGINEERING
UNIVERSITY *of* WASHINGTON

From research to reality

CEE structures research informs new Mukilteo Ferry Terminal

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MESSAGE FROM THE CHAIR

We marked more than a year of remote operations at the end of the 2020-2021 academic year. I couldn't be more impressed with our faculty and staff, who created a high-quality online educational experience. I'm also proud of our students' resilience in adapting to this unexpected educational paradigm. As we look forward to in-person classes resuming in autumn 2021, faculty are considering how to apply what they've learned during remote teaching, particularly utilizing online educational tools and programs to enhance in-person courses.

Despite the burden of increased safety protocols for lab and field-based research and online research meetings, our faculty and students have continued to thrive and make headway on their research goals. Stories in this issue of *The Bridge* showcase recent research by professor Tim Larson to uncover previously unknown hazards of aircraft pollution as well as associate professor Becca Neumann's work to investigate the human health risks of eating aquatic organisms from arsenic-contaminated urban lakes in Puget Sound.

Important to our mission and values as a department, work also continued throughout the year to advance Justice, Equity, Diversity and Inclusion (JEDI) efforts within CEE; these activities are highlighted in this newsletter. In addition to increasing the number of women's, ADA compliant and gender-neutral restrooms in More Hall and the introduction of several JEDI-focused courses, the department held town hall meetings. These provided an opportunity for faculty, staff and students to discuss JEDI issues within CEE as well as provide accountability for the CEE JEDI Committee and student advisory boards. We look forward to working with professor Karen Thomas-Brown, the College of Engineering's new Associate Dean for Diversity, Equity and Inclusion, to further expand JEDI within the department.

This issue of *The Bridge* highlights contributions and achievements of a number of CEE community members, including alumna Kris Betty (BS '83) whose contributions to advancing construction management of public works projects are recognized with the CEE Distinguished Alumnus Award. We also remember the accomplishments and contributions of Emeritus Professors David Stensel and Richard Bogan, both of whom passed away in 2021.

Laura Lowes
Chair & Professor

New CEE endowed professors

In recognition of their professional accomplishments and contributions to the department and college, the following CEE faculty have received endowed professorships. With durations of three to five years, professorships provide discretionary funding that enables faculty to increase their research impact or expand educational opportunities. Congratulations to the following faculty:

PEDRO ARDUINO
Henry Roy Berg
Endowed Professor

JEFF BAN
William M. and Marilyn M. Conner
Endowed Professor

FAISAL HOSSAIN
John R. Kiely
Endowed Professor

STEVE MUENCH
Tom and Marilyn Draeger and Beavers
Charitable Trust Endowed Professor

MIKE MOTLEY
John R. Kiely Endowed
Associate Professor

JESSICA RAY
Robert O. and Irene V. Sylvester Family
Endowed Assistant Professor

MARI WINKLER
John R. Kiely Endowed
Assistant Professor

BUILDING A FOUNDATION OF

diversity AND equity

The CEE community is taking concrete actions toward creating a more diverse, inclusive and equitable environment. To do so, the work of the Justice, Equity, Diversity and Inclusion (JEDI) Committee has accelerated in recent months, resulting in the implementation of several new initiatives.

"It's important that the culture of the department be welcoming to all people, that's core to our mission," says professor Julian Marshall, who leads the JEDI Committee with associate professor Jessica Kaminsky.

Supporting and encouraging a diverse community is important for the future of engineering, says Marshall, as more diverse engineering teams lead to new ideas and solutions. It's also important for engineers today to consider the impact of their designs on society, he says.

"While it used to be ok to stick to just the equations, there's a broader recognition now that we are here to solve problems in society and we have to be aware of social contexts," Marshall says.

With these overarching goals in mind, and with input from students, faculty and staff, the JEDI Committee has ushered through several initiatives, with more on the way. A few highlights are provided below.

Gathering input

In spring 2020, students petitioned the department for meaningful change, asking for immediate action to "ensure a safe and inclusive educational environment, particularly for Black students, students of color, LGBTQ+ students, students with disabilities and other represented groups."

"The student petition triggered significant change in our department," Kaminsky says. "I hope the students who led it and signed it are proud of the positive impact their activism has had!"

In response to the petition, chair Laura Lowes organized a department-wide listening session in June 2020 to hear from students, staff and faculty. This was followed by town halls in February and May 2021. Throughout the year, students have been able to share thoughts, concerns and suggestions through weekly drop-in sessions with the JEDI Committee and an anonymous feedback form.

Student advisory boards

To ensure that student voices are represented in department matters, including diversity, equity and inclusion efforts, student advisory boards were formed in January 2021. Representatives from both the undergraduate and graduate student classes serve one-year terms, working as liaisons between students and CEE's faculty and administrators.

New courses

In spring quarter, the department introduced new courses that focus on diversity and inclusion topics. A three-credit class, Engineering, Environment and Justice, was taught by Khalid Kadir, an instructor at University of California, Berkeley. A one-credit JEDI Seminar, taught by Marshall, focused on topics at the intersection of JEDI and CEE's six research areas as well as other critical topics such as climate change. A five-credit Grand Challenges Impact Lab course, taught by associate professor Becca Neumann, provided an opportunity for students to design civil infrastructure to meet the needs of Seattle's homeless population. There was a waitlist for all three classes and the department hopes to offer similar courses next autumn to meet student demand.

Faculty and staff trainings

Formal JEDI trainings were offered to faculty and staff throughout the academic year, including a three-part training session in March 2021 and a one-time workshop on inclusive teaching in April 2021. Additional training sessions are anticipated for the 2021-2022 academic year.

Equitable bathrooms

Construction is currently underway to provide more women's and gender-neutral restrooms in More Hall, an older building that houses much of the department. The project is expected to be completed by autumn 2021, when the UW plans to reopen campus.

Stay informed!

The JEDI Committee provides frequent updates at **www.ce.washington.edu/JEDI**

From RESEARCH to REALITY

CEE structures research informs new Mukilteo Ferry Terminal

A bumpy journey turned to smoother sailing after engineers decided to utilize research from CEE's Structural Research Laboratory when designing the wharf for the new Mukilteo Ferry Terminal, which opened to the public in December 2020.

One of the busiest ferry routes in the state, with more than four million riders per year, the Mukilteo Ferry Terminal connects Whidbey Island to the greater Seattle metropolitan area. The aging terminal, built along the shore of Possession Sound, hadn't seen improvements since the 1980s and suffered from operational deficiencies, the inability to accommodate future growth and, perhaps most importantly, failed to meet standards for seismic safety.

"The old site would not have performed very well during a seismic event, with old timber piles not embedded very deeply. There would have been a lot of damage and it would probably not have been repairable," says CEE alumnus Dan Alire (MSCE '02), who led the project for Washington State Ferries (WSF) while employed at KPFF Consulting Engineers.

A challenging building site

The new $187 million ferry terminal is located in close proximity to the Whidbey Island Fault Zone on a site that is highly susceptible to liquefaction and lateral spreading. Liquefaction and lateral spreading occur when the soil beneath a structure loses strength and liquefies, which can trigger lateral ground movement and settlement.

"The liquefied soils are fairly deep, and a non-liquefiable soil layer rests on top," Alire says. "If an earthquake liquefied the deep soil, the non-liquefied crust would push against the wharf and try to drive it into the water with immense force."

Typical wharf construction relies on piles driven into the earth and a horizontal concrete slab structure resting on top, with a connection between the two acting like a hinge. However, the engineers' analysis indicated that during a seismic event this solution would result in excessive movements of up to seven feet, which would impact the overall stability of the structure. The design team explored several other options, but they all presented unique challenges and costs.

After learning about research in CEE's Structural Research Laboratory that sounded promising, Alire reached out to CEE researchers to explore using concrete-filled steel tubes (CFSTs). Although the Washington State Department of Transportation (WSDOT), which oversees WSF, has utilized CFSTs in a handful of construction projects during the past decade, this would be their first time using them for a wharf structure.

A stronger system

As the name implies, CFSTs are steel tubes that are filled with concrete. A type of structural frame system, CFSTs offer considerably higher strength and stiffness when compared to other pile designs that are commonly used in building foundations.

"CFSTs were very suitable for this project," says Professor Emeritus Charles Roeder, who has researched CFSTs together with professor Dawn Lehman for the past 20 years. "They have two to three times the shear strength of a reinforced concrete shaft of the same size."

Although they are widely used in countries throughout Asia and Australia, CFSTs are not often utilized in the United States, says Roeder, which is largely due to issues related to connecting the CFSTs to the rest of the frame system.

Working together with the UW researchers, the Mukilteo Ferry Terminal engineering team developed a system that paired CFSTs with a connection called a fixed pile head, the stiffness of which is around four times greater than other more commonly used connections. The combination resulted in enough strength to control the anticipated movement of the wharf during a seismic event.

"We did some preliminary studies and the results were that the structure went from several feet of movement to about a foot or less," Alire says.

From concept to construction

The process to implement the research entailed taking ownership of the concept and performing due diligence, says Alire. This involved tailoring the research concept to the needs and constraints of the project and working through technical questions with WSDOT's structural engineer, alumnus Geoff Swett (MSCE '98).

"Taking something from research to practice, a translation has to happen. There are steps in between that relate to due diligence, risk, and identifying constructability and how a contractor will build it," Alire says. "The research gave us a great solid start to find a suitable solution that was experimentally substantiated."

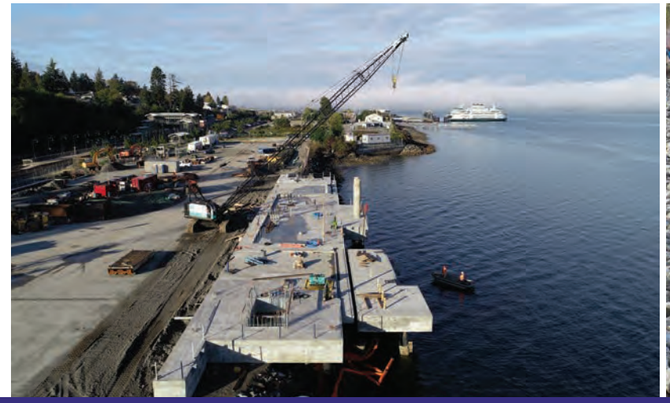


Photo above: The new Mukilteo Ferry Terminal opened in December 2020. Photo right: Crews put the finishing touches on the passenger building foundation, supported by concrete-filled steel tubes. Photo far right: During the first phase of construction, 55 hollow steel piles were installed, which were filled with concrete. The concrete-filled steel tubes serve as a support structure for the terminal, which includes the passenger building and vehicle transfer span. Photos courtesy of Washington State Ferries

CLEARING THE Air

UW researchers, including professor Tim Larson, uncover previously unknown hazards of aircraft pollution

The impacts of air pollution on communities living near airports are no longer up in the air, thanks to breakthrough research that has not only identified the previously unmeasured footprint of aircraft-originating air pollution, but has started to unravel public health concerns and explore mitigation measures.

CEE professor Tim Larson has been involved in all of these efforts, in collaboration with researchers at the UW; University of Southern California; Tufts University and University of California, Los Angeles. In recent years, there has been a flurry of activity after researchers discovered a way to distinguish air pollution originating from aircraft from other sources, such as freeway traffic. This enabled them to map the corresponding footprint of aircraft air pollution.

"A lot of air quality studies were done near airports, but what was not fully appreciated were the impacts further downwind and the ultrafine particle plume that encompassed a larger area," Larson says. "It's clearly an issue of concern for people living near the airport."

The research may have considerable public health impacts, as ultrafine particles are not monitored or regulated by the federal government, although they may negatively affect health more than larger air pollution particles. In the United States, 40 million people live near major airports — and the population tends to be lower income minority groups and people of color.

"There is a lot of ethnic and racial diversity in South King County that overlaps with where the airport is and where the flight paths are," says Environmental & Occupational Health Sciences (EOHS) associate professor Edmund Seto. "Roadway traffic has traditionally been the major source of ultrafine particles that people have been concerned with, but now there's increasing evidence of health effects from aircraft ultrafine particles."

EOHS assistant professor Elena Austin (center) demonstrates air sampling methods to Washington State Representative Tina Orwall (left) and SeaTac Deputy Mayor Peter Kwon during a visit to Highline Public Schools last September. Photo credit: Mark Stone / UW Photography

Studying SeaTac Airport

To investigate the air quality near SeaTac Airport, UW researchers completed a two-year study in 2019. The study identified — for the first time at SeaTac Airport — a distinct type of ultrafine particle pollution associated with aircraft, which was found at elevated levels in surrounding neighborhoods and up to 10 km downwind of the airport.

The study built upon research conducted five years earlier at Los Angeles International Airport (LAX), which found that air pollution particles from aircraft are smaller in size when compared to roadway particles and also contain less black carbon. The SeaTac Airport study also made a few notable advances. Researchers determined the size distribution of the ultrafine particles gathered via fixed locations and mobile monitors. Rather than differentiating small and large particles, they measured everything on the spectrum.

"That turned out to be important, as it allowed us to distinguish with more certainty between the aircraft particles and roadway traffic ultrafine particles," says EOHS assistant professor Elena Austin.

The researchers also found higher concentrations of ultrafine particles located under the landing paths, rather than take-off paths. This is partly due to the landing approach bringing jets relatively close to the ground for around four minutes while take-off lasts less than a minute.

Throughout the study, which was funded by the Washington State Legislature, the researchers collaborated with community groups, state agencies and local legislators.

Safeguarding students

In response to the SeaTac Airport findings, the UW researchers are working on a new study to help protect school-age children, who may be especially vulnerable to poor air quality. They are investigating air quality at five schools near SeaTac Airport to determine if ultrafine air pollution impacts indoor air quality. The UW Healthy Air, Healthy Schools project is being undertaken in partnership with the cities of SeaTac, Burien, Federal Way, Normandy Park and Des Moines.

"Before the recent aircraft studies, there was a lot of interest in how schools can protect children from wildfire smoke, which infiltrates quite readily indoors, but less is known about these smaller particles that come from aircraft," Seto says. "Hopefully what we learn will be generalizable to schools in the region dealing with air quality issues."

The researchers are evaluating two interventions for improving air quality inside schools: portable HEPA air purifiers in classrooms and improvements to existing heating, ventilation and air conditioning systems. The pilot study is expected to be completed by December.

A healthy concern

Researchers are now exploring health impacts on people who reside near airports and are exposed to ultrafine particles from aircraft emissions. A recent study found that women who live near incoming flight paths and downwind of LAX have a higher risk of preterm birth.

Professor Tim Larson

For the study, birth certificates from the California Department of Health were used to identify all mothers who gave birth from 2008 to 2016 while living within 15 km of LAX. The researchers determined in utero exposures using a novel dispersion model developed at the UW that predicted air quality impacts downwind of the airport. The findings revealed that expectant mothers with the greatest levels of exposure were 14% more likely to experience preterm births.

Premature newborns are at risk for a number of health problems — from heart, lung and brain development to vision and hearing impairments, according to separate health studies. Although it is not known exactly how ultrafine particles lead to preterm birth, studies link exposures to inflammation and increased oxidative stress that can damage cells, proteins and DNA.

"Larger particles can get in the airway, but the body can filter them out," Larson says. "The ultrafine particles are small enough that the body's defenses don't recognize them, so they can go through the barriers between the blood and lungs. They can go to all sorts of organs and can even cross over into the placenta."

Prompted by the findings at SeaTac Airport, the Seattle & King County Public Health Department released a study in December 2020, investigating the health of individuals who live near the airport. The study found lower life expectancy and increased risk of various health problems, from stroke to heart disease to respiratory problems.

"It certainly highlights the need for continued research," Austin says. "We don't know whether it's the air pollution or other types of community exposures near SeaTac that may be contributing to these health disparities, but they certainly exist and are quite striking."

What are ultrafine particles?

Communities near airports are exposed to ultrafine particle air pollution, which is not routinely monitored or regulated by the federal government. At less than 0.1 micron in diameter, ultrafine particles are 700 times thinner than the width of a human hair. But some ultrafine particles are even smaller — to differentiate these smaller ultrafine particles, which are between 0.01 to 0.02 microns in diameter, the UW researchers coined a new term, "ultra ultrafine particles."

PacTrans
launches doctoral webinar series

To create a platform for students to present their research to peers, Pacific Northwest Transportation Consortium (PacTrans) launched a new doctoral webinar series this spring. A regional university transportation center that is administered by the U.S. Department of Transportation, PacTrans provides funding to support more than 20 doctoral students at the UW and 48 doctoral students total across five universities in Washington, Idaho, Oregon and Alaska.

"The new webinar series is a vehicle to disseminate and showcase the research done by the students, as well as to encourage exchanges between students within and across the participating universities," says Anne Vernez Moudon, PacTrans' associate director of education and UW Professor Emeritus of Urban Design, who is spearheading the effort. "PacTrans has a strong program of tech transfer to ensure that the work being supported is shared broadly."

The inaugural webinar was presented by Oregon State University doctoral candidate Chen Chen in March. He discussed his research to improve life safety in the Cascadia Subduction Zone by assessing evacuation decisions using a new type of modeling framework.

To oversee and promote upcoming student webinars, a student advisory committee is being established. In addition to students at the consortium universities, Moudon hopes to also feature students at universities who are collaborating on shared research. They plan to organize about six webinars per year, which will be available online at www.depts.washington.edu/pactrans.

Urban Freight Lab's
sustainable last-mile delivery project

In the Belltown neighborhood of Seattle, the Supply Chain Transportation & Logistics' (SCTL) Urban Freight Lab has launched one of the nation's first zero-emissions delivery pilots that focuses on the "last-mile" — when parcels are moved from a transportation hub to a final destination. The project is a collaboration between the City of Seattle and tech and delivery companies including AxleHire, Coaster Cycles, BrightDrop and REEF.

"In partnership with our members, and the City of Seattle, we are excited to help catalyze a transition to zero-emissions last-mile delivery," says SCTL director and CEE professor Anne Goodchild. "We anticipate the pilot will reduce traffic in Belltown, provide access to safe and convenient goods and services, and allow our partners to test novel, zero-emissions delivery solutions."

The pilot project builds on the center's ongoing work to alleviate traffic congestion by addressing the last leg of urban deliveries, when delivery couriers must locate both parking and customers. In addition to reducing congestion, improving urban delivery positively impacts sustainability, livability, business efficiency and consumer demand. The new zero-emissions last-mile delivery approach focuses on transporting goods from a transportation hub to a final destination utilizing new technology and green transportation options. At a staging location, pallets are loaded with packages before being connected to a three-wheeled electric bike. A driver then delivers packages to customers via the most efficient routes available.

By employing innovative technologies and solutions, the pilot project is designed to make the delivery of goods and services more sustainable, which is in alignment with the City of Seattle's new Transportation Electrification Blueprint that includes the goal of transitioning 30% of goods delivery to zero emissions by 2030.

RAPID Center
collects post-wildfire data

The megafires that turned more than 7 million acres of West Coast land into smoldering rubble last summer left behind something valuable for researchers: perishable data.

"There are long-term lingering effects of these wildfires that we don't fully understand — and which can significantly impact affected communities," says CEE professor Joe Wartman, who directs the Natural Hazards Reconnaissance Facility (known as RAPID), which supports data acquisition in the aftermath of natural disasters.

Following the 2020 megafires, RAPID partnered with researchers on the West Coast to gather perishable data at three wildfire sites in Oregon. The most immediate use of the data will be to better understand a type of landslide called post-fire debris-flow, which has resulted in numerous deaths. This hazard results from chemical changes to soil during extreme burning, which can form an organic coating on the soil that repels water, causing rain to run off rather than be absorbed into the ground. Collecting mud and debris, the runoff can be life-threatening as it rushes downhill.

To improve warning systems, researchers are updating the federal government's models for post-fire slope stability hazards. To document the condition of post-fire hillsides in areas likely to experience debris flow, researchers collected high-resolution aerial imagery and lidar data, which will be used to generate 3D images that show detailed topographic information. This will be used to map post-fire sediment and debris loading of channels and to monitor erosion.

TRAC works on transit tech for underserved groups

Mobility applications focus on efficiency and finding the shortest paths, leaving out information critical to people with disabilities, older adults and anybody needing more support. Now, the UW is leading a team working toward a solution. Two UW centers, together with Microsoft, Google, Washington Department of Transportation and other public and private partners, are collaborating on the Transportation Data Equity Initiative.

The U.S. Department of Transportation awarded the project $11.45 million in January as part of a program focused on promoting independent mobility for all. The UW centers involved are the CEE-affiliated Washington State Transportation Center, directed by Mark Hallenbeck, and the Taskar Center for Accessible Technology, part of the Paul G. Allen School of Computer Science & Engineering at the UW.

Three demonstration applications will be built as part of the UW-led initiative, addressing the challenges of underserved populations and showing how the data can be used. The Taskar Center's Multimodal AccessMap app will facilitate A-to-B trip planning for people with mobility limitations. The Soundscape app, developed by Microsoft, will enable spontaneous travel for people who are blind and visually impaired. 3-D Digital Twin, developed by San Francisco video game company Unity Technologies, will be a 3D virtual reality simulation tool that will allow older adults and multilingual travelers to explore, assess and visualize a trip. The applications will be deployed in 2022 in six counties in Washington, Maryland and Oregon.

REMEMBERING

Professor Emeritus David Stensel

With a lifelong passion for returning clean water to the environment through natural biological processes, Professor Emeritus David Stensel was truly a fount of knowledge. Over the years, he made notable research advancements, authored a textbook and was recognized with numerous awards.

"Dave was a generous colleague who freely shared his knowledge and skills, never holding back," says Research Professor Emeritus Stuart Strand. "He was a fine mentor as evidenced by the success of his students in academia and many other doctorate and master's students who have gone on to success in wastewater and remediation engineering."

Stensel passed away in March 2021 at the age of 76. He received his Ph.D. in environmental engineering from Cornell University and joined UW CEE in 1984 after teaching at the University of Utah for four years and working in industry for a decade. He retired in 2016 after 32 years of teaching and conducting research with the department.

As a colleague, Stensel was known as a good friend and research collaborator. He shared grants and lab space with numerous faculty over the years, in addition to sharing his knowledge and expertise.

"I frequently asked Dave to explain how some treatment process actually operated as opposed to the way it was described in textbooks, and he was invariably able to enlighten me," says Professor Emeritus Mark Benjamin. "He did so not just willingly and thoughtfully, but with palpable excitement that came from a place of true love for his profession."

Research highlights

Stensel is most well-known for his work to advance biological nutrient removal processes, which entails using microorganisms to break down organic substances in wastewater without the use of chemicals. Stensel focused on phosphorus recovery as well as the biodegradation of estrogen compounds in wastewater treatment. He worked closely with students designing and executing experiments that often led to breakthroughs.

"That was just like Dave, always reaching out to understand new techniques, to apply them to advance the scientific basis and the cutting edge of environmental engineering," says Strand.

After retirement, Stensel remained involved in research and led a project to develop an innovative new wastewater treatment system with the goal of improving surface water quality at a lower cost than other options, while also saving space and energy. As part of the research, a pilot study was conducted at Seattle's West Point Treatment Plant. During retirement, Stensel was also in demand as a water treatment consultant throughout the country.

Publications and awards

Stensel is the co-author of a textbook on wastewater engineering that is widely used in the classroom and by practicing engineers. Titled "Wastewater Treatment Engineering," the fifth edition was published in 2014. Stensel stood out for having expertise that spanned the latest tools and theories to long-established fundamentals, say colleagues.

"As a result, he was constantly in great demand to contribute chapters to textbooks, serve on advisory committees with practitioners, and collaborate on research projects with colleagues from other institutions," says Benjamin.

Over the years, Stensel received numerous honors, including the ASCE Rudolf Hering Medal, the Water Environment Federation Harrison Prescott Eddy Medal, which he was awarded twice, the Water Environment Federation George Bradley Gascoigne Medal, and the Frederick George Pohland Medal from the American Academy of Environmental Engineers and Scientists.

One of his greatest honors was receiving the Water Environment Federation's 2019 Camp Applied Research Award, the highest award bestowed by the society to a researcher who helped advance the development of wastewater collection or treatment systems.

REMEMBERING

Professor Emeritus Richard Bogan

Mentoring students wasn't something that the late CEE Professor Emeritus Richard Bogan confined to the UW campus. He regularly invited student officers from Associated Students of University of Washington (ASUW) to his home for dinner with his family of seven.

"We had the ASUW officers of the student chapter over to our house once a month, all year long, for dinner," remembers Bogan's wife, Susan. "Richard was passionate about his students; he cared about them and walked the extra mile with them."

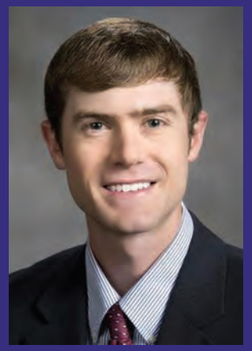
Bogan, who worked as a UW CEE professor for 45 years, passed away in December 2020 at the age of 94. Raised in Seattle, Bogan served in the United States Army Air Corps during World War II. He then earned a bachelor's degree from the UW in 1949, followed by his master's and doctoral degrees in civil and sanitary engineering from Massachusetts Institute of Technology.

Throughout his career, Bogan's teaching and research specialties were water and waste treatment and solid waste disposal. He worked on pioneering programs to address water pollution in the 1950s and was involved in several notable projects locally and nationally, from investigating radioactive waste problems at the Hanford Site in Washington to wastewater handling for vehicles in space.

After retiring in 1995, Bogan enjoyed a variety of activities, from earning his private pilot's license to fishing at his family's vacation home in Montana. He also enjoyed hosting large family gatherings and giving back to the community. Together with his wife, he organized and coached little league baseball at the Montlake Community Center for 12 years.

FACULTY HONORS

Assistant professor Brett Maurer is the recipient of the 2021 United States Universities Council on Geotechnical Education and Research Early Career Researcher Award, which recognizes significant and innovative contributions to the field of geotechnical engineering. The overarching theme of Maurer's research is developing models and software to study soil liquefaction, which can cause major damage during earthquakes.



Assistant professor Jessica Ray was named to a list of 1,000 inspiring Black scientists published by Cell Mentor in December 2020. The list was compiled to honor Black scientists for their efforts in research and teaching, mentorship, advocacy and diversity and inclusion initiatives. Ray's research is focused on designing low-cost composite materials to selectively remove contaminants in stormwater and wastewater.

Assistant professor Michael Gomez is the recipient of a National Science Foundation Faculty Early Career Development Program Award, which supports early career faculty who have the potential to lead notable advances in research and education. The award supports Gomez's research to improve the resilience of civil infrastructure during earthquakes and other natural hazard events by developing stronger soils inspired by nature.

Associate professor Jessica Kaminsky has been awarded the 2021 Daniel W. Halpin Award for Scholarship in Construction, bestowed by the American Society of Civil Engineers. The award recognizes Kaminsky's research, which focuses on creating sustainable living environments and exploring contexts that lead to changes in basic infrastructure. Her goal is to make basic civil infrastructure better serve all the world's people.

FOOD for thought

Contaminated urban lakes pose consumption risk

After analyzing the human health risks of eating aquatic organisms from arsenic-contaminated urban lakes in the Puget Sound lowlands, UW researchers have a menu of concerns. Specifically, they found that consuming certain aquatic organisms in the lakes elevates cancer risk.

"The idea was to focus on organisms that people might eat, so we studied snails, crayfish and sunfish," says CEE associate professor Becca Neumann. "What we are seeing is elevated levels of arsenic in them."

Four small public access lakes with varying levels of arsenic contamination and depth were selected for the study: shallow lakes Bonney Lake, Steel Lake and Lake Killarney, and Angle Lake, which is deeper than the others. All are located downwind of the former Tacoma-area ASARCO copper smelter, which pumped waste byproducts that contained arsenic and lead into the air for 96 years before ceasing operation in 1985.

Overall, the researchers found the shallow lakes had proportionately more arsenic in the sediments near the shore when compared to the deeper lake and that near-shore sediment and shallow water arsenic concentrations controlled the amount of arsenic in tissues of the snails, crayfish and sunfish. Lake Killarney, a shallow lake with the highest concentrations of arsenic in near-shore sediments, posed the greatest human health risk. The study builds on research conducted two years ago, when the researchers discovered that the water of some shallow lakes contains surprising levels of arsenic, due to unique characteristics that facilitate the movement of arsenic from lakebed sediment up into the surface waters and near-shore areas where the aquatic food web resides.

Although it's currently unknown how many people may be eating from the lakes, the researchers speculate that some populations may be fishing for subsistence reasons rather than sport. Many states, including Washington, don't require a permit to harvest snails.

"The population we see out there fishing on a regular basis is more diverse than the nearby homeowner population," says Jim Gawel, associate professor of Environmental Chemistry and Engineering at UW Tacoma. "There are fishermen who come out when they stock trout in the lakes, but there's also a population that fishes throughout the year."

Supported by UW's Superfund Research program, the research team includes scientists from UW Civil & Environmental Engineering, UW School of Aquatic & Fishery Sciences, UW Tacoma Environmental Sciences, and Dartmouth College Department of Earth Sciences.

Photos clockwise from top: Using a fishing net, UW Tacoma Environmental Sciences undergraduate student Ken Burkart (left) and UW Tacoma research technologist Marco Barajas (right) catch sunfish at Angle Lake.

Associate professor Rebecca Neumann (right) and Marco Barajas (center) set out crayfish traps.

A close-up of a crayfish trap being set in Lake Killarney.

Photos by Julian Olden, Dennis Wise and Olivia Hagen/ University of Washington

Arsenic exposure and cancer risk

Arsenic enters the aquatic food chain primarily through diet. This occurs when plankton ingest arsenic, mistakenly thinking it is a nutrient, before being consumed by other organisms. Arsenic diminishes in organisms as it moves up the food chain; however, this means that eating lower on the food chain is especially problematic.

"Snails have a lot of arsenic in them, as they are crawling on the surface of the lakebed and are grazers," Neumann says. "With snails, we found that in all of the contaminated lakes there was increased cancer risk."

Snails on average contained the most arsenic of the three species investigated. Concentrations of arsenic in snails and crayfish from Lake Killarney were higher than all other lakes in the study. Arsenic concentrations in fish were also highest in Lake Killarney, followed by Steel Lake. The researchers calculated that consuming aquatic organisms from Lake Killarney resulted in four to ten times greater health risk compared to organisms from the deeper Angle Lake, which has similar arsenic concentrations in sediments from the deepest part of the lake.

According to the researchers, cancer risk is determined by the aquatic organisms' concentration of inorganic arsenic, which is highly toxic compared to organic arsenic, and the quantity of organisms consumed by people. Based on their findings and Washington State Department of Health (DOH) guidelines, the researchers advise no consumption of snails or crayfish from the arsenic-contaminated lakes in this study (Steel, Killarney, and Angle lakes) and no more than one meal per month of sunfish from Lake Killarney.

Next steps

The researchers are in the early stages of working with the DOH to explore issuing a fish consumption advisory for the lakes.

"The risk is there, but the question is how many people are at risk?" Gawel says.

If additional funding is approved, the researchers plan to survey lake users about their food consumption. They also hope to create a screening tool to quickly determine if lakes have concerning levels of arsenic in the food web, explore remediation technologies to remove arsenic from lakebeds, and investigate the impact of arsenic on aquatic organisms.

Community collaborators

Community partners include Washington State Department of Ecology, Washington State Department of Fish & Wildlife, Environmental Protection Agency Region 10, Public Health Seattle/King County, King County Environmental Programs, City of Federal Way, Lake Killarney Improvement Association, Steel Lake Management District Advisory Committee and Angle Lake Shore Club.

Over the moon

Alumni win NASA contest to design better space toilet

It's an out-of-this-world accomplishment: Two CEE alumni took first place in a NASA contest to design a better toilet for astronauts to use on the moon.

With an innovative, yet straightforward design that also makes space toilets more accessible for women astronauts, alumni Byron "Boone" Davidson (BSCE '11) and Kunal Vaswani (BSCE '11) competed against more than 2,000 teams in NASA's Lunar Loo Challenge. The contest crowdsourced designs for compact toilets that operate in lunar gravity, which is about one-sixth of the gravity on Earth.

"Being a fan of space, it was easy for me to get hooked on this project. I was working on something that could end up on the moon — that was mind blowing," says Davidson, whose fascination with space dates back to his childhood when he attended the launch of the space shuttle Endeavour in 1993.

Upon learning about the contest, Davidson quickly assembled a team and also contacted someone with experience using space plumbing: retired Air Force Lieutenant General Susan Helms, the first U.S. military woman in space, who was aboard the 1993 Endeavour.

"When the Lunar Loo contest came around, I saw it as a good excuse to reach out to her and ask if she'd be interested in helping us out," says Davidson, whose uncle is a friend of Helms.

Expert advice

Interviewing a former astronaut was more insightful than the team could have imagined. Helms shared her struggles using toilets on various space shuttles, as well as the International Space Station, and explained that space toilets have historically been designed for men.

Since space toilets separate solid waste from liquid waste, a suction hose with different attachments for women and men is employed for liquid waste. This poses one of the biggest challenges for women when using a space toilet, Helms shared, since it's not possible for women to complete both bodily functions at once, due to their anatomy.

Other notable problems, Helms said, were inconsistent vacuum suction, which didn't fully keep waste away from the posterior, and difficulty aiming into the toilet. Space toilets have a 4-inch diameter, in comparison to about 10 inches for standard toilets.

"She said aiming is an on-the-job learning curve. There is even a mock space toilet at the training facility for astronauts to try before they have to use a toilet in space," says Davidson, who is employed by MacKay Sposito, an energy, public works and land development company.

Dynamic design

Although the four-member team didn't have any previous experience designing toilets, they completed their design in fewer than two months.

"Our goal, to paraphrase the Navy's KISS principle, was to Keep It Simple, Silly. We developed a straightforward design that adapted existing, proven products in a clear, logical way that is easily serviceable and avoids the pitfalls of the current space toilets," says Vaswani, who is employed at Magnusson Klemencic Associates.

The first challenge the team addressed was replacing suction, which has historically been used to pull waste into space toilets in the absence of gravity. As an alternative, the team decided to try pushing the waste down from the top of the toilet. To do so, they utilized one of the most powerful fans on the market, the bladeless Dyson Ring Fan, which they placed directly below the toilet seat and positioned to blow downward.

To make the toilet easier for women to use, the team's design allows liquid and solid waste to be collected in the same chamber. The design also makes aiming easier with a larger seat, which is crafted from memory foam to create a better seal.

Another signature element of the team's design was a new approach to waste collection. Modeled after the Diaper Genie, which seals babies' diapers separately upon disposal, waste from the space toilet can be sealed automatically between uses.

Ready to launch

NASA engineers are now taking the top winning designs into consideration as they develop a space toilet that will be utilized specifically for NASA's Artemis program, which intends to land the first woman and next man on the moon in 2024.

"I do hope I can say something I put my fingerprint on made it to the moon!" Davidson says.

Byron "Boone" Davidson

Kunal Vaswani

Second annual CEE Distinguished Alumnus Award

Alumna Kris Betty (BS '83) dedicated her career to the advancement of public works in the region. To do so, she not only built large infrastructure projects — she also built trust.

In recognition of Betty's work to improve the civil engineering field by increasing public agencies' confidence in the construction management process, she is the recipient of the second annual CEE Distinguished Alumnus Award. Founded by CEE chair Laura Lowes, the award acknowledges the achievements of alumni in industry and highlights how civil and environmental engineering degrees create meaningful impact.

"Early on in my career, there was a fundamental lack of trust and mismanagement between project owners and contractors, so there was an opportunity to bring professionalism, attention to detail and accountability to how designs get constructed," says Betty.

Having identified a need that wasn't currently addressed in the profession, and which she felt passionate about, Betty founded KBA, Inc. in 1994. Based in Bellevue, Washington, the engineering firm specializes in construction management services for large-scale transportation, water and wastewater, port facility and land development projects.

"Making sure that project owners receive a good product and good value with taxpayer dollars is really important," says Betty, who retired from KBA in 2019. "The way that taxpayer money is deployed and handled must comply with the community commitments that have been made."

Over the years, Betty grew the company from one person to more than 100 employees and oversaw the management of multi-million dollar construction projects for local and regional entities including the Washington State Department of Transportation, Sound Transit, King County, King County Housing Authority and City of Seattle. Enhancing trust and productivity between public agencies, construction managers and contractors, Betty says, relied on a new approach.

"It's deeper than communication, it's the ability to spot potential problems and diligently pursue resolution," Betty says. "Conflicting priorities often arise during the construction phase of a project, resulting in cost, schedule, technical or compliance issues. My team helped owners, contractors and designers reach a consensus on appropriate solutions."

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Laura Lowes, *Professor & Chair*
CONTENT: Brooke Fisher
ce.uw.edu
TEL 206.543.2390 FAX 206.543.1543

CIVIL & ENVIRONMENTAL ENGINEERING
UNIVERSITY of WASHINGTON

More Hall, Box 352700, Seattle, WA 98195-2700

Send address corrections, questions and comments by email to comments@ce.washington.edu or to the return address above.

RESEARCH RECAP

People of color hardest hit by air pollution

A new study models peoples' exposure to air pollution and shows that exposure disparities among people of color and white people are driven by nearly all emission source types, rather than just a few. A team of researchers, including CEE professor Julian Marshall, have found that white people are exposed to lower-than-average concentrations from emissions source types that, when combined, cause 60% of their total exposure. Conversely, people of color experience greater-than-average exposures from source types that, when combined, cause 75% of their total exposure.

Genetically engineered grass cleanses toxic soil

Large swaths of U.S. military land are covered with munitions components, including the explosive chemical RDX that doesn't naturally break down and can contaminate groundwater. Designated as a priority pollutant by the Environmental Protection Agency, RDX is toxic and can cause cancer. Now, a team of researchers, including CEE Research Professor Emeritus Stuart Strand, has genetically engineered switchgrass to remove RDX from soil. This is the first time researchers have used a genetically engineered plant in the field to remove pollutants that are resistant to degradation.