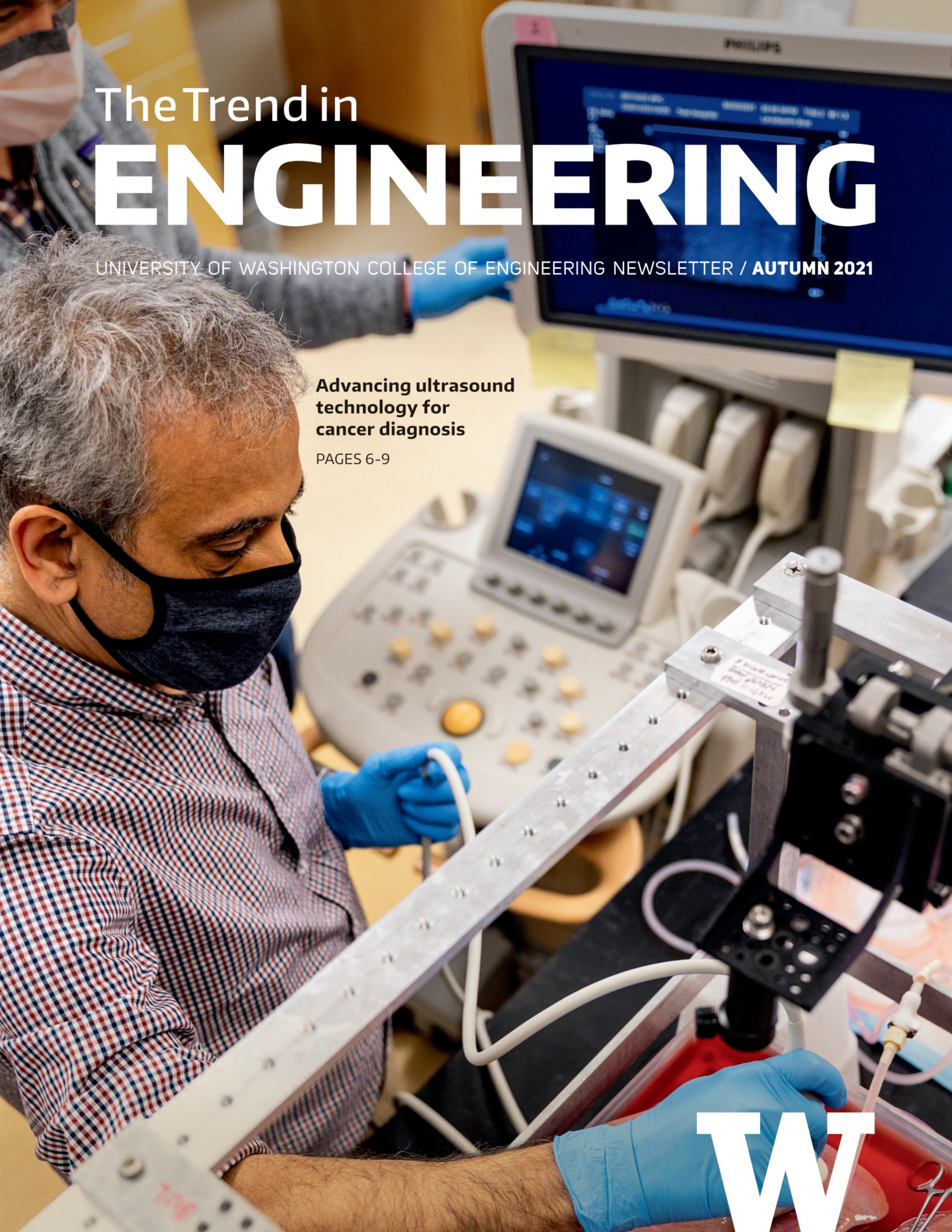


The Trend in ENGINEERING

UNIVERSITY OF WASHINGTON COLLEGE OF ENGINEERING NEWSLETTER / **AUTUMN 2021**

Advancing ultrasound technology for cancer diagnosis

PAGES 6-9

FROM THE **DEAN**

Together we are traveling a path to establish new norms not only for managing and living with COVID-19 over the long term but for transforming engineering education. This past year, I have had the privilege to work alongside faculty and staff on “Engineering Excellence for the Public Good,” our ambitious five-year strategic plan for the College. The plan, which provides a new vision for us, is truly a product of our community: more than 300 individuals from across the College and the UW, as well as many of you — our alumni, donors, friends and partners — participated in its development. Implementation planning is already underway, and I look forward to sharing the results of our collective work with you.

This issue outlines several examples of engineering excellence for the public good — from life-saving health-care technology developments to natural disaster research that can help inform policy. As a medical doctor and engineer, I’m particularly excited for you to meet Dr. Tueng Shen, who joined us last autumn as our first associate dean of medical technology innovation, and to read more about how the College and the UW School of Medicine are working together to expand health innovation.

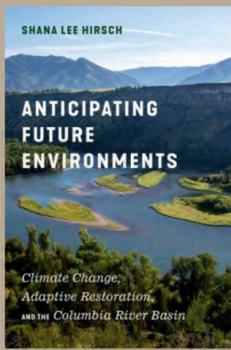
What defines our community? It’s our belief in possibility, our optimism and our determination. It’s a connection to one another near and far. It’s a drive that pushes us to tackle challenges and pursue progress. It’s the conviction that together we can create a world of good. Thank you for being a part of our engineering community.

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

Recent PUBLICATIONS

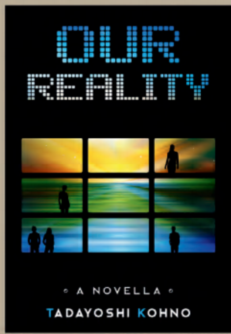
Discover something to read in these books by our faculty — including fiction, non-fiction and books for young audiences.

Anticipating Future Environments: Climate Change, Adaptive Restoration and the Columbia River Basin
Through exploring salmon habitat restoration science in the Columbia Basin, Human Centered Design & Engineering (HCDE) research scientist Shana Lee Hirsch considers how climate change affects the work of scientists involved with ecological restoration. UW Press, 2020.



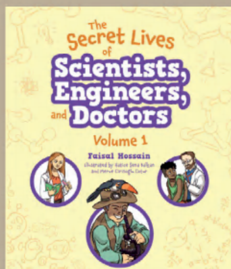
Flying Free: My Victory Over Fear to Become the First Latina Pilot on the U.S. Aerobatic Team
HCDE Professor Cecilia Aragon tells her story of attaining many firsts: from first Latina on the U.S. Unlimited Aerobatic Team to the first Latina full professor in the College of Engineering. Blackstone, 2020.

Our Reality
In this novella, Paul G. Allen School of Computer Science & Engineering Professor Tadayoshi Kohno invites readers to consider who benefits from technology – and who doesn't. Independently published, 2021.



Telling Stories: On Culturally Responsive Artificial Intelligence
The UW Tech Policy Lab – a collaboration of the Allen School, Information School and School of Law – presents a collection of stories about AI and its effects on future life. UW Tech Policy Lab, 2021.

The Secret Lives of Scientists, Engineers and Doctors
Civil & Environmental Engineering Professor Faisal Hossain's two-volume series for young readers showcases stories of the struggle, growth and success of a geneticist, a biologist, a cancer researcher and other STEM professionals. Mascot Books, 2021.



STRATEGIC PLAN 2021–2026

Engineering excellence for the public good

In the College of Engineering, we believe in engineering education that is academically meticulous, technically rigorous, collaborative and inclusive. Engineering education must prepare students to create significant societal impact, helping to shape a healthier and better world. In short, we are committed to engineering excellence for the public good.

Engineering for the public good pursues solutions to improve the quality of life for all — whether in infrastructure, technology, transportation, health, environment or manufacturing. As society's needs expand more rapidly than ever, where do we begin? We believe the answer starts with an inclusive engineering student experience grounded in technical excellence.

Over the next five years, we will focus our work in four areas:

1. **CREATING A HEALTHIER AND MORE JUST WORLD THROUGH OUR WORK:** We are committed to making the world a better place by producing the highest-quality graduates and research and engaging our community. We will augment our relationship with the health sciences to accelerate health-care solutions. We will distinguish ourselves from other engineering schools by focusing on high-impact interdisciplinary research and incentivizing collaborations that serve the public good.

2. **EMBRACING THE POWER OF DIVERSITY, EQUITY AND INCLUSION (DEI):** Organizations are most innovative when their members represent and draw upon a variety of backgrounds and respect the perspectives that arise from these differences. For these reasons, DEI is central to our mission of producing outstanding engineers. We commit to building a culture where all members thrive, are valued and feel a sense of belonging.

3. **TRANSLATING INNOVATION INTO IMPACT:** As part of a tier-one public research university with a global footprint, we are committed to turning our innovations into impactful real-world solutions. To increase technology translation, we plan to expand cross-disciplinary collaboration, grow opportunities for students and researchers to engage in entrepreneurship, and deepen our industry partnerships.

4. **INVESTING STRATEGICALLY IN OUR FUTURE:** The College provides a remarkable return on the resources entrusted to it by students and their families, the state of Washington, funding agencies and generous donors. We commit to strengthening our financial foundation and physical infrastructure, raising our visibility, investing in our people and increasing operational efficiencies through data-driven assessment.

The College has a long history of producing outstanding engineers; now is the time to push boundaries and broaden the impact of our work. Engineering excellence for the public good calls on all of us to work together — to the notion that "we" is indeed greater than "me." Our new chapter begins now. We hope you'll join us on our journey.

Learn more about our efforts and read our complete plan at engr.uw.edu/plan

Alberto Aliseda to serve as Mechanical Engineering's chair

In June, we welcomed PACCAR Professor of Mechanical Engineering Alberto Aliseda as Mechanical Engineering (ME)'s chair. An internationally recognized researcher whose work touches on fundamental areas of fluid dynamics with applications in human health, transportation and renewable energy, Aliseda fosters meaningful partnerships across campus and with industry.

Aliseda has been with ME since 2006. He holds degrees in aerospace engineering from the Polytechnic University of Madrid. He completed his Ph.D. in mechanical and aerospace engineering and did postdoctoral research in bioengineering at the University of California, San Diego. At the UW, he directs the Multiphase and Cardiovascular Flow Lab and the PACCAR Advanced Research Center.

Aliseda's vision for ME will propel the department from its current high level to even greater heights in the years to come. He is an experienced leader dedicated to advancing inclusive excellence in mechanical engineering education and research.

Lilo Pozzo named Materials Science & Engineering's interim chair

Boeing-Roundhill Professor of Chemical Engineering Lilo Pozzo has been named as interim chair of Materials Science & Engineering (MSE). Her two-year appointment began in September. Pozzo's dedication to leadership and service, plus her collaborations with MSE faculty to accelerate the pace of materials discovery, uniquely qualify her for this role.

Pozzo is committed to building more diverse, equitable and inclusive communities. She is dedicated to improving engineering education through curriculum development in entrepreneurship and service-oriented global engagement. She has been recognized with numerous awards such as the Department of Energy's Women in Engineering Clean Energy Education Award, the College of Engineering Teaching Award and the UW Outstanding Undergraduate Research Mentor Award.

Pozzo joined the College in 2007, after earning her Ph.D. in chemical engineering from Carnegie Mellon University. She maintains a thriving research program in the area of colloids, polymers and other soft-matter systems.

Mari Ostendorf appointed UW Vice Provost for Research

Mari Ostendorf, Endowed Professor of System Design Methodologies in Electrical & Computer Engineering, assumed the role of UW Vice Provost for Research in September. She will lead the UW's growing research portfolio, which has expanded from $996 million to $1.63 billion over the past 16 years.

A prominent researcher in speech and language technology, Ostendorf's work focuses on conversational artificial intelligence, exploring dynamic and context-aware models for understanding and generating speech and text in multi-party contexts. This research contributes to a variety of applications, from education to clinical and scientific information extraction.

Ostendorf earned her doctoral, master's and bachelor's degrees in electrical engineering from Stanford University, joining the UW in 1999 after several years as an electrical and computer engineering faculty member at Boston University. She had been serving as UW Associate Vice Provost for Research since 2017 and was elected to the National Academy of Engineering earlier this year.

MANAGE YOUR Trend subscription

Would you prefer to receive this newsletter by email? Opt out of receiving hard copies by emailing us at **trenduw@uw.edu**

IEB update

Design for the Interdisciplinary Engineering Building — which will promote a new level of collaboration and hands-on learning — has included an unprecedented number of student voices to focus on access and inclusivity.

The College of Engineering's Interdisciplinary Engineering Building (IEB) represents a new way of ensuring inclusive design through direct communication with the people who will spend many hours in it: engineering students. From their entry as first-year pre-major engineers, students will learn and study, tackle design and prototyping challenges, and find student services and opportunities for collaboration in the new facility. To make certain all voices were heard, architects and leaders spent considerable time and effort to gain student opinions.

The project is in the schematic design phase, during which requirements are translated into detailed designs. Once complete, the IEB — which will be situated on Stevens Way across from the HUB — will feature labs, classrooms, and project space for ideation and fabrication. Additionally, it will house engineering student organizations and will serve as a hub for student support services, such as the Engineering Academic Center. Thanks to student input, the building will be "of the students, by the students and for the students," says Dan Ratner, the College's associate dean for academic affairs.

According to IEB architect Billie Faircloth, partner and research director at KieranTimberlake, a critical priority for the project is for the building to be "inclusive, adaptable and collaborative" — something the architecture firm heard frequently in the more than 400 responses to a survey asking students what attributes of spaces are important to them.

In addition, student leaders from the College's Student Advisory Council and other student organizations participated in focus groups to discuss how the IEB could be welcoming to all students, especially underrepresented students.

Image courtesy of KieranTimberlake. Note: This rendering has been provided for the purpose of site development and building massing; it does not represent architectural design at this stage of development.

"The feedback gave us amazing insight into the ways that buildings and spaces support and promote equity," Faircloth says. Themes that emerged included the importance of access, representation, resources and values. These have become guiding principles for the design process.

"The IEB has to be inviting," says Karen Thomas-Brown, the College's associate dean for diversity, equity and inclusion. "Any student has to be able to walk in and feel that they don't have to prove that they belong there — especially students who are marginalized."

According to the student focus groups, ways the IEB could support diversity and inclusion range from indigenous land acknowledgement signage to representation in the building's artworks, to featuring practical, accessible spaces that offer storage, flexible seating and amenities such as a kitchenette to prepare food while students study and collaborate.

The IEB's design is also informed by the technological advances catalyzed by the pandemic. For example, some faculty have found that using breakout rooms is helpful when teaching a class via Zoom; this approach can be adapted in the physical environment by replacing traditional lecture style classrooms with flexible arrangements to accommodate small group and hybrid learning experiences.

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

HOPE and HEAL

By Chelsea Yates
Photos by Dennis Wise / University of Washington

ONE RESEARCHER COMBATS CANCER WITH THE HELP OF UW DOCTORS AND TOOLS DEVELOPED BY HIS COLLEAGUES.

On June 26, 2019, Barry Lutz received news no one wants to get: he had Stage IV colon cancer, as well as a mass in his liver.

“It was a complete surprise,” the associate professor of bioengineering says. The median age for colon cancer diagnosis in men is 68; Lutz was 44. Neither he nor anyone in his family had a history of colon cancer.

On the cover: Mike Averkiou prepares to study liver blood flow patterns in his lab.

This page: Manjiri Dighe, left, prepares the microbubble contrast agent while Mike Averkiou attaches an articulated arm to the bed to keep the ultrasound probe stationary during the scan. Barry Lutz, center, photographs the process.

Opposite page: Mike Averkiou and bioengineering Ph.D. student Connor Krolak use the microbubbles on a liver model.

Stage IV occurs when cancer in the colon has spread to other organs and tissues, most commonly to the liver. Chemotherapy may shrink the metastases, but at Stage IV it's rarely expected to cure the cancer entirely. The same goes for surgery. Typically it's not performed at this stage to cure patients but to give them more time to live.

Lutz's care team, led by oncologist Eddie Marzbani at UW Medical Center - Northwest, set to work. One of their immediate concerns was the mass in Lutz's liver. On that front, there was hopeful news: after a biopsy and scanning, the mass didn't seem to be cancerous. Lutz's diagnosis was changed to Stage III; he had surgery to remove the cancer in his colon and spent the next six months in treatment.

Lutz finished chemotherapy and on December 21, he had a CT scan to serve as a clean baseline for future monitoring. The next day, he moved with his family to Texas to be near relatives and to resume a sabbatical, which had been interrupted by his cancer diagnosis. Things were looking up.

But a few days later — on December 24 — Dr. Marzbani called with bad news. Instead of clearing him, the CT scan showed the mass in his liver had actually grown during chemotherapy.

Though the scan could detect the mass, it couldn't determine if the mass was malignant. So Lutz and his medical team were looking at a second surgery — in the liver this time. But it was risky. The mass appeared too big to remove completely and, if it was cancerous, the likelihood that cancer would spread was high. Plus, surgery could undermine Lutz's already weakened immune system.

At this point, Lutz says, everything seemed "pretty dark."

TINY BUBBLES

When bioengineering Associate Professor Mike Averkiou learned of his colleague's diagnosis, he immediately offered to help. Averkiou has been developing contrast-enhanced ultrasound (CEUS) imaging for cancer diagnosis — with special emphasis on liver cancer — for over twenty years, first at Philips Ultrasound, then at the University of Cyprus and now in his UW lab. He partners with Dr. Manjiri Dighe in UW Radiology to transfer CEUS research from the lab to the clinic.

For CEUS, microbubbles similar in size to red blood cells are injected into a patient's blood and travel through the bloodstream. They improve the contrast of images of organs and lesions during an ultrasound. Like contrast-enhanced CT and MRI scans, the most common imaging methods used today for cancer detection, CEUS provides doctors with important information about a tumor's size and location. It also offers something that CT and MRI scans can't: real-time quantifiable blood flow information.

Averkiou suggested a CEUS exam to characterize the mass in Lutz's liver based on its vascular patterns: if the mass was metastatic, these patterns would be distinctively different than if it was benign. This information could help Lutz's team decide whether or not to pursue the high-risk surgery.

ING

"Not only does this method give us complementary information to traditional CT/MRI scans, but it's less expensive and can be easily done at a patient's bedside. It doesn't expose patients to radiation and may be repeated as often as necessary."

BIOE ASSOCIATE PROFESSOR MIKE AVERKIOU

Although contrast-enhanced ultrasound imaging has long been used across Europe and Asia to detect and monitor cancers, it's fairly new to the U.S., having just been approved by the FDA for oncology (and only for liver cancer) in 2016. UW Medicine is one of the few sites in the country to offer it. Averkiou hopes this will change and wider CEUS adoption will follow.

"Not only does this method give us complementary information to traditional CT/MRI scans, but it's less expensive and can be easily done at a patient's bedside," he says. "It doesn't expose patients to radiation like CT scanning does and may be repeated as often as necessary. It's not possible for a patient to have CT scans every three to four weeks to monitor cancer, such as when the patient is undergoing chemotherapy. That would be too much radiation."

Based on the blood activity Averkiou was able to image and quantify, he determined that the mass was indeed a metastasis — critical information that led Lutz's care team to biopsy and characterize the tumor to identify a new course of treatment.

ONCOPLEX TESTING AND IMMUNOTHERAPY

The biopsy confirmed Averkiou's findings, and Lutz's care team contacted doctors Colin Pritchard, Eric Konnick and Steve Salipante in UW Lab Medicine & Pathology to run several tests, including the UW-OncoPlex panel. Developed by Pritchard, Salipante and collaborators, UW-OncoPlex is a genetic test used at UW Medicine and elsewhere to determine if immunotherapy or other targeted therapies might be an option for patients like Lutz. Immunotherapy facilitates the body's own immune system to recognize, control and eliminate cancer cells, potentially providing long-term cancer control.

The tumor was growing fast and time was running out, so while waiting for test results, Lutz's care team scheduled surgery to remove it and give him a bit more time to live. The night before the surgery, the team received the results: Lutz was a good candidate for immunotherapy.

"Based on the CEUS findings we made the critical decision to cancel the operation and pursue immunotherapy," Lutz says. "Our rationale was surgery won't save me because without an effective systemic treatment, tumors will likely pop up somewhere else, so we'll do therapy and monitor the tumor. If the therapy works on this tumor, it will likely work on metastases we can't see."

Lutz started immunotherapy on February 26, 2020. He flew back and forth between family in Austin and treatments in Seattle during the spring and summer of 2020 so his team could monitor the tumor by both CT scan and CEUS.

The news at first was disappointing: neither showed signs of tumor shrinkage, implying that the immunotherapy wasn't working. But after only the second round, CEUS revealed something that the CT scan couldn't.

"It showed that blood flow into the tumor was considerably reduced," Averkiou explains. "This meant that, even though it hadn't changed size, the tumor was regressing."

Cautiously, Lutz began to feel hope.

"If we had relied only on the CT scans, we may have concluded that immunotherapy wasn't working since the tumor wasn't getting smaller. I would've thought we were teetering on the edge and that the tumor could start growing again any time," he says. "Would we have changed therapy or stopped all together? I don't know. Because of the ultrasound, we stayed the course, and I enjoyed time with family with more optimism."

The team continued monitoring the tumor through treatment. It never shrank, but it also never regained blood flow. In September 2020, Dr. Jonathan Sham of the UW Liver Tumor Clinic removed it.

"It was softball-sized and totally dead, just as the ultrasound showed," Lutz recalls.

Today, a cancer-free Lutz is back in Seattle. He recently began a new project with Steve Salipante from the UW Lab Medicine & Pathology team; during his UW-OncoPlex testing the two discovered shared research interests. And Lutz continues to receive CEUS to watch that no tumors have returned.

"The contrast enhanced ultrasound and the UW-OncoPlex panel helped save my life," he says. "I have a lot to be thankful for at UW Medicine — from oncology to surgery and two great UW technologies. They all came together to give me a real gift."

Opposite page, top left: Krolak and Averkiou examine Lutz's lesion. Bottom left: Bioengineering Ph.D. student Sara Keller holds a vial of microbubbles ready for use in an experiment. Bottom right: An ultrasound scanner on a liver model.

This page: Averkiou, left, and Lutz, right, during a recent contrast-enhanced ultrasound of Lutz's liver. The image on the left side of the screen depicts microbubble contrast agents in the blood flow of Lutz's liver, confirming the absence of metastatic lesions. The image on the right is a normal ultrasound image showing liver tissue.

Monitoring CORAL MOVEMENT

By Sarah McQuate

Researchers apply engineering methods to track the imperceptible movements of stony corals.

Coral reefs are under threat from rising sea temperatures, ocean acidification, disease and overfishing, among other reasons.

Tracking signs of stress and ill health is difficult because corals behave differently depending on what's happening in their environment. Some scientists wonder if recording changes in coral movements over time could help monitor a coral reef's health.

This is not a straightforward task. Some coral species wave and pulse in the current, but others have rock-like skeletons and their movements may not be visible to the human eye. A new study led by aeronautics and astronautics (A&A) researchers borrowed image-analysis methods from engineering to spot the minute movements of a stony coral.

"In mechanics, we have to be able to measure imperceptible deformations in materials and structures to understand how much load these systems are experiencing and to predict potential failures," says A&A Associate Professor Jinkyu Yang. "We thought we could use these same analysis methods to study living systems, such as corals."

The team photographed stony corals, which have textured surface patterns. They took 200 images of a stony coral specimen in a tank at a rate of 30 photos per hour in daytime and nighttime conditions.

Above: A proof-of-concept study led by UW researchers has borrowed image analysis methods from engineering to spot the minute movements of a stony coral. Image by Michael Webster

Then they used two analysis methods to search for movement. Both compare subsequent images in a series to the first image. From here, the team could measure parameters such as pixel velocity, what parts of the coral are moving, and whether something is being compressed or stretched. The researchers further processed the photos to identify different types of movements occurring across the coral.

Overall, the researchers saw more activities under the nighttime conditions. They also saw movement for the tissue growing on the coral's stony skeleton as well as the coral polyps, though the polyps had larger movements.

"Corals often feed more at night by expanding their polyps and using their tentacles to catch zooplankton prey, and here we are able to quantify these nocturnal movements," says Hollie Putnam, assistant professor of biological sciences at the University of Rhode Island. "This application of engineering techniques and analyses to assess subtle and dynamic movements can transform our understanding of coral behavior and physiology, which is critical as corals are under threat."

The team plans to work with more coral species. Ultimately, the goal is to make the technique useful for determining potential changes in coral health under different circumstances.

"One investigation that should be considered is looking at how coral tissue motion changes upon exposure to pollutants, such as chemical dispersants and oil," Yang says. "Also this method could be used to monitor coral reefs by using satellite images or pictures taken by citizen scientists."

ARGUING on the internet

UW researchers study how to make online arguments productive.

UW researchers want to understand why people get into online disagreements in order to develop potential design interventions that make interactions more productive.

"People want to have difficult conversations online," says Amanda Baughan, a doctoral student in the Paul G. Allen School of Computer Science & Engineering. Her team conducted local and nationwide surveys and identified technological design interventions based on their findings.

Many survey participants shared that they avoid online arguments. But participants also wanted to have online discussions about topics including politics, ethics, religion and race. When participants had difficult conversations online, they preferred text-based platforms over image-based platforms. They also preferred having discussions in private chats.

To make online interactions more productive, researchers came up with 12 recommendations for platforms, including:

- Democratizing: Allowing community members to use reactions, such as upvoting, to boost constructive comments or content.
- Humanizing: Reminding users that they are interacting with other people by preventing them from being anonymous, increasing their profile picture size, or providing more details about them.
- Channel switching: Providing users with the ability to move a conversation to a private space.

The researchers hope to deploy these interventions to see how they impact online conversations. But first, they say, social media companies should consider the purpose of the interaction spaces they've created and whether their platforms are meeting those goals.

Photo by Conscious Design / Unsplash

GRASSES CLEAN toxic soil

Genetically engineered switchgrass cleanses soil of pollutants left by military explosives.

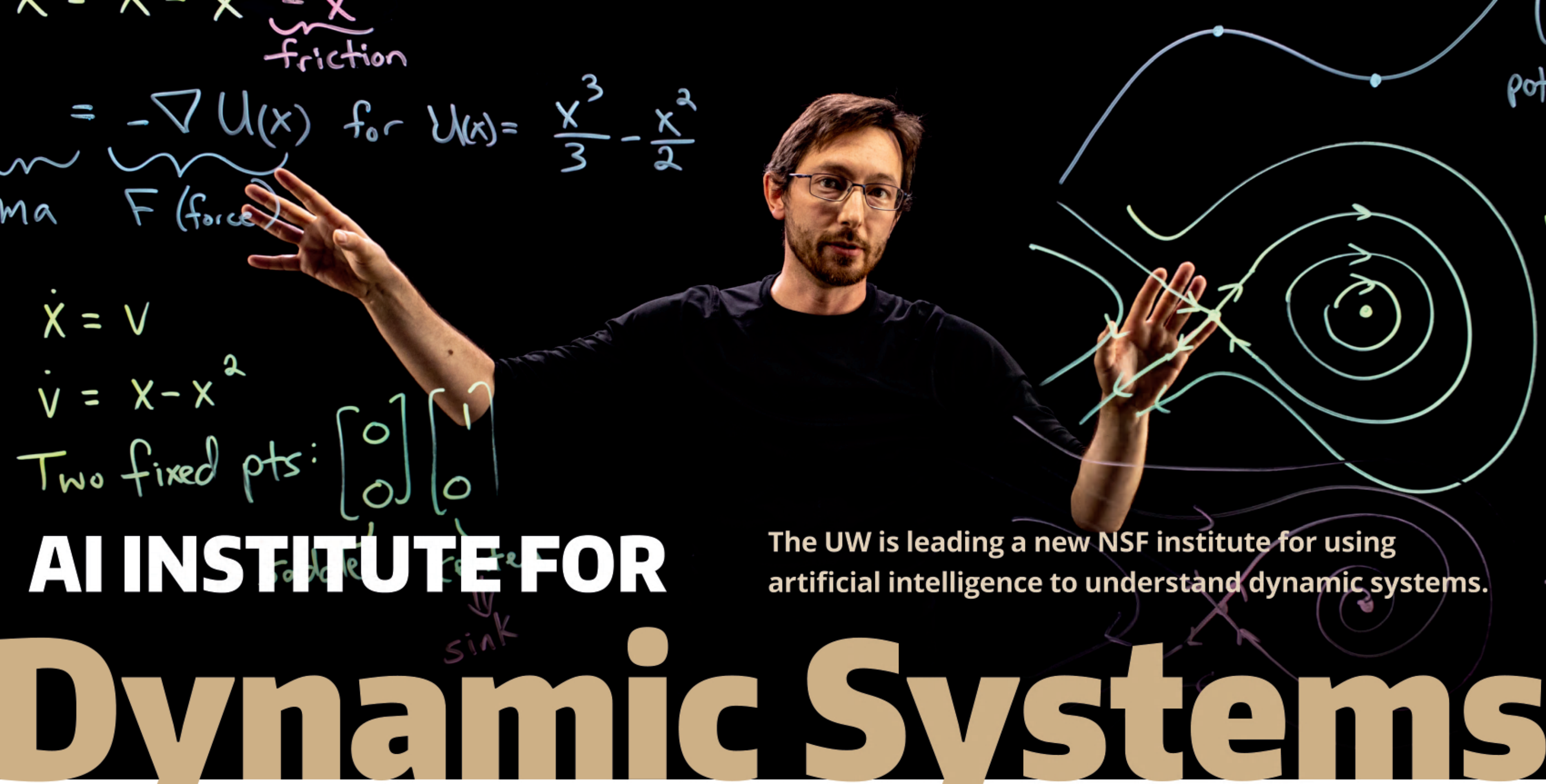
Large swaths of U.S. military land are covered with munitions components, including the explosive chemical RDX, which is toxic to people and can cause cancer. It also doesn't naturally break down and can contaminate groundwater. Civil and environmental engineering (CEE) researchers are part of a team that has engineered a grass that removes RDX from soil. They've demonstrated that, over three years, their switchgrass could break down RDX at a New York state military range.

"Our lab's expertise is in genetic engineering plants so that they can degrade pollutants," says CEE Professor Emeritus Stuart Strand. "The goal is to prevent cancer-causing chemicals from contaminating groundwater beneath active, live-fire training ranges by planting these grasses in and around target areas."

Researchers inserted genes from a soil bacterium that has evolved to break down RDX into switchgrass. They then compared three conditions — no plants, non-genetically engineered grass and engineered grass — on plots containing RDX at a typical concentration found in contaminated sites. After three years, excess water from the plots with the engineered grass contained lower levels of RDX than the other plots. Additionally, the engineered plants had little or no RDX in their tissues, suggesting that these grasses were metabolizing this chemical.

This is the first time genetically engineered plants have been used in the field to remove pollutants resistant to degradation, according to the researchers.

Above: UW researchers Ryan Routsong, left, Long Zhang, center, and Stuart Strand, right, genetically engineered switchgrass to break down the explosive chemical RDX using genes from a soil bacterium. Photo taken in 2018 by Mark Stone / University of Washington



AI INSTITUTE FOR Dynamic Systems

The UW is leading a new NSF institute for using artificial intelligence to understand dynamic systems.

By Sarah McQuate

The UW will house a new artificial intelligence research institute thanks to funding from the National Science Foundation (NSF). The AI Institute for Dynamic Systems will focus on fundamental AI and machine learning theory, algorithms and applications for real-time learning and control of complex dynamic systems, which describe chaotic situations where conditions are constantly shifting and hard to predict.

"The engineering sciences are undergoing a revolution that is aided by machine learning and AI algorithms," says institute director J. Nathan Kutz, a professor of applied mathematics. "This institute brings together a world-class team of engineers, scientists and mathematicians who aim to integrate fundamental developments in AI with applications in critical and emerging technological applications."

Researchers know the basic physics principles behind dynamic systems, which include situations such as turbulence or how the body recovers from an injury. But these scenarios often happen on multiple timescales at once and can include many types of physics, making it hard for researchers to understand exactly what's going on.

The overall goal of this institute, which will receive about $20 million from the NSF over five years, is to integrate physics-based models with AI and machine learning approaches to develop data-enabled efficient and explainable solutions for challenges across science and engineering. In addition to research, the institute will focus on education and training. It will provide open-source educational materials including lectures, data and code packages, plus AI ethics training.

"Some of our questions include: Can we develop better machine-learning technologies by baking in and enforcing known physics, such as conservation laws and symmetries?" says institute associate director Steve Brunton, an associate professor of mechanical engineering. "Similarly, in complex systems where we only have partially known or unknown physics — such as neuroscience or epidemiology — can we use machine learning to learn the 'physics' of these systems?"

The UW is partnering with several regional institutions — the University of Hawaii at Mānoa, Montana State University, the University of Nevada Reno, Boise State University, the University of Alaska Anchorage and Portland State University — as well as Harvard University and Columbia University.

"We are so excited to bring together a critical mass of amazing and innovative researchers from across the U.S.," Brunton says. "We also have a deep connection with industry partners, such as Boeing, which provides us with an incredible opportunity to make sure that we are focused on important and relevant problems and that our technology will actually be used."

The UW is also a partner institution on another newly announced NSF institute, the AI EDGE Institute, which is led by Ohio State University. The goal of this institute is to design future generations of wireless edge networks that are highly efficient, reliable, robust and secure.

Above: Steve Brunton uses a lightboard to create educational and research videos focusing on key aspects of AI and machine learning for engineering dynamical systems and control. As part of the institute's educational component, this video content will be available online. Photo by Dennis Wise / University of Washington

Learn more at dynamicsai.org

ADVANCING ENGINEERING AND SCIENCE

UW Engineering researchers are elected to the National Academy of Sciences and to the Washington State Academy of Sciences.



From left to right: Anna Karlin, Kristi Morgansen and Tueng Shen.

Paul G. Allen School of Computer Science & Engineering Professor Anna Karlin has been elected to the National Academy of Sciences, which recognizes members for their distinguished and continuing achievements in original research. Karlin, who holds the Bill and Melinda Gates Chair in the Allen School, works in theoretical computer science. Her research centers on designing and analyzing certain types of algorithms — such as probabilistic algorithms, which incorporate a degree of chance or randomness, and online algorithms, which can handle input delivered in a step-by-step manner. She also works in algorithmic game theory.

Karlin was elected to the Washington State Academy of Sciences this year, as was Kristi Morgansen, professor and chair of aeronautics and astronautics, and Tueng Shen, Associate Dean of Medical Technology Innovation in the College of Engineering and the School of Medicine. The state's Academy honors scientists, physicians and engineers for their outstanding record of scientific achievement and ability to bring the best available science to bear on issues within the state of Washington.

TURNING A SINGLE PHOTO INTO A VIDEO

How much more epic would that vacation photo of Niagara Falls be if the water were moving? Allen School researchers can make that happen.

Paul G. Allen School of Computer Science & Engineering researchers have developed a deep learning method that animates flowing material, including waterfalls and clouds. This technique produces a short video, giving the impression of endless movement.

"What's special about our method is that it doesn't require any user input or extra information," says Allen School doctoral student Aleksander Hołyński. "All you need is a picture. And it produces as output a high-resolution, seamlessly looping video that quite often looks like a real video."

Developing a method that turns a single photo into a believable video has been a challenge for the field.

The team's system predicts how things were moving when a photo was taken and uses that information to create the animation. Researchers trained a neural network with thousands of videos. Their system uses that information to determine if and how pixels should move. Then it animates the photo through a method called "symmetric splatting," which predicts the future and the past for an image and then combines them.

Currently, the team's method works best for objects with predictable fluid motion.

"We'd love to extend our work to operate on a wider range of objects, like animating a person's hair blowing in the wind," Hołyński says. "I'm hoping that eventually the pictures that we share with our friends and family won't be static images. Instead, they'll be dynamic animations like the ones our method produces."

Above: Palouse Falls, Washington. Photo by Sarah McQuate / University of Washington

Research Impact

UW RESEARCHERS HELP DETERMINE CAUSE AND SCOPE OF DEADLY WINTER DISASTER IN UTTARAKHAND, INDIA.

By Sarah McQuate

The Uttarakhand region of India experienced a humanitarian tragedy on Feb. 7, 2021, when debris and water barreled down the Ronti Gad, Rishiganga and Dhauliganga river valleys.

The event began when a wedge of rock carrying a glacier broke off of a steep ridge in the Himalayan mountain range. The resulting debris flow destroyed two hydropower facilities and left more than 200 people dead or missing.

A self-organized coalition of 53 scientists, including two civil and environmental engineering (CEE) researchers, came together to investigate the disaster's cause, scope and impacts. Using satellite imagery, seismic records and eyewitness videos to produce computer models of the flow, the team determined that the flood was caused by falling rock and glacier ice that melted on its descent — not by a lake or diverted river. This information will help researchers and policymakers better identify emerging hazards in the region.

Above: The destroyed Tapovan Vishnugad hydroelectric plant after the devastating debris flow on Feb 7, 2021. Image by Irfan Rashid / Department of Geoinformatics, University of Kashmir

"On the morning of the event, I saw a headline about a disaster in the Himalayas," says CEE Assistant Professor David Shean. "I sat down at the computer and pulled up the satellite images that had been acquired that morning. When I saw the dust cloud moving down the valley, I started writing emails to other scientists asking if they were working on this. One email thread quickly became five, then 10, and the response effort consumed most of our waking hours for the next two weeks."

Initial hypotheses suggested a glacial lake outburst flood. But there are no glacial lakes large enough to produce a flood anywhere near the site, the team determined.

"Our access to high-resolution satellite imagery and research software and our expertise in satellite remote sensing were crucial to get a bird's-eye view of how the event unfolded," says CEE doctoral student Shashank Bhushan. "We worked with our French collaborators to coordinate satellite collections within days of the event and rapidly process the images to derive detailed topographic maps."

The researchers compared the images and topographic maps from before and after the event to document changes and reconstruct the sequence of events.

They tracked a plume of dust and water to a dark patch on a steep slope. The patch turned out to be the scar left by the 35 million cubic yards of missing rock and glacier ice — enough material to cover Washington, D.C., with a half-foot-deep layer. The researchers determined that this was the source of a giant landslide that triggered the cascade of events.

"We hope that lessons learned from this effort will improve our ability to respond to future disasters and guide policy decisions that will save lives."

CEE ASSISTANT PROFESSOR DAVID SHEAN

They also used the maps to learn more about the block of ice and rock, which fell over a mile before impacting the valley floor.

"To put this height in context, imagine vertically stacking up 11 Space Needles or six Eiffel Towers," Bhushan says.

During the fall, most of the glacier ice melted within minutes, and resulted in a huge volume of water associated with the flooding.

"This is highly unusual," Bhushan says. "A normal rock landslide or snow/ice avalanche could not have produced such huge volumes of water."

The team used satellite image archives to show that previous large ice masses had been dislodged from the same ridge and struck the same valley in recent years. The researchers suggest that climate change is likely increasing the frequency of such events, and that the greater magnitude of the latest disaster should be considered before further infrastructure development in the area.

"These high-mountain rivers are appealing for hydropower projects, and we need a better understanding of the full spectrum of potential high-mountain hazards," Shean says. "We hope that lessons learned from this effort will improve our ability to respond to future disasters and guide policy decisions that will save lives."

For Bhushan, the work has been personal.

"In general, doctoral research projects are very niche. I sometimes have a hard time explaining to my parents why measuring glacier dynamics is important," he says. "But due to the scale of this disaster, my family and friends back in India were very curious to know how this event unfolded, and they were expecting me to come up with an answer. These interactions provided me with a sense of belonging and motivation that some of my research can be of such immediate use to society."

Breakthroughs

Playing with plasma

Nuclear fusion involves heating plasmas to extremely high temperatures so that atoms fuse together. But getting plasmas hot enough can be challenging due to their dynamic nature. Aeronautics and astronautics researchers used a gaming graphics card to precisely control plasma formation in their prototype fusion reactor.

Using smartphones to detect bacteria

Bioengineering researchers used smartphone images to illuminate potentially harmful bacteria on skin and in the mouth. Their approach identifies microbes contributing to acne, plus bacteria that can cause gingivitis and dental plaques. This method may pave the way for quick, affordable at-home assessment of oral and skin health.

Let there be light

Electrical and computer engineering researchers are developing a computer chip that uses laser light instead of electricity. This chip could accelerate the computing speed and efficiency of AI and machine learning applications while reducing energy consumption. It will be over ten times more powerful than today's silicon-based microprocessors, the team says.

Technology to support kids' health

A King County, Washington, assessment revealed that infants from marginalized groups encounter the highest rates of infant mortality and lowest birth weights. So Human Centered Design & Engineering and School of Medicine researchers are developing a smartphone technology to provide accessible, culturally relevant activities and health recommendations to support child development.

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

LEADING AN INNOVATION PARTNERSHIP

Interview by Chelsea Yates | Photos by Dennis Wise / University of Washington

LONGSTANDING PARTNERS, THE UW COLLEGE OF ENGINEERING AND SCHOOL OF MEDICINE HAVE CREATED A POSITION TO EXPAND HEALTH INNOVATION. MEET DR. TUENG SHEN, THE FIRST TO SERVE IN THIS NEW ROLE.

The College of Engineering and the UW School of Medicine have a long history of working together to advance health care research and innovation. Last fall, the two schools took their partnership to a new level by developing a shared leadership position: associate dean of medical technology innovation. This position will bring together engineering and medical researchers to expand health innovation at the UW and build long-term relationships between researchers and industry, nonprofits and community organizations.

Dr. Tueng Shen, a professor of ophthalmology and adjunct professor in bioengineering and global health, is the first to serve in this new role. With degrees in engineering and medicine — Shen has a Ph.D. in medical engineering and medical physics from the Massachusetts Institute of Technology (MIT) and a M.D. from Harvard Medical School — and years of experience in patient care and technology innovation, she has worked throughout her career to bring together physicians and engineers to shape the future of health care.

The College of Engineering's Chelsea Yates recently spoke with Shen — who holds the Graham and Brenda Siddall Endowed Professorship in cornea research — about her path to engineering and medicine and how she's working to expand health innovation as associate dean.

What led you to study engineering and medicine?

I immigrated to the U.S. with my family when I was 18 years old, speaking only Chinese. In college I took a lot of math, physics, computer science and studio art courses while catching up on English. I realized the power of the languages of science and art in communicating with others.

I was certain about studying engineering but not sure about clinical medicine until my Ph.D. training at MIT when I was required to take an Introduction to Clinical Medicine course. Talking to patients gave me a new perspective about the potential impact of my research, and that resonated with me. I decided to pursue medical training after finishing my engineering degree. For me it was a great opportunity to learn a new language.

Why did you decide to focus on eye care?

In medical school I discovered that I loved surgery and was drawn to ophthalmology — a surgical subspecialty focused on improving vision with great impact on the quality of life. Plus, as a field, ophthalmology had a history of adapting new technologies very quickly and successfully. So it was a natural fit for me.

You've led several projects that bridge research technology and patient care. Tell us about some of them.

Early in my career at the UW, I partnered with engineering researchers to build a contact lens with wireless sensors that could monitor diseases like diabetes. This project continues today at Google. I've also worked with engineering colleagues, especially Buddy Ratner in bioengineering, to create biomaterials and build artificial corneas to help treat global blindness. Most recently we are exploring new ways to characterize corneal biomechanics using innovative ultrasound and imaging technologies developed by bioengineering researchers Matt O'Donnell, Ivan Pelivanov and Ricky Wang. These collaborations not only develop new technologies to improve patient care, but also create valuable training environments for our students to become tomorrow's leaders in industry, academia and medicine.

What drew you to the associate dean role?

The COVID pandemic has shown us how interconnected and interdependent we all are and how important it is for all of us to be healthy, both physically and mentally. And while scientists discovered vaccines at lightning speed, we also uncovered glaring health disparities. I believe we're entering a new era of health and health care, where commitment to health equity is a must. Medical technology innovation is critical to solving this global challenge. Engineers and physicians must be at the heart of this transformation together. I feel very fortunate to serve in this role and help guide this work.

The UW is poised to be a leader in health equity and innovation. We're located in a vibrant innovation community, and we have excellent engineering and medical schools — both of which have been my home since I came to the UW in 2003. I believe that building more bridges across the schools will catalyze innovation and transform health care. There are excellent cross-disciplinary programs already in place, such as Engineering Innovation in Health and the Master of Applied Bioengineering program. I'm eager to make broad collaborations the norm at the UW.

How does having an engineering background enhance your clinical practice, and how does being a medical doctor impact your work as an engineer?

To this day I practice medicine with the mindset of an engineer. As a physician, I'm constantly asking if our discoveries and solutions are meeting the needs of our patients. It can seem that engineers and clinicians speak different languages. As a clinician engineer, my ability to communicate across disciplines has allowed me to always position my research at the intersection of engineering and medicine.

What advice do you have for engineering students and faculty who want to deepen their experience with health care innovation?

Remember engineers and clinicians share the same goal: to help people and to improve society. For engineering students, exposure to health-care environments, such as in clinics and operating rooms, will help you communicate with clinician partners. I plan to create more opportunities for engineering students to explore the world of medicine. I'm here as a resource and my role is to facilitate.

Tueng Shen, left, in her lab with bioengineering graduate student Mitchell Kirby.

GRADUATE RESEARCH TAKES FLIGHT

By Amy Sprague

Sensing research is aboard the 2021 Boeing ecoDemonstrator, giving students an opportunity to test algorithms and models during flight.

BIG WINS for student robotics teams

Engineering teams Husky Robotics and Advanced Robotics at the University of Washington (ARUW) soared at this summer's competitions. In June, Husky Robotics, which designs and builds mock Mars rovers, finished as the top U.S. team in the 2021 Virtual University Rover Challenge. Teams generally test their rovers against rivals in the Mars-like environs of the Utah desert. Due to COVID-19, this year Husky Robotics set up their missions on a UW recreation field following detailed instructions from the judges.

That same month, ARUW placed first at the North American RoboMaster University League Competition at Texas A&M University. For RoboMaster competitions, teams design and build seven robots, each of which serves a unique purpose and works alongside the others to launch projectiles at opposing team's machines during a match. The team with the fewest hits at the end of a match wins. ARUW won the competition after five rounds.

Opposite page: Husky Robotics, left, and ARUW, right.

Aeronautics and astronautics (A&A) doctoral student John Berg is well versed in testing flight sensing models. As part of A&A's Nonlinear Dynamics and Control Lab (NDCL), he is the go-to for hardware integration, moving the lab's models from theory to practice.

Berg has tested sensor data on wing models for A&A's 3X3 Low-Speed Wind Tunnel and Kirsten Wind Tunnel. This year, his research team has the opportunity to test its models in real flight conditions.

This project is one of approximately twenty new technologies chosen to fly on the 2021 ecoDemonstrator, a Boeing 737-9 operated in partnership with Alaska Airlines. Boeing's ecoDemonstrator program, which first flew in 2012, has tested nearly 200 new technologies that enhance flight safety and sustainability.

LOCATION, LOCATION, LOCATION

More accurate sensing in flight creates more responsive control for a smoother ride and increased fuel efficiency. Sensors placed in strategic locations on aircraft capture information, such as gust speed and orientation relative to the airflow.

"We need to be precise about where we place these sensors to get the best data," says A&A graduate student Burak Boyacıoğlu, who has worked extensively on getting sensor locations right. "The answer is not adding more sensors because the costs add up."

More sensors also means more data and more hard-wiring, which may add weight to the plane. Boyacıoğlu says that the key to get the best information is sampling the data systematically and positioning the sensors in optimal places. He lets Berg and other team members know where to place sensors on the wings then tests the data to analyze and adjust the locations.

Opposite page: A rendering of this year's ecoDemonstrator plane, a Boeing 737-9 operated by Alaska Airlines. Courtesy of The Boeing Company.

TAMPING DOWN THE NOISE

A&A doctoral student Kimber Hinson aims to make sensing more accurate by accounting for the noise the sensors pick up and incorporating it into a dynamic model. Noise can include air pressure, friction, electromagnetic interference or temperature — all of which can skew sensor readings.

"You have to use several methods to measure the same thing," says Hinson, who is also a guidance, navigation and control engineer at Boeing. "If you understand the noise that's in each measurement and the system as a whole, then you can more accurately estimate how to control for it and develop more accurate algorithms."

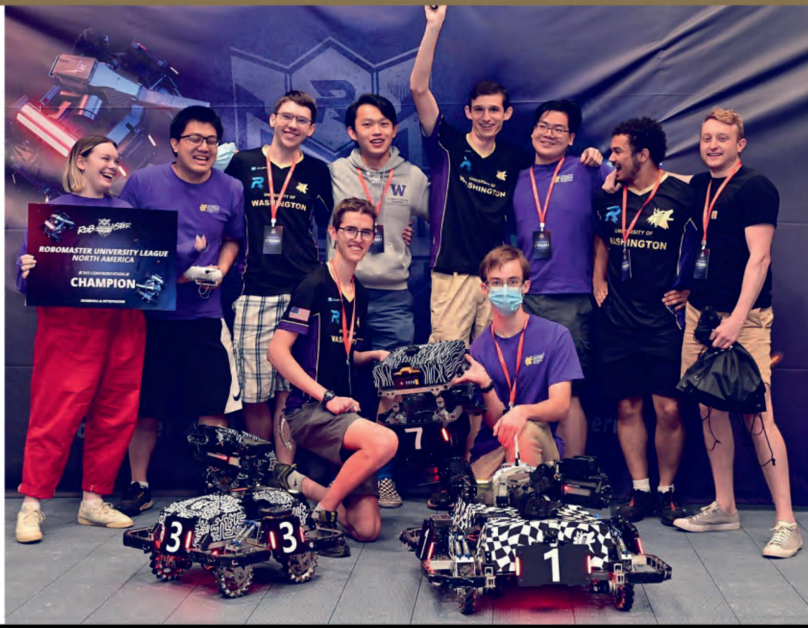
Hinson's modeling and Boyacıoğlu's measurements complement each other. "While Burak is measuring actual values, I am looking at model estimations, and we can compare those values," she explains. "The accuracy of these estimations will tell us if we need to adjust the model to account for additional forces or noise that we cannot measure."

EXTRAORDINARY OPPORTUNITY TO ADVANCE FLIGHT

"This project is extremely exciting because we are combining the theory of sensor placement and the noise covariance that our graduate students are advancing with a progression of wind tunnel testing, which is a huge advantage here at the UW," says A&A Chair Kristi Morgansen, who leads the NDCL lab. "To have earned a spot on the ecoDemonstrator to test our algorithms under actual flight conditions is invaluable to help us adjust our modeling."

Boeing is excited about the students' contribution as well.

"Our goal with this program is to accelerate innovation by working with partners and trying new technologies to create more sustainable aviation," says Paul McElroy, who manages ecoDemonstrator communications at Boeing. "We are thrilled to have this UW research on this year's airplane."



COLLEGE OF ENGINEERING
UNIVERSITY of WASHINGTON

371 Loew Hall, Box 352180
Seattle, Washington 98195-2180

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

Judy Mahoney
Associate Dean of Advancement

Heather Hoeksema
Senior Director of External Relations

Chelsea Yates
Associate Director of Content

UW Creative Communication
Graphic Design

FIND US ON SOCIAL

Facebook: **UWEngineering**
Twitter: **@uwengineering**
Instagram: **@uwengineering**

READ ONLINE AT
engr.uw.edu/news/trend

Send comments or address corrections to: trenduw@uw.edu

EVENTS

The following is a sample of upcoming free events in the College of Engineering. Check each online listing for updates and in-person and virtual attendance information. For more events, visit engr.uw.edu/calendar or contact departments directly.

Data Science Seminar Series

eScience Institute

BEGINNING IN OCTOBER, RUNS THROUGH SPRING 2022, 4:30 P.M.
escience.uw.edu/uw-data-science-seminar

Virtual and in-person lecture series featuring researchers from government, industry and academia addressing topics in applied data science from arts, humanities and sciences to methodological areas such as computer science, applied math and statistics.

Steve and Sylvia Burges Endowed Lecture

Civil & Environmental Engineering

OCT. 28, 4:00 P.M., Kane Hall
ce.washington.edu/news/lecture/burges

This annual lecture features distinguished civil and environmental engineering experts who are broadening the horizons of engineering students and professionals beyond the purely technical challenges of our times.

UW Space Symposium: Powering Space

Aeronautics & Astronautics

NOV. 5, 9:00 A.M. TO 6:00 P.M.
sparc.uw.edu

This virtual symposium brings together space researchers, policymakers and industry professionals, and will cover topics including space design for social good, power for propulsion, power for sustainable built environments and workforce development.

XR Day

Human Centered Design & Engineering

NOV. 18, 9:00 A.M. TO 6:00 P.M.
hcde.uw.edu/xr-day

An interactive conference for industry professionals, alumni, academics and students to explore the long-term potential in XR (augmented, virtual, and mixed realities) design and technologies through cross-disciplinary conversations and collaboration.

Boeing Advanced Research Center Seminar

Mechanical Engineering and Chemical Engineering

NOV. 23, 3:30 P.M.
me.uw.edu/news/seminar/barc

In a virtual and in-person lecture, Jill E. Seebergh, Senior Technical Fellow at Boeing Research & Technology, will offer career insights and discuss her work in chemical technologies to improve aircraft performance, manufacturing, and health and safety.

SAVE THE DATE

Engineering Exploration Night

JAN. 20, 2022
Alumni and students connect to discuss engineering careers and fields. Students meet with a diverse group of industry professionals in a "speed date" format. Each year, we seek engineering alumni from all disciplines.

Interested in participating? Email Zoe Bartholomew, zfinnb@uw.edu.