THE BRIDGE

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Saving the salmon

CEE researchers answer a decades-old question:
What causes the death of coho salmon in urban streams?

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FALL 2020

CIVIL & ENVIRONMENTAL ENGINEERING
UNIVERSITY *of* WASHINGTON

An extraordinary expedition

CEE alumna Madison Smith joins the largest polar expedition in history.

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MESSAGE FROM THE CHAIR

This fall, the CEE community continues to not only embrace the present, including remote learning and research, but is also actively advancing efforts to build an even better CEE department. Initiatives are underway that aim to create a welcoming environment for a diverse community of students, staff and faculty; to expand the CEE curriculum to incorporate new engineering design and analysis methods as well as social justice and equity considerations; and to improve learning facilities for all students.

In light of current events, the department's Diversity, Equity, Inclusion and Culture (DEIC) committee, established in 2018, has accelerated its work in recent months. The committee is working to introduce changes throughout the department that will encourage and support a more diverse engineering community. Its focus is on three areas of growth: department culture, curricula and self-education. A few highlights include working to include DEIC-related questions in teaching evaluations, a new DEIC-focused course, and adding DEIC content to core CEE classes. I encourage you to check out the committee's important work at ce.uw.edu/diversity. A separate, but related, effort to increase diversity in STEM fields is highlighted in this newsletter — professor Faisal Hossain recently published two children's books that aim to encourage and inspire children from diverse backgrounds to consider careers in the sciences.

As we envision the future, an endeavor is underway both at the college and department levels to provide enhanced learning space for CEE students. At the college level, work is in progress to create an "engineering central" called the Interdisciplinary Engineering Building, which will serve as a hub for all engineering students and provide additional learning space for CEE students. Planning is also simultaneously in progress to modernize More Hall, an aging building that is tight on space and long overdue for upgrades. The success of both initiatives, which are highlighted in this newsletter, relies on private support from donors. We thank those of you who have already made gifts to support these efforts and look forward to shaping the future with even more alumni and friends.

Laura Lowes, Chair & William M. and Marilyn M. Conner Professor

During these unprecedented times, I continue to admire the adaptability of our CEE community. This edition of *The Bridge* features several innovative projects, including assistant professor Mari Winkler's work to detect COVID-19 in the wastestream and associate professor Edward Kolodziej's identification of a previously unknown chemical that causes death in stormwater-exposed coho salmon.

This issue of *The Bridge* showcases the creativity and innovative spirit of the CEE community. It also demonstrates our dedication to not only advancing the science and technology of civil engineering, but to educating a diverse community of engineers who will be prepared to create more sustainable and resilient civil infrastructure and protect the health of our environment, for the benefit of all. Assistant professor Nirni Kumar, who passed away last summer, exemplified all that is good in the CEE community. We remember him as a creative and innovative researcher, a dedicated teacher and mentor, and a treasured colleague and friend. He is greatly missed.

Laura Lowes
Chair & William M. and Marilyn M. Conner Professor

Faculty honors

Professor Faisal Hossain received the prestigious 2020 American Geophysical Union International Award for his role in improving access to water resource information in the developing world. Using satellite and weather model data, Hossain has introduced irrigation advisory and flood forecasting systems in several countries.

Assistant professor Paolo Calvi was one of eight recipients of an International Association for Bridge and Structural Engineering 2020 Outstanding Paper Award. In collaboration with researchers in Italy, Calvi co-authored a paper that details the collapse of a portion of the Morandi Bridge, which killed more than 40 people in 2018.

Professor Joe Wartman and graduate student Will Pollock received a silver EXCEL Award from Association Media & Publishing for a magazine article they co-wrote on geologic hazard risks to Syrian and other refugees. Their article was titled "No Place to Flee" and was published in the American Geophysical Union's journal *Eos* in November 2019.

Assistant professor Jessica Ray was one of Chemical & Engineering News's "Talented 12" honorees for 2020 for her work to use chemistry to help solve water shortages. Ray envisions a circular approach to the wastewater lifecycle that entails both resource recovery and recycling of water.

Professor Julian Marshall and former research scientist Christopher Tessum's research on the ethnic disparities in exposure to air pollution was featured in an NPR article, which was selected as one of the "Top 10 stories of 2019" by Proceedings of the National Academy of Sciences. The researchers found that Black and Hispanic Americans bear a disproportionate burden from air pollution.

DEPARTMENT NEWS

REMEMBERING
Nirnimesh Kumar

Mentor, friend and colleague — assistant professor Nirnimesh ("Nirni") Kumar excelled at all of these roles in addition to his full-time position as a teacher and researcher. The CEE community mourns the loss of Kumar, a valued colleague who passed away in August 2020.

Described as a "rising star in the field" by his colleagues, Kumar made substantial contributions to the field of physical oceanography in a short amount of time. His legacy includes developing models that are already being used by coastal scientists to better understand the region of the ocean near the shoreline.

"I can honestly say that I haven't met anyone who'd been so productive and made such a large impact on the field at such an early stage in their career," says CEE professor Alex Horner-Devine.

A legacy of research

A coastal physical oceanographer, Kumar joined the CEE faculty in fall 2016. A member of the department's hydrology and hydrodynamics research group, he worked closely with fluid mechanics researchers across campus.

"Nirni was at the very center of our research group. He filled it with energy and enthusiasm," says CEE professor Jim Thomson.

In his research, Kumar developed public-domain models that advanced the understanding of how water circulates in the region near the shoreline, and the nature of sediment transport. His contributions to the Coupled Ocean-Atmosphere-Wave-Sediment Transport modeling system transformed the way that wave-current interactions are modeled by coastal scientists and engineers.

"The technical advances Nirni made in numerical modeling of coastal hydrodynamics, along with his scientific results and ideas, have set the course for years of exciting new research," says UW Applied Physics Lab research scientist Melissa Moulton.

In addition to numerical modeling, Kumar also enjoyed hands-on work in the field and lab. In November 2019, he spent a month aboard a research vessel traveling along the northern coast of Alaska to investigate how the interactions of waves, sea ice and the ocean contribute to the eroding Arctic coastline.

"The sense of camaraderie in working with Nirni was palpable. Our collaborations were set up for him to run computer models and me to collect field data, but these separate roles were silly — he was right there in the field helping with everything," says Thomson, who worked with Kumar aboard the vessel.

A mentor to many

Kumar was especially generous with his time, encouragement and support. Faculty say that his mentorship was not limited to students — they all learned from him.

"While he had high expectations, Nirni communicated with a generosity, sincerity and humor that inspired rather than intimidated," says Horner-Devine.

Students had a special connection with Kumar, who made them feel heard and valued, say colleagues. Many graduate students in the Environmental Fluid Mechanics research group were co-advised by Kumar, worked with him as teaching assistants, or collaborated with him on papers.

Nirni is greatly missed by CEE faculty, staff and students.

For more information, visit ce.uw.edu/nirni

Below: Assistant professor Nirni Kumar (third from left) during a month-long research trip along the coast of Alaska. Photo credit: John Guillote

an EXTRAORDINARY expedition

Alumna Madison Smith advances climate change research as part of the largest polar expedition in history.

Not many people can say they've had Arctic sea ice as their backyard for an extended period of time. But CEE alumna and UW Applied Physics Lab postdoc Madison Smith (Ph.D. '19) can describe the experience.

"I've been to the Arctic before, but something unique during this experience was getting to stay on the same ice and seeing the daily changes, similar to how you might see your backyard or neighborhood park," says Smith, who returned to Seattle in late August after four months overseas. "Seeing the changes over the seasons was a special experience."

For nearly three months, Smith conducted research aboard the German icebreaker Polarstern as part of the MOSAiC expedition, the largest polar expedition in history. Led by the Alfred Wegener Institute's Helmholtz Centre for Polar and Marine Research, the year-long expedition started in September 2019 when the Polarstern set sail from Tromsø, Norway. The vessel returned to shore on October 12, 2020.

By design, the ship was intentionally trapped in sea ice in the Central Arctic for most of the expedition, becoming a drifting research platform from which researchers set-up a complex network of measuring stations on the surrounding ice. The international collaboration involved more than 300 scientists from 20 countries who shared the same goal: to advance climate change research.

As a postdoctoral researcher in UW's Applied Physics Laboratory, Smith became involved in the expedition through her work with principal physicist Bonnie Light. MOSAiC comprised numerous independently funded research projects, for which researchers received endorsement for space on the ship.

"People have talked about MOSAiC for years, and I was interested in being part of it," Smith says. "I ended up being the primary representative for our project during the summer. It was a lot more responsibility, but I learned so many things."

On board the Polarstern

Joining the fourth leg of the expedition, Smith arrived aboard the Polarstern in June after completing a mandatory two-week quarantine in Germany. Designed as a research vessel, the ship housed a variety of labs, a lecture room and other scientific workspaces.

"The ship was like a little city, with 100 people on board," Smith says. "The evenings were busy with packing up gear for the next day, downloading data and having meetings about what we wanted to do — it was a very busy couple of months."

Once on board, the incoming researchers trained with scientists from the previous leg of the expedition to get up-to-speed on data gathering procedures. Collecting continuous datasets to monitor seasonal changes throughout the year-long expedition was an important component of the overall research mission.

Ice team research

A member of the sea ice team, Smith collaborated with 13 other scientists to collect measurements for continuous datasets and also gathered data for her own research. The majority of each day was spent on the large pack of floating ice adjacent to the ship, where researchers took various measurements.

For her sea ice research, Smith studied how sunlight is reflected, transmitted and absorbed by the melting ice cover and surrounding ocean. With ice becoming thinner, increased absorption of sunlight may be a substantial contributor to the warming of the ocean.

"The white ice stays much cooler and the water is getting warmer, so we are trying to understand how this varies," Smith says.

To determine how much heat was absorbed in the open water around the ice, Smith took regular temperature measurements and monitored contributing factors, such as the salinity of the ocean. She also measured the albedo, which indicates how much sunlight is being reflected by the ice.

One surprising finding was that the sea ice around the ship contained a considerable amount of sediment, which accumulates on top of the ice during the warmer summer months as the ice melts away. The sediment could play a role in how much sunlight is reflect or absorbed by the ice.

"It was interesting to see how the ice had dirt and rocks on top and how the albedo was different," Smith says. "That will be something really meaningful to contribute to our understanding of the Arctic. It may play a relatively significant role in how sea ice melt plays out and might change some of our predictions for Arctic sea ice in certain areas."

Improving climate predictions

Back in Seattle, Smith has resumed her post-doctoral research, which entails analyzing data from the expedition. In addition to monthly meetings with the larger MOSAiC team to discuss data processing and pertinent findings, Smith continues to work closely with the sea ice team. She will also be collaborating with the National Center for Atmospheric Research in Boulder, Colorado, to utilize the data to improve climate models for enhanced long-term predictions in the Arctic.

"We will put together stories of what we think is interesting and hopefully will have impacts for the Arctic science community," Smith says. "To be part of such a large, collaborative, interdisciplinary expedition was unlike anything I've ever done."

Photo opposite: Members of the expedition take turns on "bear-guard" duty to keep watch for polar bears while scientists work on the ice. Here, CEE alumna Madison Smith is acting as bear-guard at the site of stakes used to measure the rate of melt at the top and bottom of the ice. Photo credit: Lianna Nixon

Saving the salmon

A CEE-led research team answers a decades-old question: What causes the death of coho salmon in urban streams?

Just as salmon swim against the current, a team of researchers faced a difficult journey on their quest to answer a decades-old problem: What causes the death of coho salmon that are exposed to stormwater runoff?

After five years, the UW-led research team has successfully traced the previously unexplained coho salmon mortality to a formerly unknown chemical that is a byproduct of an industrial chemical widely used to preserve rubber tires— of which three billion are produced annually around the world.

"Just like food needs preservatives so it doesn't spoil, this chemical is put in tires so ground-level ozone doesn't degrade them," says lead researcher Edward Kolodziej, an associate professor in CEE and the UW Tacoma Division of Sciences & Mathematics. "The tires wouldn't last as long if the preservative chemical wasn't there."

The researchers published their findings in the journal *Science* in December 2020. The interdisciplinary research effort extended across Washington state and Canada, with collaborators from the University of Washington Tacoma and Seattle campuses, the Center for Urban Waters at UW Tacoma, Washington State University (WSU) Puyallup, the University of Toronto, the San Francisco Estuary Institute and the Southern California Coastal Water Research Project. Also assisting in the effort were CEE associate professor Michael Dodd and CEE graduate students Haoqi Zhao, Ximin Hu and Huan He.

"We are dealing with an acute toxicant here, something that is lethal in the water and kills large fish quickly," says Kolodziej. "What we found applies to every busy road in the world as far as we know."

Photo above: Near the UW campus, CEE associate professor Ed Kolodziej, left, collects samples from an engineered water treatment system in Thornton Creek with researcher Zhenyu Tian. The researchers are monitoring the water quality of the creek following restoration efforts to provide more habitat for salmon. Photo credit: Mark Stone/University of Washington

A puzzling problem

For more than 20 years, researchers throughout Puget Sound have been perplexed by the unexplained death of adult coho salmon, which occurs in urban streams when the fish return to spawn.

"Everyone was telling me about stormwater and how coho died and they didn't know why," says Kolodziej, who joined CEE in 2014 as part of the UW Freshwater Science Initiative. "This seemed like the perfect type of problem to apply our technical expertise to."

The phenomenon often occurs after heavy rainfall, when runoff from roadways heads into waterways, transporting toxic substances and chemicals from fertilizers and pesticides to antifreeze and heavy metals from cars. The stormwater is so toxic that coho salmon often die within a few hours. In urban watersheds located in close proximity to roadways, studies show that more than 90% of salmon may die before spawning.

It's not yet known how widespread the problem may be. Although coho salmon are found throughout the North Pacific Ocean and are abundant in coastal areas from Alaska to California, the majority of current data and observations are from Washington state. In preliminary testing of stormwater samples from urban areas in California, the toxicant was also identified at lethal concentrations.

Narrowing 2,000 chemicals to one

Based on previous studies, the researchers suspected the toxicant was related to tire and road wear particles, which were consistently found in water samples from urban streams with a history of coho salmon mortality.

Although identifying a single chemical toxicant may sound like a straightforward task, tire and road wear runoff contains more than 2,000 chemicals. Starting with this "toxic chemical soup," the researchers used a process called fractionation to separate the complex mixture into increasingly smaller parts based on differences in chemical properties. Once they identified a reasonable number of suspected toxicants, they exposed fish to the chemicals, but they failed to induce mortality.

The researchers continued to use fractionation until they identified a single unknown compound, which appeared as a small pink-red crystal. Because they were unable to trace the compound back to any known chemicals, the researchers began to consider that it may be a chemical byproduct.

They eventually linked the unknown chemical to an industrial chemical, 6PPD, which is widely used as an antioxidant to preserve rubber tires. The toxicant is produced when 6PPD reacts with atmospheric ozone, a ground-level gas created by photochemical reactions involving pollutants such as vehicle exhaust and gasoline vapors. It is during the reaction of ozone with 6PPD that 6PPD-quinone is produced, which is toxic to coho salmon.

"It was a pretty hard task, so I won't say there was just one breakthrough," says Zhenyu Tian, a research scientist at the Center for Urban Waters at UW Tacoma. "This chemical is a transformation product more dangerous than the parent compound."

Confirming the identity

The researchers' next step was to confirm the identity of the unknown compound. Typically, this is achieved using a commercial standard.

"But that commercial standard didn't exist in this case," says CEE associate professor Michael Dodd. "So, we worked with Ed's group to generate a standard that helped to confirm the identity of the toxicant compound."

The synthetic standard served two functions. It was sent, together with the pure isolate, to the University of Toronto, where researchers confirmed the chemical structures matched. The synthetic standard was also used to evaluate fish toxicity in laboratory tests led by assistant professor Jen McIntyre from WSU Puyallup. During a fish exposure in February 2020, both the synthetic standard and naturally occurring toxicant induced mortality in coho salmon in fewer than five hours.

"By comparing the mortalities in the fish toxicity tests, it was confirmed that the lab derived standard elicited the same response as the toxicant isolated from tire particle leachate," Dodd says. "This was an important part of confirming the identity of the toxicant compound."

Protecting coho salmon

The researchers speculate that relying only on current stormwater treatment methods to keep 6PPD-quinone out of urban waterways will be difficult due to the vast quantity of stormwater. Rather, they suggest source control as a probable long-term solution and have initiated contact with tire companies and regulatory agencies.

"Tires need antioxidants to make them last and make them stronger. It's just a question of which chemicals should be used and carefully evaluating their safety for humans and aquatic organisms," Kolodziej says. "Chemists have many tools to figure out a safer alternative."

The researchers continue to investigate the toxicant to answer questions such as how fast the compound forms at various ozone levels and the concentration required for toxicity.

"This is the first thing I've worked on in my career where I'm not sure where the story ends," Kolodziej says. "It has been intellectually interesting — I'm waking up at night wondering how many species it impacts."

After 37 years at the UW, VICE DEAN GREG MILLER RETIRES

Civil engineers are good at building things. A hallmark of vice dean and professor Greg Miller's career is building non-tangible things — such as collaborative relationships across the College of Engineering (COE).

"The best thing about being in the Dean's Office and the vice dean role was getting to see that big picture perspective and making connections and bringing people together," Miller says. "It was possible to help make the whole greater than the sum of its parts."

Effective September 1, Miller retired after 37 years in the College. During his tenure, he spent 13 years in leadership positions, serving as interim dean, vice dean, associate dean and CEE department chair.

"I realized early on how fortunate I was to get this position and have never taken it for granted," Miller says. "I started here at age 25; I've been at this a long time, and I've seen many changes, most notably the broadening of participation in engineering, which needs to continue."

Intro to engineering

Calling his career trajectory the "path of least resistance," Miller first learned about engineering from his father and brother, both of whom were engineers.

After graduating with his BSCE from the UW in 1980, Miller went on to earn his master's and Ph.D. degrees from Northwestern University in Illinois. During his graduate studies, he got his first teaching experience.

"My adviser at the time had some health issues, so I took over his classes and got to teach," Miller says. "I really, really liked it and got some good feedback, and that definitely influenced my interest in seeking a faculty position."

Returning to the UW

At the end of 1983, Miller returned to the UW as a faculty member, joining CEE.

"I had the uncommon experience of being an undergraduate at the UW and, a few years later, my former professors were colleagues," Miller says. "Later, through a strange twist of fate, I was in a leadership role. In each of those roles, I felt supported, which is again a testament to these people and the institution."

Throughout his career, Miller's research and teaching focused on the areas of applied mechanics and computational methods, with applications for structures, geotechnical systems and transportation infrastructure. Together with graduate students, he founded a start-up called Dr. Software, developing software used to teach structural analysis in educational contexts.

"For any of us who've ended up at a university with a faculty position, it's truly a privilege to get to work with students at all levels in the enterprise of learning," Miller says.

Legacy of leadership

Since 2007, Miller has served in a number of leadership positions. In between two roles in the COE Dean's Office, Miller served as chair of UW CEE for eight years.

"It was very helpful to be in the Dean's Office prior to becoming chair, to get that perspective," Miller says. "And then coming back to the Dean's Office, after having been a department chair, I knew what departments deal with and manage."

Miller's first role in the Dean's Office was associate dean of infrastructure and computing. He most recently served as vice dean of research and faculty affairs, where he and his team worked to promote and support research programs, seed college initiatives and assist faculty with research and funding proposals. Following Dean Mike Bragg's retirement in 2019, Miller also served as interim dean.

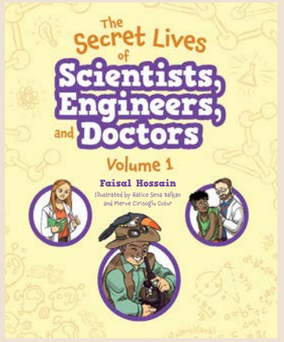
"The things I feel best about in my leadership roles have been the things few people knew I was involved in, and what's been possible working behind the scenes," Miller says. "Broadly speaking, it's having had a role in helping lots of different people move toward their goals."

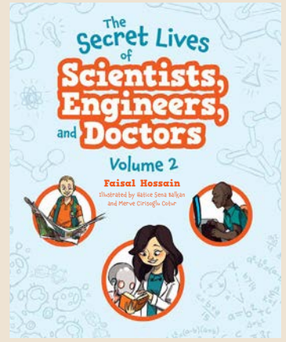
Retirement plan

And as for how Miller will be spending his time during retirement, he has many interests both technical and non-technical, the latter of which includes learning new musical instruments, athletics and sailing with his wife on an unexpectedly acquired older sailboat.

"It's strange to end your career by vanishing from Zoom screens," Miller says about retiring during the pandemic. "There are so many offices I need to walk into to express my appreciation. That will be a high priority for me when we can finally go back to campus."

CHILDREN'S BOOKS aim to increase diversity in STEM





To encourage a more diverse community of engineers, scientists and doctors, CEE professor Faisal Hossain is leveraging the power of storytelling to inspire children, especially those from underrepresented and diverse backgrounds, to pursue careers in the sciences. A recently published two-volume children's book series, *The Secret Lives of Scientists, Engineers and Doctors*, is geared toward elementary school students from second-to-fifth grade.

"In my lifelong passion for science communication, I toyed with the idea of using fun cartoon illustrations to describe inspirational and hopeful stories about extraordinary scientists, engineers and doctors. By highlighting a personal story of struggle, a moment, or a journey, my hope was that our children will understand that they, too, can become successful professionals in science, medicine, engineering and other allied disciplines," says Hossain.

For the past two years, Hossain has worked on the undertaking as part of a team of 18 engineers, scientists and doctors across the nation selected by the National Academies of Science, Engineering and Medicine to lead the initiative. The members initially started sharing their own stories about what led them to pursue a career in the sciences before collecting content for the picture books through a nation-wide solicitation. The team selected 22 short stories that were inspirational, highlighted overcoming adversity and appealed to children from diverse backgrounds.

The books may just be hitting the shelves, but Hossain already has ideas for future volume topics, from virus hunters to public health experts to a volume that focuses on civil engineers. The production of the books was sponsored by a generous contribution from the Gordon and Betty Moore Foundation.

Available to order online

Proceeds from the sale of the books will help fund future volumes on science-related themes. Ordering details: ce.uw.edu/news/childrensbooks

TRAVIS THONSTAD joins CEE faculty

For the past four years, Travis Thonstad worked for an organization with a mission focused on advancing innovation. Clearly, he'll fit right in at the UW.

"I am looking forward to working with industry and state and local agencies to contribute to the types of innovative solutions that our region is known for," says Thonstad, who joined CEE as an assistant professor in September.

Based outside of Washington, D.C., Thonstad worked as a research structural engineer at the National Institute of Standards and Technology (NIST), an agency of the U.S. Department of Commerce that promotes innovation and advancements in science. While at NIST, he worked on a variety of research that included developing robust structural systems.

"I was deployed in the field to perform a preliminary investigation on the impacts of Hurricane Harvey on the Houston area, and initiated several exploratory research projects that investigated the use of innovative materials to improve the resilience of reinforced concrete structures," Thonstad says.

Thonstad's work at NIST builds on his research interests that include developing novel structural systems, improving the resilience and robustness of bridges and buildings, and assessing the performance of aging infrastructure.

"The vision for this research is to develop and validate technologies for resilient, rapidly constructible, and robust structural systems that can meet the current and future needs of society," Thonstad says.

While on the East Coast, Thonstad also taught prestressed concrete courses as an adjunct professor at the Catholic University of America in Washington, D.C. Originally from Portland, Oregon, Thonstad completed his education throughout the Pacific Northwest, attending the University of Puget Sound, Oregon State University and the UW.

"I am incredibly happy to be returning to the Pacific Northwest," Thonstad says. "I am also looking forward to collaborating with UW colleagues, both within and outside of the department, and working with and teaching the next generation of Huskies."

Photo credit: Urban Freight Lab

Recent delivery: Parcel lockers in Belltown

The Urban Freight Lab is well on its way to delivering results. Researchers recently installed parcel pick-up lockers and street sensors in Seattle's Belltown neighborhood, as part of a three-year project funded by the U.S. Department of Energy to help alleviate traffic congestion and emissions by addressing the last leg of urban deliveries.

The Belltown lockers will enable researchers in the Urban Freight Lab, housed at the Supply Chain Transportation & Logistics Center (SCTL), to gather data about delivery patterns, together with sensors installed under the pavement at nearby vehicle loading zones. By creating "delivery density," the lockers have the potential to reduce the amount of time it takes delivery drivers to locate parking and hand-off packages. They also may eliminate failed deliveries, when delivery drivers are unable to locate a package's recipient.

"In 2020, we've seen an acceleration of deliveries due to COVID-19, with e-commerce sales in May 2020 almost double what they were in May 2019. This has exacerbated the challenges presented to communities from delivery traffic," says CEE professor and SCTL director Anne Goodchild. "Our pilot will evaluate the benefits we expect for communities, consumers and carriers, from both locker systems and real-time parking availability information."

The research aims to better understand and reduce congestion and emissions in cities by improving the "Final 50 Feet" of the goods delivery system. The term describes the complicated last leg of urban deliveries, when a delivery driver must locate both parking and recipients, which can be time-consuming and lead to traffic congestion. In recent years, congestion in Seattle has stemmed from a rapidly growing city coupled with an increase in online shoppers.

The parcel lockers offer 24-hour contact-free package pick-up. When packages arrive, people are alerted by a phone notification and receive a code to unlock the appropriate locker. All major carriers deliver to the lockers, including UPS, USPS, FedEx and Amazon. The researchers are also developing a mobile app that will enable delivery drivers to view available loading zones in real time.

PacTrans launches new transportation training institute

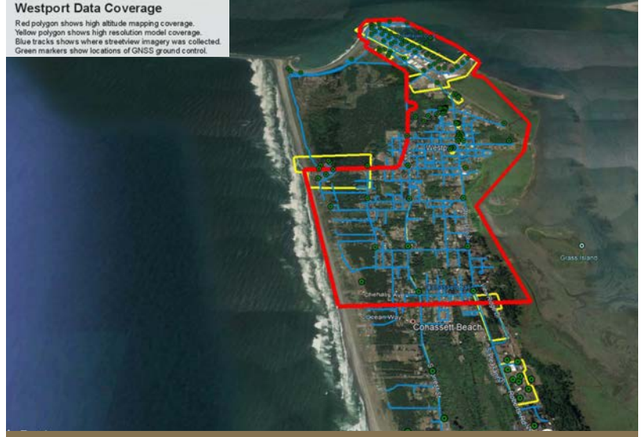
Transportation training in the Pacific Northwest is on the fast track to implementation, with the upcoming launch of PacTrans' Workforce Development Institute (WDI) in December. The WDI will offer short-term trainings for transportation agency employees as well as students and professionals seeking transportation engineering jobs.

The idea for the WDI emerged in 2016, following conversations between PacTrans and transportation agency officials, who wanted to establish a new workforce training program to address increasing needs throughout Federal Region 10, which consists of Washington, Idaho, Oregon and Alaska. It has been a decade since a similar program was offered by the CEE department.

"Since then, working professionals have lost easy access to continuing education and local needs for workforce development accumulated," says post-doctoral researcher Wei Sun, who has been working on the initiative with professor Yinhai Wang. "With the recent technology development and applications in transportation practice, such as connected and autonomous vehicles and smart cities technologies, the demand for continuing education and workforce development is getting even stronger."

To determine training needs throughout the region, Sun and other members of the planning team conducted extensive research, interviews and surveys. Initial trainings will include topics such as transportation data analysis and tools, GIS for transportation, pedestrian safety planning and more. The first training course will kick off in December with a virtual training for Washington State Department of Transportation employees.

Additional courses are planned for 2021 and will be taught by both professors and practitioners from companies and agencies. Down the road, the WDI also plans to facilitate K-12 outreach workshops to introduce youth to the field of transportation engineering.



Informing coastal resilience through geo-narratives

Every few centuries, a subduction zone earthquake typically occurs off the coast of Washington, which has the potential to generate a tsunami. To increase coastal resilience and preparedness, a UW research team associated with the Natural Hazards Reconnaissance Facility (known as "RAPID") is gathering coastal data to create and evaluate a new type of data-sharing method called geo-narratives.

Funded by the National Science Foundation, the project aims to translate scientific information, particularly the latest science predictions, into locally actionable information that can be used by communities for emergency preparedness and response planning. An emerging approach for sharing data, geo-narratives are web-based presentations that add context to data by including narrative and video, which helps capture information and nuances that otherwise may be missed. For example, high-resolution imagery detailing a community's landscape, which shows recognizable buildings and structures, would be overlaid with hazard models and narrative explaining risks and considerations.

In August, a team of researchers and students traveled to Westport, Washington, to conduct socially distanced data collection. Over the course of a week, they gathered aerial images of the Westport peninsula captured by drones as well as street view imagery using a camera similar to Google Street View, which is mounted on top of a car. To generate 3D visualizations, lidar scans were also taken inside schools and along the commercial district.

The geo-narratives will be shared with the community for planning and emergency preparedness workshops, to help inform long-term planning and urban design as well as short-term hazard responses such as evacuation, emergency management and post-disaster relief. To measure the effectiveness of the geo-narratives in informing meaningful planning and policy decisions, the researchers plan to conduct interviews and surveys.

Future Rivers graduate trainee program welcomes first cohort

The inaugural Future Rivers graduate trainee program kicked off this fall, with a cross-disciplinary cohort of 12 students, two of whom are CEE Ph.D. students. The research traineeship graduate program was established to facilitate better management of freshwater ecosystems, which provide goods and services that help support economies and livelihoods around the world.

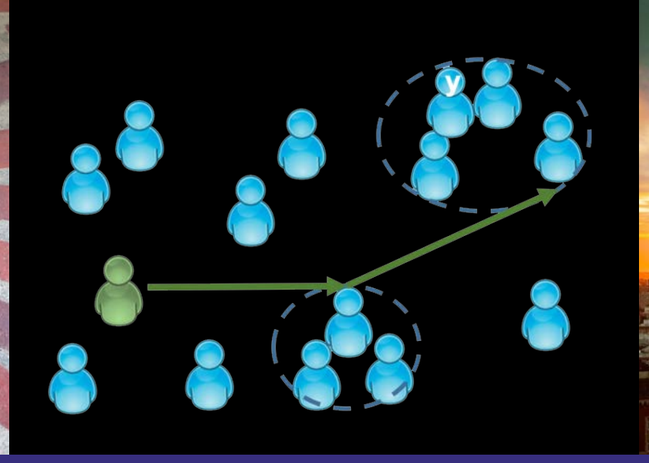
A National Science Foundation program, Future Rivers trains graduate students in data science methods to gain a better understanding of the interactions between food, water and energy and the impact of potential changes to these ecosystems. Despite the important societal and economic benefit of freshwater systems, the ability to fully grasp how they may be impacted by various factors, such as hydropower, is limited.

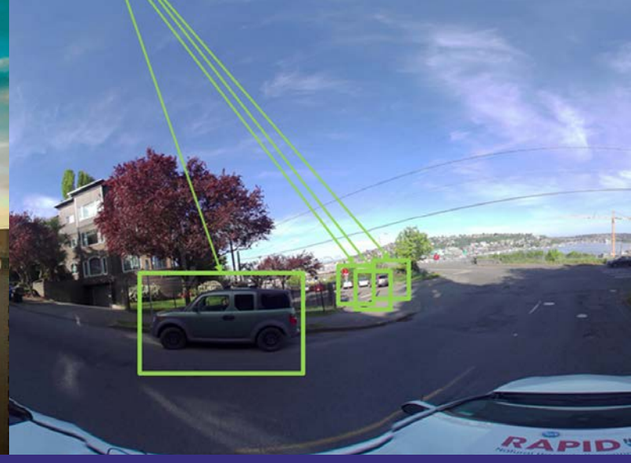
The Future Rivers program is closely tied to the Freshwater Initiative, a collaboration between the College of Engineering and College of the Environment that is working toward advancing freshwater research. Participants from CEE are Ph.D. students Hannah Besso and Carina Thompson, advised by professors Jessica Lundquist and Faisal Hossain.

During the year-long program, students will embark on data science coursework, strengthen their science communication skills and deepen their understanding of the food-energy-water-human nexus in freshwater ecosystems. As the program also aims to increase cultural awareness and inclusivity among the participants, students and faculty will attend quarterly, in-depth workshops from the UW's Center for Evaluation & Research for STEM Equity.

The application for next year's cohort is open. Current or prospective master's and Ph.D. students may apply. For additional information, contact futurerivers@uw.edu.

RESEARCH RESPONSE: COVID-19





In light of the COVID-19 pandemic, several CEE faculty shifted their focus to working on projects aimed at creating and informing a more resilient community.

DETECTING COVID-19 OUTBREAKS THROUGH WASTEWATER MONITORING

To quickly and economically detect COVID-19 outbreaks, a CEE-led research team is working to introduce a testing system that utilizes wastewater samples from neighborhood pump stations, which has the potential to reduce the burden of individual testing.

"Across the world, people are thinking about using the sewer to check for the virus, but most focus on wastewater treatment plants, where the signal is very diluted as the wastewater comes together from all kinds of households and industrial facilities in the area," says assistant professor Mari Winkler. "So, to locate the infection within a zip code, our idea was to check the pump stations."

Located in neighborhoods, pump stations help transport and funnel raw sewage to larger wastewater treatment plants, which typically serve municipalities. By collecting samples before sewage from numerous neighborhoods converges, specific community outbreaks can be identified. For an even more close-up assessment, the researchers plan to collect samples from utility holes, which will facilitate monitoring at facilities such as hospitals, nursing homes and student housing.

This will be the first time this type of sampling system is implemented in Seattle. In addition to being more economical, the researchers say this sampling method can detect outbreaks faster than waiting for individuals to get tested.

The project is being undertaken in collaboration with UW Department of Environmental & Occupational Health Sciences professor Scott Meschke, Public Health Seattle King County, King County Wastewater Division, Institute of Disease Modelling, Fred Hutchinson Cancer Research Center and Seattle COVID Assessment Network.

A MOBILITY INFORMED COVID-19 TRANSMISSION MODEL

A trip to the grocery store or a friend's house may seem harmless enough, but the spread of COVID-19 is closely tied to people's mobility. To help determine the level of travel that is safe for communities, as well as when an outbreak is likely to occur, researchers have developed a new type of mobility informed infectious disease model. It is already being used by the Centers for Disease Control and Prevention (CDC) to forecast COVID-19 deaths across the country.

"Overall mobility is measured by the number of places an average person visits in a day," says professor Jeff Ban. "If a critical value is exceeded, our model will indicate an outbreak of more COVID-19 cases. Of course, public health measures such as social distancing and masks will change the critical value and other parameters of the model."

Ban's model — which he developed in collaboration with Yunfeng Shi, a materials science and engineering researcher at Rensselaer Polytechnic Institute — was inspired by the idea that simple chemical reactions, such as how molecules collide to form reactions, could be applied to forecasting COVID-19 transmission. Similar to how the likelihood of molecules colliding increases according to distance traveled, the researchers speculated that the risk of encountering someone infected with COVID-19 also increases the more a person travels.

Therefore, to control COVID-19 outbreaks, the average mobility over a period of time must be lower than a critical value, which varies by city and considers public health measures such as social distancing and city-wide mask usage. For example, the critical value was 30% of the pre-COVID average mobility for New York City and 60% of the pre-COVID average mobility for all other counties in New York in mid-March. Although this is not the first COVID-19 transmission model that incorporates mobility, the researchers say it is unique in its simplicity and accuracy.

IS THE AIR GETTING CLEANER DURING THE COVID-19 PANDEMIC?

Starting in mid-March, many states issued stay-at-home orders or encouraged people to work from home to curb the spread of COVID-19. In cities nationwide, daily traffic dropped. But did fewer cars on the road lead to cleaner air? Not necessarily, according to a study led by CEE researchers.

Using air quality data from the U.S. Environmental Protection Agency, the researchers looked for changes in two common pollutants: ozone and fine particulate matter called PM2.5. Compared to the past 10 years, neither pollutant has been consistently lower than expected levels since stay-at-home orders began. But the team found that NO2 — a pollutant that mainly comes from car exhaust — was at much lower levels in Seattle, Los Angeles and New York. In these cities, it was 30% lower on average after stay-at-home orders were implemented.

"It's difficult to determine whether the air really is cleaner now because there is a lot of variability in weather and emissions patterns," says CEE professor Julian Marshall. "You can't look solely at concentrations today and compare them to the same day a month or a year ago."

Because pollutant concentrations vary over time and across regions, the researchers developed a method to determine whether pollutant levels in any given week were notably different from normal. The team's metric compared a pollutant's median concentration during a week in 2020 to its median concentration in the same time period over the past 10 years.

"Everybody thinks that because so many people are not driving the air is really clean, but it really depends on what type of pollution you're talking about," says Ph.D. student Bujin Bekbulat. "Cars are the main contributor to NO2 levels, which are down, so there's something to people's intuition. But we're still using electricity, and power plants generate emissions."

SCANNING STREETS TO DOCUMENT COVID-19

Community resilience comes into play during natural disasters, such as earthquakes and hurricanes, but what about during a pandemic? To better understand factors that may contribute to community resilience during COVID-19, an interdisciplinary team of UW researchers including CEE professor Joe Wartman has hit the streets to track COVID-19 response over time.

To capture what's happening in Seattle, and changes over time, the researchers are scanning the streets every few weeks using a car-mounted camera similar to Google Street View. The project started in May, following the city of Seattle's shut-down in March 2020 to slow the spread of COVID-19. The team's driving route, which takes around 10 hours to complete, was designed to capture different aspects of the city, from hospitals to restaurants to parks.

"This is an amazing tool for quickly gathering highly perishable data from across the city," says Wartman, a co-lead on the project. "Unless we capture these scenes now, these sights — and the rich data they contain — will be lost forever."

By scanning the streets, the researchers are collecting images that can be used to track changes over time: if people are outside, if they are social distancing, where they are gathering and how their activities change as the pandemic progresses. Since the camera creates large datasets, the researchers are developing algorithms to help identify people, vehicles and even if social distancing protocols are being followed. The project will continue until at least fall 2021.

"I can already see a significant difference between the May dataset and what's happening now," Wartman says. "For example, when we first drove past Harborview Medical Center, no one was present on the block. Now it's beginning to look like it used to."

Investing IN FUTURE CEE STUDENTS

Both college and department-level building plans will enhance the student experience.

Despite a growing student body, the building that houses the Civil & Environmental Engineering Department is only growing older. Built in the 1940s, More Hall is tight on space and in need of significant renovations and updates to meet current educational needs.

To address this, both college-wide and department-level initiatives are underway, offering two pathways to achieving a shared goal. Aimed at improving learning facilities for future students, the success of both relies on private support from donors.

A new 'engineering central' building

The UW College of Engineering (COE)'s 10 departments are spread out in buildings across campus. To better facilitate collaboration and interdisciplinary learning opportunities, planning is underway to create an "engineering central" called the Interdisciplinary Engineering Building (IEB). Serving as a hub for all engineering students, the IEB will provide more learning space for CEE students.

Due to unprecedented growth in the COE, the IEB represents the first phase of a 10-year facilities plan. The second phase entails improvements to existing engineering facilities, including eventual upgrades to More Hall, as well as a second new building. Currently in the early stages of design, the project is devised as a public-private partnership.

To meet the estimated project cost of $100 million, COE leadership is working closely with UW Capital Planning to request $45 million in construction funding from the State of Washington. Fundraising for private gifts also kicked off in 2019, with significant pledges from several CEE alumni and supporters. One of the first gifts came from the family of the late Paul Liao (Ph.D. '72), whose wife Mei-Yea and daughters wanted to honor his legacy.

"Contributing to this next chapter for expanding the engineering school provides an incomparable way to honor the legacy of Paul Liao. Throughout his life, he placed a high value on education, considering these as opportunities and starting points for knowledge and innovation. We believe the Interdisciplinary Engineering Building will cultivate collaboration across all engineering disciplines, enhance learning opportunities for students and honor Paul's wish to give back to the UW community," says Liao's daughter, Dahlia Mak, on behalf of the family.

The IEB will be particularly beneficial for departments with space constraints and outdated buildings, such as More Hall. The new IEB space will also be better suited to today's engineering education requirements, facilitating more collaborative hands-on learning with flexible classrooms, research labs, dedicated gathering spaces and areas for student club projects.

As a hub for engineering students, the new building will provide freshmen and sophomores with a greater understanding of the range of engineering disciplines, particularly through the building's design. Since first-year students may not be familiar with the critical work of civil and environmental engineers, Dean Nancy Allbritton feels strongly about promoting the importance of the field. To that end, preliminary ideas include showcasing features of the building that were designed by civil engineers and a wall display that tracks energy usage.

More Hall building upgrades

While the IEB will impact future CEE students, it doesn't lessen the urgent need to modernize More Hall, an aging building that is tight on space and long overdue for upgrades. Current building priorities seek to create an inviting, welcoming space for a more diverse student body as well as enhanced labs and equipment to enable students to better collaborate on projects and complete more hands-on assignments.

Donations to More Hall upgrades can have a big impact. Two years ago, longtime department supporters Marilyn and Tom Draeger (BSCE '68) donated $20,000 to the Environmental Engineering Lab to fund much-needed lab equipment, which is now utilized by juniors in the environmental engineering bachelor's degree program as well as civil engineering students taking introductory environmental engineering courses.

"We wanted to contribute to a cause that would affect the most students," says Marilyn Draeger.

Current building priorities:

CEE seeks donations big and small to improve the following student facilities:

- **ENTRANCE AND LOBBY:** A welcoming entrance for students and visitors, as well as a central gathering space, will make the department more inviting and enable enhanced student interaction outside the classroom. While knocking down walls to create a lobby would mean losing some existing multipurpose space, this would be recaptured in the IEB.
- **EQUITABLE RESTROOMS:** Adequate restrooms in More Hall are long overdue. Although one-third of undergraduate students are female, there are few women's restrooms and no dedicated options for non-binary students.
- **COMPUTER LAB:** Enhancements are needed to make the computer lab more conducive to instruction and to provide workspace for student groups.
- **ENVIRONMENTAL ENGINEERING LAB ENHANCEMENTS:** To continue building up the Environmental Engineering Lab for the bachelor's degree program launched in 2017, additional support is needed for space upgrades and instrumentation.

INVEST IN **CEE students**

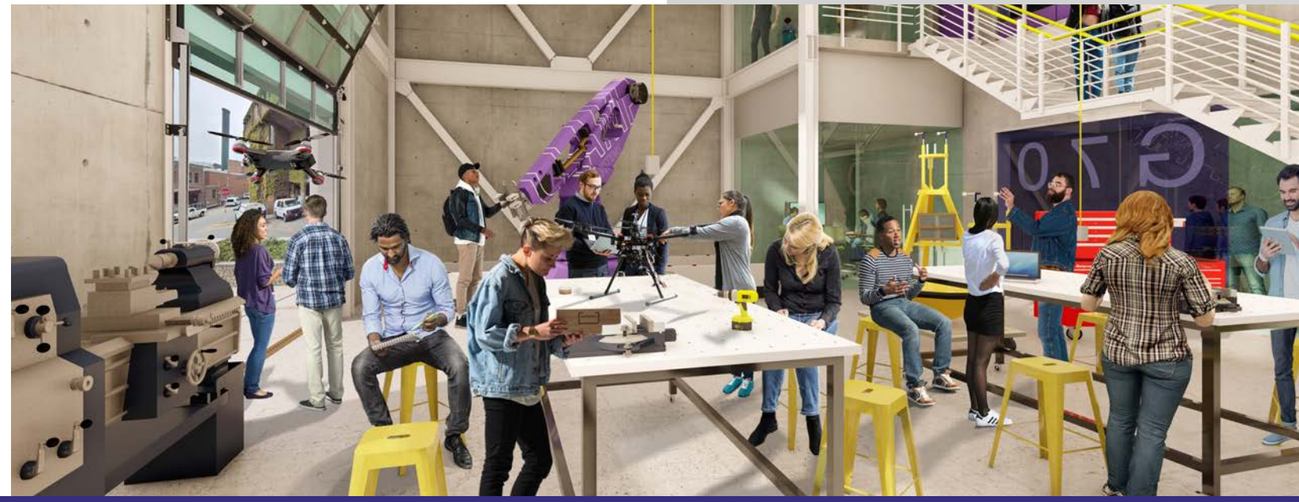
If you are interested in supporting the IEB or making an investment in More Hall upgrades, contact Kaitlin Colleary at kaitcoll@uw.edu.

Images: Artist conceptions of the Interdisciplinary Engineering Building courtesy of McGranahan Architects.

A case for capacity

During the past decade, the College of Engineering (COE) has grown significantly to meet increasing demand from students for an engineering education and by industry for qualified engineers. Since 2009, COE has grown more than 65% in total degrees granted annually. However, because there has been less growth in the overall footprint of engineering facilities during this time, COE lacks the amount and type of space necessary for today's interdisciplinary, collaborative engineering education. This is especially true in departments with dated facilities, such as CEE.

Space is also needed to house freshmen and sophomore classes and programs following the launch of Direct-to-College (DTC) admission in 2018. Intended to transform and improve the student experience, DTC admits more than 800 new first-year students into the college each year. Assured placement in one of the 10 engineering departments, students are now able to engage with COE earlier than before.



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Enjoy the videos
2020 WENK AND EVANS LECTURES

Two endowed lectures were held virtually this fall. Enjoy the Wenk and Evans lecture videos at ce.washington.edu/news/video.

Wenk Lecture
Dr. Elizabeth Hausler presented a talk titled "Resilient Housing: At the Nexus of Climate Justice, Technology and Finance." A global expert on resilient building and post-disaster reconstruction, Hausler is the founder and CEO of Build Change, an organization that helps prevent the loss of life in earthquakes and typhoons by designing disaster-resistant houses and schools in emerging nations.

Elizabeth Hausler, photo credit Roger Askew-Skoll Foundation

Evans Lecture
CEE alumnus Jay Lund (Ph.D. '86), a professor at the University of California, Davis, presented a talk titled "The Success of Societies: Engineering's Role." Lund reflected on how engineering is successful or unsuccessful within a social context, how infrastructure supports public health and prosperity, and current and future challenges.

Jay Lund, photo courtesy of the speaker