The Trend in

ENGINEERING

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

Breaking ground on a new home for all engineering students

PAGES 6-8

FROM THE **DEAN**

A year ago, we launched "Engineering Excellence for the Public Good," the College's ambitious five-year strategic plan. Since then our engineering community has been hard at work implementing strategies and timelines to help us achieve our goals.

This issue includes several examples of what engineering excellence for the public good looks like: a graduate student partnering with local non-profit organizations to improve emergency food response, researchers who are tracking microplastics in the ocean to better understand their impact, and more.

Diversity, equity and inclusion (DEI) is a critical component of engineering excellence for the public good, and though we have much work to do in this area, I am inspired by the transformation already underway. We're establishing new programs to make engineering accessible to more Washington students, investing in new staff roles to support DEI, and exposing inequities and offering solutions through research, books and new courses.

I want to acknowledge the major role that our alumni, donors and industry partners are playing in these efforts. In September we broke ground on our new Interdisciplinary Engineering Building, thanks in part to The Boeing Company, Amazon, T-Mobile and the state of Washington. Once complete, the state-of-the-art building will be a home for all engineering students and a leading example of a learning facility backed by both public and private investments.

Everyday I am reminded of the power of what we can achieve in community. Thank you for continuing to be a part of UW Engineering.

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

INTRODUCING COMPUTING FOR THE ENVIRONMENT

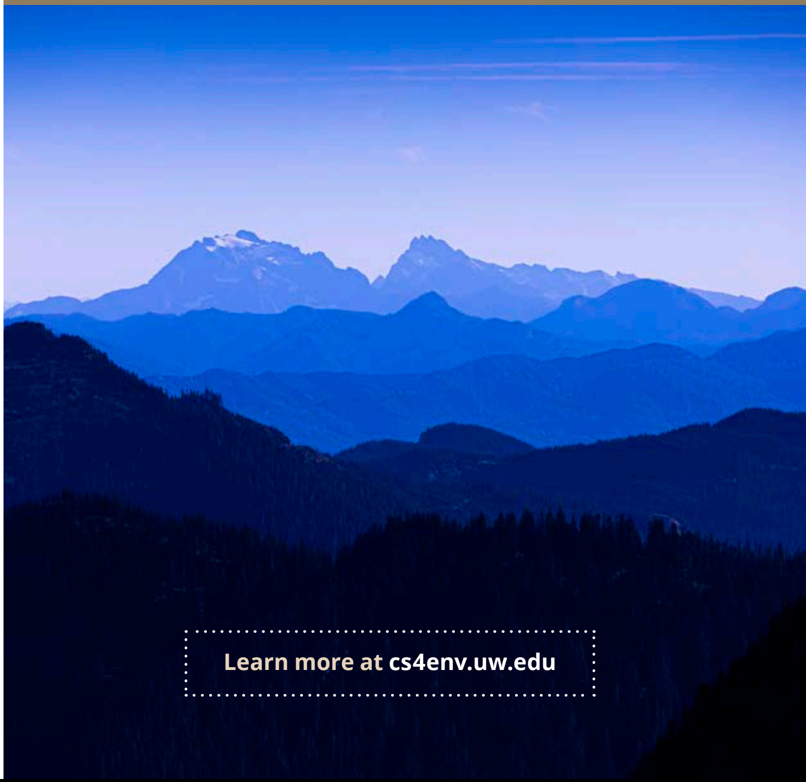
Computing for the Environment (CS4Env) brings together UW civil and environmental scientists and engineers with computer scientists and engineers and data scientists to accelerate research addressing climate change, pollution, biodiversity and more. The cross-disciplinary research teams are applying technologies and tools — including deep learning, data visualization, software engineering and machine learning — to address topics ranging from air quality and wildlife conservation to wildfires and landslide risk.

CS4Env launched this summer with 12 inaugural projects and under the direction of Vikram Iyer, an assistant professor in the Paul G. Allen School of Computer Science & Engineering; Dorothy Reed, a professor of civil and environmental engineering (CEE), and Alex Turner, an assistant professor of atmospheric sciences.

"Research to slow down the impacts of climate change requires a multidisciplinary approach involving a lot of data collection and analysis," Reed says. "For example, some of us in CEE have lots of domain expertise but face challenges in collecting and processing huge datasets."

"One of the aims of CS4Env is to provide a platform that brings together researchers with expertise, allowing us to tackle big interdisciplinary problems in the environment," Turner adds.

The initiative provides seed funds for research teams to explore new projects, positioning the teams to be competitive for future funding opportunities.



Learn more at **cs4env.uw.edu**

Bart Nijssen to serve as Chair of Civil & Environmental Engineering

This fall, we welcomed Allan & Inger Osberg Professor Bart Nijssen to the role of chair of the Department of Civil & Environmental Engineering (CEE). Nijssen is committed to addressing issues such as climate change, natural and environmental hazards, pollution and biodiversity. As an internationally recognized hydrology researcher, he appreciates the role civil and environmental engineers serve as builders and managers of infrastructure to shape the world of tomorrow.

Nijssen holds a degree in hydrology from Wageningen University and a Ph.D. from the UW. He served on the faculty of the University of Arizona, then worked as a senior vice-president of 3TIER in Seattle, a company focused on assessing renewable energy projects, before returning to the UW in 2011.

Nijssen is dedicated to advancing inclusive excellence in engineering and plans to continue positioning CEE's Justice, Equity, Diversity & Inclusion (JEDI) work as an integral part of the department's curriculum.

Cynthia Chen named Interim Chair of Industrial & Systems Engineering

In September, Cynthia Chen began her two-year appointment as interim chair of the Department of Industrial & Systems Engineering (ISE). A UW civil and environmental engineering professor since 2009, Chen is an internationally renowned scholar in transportation science and directs the THINK (Transportation-Human Interaction and Network Knowledge) lab, examining the relationship between human behavior and infrastructure systems.

Chen has more than 60 peer-reviewed publications, and her research has been supported by federal, state and regional agencies. Recently she led a multi-institution team with a $2 million grant from the National Science Foundation (NSF) to design an adaptable society that can quickly respond to external disruptions such as natural hazards.

Chen has served on UW's College Council and as the program director of the NSF's Civil Infrastructure Systems, CMMI (Civil, Mechanical, and Manufacturing Innovation) division. Her research offers insights with broad impacts on transportation systems operation, policy design and urban planning.

A new Bachelor of Science in Electrical & Computer Engineering

By Wayne Gillam

This fall, the Department of Electrical & Computer Engineering (ECE) started a four-year transition toward offering a Bachelor of Science in Electrical & Computer Engineering rather than a Bachelor of Science in Electrical Engineering. This evolution reflects recent changes in electrical and computer engineering. The move also allows the department to provide greater flexibility for students and enable a nimbler response to advances in technology.

"Electrical engineers have been working with and building computers for years, and because of how the field has evolved, we now expect our graduates to be highly knowledgeable and proficient in computing," says ECE Professor and Chair Eric Klavins.

In 2018, ECE changed wording within its name from "electrical engineering" to "electrical and computer engineering" to acknowledge the tight integration that exists between computing and electrical engineering. The new degree program reflects this integration and better aligns the undergraduate curriculum with the department name.

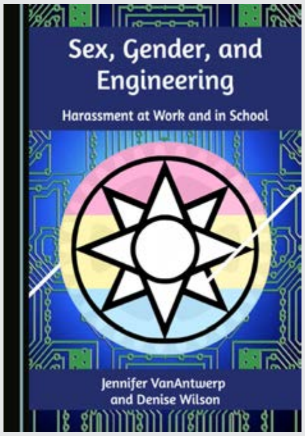
SEX, GENDER AND ENGINEERING

Professor Denise Wilson's new book and course on sexual harassment in engineering seek to disrupt a culture of silence.

By Misty Shock Rule

Denise Wilson, a professor of electrical and computer engineering, is working to end the prevalence of sexual harassment in engineering. She and her colleague Jennifer VanAntwerp of Calvin University are co-authors of Sex, Gender, and Engineering: Harassment at Work and in School, recently published by Cambridge Scholars Publishing.

Wilson will teach a class to accompany the book in spring 2023.



"There are huge holes to understanding what's going on in the workplace," she says. "The book and the course are about raising student awareness and helping them understand how to strategize toward a better work environment no matter where they are in the hierarchy."

This book isn't a traditional textbook. It uses anecdotes to help connect students with the experience of sexual harassment.

Wilson says the unwritten rule about harassment in engineering — to just "shut up and deal with it" — is conveyed not only by the male-dominant majority but also by those who have advanced in the field while quietly enduring abuse. This tendency to keep things quiet explains why things haven't changed, even as gender representation in engineering has diversified, Wilson says.

"How do we overcome that? I think it's only by talking about it and by telling stories, along with the data," she says.

College of Engineering Associate Dean of Diversity, Equity & Inclusion Karen Thomas-Brown says the book is effective for "undergraduate students who may have never experienced harassment or heard about the law. Students are going to be able to say, 'Oh, so this is not just a bunch of women saying you shouldn't do this to us. There are laws.'"

Thomas-Brown — who, as the lead of the College's Office of Inclusive Excellence, plans to use a data-driven approach to create change "top-down and inside-out" — is creating a suite of required college-level DEI courses: a general course on diversity in society, a course on race, and a course on justice, equity, diversity and inclusion in engineering.

A fourth course — on sex, gender and harassment, paired with Wilson's and VanAntwerp's book — will be added. Next spring's course will serve as a pilot, assessing what holes there might be in the book or course before rolling it out to the entire college.

Wilson wants to create the change for her field that she's undergone herself. She has come a long way from being the young woman who kept quiet about the harassment she herself experienced.

"It's much harder to shut me up. I'm much more outspoken," she says. "I learned the only way I'm going to do my best and contribute to change is just to be who I am and speak. I have learned to keep speaking even when there's silence on the other end."

MEET COREY CLAY

The College's Office of Inclusive Excellence (OIE) plans to work with engineering departments to create new DEI positions and expand DEI efforts. We welcome Corey Clay, who is the first to serve in one of these roles for Mechanical Engineering (ME).

Interview by Lyra Fontaine

What led you to working in diversity, equity and inclusion (DEI)?

In the psychology and criminal justice courses I taught at universities in Houston and Portland, many students had no idea about the inequities that people who look like me go through. Through examining inequities, having discussions with and mentoring students, I realized I was doing DEI work.

After George Floyd was murdered, I created the Pacific Northwest Institute for Racial Trauma, through which I give talks on racial trauma, anti-racism, allyship and workplace inclusion. Upon moving to Seattle last year, I worked at a homeless shelter while pursuing graduate school and opportunities to focus on DEI work. As an academic, as well as a U.S. Army veteran and former law enforcement officer, I feel like I have this wealth of knowledge I can use to implement DEI into a strategy.

What are your responsibilities as the College's and ME's first DEI officer?

I was brought in to facilitate conversations that may be difficult for some as well as to implement a plan for DEI. We want to ensure that the department is more reflective of society itself. Representation matters. My goal is to work with the department and with OIE to create a long-term plan for the department. This means looking at the data and pinpointing our strategies to recruit underrepresented populations. Diversity isn't always about skin color; it's also diversity of thought and of different backgrounds. The plan, which will roll out this fall, will focus on how to grow the faculty and student body. It will also ensure that the department is inclusive of who we represent.

What are you most looking forward to in this role?

Last spring I facilitated a series of monthly DEI forums. The first one was about George Floyd. His murder is in many ways the impetus for why I'm at the UW, so I wanted to unpack it with the ME community. The second forum focused on disability and ableism. The final one was about critical race theory, which I felt was important since there's a lot of misinformation about what it is and what it isn't. I look forward to continuing to host forums like these this year.

Why is it important for engineering departments to embed DEI in all that they do?

Nearly every industry has concluded that diversity increases output and that the more successful businesses are diverse businesses because they're made up of people with different lived experiences and perspectives. I'm not skilled at teaching mechanical engineering, but I am skilled at facilitating discussions about diversity, equity, inclusion and social justice — which is just as important when it comes to educating tomorrow's engineers.

Read the full interview at: **me.uw.edu/dei-officer**

IEB GROUND

By Jackson Holtz

This fall, the UW broke ground on the new $102 million Interdisciplinary Engineering Building, supported by public and private investments.

Wearing purple hard hats and using gold-plated shovels, officials from the University of Washington broke ground Thursday, September 15, on the new, $102 million Interdisciplinary Engineering Building (IEB). Once complete, the state-of-the-art 70,000-square-foot building will be an example of a student-focused learning facility backed by both public and private investments. The project aims to fuel economic growth and create a pipeline of future, local engineering talent.

The IEB, which will be constructed along Stevens Way east of the Husky Union Building, will provide much-needed space for project-based collaborative learning as well as a student-focused "home" for engineering undergraduates. The College of Engineering's new five-level building will provide a welcoming and inclusive space to introduce students to more engineering pathways and facilitate tomorrow's discoveries.

Interest in engineering has exploded, and since 2009 the UW has nearly doubled the number of undergraduate and graduate engineering degrees, but classroom and activity space hasn't kept pace. With the addition of the new contemporary engineering building to the Seattle campus, the UW can focus on cross-college multidisciplinary teamwork, improve diversity and increase engagement with industry — all to prepare students for the engineering careers of the future. In addition to being a home for students, the building will also serve as the front door to industry and a direct connection for hiring students with interdisciplinary skills.

"Our great public university is dedicated to creating access to excellence for the students of our state," says UW President Ana Mari Cauce. "With this new facility, we will be able to open doors of opportunity for even more talented, driven future engineers. These future innovators, creators and entrepreneurs will get the kind of student-centered, hands-on training that will empower them to take on the biggest challenges facing our communities."

BREAKING

The College of Engineering deeply thanks the community partners, companies and individuals who already have pledged their support:

- The state of Washington, which has contributed $50 million.
- The Boeing Company, which gave $10 million to name the IEB's second level, which will feature the AI Engineering Institute.
- Amazon, which announced a $5 million gift in September for the building's Student Support Suite.
- T-Mobile, which announced a $5 million gift in September to name the Engineering Academic Center. The center will be housed in the IEB and focuses on student support.
- UW alumni, individuals and other organizations who have contributed more than $18 million.

The IEB's architect is KieranTimberlake, and contractor is Hensel Phelps. Construction is scheduled to be completed by mid-2024.

Keep up with the IEB's progress and find out how you can help us advance engineering education at **engr.uw.edu/ieb**

Opposite page: UW President Ana Mari Cauce (center left) and College of Engineering Dean Nancy Allbritton (center right) ceremoniously break ground on the IEB with engineering students Liban Hussein (left) and Aisha Cora (right).

This page, center right: Greg Hyslop, chief engineer and executive vice president of Engineering, Test & Technology at The Boeing Company, and Karen Thomas-Brown, the College's associate dean of diversity, equity and inclusion, attend the IEB groundbreaking. Lower right: President Cauce delivers remarks at the event.

IEB renderings on the cover and across pages 6-8 are courtesy of KierenTimberlake. Note: all are conceptual and may not represent the final look of the building.

Boeing and the UW:
A LASTING PARTNERSHIP

The IEB's second level, shown here in a conceptual drawing, will be named for Boeing, thanks to a $10 million gift from the aerospace company.

Boeing's relationship with the UW dates back more than a century, and the company's latest investment will support new educational space that focuses on artificial intelligence (AI). In particular, Boeing's gift supports naming rights for the IEB's second level, which includes the College of Engineering's new AI Engineering Institute and adjacent curricular spaces.

"Boeing's significant investment is a reflection of our longstanding and deep partnership, and we are proud to continue working together to advance engineering education, create opportunities for students and expand the pipeline to develop the highly-skilled diverse workforce our region and our world needs," says UW President Ana Mari Cauce.

The College of Engineering graduates more than 50% of the state's new engineers. Boeing is a top employer of UW engineering graduates, with nearly 1,200 engineering alumni hired in the last five years and 6,500 UW alumni currently working for the aerospace company, according to LinkedIn and other data.

"The new Interdisciplinary Engineering Building offers Boeing the opportunity to partner more closely with the university on cutting-edge technologies that enhance the safety and sustainability of our products and services," says Greg Hyslop, Boeing chief engineer and executive vice president of Engineering, Test & Technology. "Through continued research and talent development, we will advance our work in artificial intelligence, machine learning and other capabilities that support our digital innovation. It helps us all move toward a dynamic and exciting future in the state of Washington."

Since Boeing's earliest days, leaders have partnered with the UW to nurture talent and foster engineering innovation. In 1917, company founder Bill Boeing gave the UW $6,000 to construct a wind tunnel, the same year that UW aeronautics courses began. UW's aeronautics department officially was established in 1929, and in 2012 was named the William E. Boeing Department of Aeronautics & Astronautics. Today, Boeing uses a newer wind tunnel at the UW to test nearly every new airplane the company's engineers design.

Boeing contributions to the UW over the years include internships, scholarships and other innovative opportunities for students, especially those who come from marginalized communities, to enter engineering fields.

With dedicated space for Industry Capstone Projects, the IEB's design further promotes close participation from students and regional industry. Boeing alone sponsors more than 10 projects annually, each involving teams of five students, a UW professor and a Boeing mentor.

"I'm grateful to Boeing for their support for our new contemporary educational building, the next milestone in our century-long relationship," says Nancy Allbritton, Frank & Julie Jungers Dean of the College of Engineering. "It sets a tone for industry engagement with our students, which translates directly into strong regional economic growth. As we advance a vision of engineering excellence for the public good, we look forward to expanding our partnership with Boeing and other local industry for the benefit of our students and our broader community."

PUBLIC **GOOD**

The power of pedaling

Graduate student Dan McCabe is working to improve bicycle-powered emergency food response.

By Brooke Fisher

Photos by Mark Stone

The power of pedaling

A class project quickly became a passion project for civil and environmental engineering (CEE) Ph.D. student Dan McCabe. A cycling enthusiast, McCabe is working to optimize the delivery of groceries from food banks to people experiencing food insecurity — by bicycle.

"I love bikes, so I'm able to combine that with my research interests," says McCabe, who is president of the Husky Cycling Club. "I've never been so excited for a class project."

To streamline delivery operations for the Pedaling Relief Project (PRP), McCabe is developing technology to automate time-intensive route planning and create safer routes for volunteers on bikes, who are hauling cargo trailers or bags stuffed with groceries.

"Overall, this represents a well-studied problem — the vehicle routing problem," McCabe says. "Any kind of package delivery company is working at a massive scale to determine what packages go on what trucks and design their routes to minimize the total distance traveled. This is a smaller-scale version of that."

Now in its second year, the PRP was founded during the early stages of the COVID-19 pandemic by Seattle's Cascade Bicycle Club to expand food bank delivery options and get groceries into the hands of people and families in need. The pandemic introduced a new segment of food-insecure people in the city, after many families lost their source of income. In addition, food banks had restricted operations and some regular customers, such as those with pre-existing health issues and senior citizens, were concerned about leaving their homes.

"There was more demand than ever for home delivery, which is a good candidate for bikes — it's challenging to find a place to park your car in a dense part of the city," says Maxwell Burton, PRP volunteer manager. "Big rides and events were also cancelled, so there was pent-up demand from cyclists who wanted to ride and also feel like they were helping out."

LOGISTICS LESSONS

Last spring, McCabe started working on the project during a graduate-level transportation logistics course.

"It's very motivating for students to have stakeholders and to see the purpose of their work," says CEE Professor Anne Goodchild, who co-taught the course. "It shows them that the applications aren't just for for-profit companies. There's a lot of social, environmental and community support they can provide using the same tools — students are attracted by that."

To discuss PRP operations and logistics challenges, Burton presented a guest lecture to the class. He explained how every six weeks, he manually builds new delivery routes from scratch for four food distribution locations. For the University District Food Bank alone, it takes five hours to build 24 routes. Another significant problem is that mapping programs often route bicyclists onto busy arterials and highways, such as Aurora Avenue.

For the class project, McCabe was eager to streamline the process for generating delivery routes, which aligns with his research interests in optimization. For his graduate dissertation, McCabe is working on planning for the future of electric bus systems.

"It's a very time-consuming process to manually build the routes and Maxwell has too many other jobs to do already," says McCabe.

The app that McCabe is developing groups together deliveries based on a variety of criteria, including the type of delivery — in addition to delivering groceries, volunteers also "rescue" donated food from grocery stores and restock Little Free Pantries — and whether the location is a house or apartment. The app also takes into consideration the carrying capacity of cyclists, and the time of day the delivery is expected.

A first iteration of the app was tested during a citywide volunteer initiative called "One Seattle Day of Service" in May. About three times as many cyclists, 75 total, turned out to volunteer at the University District Food Bank, which meant that even more new routes needed to be created.

"It was helpful to have the routes generated beforehand, with QR codes to direct people to the Google Maps routes," Burton says. "We had a lot of new volunteers and they already needed a lot of orientation on how to carry groceries on their bikes and deliver them to food bank clients."

ROADWAY RESEARCH

While the PRP initially formed as an emergency response effort, it has since become a permanent offering due to continued demand.

"We realized even post-pandemic, this is something that needs to stay," Burton says.

With the goal of rolling the app out for weekly PRP operations this autumn, McCabe continues to refine the technology and features, such as the ability for volunteers to customize routes and select delivery stops.

"We do bicycle deliveries for the food banks every Thursday, Friday and Saturday, rain or shine, 52 times a year, so there's a built-in beta test," Burton says. "Most of the volunteers who have been with me through the pandemic are more than happy to test these new systems and be part of the process."

The role that bicycles play in the larger urban goods delivery system is a topic that researchers at the Supply Chain Transportation & Logistics (SCTL) Center's Urban Freight Lab have been investigating as part of their ongoing work to alleviate congestion while getting goods into the hands of people in an efficient and sustainable manner.

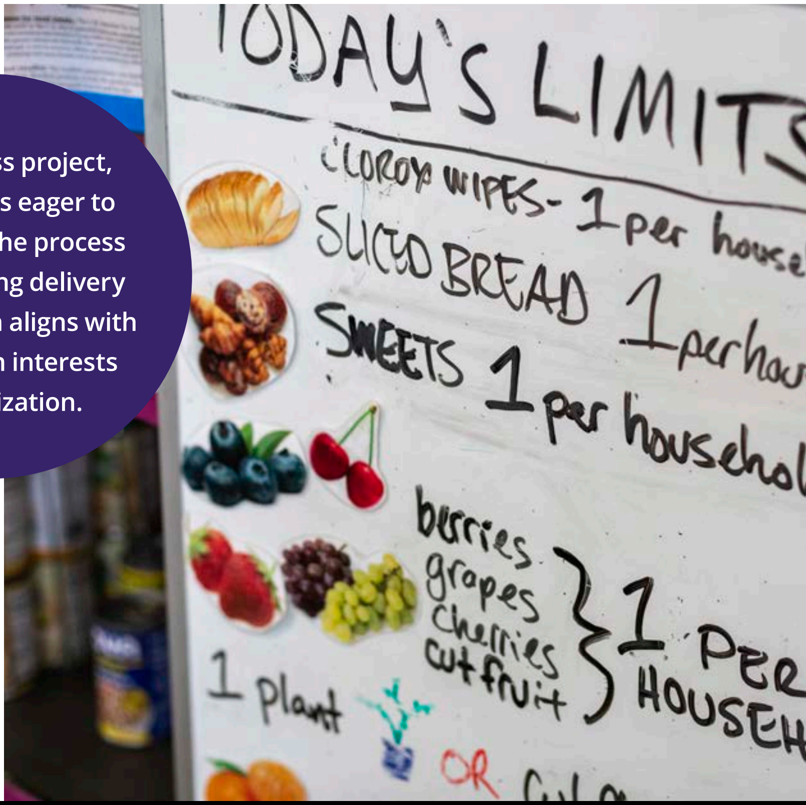
The lab's research has entailed conducting two separate pilot tests with cargo bikes, both of which used electric bicycles to deliver parcels from a hub to customers in downtown Seattle. The Seattle Neighborhood Delivery Hub was a collaboration with UW Star Lab and tech and delivery companies AxelHire, Brightdrop, Coaster Cycle and REEF; the second pilot was in partnership with United Parcel Service and the City of Seattle.

"It's not realistic to replace all trucks with bikes, as not everything can be delivered by bike," says Goodchild, who directs the SCTL. "The industry is still at a point where we are trying to figure out where to apply bikes. But where it does make sense, we want to make it as easy, enjoyable and safe as we can."

Opposite page, left: McCabe loads his bicycle with groceries at the University District Food Bank. Right: Food boxes for car delivery are packed by volunteers at the University District Food Bank. Bike deliveries are packed in paper grocery bags.

This page, left: McCabe restocks a Little Free Pantry, which contains shelf-stable items and a refrigerator for perishable goods. Right: Daily household limits are posted at the University District Food Bank.

For the class project, McCabe was eager to streamline the process for generating delivery routes, which aligns with his research interests in optimization.



A pathway to ENGINEERING

One of the College's Pathways for Inclusive Excellence, the Engineering Dean's Scholars program is making it possible for more Washington students to become engineers.

During the Summer Transition Program, Engineering Dean's Scholars take part in math and science workshops on campus before classes start.

By Chelsea Yates | Photos by Mark Stone

A field trip to the Kennedy Space Center ignited Jayden Shafer's interest in aerospace engineering.

"After that, I knew I wanted to be an engineer," says Shafer, who grew up near Tri-Cities, Washington. "I also knew I wanted to attend the UW."

Upon starting high school, Shafer became concerned about reaching his goal. "My school had limited math and science offerings," he recalls. "There were no chemistry classes, and the most advanced math class I could take was algebra."

He applied to the UW anyway, citing engineering as his top choice of study. In 2021, he was one of approximately 50 students admitted to the College of Engineering as an Engineering Dean's Scholar. Launched that same year, the Engineering Dean's Scholar program (EDS) supports Washington state students who show they have the potential to become excellent engineers but may need an extra boost to get there.

"EDS is for students across the state who want to study engineering but may not have the academic background, familiarity with engineering or support to succeed as engineering students at the UW," says Scott Pinkham, who directs the program.

Along with STARS and Allen School Startup, EDS is part of the College's Pathways for Inclusive Excellence (PIE), an initiative that provides underserved students from Washington state opportunities to pursue engineering and computer science in a supportive environment that is committed to their academic success.

All three PIE programs focus on holistic programming and support starting the summer after high school and through the first or second year at the UW. Students who complete one of the three programs are guaranteed entry into an engineering or computer science major.

Building community is a central tenet of all three PIE programs.

"Our goal is to help students understand what engineers do, to provide them with the academic support and resources they may need, and to help them understand they're not alone in the transition to life as an engineering student," Pinkham says.

Above: EDS students experiment with a 3D printing project as part of the Summer Transition Program. Below: The students work on computers (left) and with 3D printers (right) in The MILL, a campus makerspace and learning facility.

ACCEPTANCE, BELONGING, COMMUNITY

EDS starts with the Summer Transition Program, a preparatory experience that takes place before the fall quarter begins. Students are immersed in math and chemistry workshops as well as social and team building activities. They also meet with professors from across the College and with professionals working in industry.

"The Summer Transition Program is designed to help students learn about themselves and how to navigate the UW, establish a path to graduation and build a network of peers they can share the journey with," Pinkham says. "We work to instill the importance of self-awareness and a growth mindset so students are more resilient and will persist in their engineering studies."

For Dean's Scholar Fiona Clayton, the Summer Transition Program was a game-changer.

"I went to an engineering-focused high school so I thought I was ready for classes, but wow did the Summer Transition Program give me an academic boost I didn't know I needed," she says. "It's also where I first met my EDS cohort. If I hadn't had that community my first year at the UW, I would have had a hard time surviving."

During their first academic year, the Dean's Scholars attend supplemental math and science workshops alongside their core studies. The students study together and attend events, such as industry talks and tours. Students are paired with an engineering adviser who helps them with everything from exploring engineering majors and creating academic plans to navigating housing, identifying scholarship opportunities, and finding clubs and student groups to join.

"Once the school year started, I struggled at first but the supplemental workshops helped me get on track," Shafer says. "Thanks to my peers and to EDS, I felt more determined to stay on top of my homework."

Engineering Dean's Scholar Holland Kantner agrees. He grew up in Belfair, Washington, an unincorporated community on the Olympic Peninsula, and wanted to attend the UW so he could stay close to family.

"For me the best part has been having an established cohort of peers, both for homework and study groups as well as for socializing and friendships," he says. "It's helped make a big place like the UW seem less intimidating and lonely."

MAKING THE MOST OF A FIRST-YEAR PROGRAM

Shafer, Kantner and Clayton all say that since the program is focused on the first year, it's important to take advantage of all of the resources and opportunities it provides.

Clayton is especially thankful that EDS introduced her to the Engineering Academic Center, which offers exam review sessions and tutoring to all UW engineering students. "I feel confident that the support staff is always going to be in my corner," she says.

Shafer recently completed a summer internship on a product development team at Boeing. He learned about the opportunity through EDS.

"I didn't think I had a chance of getting an internship, but Scott and other staff members encouraged me to apply," he says. "They're really there to help you access opportunities and feel like you belong in engineering."

For Kantner, one of the key takeaways has been a deeper understanding of diversity — across people and the field.

"Overall, EDS exposed me to so much difference, in terms of people's backgrounds, types of engineering, research, jobs and opportunities," he says. "It helped me relax the idea that I need to lock into one area and instead consider engineering in a much broader way."

Learn more at **engr.uw.edu/deans-scholars**

Tracking microplastics in the ocean

Researchers are using fluid mechanics to better understand how the tiny pieces behave.

By Lyra Fontaine

In the UW's Harris Hydraulics Laboratory, researchers are tracking how microplastics — tiny pieces of plastic less than five millimeters long — behave over large distances in a turbulent environment.

The goal is to better predict microplastics' transport, distribution and degradation in the ocean. According to the researchers, understanding how the pieces move can inform our knowledge of the speed at which they break down and where they end up, which could provide insight about how to manage and mitigate plastic pollution in the ocean as well as where to remove it.

Plastic degrades slowly with sunlight, but it remains unknown how long it takes to degrade in the ocean. Researchers know that the depth and orientation of the tiny pieces can determine how much sunlight each object receives. To track the particles, mechanical engineering (ME) postdoctoral researcher Luci Baker images the particles' shadows projected onto a wall of a wave tank, then tracks the shadows over long distances.

"The experiments will lead to tons of data," says Baker. "We'll be able to track particles' position and orientation through space, and the depth and concentration. That's the fun part."

USING FLUID MECHANICS TO STUDY MICROPLASTICS

Microplastics have been found not only in bodies of water, including the Arctic Ocean, but inside animals, humans and tap water.

"We need to know what's happening and where they are going," Baker says.

ME Assistant Professor Michelle DiBenedetto shares Baker's concerns about microplastics — a topic she considers understudied in the fluid mechanics engineering community.

"There is a lot that we don't know because microplastics are a new pollutant," DiBenedetto says. "The implications of microplastics in the ocean are unclear, which is all the more reason to study it. We are using engineering tools to explore these questions."

Last summer, Baker became the first researcher to join DiBenedetto's fluids lab, which investigates interdisciplinary fluid mechanics problems such as how particles behave in ocean waves, where microplastics go in the ocean and how small swimmers like plankton behave in turbulent conditions.

DiBenedetto says Baker's research could provide insight into how other non-plastic particles behave in the ocean.

"This research could potentially apply to other tiny materials, such as small animals, ice crystals, plankton and oil droplets from oil spills," DiBenedetto says.

As a next step, the researchers will examine the data they are collecting. The research may help validate and improve existing models that simulate how plastics behave at the ocean surface. It could also help create new models for researchers to use.

"We want to extract things like microplastic concentration, orientation and particle trajectories," Baker says. "We hope our results will be useful for improving models of microplastic transport and learning how they break down and degrade in the ocean."

Above: Postdoctoral researcher Luci Baker tracks the behavior of microplastics in a wave tank that simulates the ocean surface. Photo by Dennis Wise

ClearBuds for clarity

UW researchers develop new wireless earbuds that clear up calls thanks to deep learning.

By Sarah McQuate

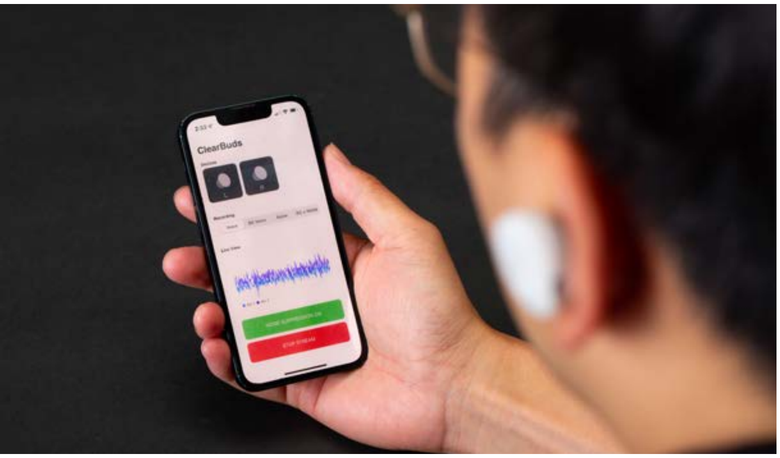
As meetings shifted online during COVID-19, many people found that roommates, traffic and other sounds disrupted conversations.

This experience inspired three UW researchers — roommates during the pandemic — to develop better earbuds. To enhance the speaker's voice and reduce background noise, "ClearBuds" use a novel microphone system and one of the first machine-learning systems to operate in real time and run on a smartphone.

"ClearBuds differentiate themselves from other wireless earbuds in two key ways," says Maruchi Kim, a doctoral student in the Paul G. Allen School of Computer Science & Engineering. "First, ClearBuds use a dual microphone array. Microphones in each earbud create two synchronized audio streams that provide information and allow us to spatially separate sounds coming from different directions with higher resolution. Second, the lightweight neural network further enhances the speaker's voice."

While most commercial earbuds have microphones on each earbud, only one earbud sends audio to a phone at a time. With ClearBuds, each earbud sends a stream of audio to the phone. The team's neural network algorithm runs on the phone to process the audio streams.

"Because the speaker's voice is close by and approximately equidistant from the two earbuds, the neural network can be trained to focus on just their speech and eliminate background sounds, including other voices," says Allen School doctoral student Ishan Chatterjee. "This method is quite similar to how your own ears work."



ClearBuds use a novel microphone system and are one of the first machine-learning systems to operate in real time and run on a smartphone. Photo by Raymond Smith

Snow Spotter

A citizen science project helps unpack snow's effect on summer water supplies.

By Sarah McQuate

The snow that falls in the mountains is good for more than just skiing, snowshoeing and breathtaking vistas. The snowpack it creates will eventually melt, and that water can be used for hydropower, irrigation and drinking water.

Researchers want to predict how much water the snowpack will provide. But in forested regions, when falling snow is intercepted by trees, it sometimes never makes its way to the ground. Therefore, current models struggle to predict what will happen.

To improve the models and investigate what happens to this intercepted snow, UW researchers created Snow Spotter, a citizen science project in which 6,700 participants viewed 13,600 time-lapse photos from Colorado and Washington and labeled photos taken when trees had snow in their branches. This information provided the first glimpse of how snow-tree interactions could vary between climates and how that could affect water supply predictions.

"We, as skiers or snow enthusiasts, know that the snow in Colorado compared to Washington is really different. But, until now, there hasn't been an easy way to observe how these differences play out in the tree canopy," says Cassie Lumbrazo, a civil and environmental engineering doctoral student. "This project leverages volunteers to get some hard data on those differences. Another benefit is that it introduces our volunteers to how research works and what snow hydrology is."

Above: A time-lapse image from a camera on the AmeriFlux Tower in Niwot Ridge, Colorado. This image is archived in the PhenoCam network and is one of the images citizen scientists analyzed in this project. Courtesy of AmeriFlux Tower

By Sarah McQuate

Improving ROBOT GRIPPERS for manufacturing

A new tool helps assembly-line robots shift gears and pick up almost anything.

At the beginning of the COVID-19 pandemic, car manufacturing companies such as Ford quickly shifted their production focus from automobiles to masks and ventilators. To do so, these companies relied on people working on an assembly line. It would have been too challenging for assembly-line robots to make this transition because they are tied to their usual tasks.

Theoretically, a robot could pick up almost anything if its grippers could be swapped out for each task. To keep costs down, these grippers could be passive, meaning grippers pick up objects without changing shape. But passive grippers can't adjust to fit the object they're picking up, so traditionally objects are designed to match a specific gripper.

"The most successful passive gripper in the world is the tongs on a forklift. But the trade-off is that forklift tongs only work well with specific shapes, such as pallets, which means anything you want to grip needs to be on a pallet," says Jeffrey Lipton, an assistant professor of mechanical engineering. "Here we're saying 'OK, we don't want to predefine the geometry of the passive gripper.' Instead, we want to take the geometry of any object and design a gripper."

Lipton and other UW researchers have created a new tool that can design a 3D-printable passive gripper and calculate the best path to pick up almost any object. The team tested this system on a suite of 22 objects — including a 3D-printed bunny, a doorstop-shaped wedge, a tennis ball and a drill. The designed grippers and paths were successful for 20 of the objects. Two of these were the wedge and a pyramid shape with a curved keyhole – shapes that tend to be especially challenging for multiple types of grippers to pick up.

One limitation of this method is that passive grippers can't be designed to pick up all objects. While it's easier to pick up objects that vary in width or have protruding edges, objects with uniformly smooth surfaces, such as a water bottle or a box, are tough to grasp without any moving parts. Still, the researchers are encouraged by the progress so far, especially with some of the more difficult shapes.

"We still produce most of our items with assembly lines, which are really great but also very rigid. The pandemic showed us that we need to have a way to easily repurpose these production lines," says Adriana Schulz, an assistant professor in the Paul G. Allen School of Computer Science & Engineering. "Our idea is to create custom tooling for these manufacturing lines. That gives us a very simple robot that can do one task with a specific gripper. And then when I change the task, I just replace the gripper."

Above: Researchers tested their system on a suite of 22 objects, some of which are shown here.

FIRST SUCCESSFUL ADAPTIVE PROSTHETIC SOCKET

Engineering researchers and clinicians work together to develop the first auto-adjusting socket, giving people with limb amputation a new level of freedom.

By Lia Unrau

People with limb amputation struggle with the comfort, fit and function of their prosthesis on a daily basis. Maintaining a secure, comfortable fit has been notoriously tricky. Natural volume changes in the residual limb throughout the day often cause users to add or remove padding to tweak the fit after sitting, standing or moving.

Now, a team of UW engineers and clinicians led by Joan Sanders, a professor of bioengineering, has solved this problem: They've created a socket that automatically changes size as the user's limb changes size.

Research participants who tested the self-adjusting socket say that the new hands-free adaptive socket solves their biggest challenge.

"I don't have to think about my socket, if I should stop and take my prosthesis off to add or remove socks," says a user who tested the auto-adjusting socket. "Everything is taken care of. I can focus on my life, what I am doing, playing with my kids. This is an amazing technology."

Sensors and motor-driven panels built into the socket work together to expand or tighten the socket's fit. The auto-adjustments are small, frequent and even undetectable to users, maintaining their preferred fit to within a fraction of a millimeter during cycles of walking and sitting. Following several successful lab tests, the auto-adjusting socket is now being tested by users at home, and a new clinical trial is under way.

The new socket created by UW researchers automatically changes size as the user's limb changes size.

BREAKTHROUGHS

Lasers trigger magnetism in atomically thin quantum materials

UW researchers have discovered that light — in the form of a laser — can trigger a form of magnetism in a normally nonmagnetic material. This magnetism centers on the behavior of electrons. These subatomic particles have an electronic property called "spin," which has potential applications in quantum computing. The researchers found that electrons within the material became oriented in the same direction when illuminated by photons from a laser.

People enter a 'dissociative state' when using social media

In a recent study, UW researchers observed how participants interacted with a Twitter-like platform to show that some people enter a state of dissociation similar to daydreaming while scrolling. The team has also designed intervention strategies that social media platforms could use to help people retain more control over their online experiences.

Using sound waves to move 'excitons'

A UW research team has developed a method of using soundwaves to move subatomic quasiparticles known as "excitons" a greater distance than ever before possible. The team's innovations lead the way to development of a new type of computing circuit that is faster and more energy efficient, using light and quantum phenomena to store, process and transmit information.

Harvesting thermal energy to power wearable electronics

Wearable electronics, from health and fitness trackers to virtual reality headsets, are part of our everyday lives — but finding ways to continuously power them is a challenge. UW researchers have developed an innovative solution to this challenge: a wearable thermoelectric device that converts body heat to electricity.

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

FUSION POWER

By Amy Sprague and Sarah McQuate

THANKS TO ADVANCEMENTS BY UW LABS AND SPINOFFS, FUSION ENERGY IS TAKING OFF.

Nuclear fusion offers the potential for a safe, clean and abundant energy source. This process, which also powers the sun, involves plasmas — fluids composed of charged particles — being heated to extremely high temperatures so that the nuclei fuse together, releasing energy. A major challenge to performing this reaction on Earth is the dynamic nature of plasmas, which must be controlled to reach temperatures that allow fusion to happen.

While fusion energy has been decades in development, the current moment is offering vast advancements in computing power, which is becoming robust enough to run the modeling needed to resolve outstanding issues.

In Aeronautics & Astronautics (A&A), researchers are pursuing two different approaches to compact, cost-effective fusion energy. As plasmas need to be formed to stably undergo sustained fusion, each lab's strategy involves a different shape and device. The HIT-SI Lab, led by senior research scientist Chris Hansen, takes advantage of the natural property of plasmas to self-organize and uses a current drive to keep the plasmas moving in a specific shape. In contrast, the Flow Z-Pinch Lab, led by A&A Professor Uri Shumlak, forms and compresses plasma in a column, the Z-Pinch, with plasma flowing along its length to stabilize it.

And investment in fusion energy is taking off. Everett-based Helion recently announced a $500 million round of investment with the potential for $1.7 billion more. UW spinoff Zap Energy landed close to $200 million, and A&A's fusion labs have received more than $5 million of funding over the past two years.

BOOSTING COMPUTING POWER

Plasma modeling is vital to unlocking plasma's potential. It's also extremely challenging due to the complex physics involved. Current methods require tradeoffs between speed, computing power and fidelity. The National Science Foundation has invested close to $1 million in A&A labs to develop optimized methods that can help avoid these tradeoffs — achieving high fidelity models with relative speed and low computing power.

In addition to the Flow Z-Pinch Lab, Shumlak leads the Computational Plasma Dynamics Lab. There, researchers are focused on targeting higher resolution and higher fidelity models only where the local conditions require it, which will accelerate simulations and facilitate studying plasma systems in greater detail.

Along with Benj Conway and Brian Nelson, a research professor emeritus of electrical and computer engineering, Shumlak has co-founded Zap Energy, a UW spinoff company building an inexpensive, compact, scalable fusion reactor. At Zap, they're exploring what's possible to model with limited computing power by assembling a hierarchy of models.

"Not only will we be able to do plasma simulations faster, but now simulations that we previously couldn't do will become possible on devices from a laptop to a supercomputer," Shumlak says. "It opens up new possibilities of deeper understanding and development of plasma science and technologies."

In the HIT-SI Lab, Hansen is teaming up with Steve Brunton, a professor of mechanical engineering, to use machine learning to better predict plasma behavior by identifying simplified models.

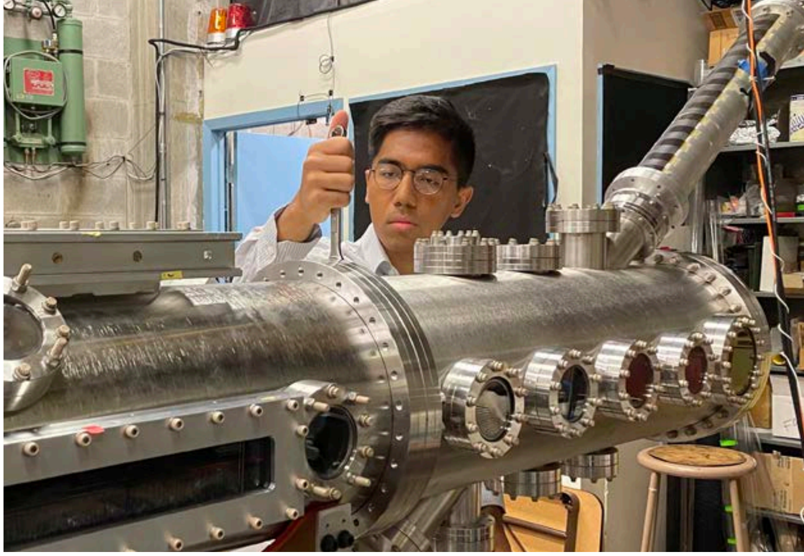
"One of the primary challenges to understanding and predicting plasmas is the huge range of scales involved," Hansen says. "For example, the evolution of a solar flare 60,000 miles across can depend on plasma dynamics on the scale of a few feet, about 10 million times smaller than the primary structure."

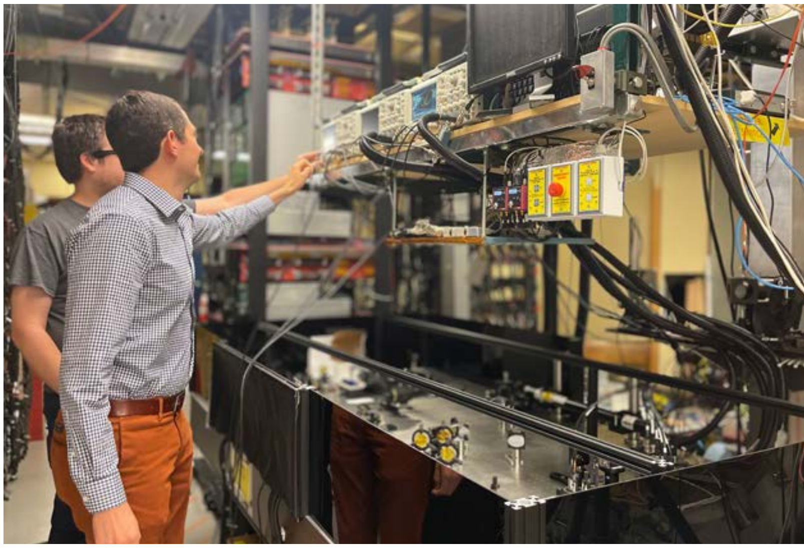
Resolving issues of scale has not been technologically possible to date. Massive supercomputers are needed to run complex computer models for even just approximations. But new methods are creating in-roads, allowing researchers to bypass noise and focus on the specific problems they're trying to solve.

DRAWING FROM COMPUTER GAMING GRAPHICS

In the HIT-SI Lab's fusion reactor, plasmas naturally organize into a doughnut-shaped object, similar to a smoke ring. These plasmas last only a few thousandths of a second, and the research team needed a faster, more efficient technology to run their control systems. They found a solution in an unlikely source: a computer graphics card, or GPU.

"The GPU gives us access to a huge amount of computing power," says A&A research scientist Kyle Morgan. "This level of performance was driven by the computer gaming industry and, more recently, machine learning, but this graphics card provides a great platform for controlling plasmas."





Top: Doctoral student Aqil Khairi makes adjustments on the Z-pinch in the Flow Z-Pinch Lab. Bottom: Research scientists Kyle Morgan and Aaron Hossack in the HIT-SI Lab demonstrate the laser system used to measure plasma density. Photos by Amy Sprague and Kenn Curry

Using the graphics card, the team can fine-tune how plasmas enter the reactor, giving them a more precise view of what's happening as the plasmas form. This could potentially allow the team to create longer-living plasmas that operate closer to the conditions required for controlled fusion power.

"The biggest difference is for the future," says Hansen. "This new system lets us try newer, more advanced algorithms that could enable significantly better control, which can open a world of new applications for plasma and fusion technology."

The HIT-SI Lab's new set of switching power amplifiers, a $1 million gift from Eagle Harbor Technologies, also helps control the lab's fusion experiments.

"Our work involves a lot of power — we're talking 10-20 megawatts — that needs to be released very precisely on microsecond timescales in order to sustain the plasma in a controlled way," Hansen says. "We have partnered with Eagle Harbor for many years on their development of precision high-power systems like these that benefit not only our lab but fusion labs around the world. The donation of these prototypes is a major enhancement of our lab."

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Prize-winning collaboration

Professor Dawn Lehman served as the technical consultant on the Pulitzer Prize-winning media team at the Miami Herald.

By Brooke Fisher

Dawn Lehman

Over the past year, Dawn Lehman, a professor in civil and environmental engineering, has served as a technical structural engineering consultant to a team of investigative journalists at the Miami Herald. Last spring, the team received the 2022 Pulitzer Prize in Breaking News Reporting for its investigation into the partial collapse of Champlain Towers South.

After the partial collapse of the 12-story beachfront condominium in the Miami suburb of Surfside, Florida, which occurred in June 2021, Lehman began providing expert commentary to news outlets, including the Miami Herald, which is based in the Miami metropolitan area. Over the course of many months following the tragedy, the Miami Herald produced multiple in-depth stories about the partial collapse, relying on Lehman's expert insight.

In addition to studying photographs, videos, drawings, reports and permits, Lehman employed techniques to the forensic investigation that she typically uses for post-earthquake evaluation. This included the use of an advanced, validated nonlinear modeling approach to investigate different collapse scenarios. While it is still unknown what caused the collapse, she helped readers understand possible causes, identified structural vulnerabilities and discussed various partial-collapse scenarios.

"The Miami Herald team was first rate. Not only did I contribute my technical knowledge, but I co-authored one of the articles. Working with them, especially investigative reporter Sarah Blaskey, was one of the best experiences of my professional life," says Lehman.