THE TREND IN ENGINEERING

Spring 2025

Peek inside the Washington Nanofabrication Facility

PAGES 14-15

From the Dean

"As I write, I'm balancing exciting developments — like this spring's soft opening of our incredible new Interdisciplinary Engineering Building and the joy of Admitted Student Preview Day — with sobering realities facing the College of Engineering.

The University and the College exist to serve the public through world-class education and cutting-edge research. Our ability to meet our mission is at risk due to significant uncertainty in state and federal funding. The state of Washington's sizable budget shortfall has led the University to take early action by implementing a hiring freeze and reducing discretionary spending, while proposed federal research funding cuts threaten our core operations. With 87% of the College's research expenditures coming from federal sponsors, potential reductions would significantly diminish our ability to conduct research, prepare engineers for the workforce and serve our community.

Painfully, we've had to cancel signature events like the Diamond Awards ceremony and Discovery Days, which would have welcomed 10,000 middle-schoolers from across Washington to campus. These decisions were not made lightly.

Looking ahead, we're focusing on what matters most: keeping our educational and research excellence at the forefront while shifting toward a sustainable operating model rather than pursuing growth. I'm committed to building stronger industry connections that can open new funding opportunities, while ensuring we retain our amazing faculty and staff.

But we cannot address these challenges alone. Your partnership is more important than ever. Here are a few ways you can help:

- Join the UW Alumni Association's organization UW Impact, **uwimpact.org**, to learn more about the issues facing the UW
- Invest your time, talent and financial support
- Partner with us to create opportunities for our students
- Work with us to expand industry partnerships

Universities aren't just educational institutions; they're economic engines and drivers of innovation. Together, we'll navigate these challenges and continue to advance engineering excellence for the public good.

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

Watch Kate Starbird's lecture online
▶ uw.edu/ufl

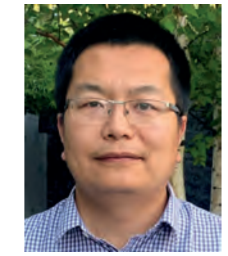
2025 University Faculty Lecture

Kate Starbird, a professor of human centered design and engineering and co-founder of the UW Center for an Informed Public, received the 2024 University Faculty Lecture Award. This annual award honors a UW scholar whose work has made a substantial impact on their discipline and on society at large.

It would be difficult to find a scholar whose findings are more relevant to their times than Starbird.

Her University Faculty Lecture, in February 2025, plumbed insights from more than decade of research revealing how online rumors, misinformation and disinformation get started, shared and spread during uncertain times — and how they are shaped by influence and improvisation.

Outstanding in their fields



Xiaodong Xu, a professor of physics and of materials science and engineering, has received the National Academy of Sciences Award for Scientific Discovery.

The award recognizes Xu's key contributions to the field of condensed matter physics. Applying scientific measurements using light and electricity, his work is advancing our understanding of unique behaviors in certain materials — in particular those just a few atoms thick.

One of Xu's key discoveries is the fractional quantum anomalous Hall effect, where tiny bits of electric charge can move in unusual ways without needing a magnetic field. This finding opens new areas of research into materials that could be useful for advanced technologies like quantum computers and electronics that work with tiny, special particles called "spins."

Corie L. Cobb, a professor of mechanical engineering and the Washington Research Foundation Innovation Professor in Clean Energy, was elected a fellow of the National Academy of Inventors.

Cobb's research lies at the intersection of manufacturing and engineered materials with a focus on renewable energy and environmental sustainability. She has advanced the commercialization and development of new manufacturing methods for semiconductors, energy storage and energy conversion materials.

The recipient of this highest distinction for inventors has 20 U.S. patents, seven U.S. patent applications and 45 international patents in the areas of additive manufacturing, materials processing, lithium-ion batteries and solar cells.

Diamond Dawgs

The College of Engineering honors four alumni with Diamond Awards for outstanding achievements and significant contributions in these areas:

Learn more about the 2025 Diamond Award recipients
▶ engr.uw.edu/da

Mekonnen Kassa
B.S. 1994, Mechanical Engineering
Principal Group Product Manager in Security, Microsoft

EMBRACING THE POWER OF DIVERSITY, EQUITY AND INCLUSION

Mekonnen Kassa made an epic journey from war-torn Ethiopia to major impact as a global technology mentor.

Paul Mikesell
B.S. 1996, Computer Science
Founder and CEO, Carbon Robotics

TRANSLATING INNOVATION INTO IMPACT

Paul Mikesell is the developer of scalable, reliable, low-cost media storage and is now applying the same innovative principles to revolutionize food production.

Gabriel P. López
Ph.D. 1991, Chemical Engineering
Distinguished Professor, Department of Chemical and Biological Engineering, University of New Mexico

CREATING A HEALTHIER AND MORE JUST WORLD

Gabriel López is a visionary educator and advocate dedicated to addressing health disparities and environmental justice through technological innovation.

Donna M. Sakson
B.S. 1982, Technical Communication (HCDE)
President, S&A Mosaic, Inc.

DEAN'S AWARD

Donna Sakson is a premier connector of people, information and jobs and a provider of advisory leadership to the UW and many other organizations.

STACKED MASTERS

By Ed Kromer

The College of Engineering's innovative new graduate degree programs provide working engineers the customizable building blocks to grow and thrive as industries evolve.

The UW College of Engineering is renowned for innovation in many fields: artificial intelligence, robotics, biomedical devices, nanofabrication and clean energy, to name a few.

Now you can add graduate education to this list.

The College offers a new type of master's degree that allows professional engineers to select from a menu of stackable certificate programs across a range of disciplines. Complete two certificates, plus an applied capstone project, to earn a "stacked" master's degree.

It sounds simple. But a stacked master's is a significant variation on traditional degrees. Both new stacked options — the Master of Science in Artificial Intelligence & Machine Learning (AI & ML) for Engineering and the Master of Engineering in Multidisciplinary Engineering — are the first such degrees at the UW and among the first anywhere.

"Stacked degrees, or 'incremental credentials,' are an innovative way forward in 21st century higher education that offers more flexible and modular education for professional learners," says Kima Cargill, the associate dean for academic affairs at the UW Graduate School. "While many universities are exploring stacking credentials, few have launched a comprehensive portfolio of programs at the scale of the UW College of Engineering."

Meeting market demand

Like any viable innovation, this one started with a need.

The College of Engineering has long met the demand for advanced learning with a wide array of traditional master's degrees.

But industries are evolving at the blistering pace of technology. And, for some engineers, evolving with these industries requires more expansive and diverse sets of expertise. This insight, developed in close partnership with industry leaders and the College advisory board, seeded the stacked master's programs.

"Industry is telling us that multidisciplinary engineering is the future and working professionals desire graduate education that can flexibly meet their unique career goals," says Cassady Glass Hastings, the College's director of new programs and innovation. "Stacked master's degrees seemed like a great opportunity to be innovative while meeting industry demand and the curricular flexibility that working professionals want."

Fast track

It can take many years to launch a new degree program in a large university — let alone new degree programs that cross disciplinary boundaries.

The stacked master's degrees, however, coalesced in only two. Once the UW Graduate School changed university policy to allow stacked degrees, Glass Hastings quickly cultivated an "ecosystem of stackability," ushering 18 new programs through the University's rigorous, 11-step approval process.

She says this effort was guided by the College's strategic commitment to innovate professional education and accelerated by departmental faculty and staff who quickly embraced the vision.

"We now have stackable certificate programs in seven of our academic units as well as new multi-department collaborations in fields that transcend disciplines, such as AI and battery engineering," says Glass Hastings. "And robotics is coming soon."

Flexibility is key

The essential component of both stacked master's degree programs is flexibility. In several dimensions.

Certificate class schedules are part-time and designed to accommodate full-time work. Many are offered online. And pacing is personalized. Program architecture allows up to six years to complete two certificates and a capstone. Students can enroll continuously or stop and start as personal and professional demands permit, spreading out the commitment of time and money required to earn a graduate degree. "The beauty of stackable certificates is that they allow you to upskill over time, earning a series of valuable credentials from the UW — and all learning applies toward a master's degree," Glass Hastings says. "You can start with one certificate program and see where it takes you."

The biggest source of flexibility, though, is the wide array of certificates to choose from.

The stacked master's degree in AI & ML for Engineering pairs a foundational certificate with your choice of four discipline-specific, data-intensive certificates.

The master's degree in Multidisciplinary Engineering offers even more flexibility to bundle any two of 15 stackable certificates across different disciplines — a set of building blocks that can be stacked in myriad combinations to meet career challenges and goals.

For instance, you might pair Aerospace Control Systems with AI & ML for Engineering. Or Modern AI Methods with User-Centered Design. Or Systems Engineering Leadership with Composite Materials and Manufacturing.

"You get to choose your own adventure," Glass Hastings says.

An industry capstone completes both degrees. The AI & ML for Engineering capstone project is team oriented and data intensive, while the Multidisciplinary Engineering capstone is an independent project often related to the student's organization or industry.

Expandable ecosystem

The ecosystem of building blocks that comprise the stacked master's degrees is designed to grow.

In addition to the initial certificate offerings of the stacked master's degree program, Glass Hastings is working to build out this interdisciplinary ecosystem across the College and beyond. A stackable certificate/degree in robotics is in the works. And the College has been invited to extend stacked degrees across the UW, pairing engineering certificates with certificates offered by the Information School and the Foster School of Business.

"The most exciting and pressing challenges in engineering today demand multidisciplinary solutions, and our new stacked master's degree program empowers students to tailor their education to tackle these complex problems head-on," adds Nancy Allbritton, dean of the College of Engineering. "By integrating expertise across disciplines, we are setting the trend for the future of engineering education and preparing graduates to lead innovation in an ever-evolving world."

BUILDING BLOCKS OF MODERN ENGINEERING

The College of Engineering offers 15 graduate certificates that can be uniquely stacked to earn two different master's degrees:

Master of Science in Artificial Intelligence & Machine Learning for Engineering – a timely program that teaches professional engineers to leverage AI and machine learning tools to solve complex engineering challenges.

Master of Engineering in Multidisciplinary Engineering – a one-of-a-kind degree that prepares engineers for a future where innovative solutions require the combination of skills in two or more disciplines.

The first step is enrolling in a certificate.

Learn more or apply online
▸ engr.uw.edu/stacked-masters

ENGINEERING HEART HEALTH

By Ed Kromer

A collaborative cohort of UW Engineering researchers is helping unlock the mysteries of the human heart at the Institute for Stem Cell and Regenerative Medicine.

Jennifer Davis was an early career kinesiologist looking to expand her understanding of muscle physiology in a biomechanics lab when she first encountered a human heart cell. Unlike other living muscle cells that appear static under a microscope, a heart cell *pulses*. Visibly. Rhythmically. A microscopic microcosm of the beating heart itself.

For Davis, it was love at first sight.

"*That's* what I'm going to work on," she decided on the spot.

Now an associate professor of bioengineering and pathology and interim director of the UW Institute for Stem Cell and Regenerative Medicine (ISCRM), Davis has dedicated her career to reversing an endemic malady of those pulsating heart cells that first captivated her.

She's in good company at UW Medicine's sprawling ISCRM (colloquially pronounced "ice cream"). This multidisciplinary convocation of researchers from around the world — organized into 150 interwoven labs representing 40 departments in the School of Medicine, the College of Engineering and several others — is advancing stem cell biology and regenerative medicine to enhance the human body's astonishing power to heal itself.

Like Davis, many of those researchers have been drawn to the cardiovascular system. It's not hard to see why. The human heart is the core of our very being, metaphorically *and* physiologically. A muscle of exquisitely complex architecture and profound importance, there are still myriad mysteries to its function and dysfunction.

And to an engineer, a good mystery is irresistible.

"Engineering is a problem-solving discipline," says Nathan Sniadecki, a professor of mechanical engineering and the institute's interim co-director. "And the heart presents a wide array of problems."

At ISCRM, Davis, Sniadecki and a collaborative cohort of UW Engineering and UW Medicine researchers are approaching the heart from multiple angles and with multiple technologies, some repurposed and others newly invented.

What can mend a broken heart?

Davis's research focuses on scarring, or fibrosis. As elsewhere in the body, damaged heart cells get replaced by scars. But unlike other parts of the body, "the heart doesn't repair very well," she says. "It's a bad general contractor."

The buildup of scarring can inhibit the normal functioning of the heart and lead to its failure.

So, the Davis Lab has worked for more than a decade to discover how to reverse scarification through a "remodeling process" that uses cell and tissue engineering.

"We know the cell type responsible for making the scar," Davis says, "and some of the molecules in that cell that, if you turn them on or off, will change the way in which they make the scar."

Her ultimate goal is to develop a "designer scar" that would improve cardiac function on its own but also optimize the host environment for integrating therapies that replace lost or damaged muscle into the heart and synthetically regenerating it to full function. This would revolutionize treatment of heart disease.

Nathan Sniadecki, left, examines tissue specimens with researchers in his Cell Biomechanics Lab. UW Medicine

Patrick Boyle applies computational tools and techniques to investigate arrhythmias. University of Washington

Measuring heart hardiness

Sniadecki approaches the heart from a biomechanical perspective, designing and developing tools, at micro and nano scales, that measure the resilience of heart cells against the forces weighing against them.

"The heart is a very complex system with so many confounding factors," he says. "So, how do you reduce the variables?"

His Cell Biomechanics Lab embeds these tiny measurement tools in engineered myocardial tissue to create insightful testbeds for the human heart — outside the human heart. "Now you have cells in a three-dimensional environment that are working together like real tissue from real human biology performing real functions," Sniadecki says.

This enables cause-and-effect biological examinations that would be exceedingly difficult to do inside a real human body. These testbeds have been applied to calculate the effects on the heart of common and experimental drugs and therapies, genetic defects, aging — even prolonged time in space.

Sniadecki hopes the work of his lab will construct a more efficient bridge between basic science and clinical application.

When sparks flicker

While Sniadecki is concerned with the mechanical nature of the heart, Patrick Boyle explores the electrical. A professor of bioengineering with a background in electrical and computer engineering, Boyle applies computational tools and techniques to investigate the systemic consequences of arrhythmias — electrical abnormalities of the heart.

His Cardiac Systems Simulation Lab models rhythmic disorders to help doctors better understand and predict when patients may be at risk of conditions like atrial fibrillation (Afib), cardiac arrest and stroke, which can strike without warning (in fact, Afib struck his own father without warning in 2022).

Recently, Boyle has begun applying artificial intelligence and machine learning to enhance the power of predictive modeling. New projects are harnessing massive repositories of patient data — millions of UW Cardiology electrocardiogram readings to better understand the risk of sudden cardiac arrest and thousands of Fred Hutch Cancer Center echocardiograms to calculate the risk of heart disease for childhood cancer survivors.

"We're looking for warning signs in the data, trying to pick up on features that are below the threshold of human visual perception," Boyle says. "This is machine learning for good."

On the other side of these enhanced prediction methods is the promise of more calibrated forms of treatment.

Whole heart solutions

Michael Regnier, a professor of bioengineering, takes a multiscale approach to heart dysfunction resulting from genetic disorders, natural trauma, aging and comorbidities such as obesity and diabetes.

His Heart and Muscle Mechanics Lab uses a combination of experimental and computational techniques — developed in-house — to examine the entire scaffolding of cardiac architecture, from microscopic proteins interacting at the cellular level all the way to that prodigious hunk of meat that regulates the circulation of blood throughout the body.

In genetic heart disease, Regnier says, "the site of insult precipitates 'pathological remodeling.' A lot of structures end up being affected to compensate for the change that's happening at the molecular scale."

> "Engineers are inventing new tools that lead to new understanding of the human heart. Biology asks the questions and engineers find a way to answer those questions."
>
> \- Nathan Sniadecki

In the Heart and Muscle Mechanics Lab, led by Michael Regnier, center, researchers use a combination of experimental and computational techniques to examine the entire scaffolding of cardiac architecture. UW Medicine

But the process can be reversed. A recent Regnier lab study mapped how a minute engineered change to the composition of myosin, the heart's molecular motor, triggers a positive chain reaction from cell to tissue to organ, ultimately strengthening heart function and reversing heart failure.

From this discovery, Regnier and his colleagues are working on an effective therapeutic for patients. "Eventually," he says, "the treatment we develop could become part of the heart failure management regimen."

Engineers bring the tools

Many more UW Engineering faculty contribute to heart research at ISCRM, by designing synthetic cardiovascular environments and applying approaches such as fluid dynamics, protein design and 3D bioprinting.

The secret to their collective advancements in engineering heart health is not only the brilliance of individual researchers and labs, but also the comprehensive and collaborative culture of the institute they work in — and the UW at large.

"The environment is truly multidisciplinary and highly collaborative," says Regnier. "It's a powerful model that allows us to cross-pollinate our research programs and our trainees, too."

They collaborate with researchers across ISCRM and the neighboring Center for Cardiovascular Biology and Center for Translational Muscle Research. And they frequently partner with UW Medicine clinicians such as Dr. Farid Moussavi-Harami, a cardiologist who honed his research skills in the Regnier lab, and who brings valuable patient insights.

"Having each component of the heart within the same center allows an exchange of ideas to holistically understand how the heart functions both in health and in disease," Davis says.

In this institute of biomedical discovery, UW engineers are contributing an essential skill set and innovative perspective. They are adapting ideas and technologies from existing fields — and inventing new ones all the time.

"We only know the planets and stars because we were able to build telescopes. We're only able to study cells because we built microscopes," Sniadecki adds. "Engineers are inventing new tools that lead to new understanding of the human heart. Biology asks the questions and engineers find a way to answer those questions."

In her lab, Jennifer Davis, left, designs tissue to improve cardiac function. Institute for Stem Cell and Regenerative Medicine

Turning coffee grounds and mushroom spores into printable, plentiful plastics

By Stefan Milne

Only 30% of a coffee bean is soluble in water, and most brewing methods extract even less. So, of the 1.6 billion pounds of coffee Americans consume in a year, more than 1.1 billion pounds of grounds are knocked from filters into compost bins and garbage cans.

While watching the grounds from her own espresso machine accumulate, Danli Luo, a doctoral student in human centered design and engineering (HCDE), saw an opportunity in this waste. Coffee grounds are nutrient-rich and sterilized during brewing, making them ideal for cultivating fungi. Before mushrooms sprout, the fungus forms a "mycelial skin," a white root-like structure that binds loose materials, creating a tough, lightweight, water-resistant material.

With funding from the National Science Foundation, Luo and her HCDE research team — Nadya Peek, an associate professor, and Junchao Yang, a master's student — developed a system to transform used coffee grounds into a paste for 3D printing. This paste, inoculated with Reishi mushroom spores, grows a mycelial skin that strengthens the coffee grounds into a resilient, compostable material. The mycelium also fuses separate printed pieces together, creating intricate designs.

The compostable packing material around this small glass was 3D printed from used coffee grounds.
Luo et al./3D Printing and Additive Manufacturing

"We're focused on creating systems for small business owners producing small-batch products," says Luo. "For instance, we're exploring how to replace Styrofoam with sustainable, customizable packaging for fragile items like glassware."

To make the paste, Luo combined used coffee grounds with brown rice flour, mushroom spores, xanthan gum (a food binder) and water. She also designed a new 3D printer head for the UW's Jubilee printer, which can hold up to a liter of the paste.

The team used the material to print packaging, a vase, a small Moai statue, and even a tiny two-piece coffin. After printing, the objects sat in a covered tub for 10 days, allowing the mycelium to form a shell around the paste. The objects were then dried for 24 hours to halt mushroom growth.

The stages of 3D printing a vase with a paste made of coffee grounds.
Luo et al./3D Printing and Additive Manufacturing

The final material is denser than Styrofoam, and more akin to cardboard or charcoal. It absorbs only 7% of its weight in water, maintaining its shape while drying back to its original weight. The material is as strong as polystyrene foam and is biodegradable and even edible (though not tasty).

Scaling up production would be challenging due to the need for homogeneous coffee grounds, but the team is exploring other recycled materials for creating similar biopastes.

"We want to expand this approach to other bio-derived materials, like food waste, to support sustainable development and reduce plastic waste," Luo says.

Assistive-feeding robot tested in the real world

By Stefan Milne

The mechanics of eating are more complex than they might appear. For about a decade, researchers in the UW Personal Robotics Lab have been developing a robot that can help feed people who can't eat on their own.

Their initial breakthrough was getting a robotic arm to deliver a marshmallow with a fork. Over time, the robot has advanced to feeding people full meals, including complex dishes.

Researchers test the UW assistive-feeding robot in the home of Jonathan Ko.

The Assistive Dexterous Arm (ADA) system attaches to a nearby surface like a wheelchair or table. Users select what bite they want on a web app, and the arm autonomously feeds them.

Recently, the team tested the robot outside the lab to feed people in settings such as a cafeteria, office and conference room. Overall, it achieved 80% accuracy. In another test, community researcher Jonathan Ko successfully controlled the robot to feed himself at home for five days, despite a variety of place-based challenges.

"The goal is to enable people to feed themselves in real environments," says Amal Nanavati, a doctoral student in the Paul G. Allen School of Computer Science & Engineering. "So, we should also evaluate the system in those environments."

The team is working to make its robotic feeding system more customizable and effective.

Watch the UW assistive-feeding robot at work
▶ **tinyurl.com/2v6aryyd**

Using bacteria to make the ground more sound

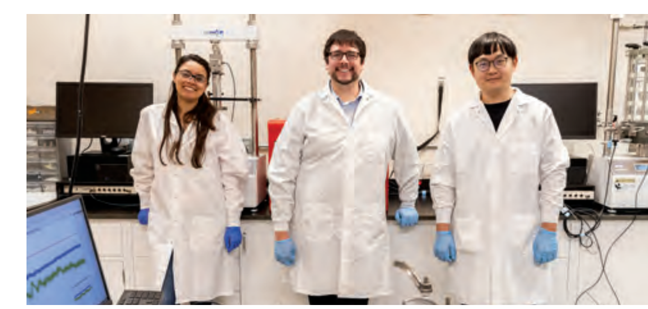
By Julia Davis

When a powerful earthquake strikes, sometimes the most damaging effects are below the surface. Intense shaking can create soil liquefaction, turning the ground into something like quicksand and causing buildings to sink, tilt and sometimes collapse.

Traditional ways to strengthen soils and prevent liquefaction use cement-based grouts and mechanical methods like ground compaction and vibration. But these approaches are costly, disruptive and harm the environment.

Mike Gomez, an associate professor of civil and environmental engineering, is developing a better alternative: biocementation, a process that uses bacteria to strengthen soils naturally from within.

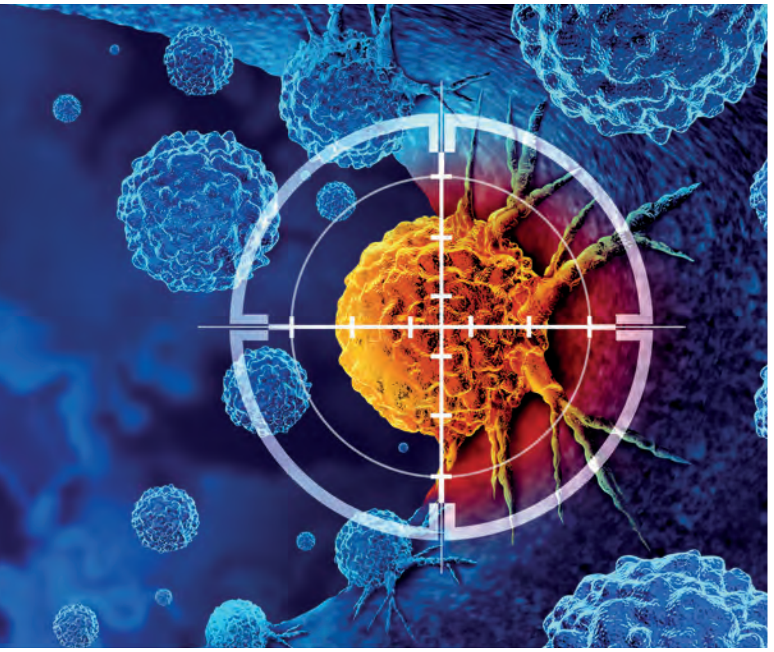
This method introduces a nutrient-rich, water-based solution to stimulate the growth of bacteria already in soil. The bacteria produce an enzyme that forms calcium carbonate, the mineral found in corals and mollusk shells and limestone. In essence, biocementation mimics — and dramatically accelerates — changes that occur naturally in a geologic time frame.



Mike Gomez, center, with grad students Chungen Tai, right, and Bruna Gabrielly Ribeiro, left, in the UW Biogeotechnics Lab.
University of Washington

In addition to environmental benefits, this method of soil stabilization flows easily under structures with little disturbance.

"There is a real opportunity to deploy this technology for problems with few existing solutions," Gomez says. "A successful field trial for liquefaction mitigation could pave the way for wider adaptation, and our research team is committed to realizing real-world impacts."



Read the full interview
▶ tinyurl.com/y69ppdf6

New therapies kill cancer cells, restore healthy tissue

By Sarah McQuate

Many traditional cancer treatments, such as chemotherapy and radiation, effectively destroy cancer cells but often lead to severe side effects that leave patients feeling even more sick.

Two UW researchers are developing treatments that aim to simultaneously treat cancer and improve patients' quality of life. Miqin Zhang, a professor of materials science and engineering and of neurological surgery, develops tiny systems that deliver cancer treatment specifically to cancer cells. Dr. Avik Som, an assistant professor of materials science and engineering and of radiology, uses interventional radiology to precisely deliver cancer treatment to the body through small needles and wires.

Both are studying a treatment method called immunotherapy, which trains a patient's own immune cells to target and destroy cancer cells. Here, they share how their approaches can treat both the cancer and the patient.

MIQIN ZHANG

Our new nanoparticle materials promise more effective and less harmful treatments in a variety of ways. First, the nanoparticles target cancer cells specifically, which minimizes side effects and enables controlled drug release to maintain therapeutic levels without toxicity spikes.

Next, we design these nanoparticles using biocompatible materials, such as iron oxide and chitosan coatings, which are derived from the outer skeleton of shellfish. This reduces immune-response reactions and makes the nanoparticles more compatible with long-term use.

Cancer's complex and variable nature means that treatments that are effective for one patient might not work for another, which makes it difficult to create one-size-fits-all solutions. But our nanoparticles support personalized medicine because we can target specific mutated genes in individual patients. Furthermore, we can develop nanoparticles that are multifunctional. For example, a single nanoparticle can have capabilities that enable both monitoring as well as treatment.

AVIK SOM

The concepts of extending patients' lives and improving their quality of life have effectively been done in parallel for years. For example, the UW has extensive history and expertise in tissue engineering. But it usually isn't combined with cancer care because the two goals often feel contradictory: Tissue engineering results from inducing cell growth, while historically cancer therapy has directly focused on killing cells. So, the fields have diverged.

But we can design novel materials to do both. One material can use different release rates to stagger the anti-cancer versus tissue-engineering effects. For example, we can use interventional radiology to implant a material directly into a tumor. The material can have an initial burst of drug release that has an anti-cancer effect. And then, after killing the tumor, the residual material can release factors that recruit normal cells to fill in the gap where the cancer was.

Alternatively, as radiologists, we can see where cancer is and isn't. It is therefore possible to selectively deliver anti-cancer agents to the cancer, while simultaneously delivering pro-tissue engineering agents to normal tissue.

How neighbors help neighbors during disasters

By Amy Sprague

Peer-to-peer resource sharing has significant — though often untapped — potential to bolster community resilience in the face of disasters.

This is according to a new study led by Cynthia Chen, a professor of industrial and systems engineering and of civil and environmental engineering.

Chen and her colleagues studied the response of people in two socially and economically distinct communities over a simulated five-day isolation period following a natural disaster. They found that place-based peer-to-peer sharing during a disaster could significantly reduce resilience loss — the product of the number of households experiencing a resource shortage multiplied by the number of days they experience the shortage.

Sharing survival resources — food, medication, first aid, warmth and transportation — had a greater impact on reducing resilience loss than infrastructure resources, such as communications, sanitation, power and shelter.

Cynthia Chen presents findings on peer-to-peer resource sharing at the 2024 International Conference on Resilient Systems.

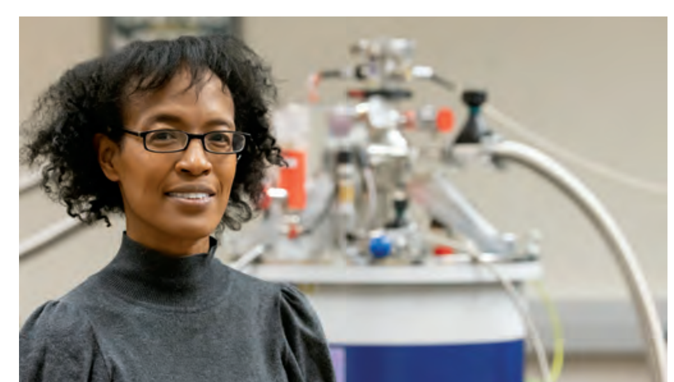
Chen confirmed that place-based social ties, such as neighborly relations, are especially important in a disaster. Perhaps more notably, she found that even a small number of social ties can make a big difference in a community's ability to share resources effectively.

"This research reveals the incredible potential of people helping each other during disasters," Chen says. "While government support remains vital, fostering local, peer-to-peer resource sharing can be truly transformative. We can make communities way more resilient by tapping into their inherent strengths."

Fine-tuning atomic disorder for quantum computing

By Wayne Gillam

Imperfection and disorder are part of life. This is true not only on the level of everyday reality, but also within matter at the smallest scales imaginable.



Serena Eley searches for ways to fine-tune the atomic disorder in superconductors and magnets. Ryan Hoover | UW ECE

At the nanoscale, the ordered atomic lattices that make up solid materials are often marred by impurities, dislocations, bends and vacancies. In materials like superconductors and magnets, this disorder can be beneficial, helping scientists control the motion of tiny "quantum vortices" of electrical current. These vortices — mini-tornadoes of current or electron spins — swirl around, disrupting electrical currents within the materials.

Serena Eley, an assistant professor of electrical and computer engineering, is fine-tuning this atomic disorder in superconductors and magnets to enhance their properties for quantum technology. Research in her Quantum Materials Group focuses on controlling the motion and formation of these vortices to improve conductivity and reduce energy loss.

This work contributes to the development of quantum computing systems, with potential breakthroughs in science, medicine and engineering.

"We try to increase our fundamental understanding of superconductivity and magnetism in a way that can contribute to a wide range of applications," Eley says. "But when designing superconductors, we also have to consider the impact of vortices. It affects all these applications."

PRECISION AT THE SMALLEST SCALE

By Chelsea Yates

Step inside the Washington Nanofabrication Facility, where tiny tech is transforming research in quantum, chips, medicine and more.

Imagine a high-tech workshop where scientists and engineers craft objects so small they can't be seen with the naked eye — or even a standard microscope. These tiny structures — nanostructures — are thousands of times smaller than a strand of hair. And they are essential for faster computers, better smartphones and life-saving medical devices.

Nanostructures are at the core of the research happening every day in the Washington Nanofabrication Facility (WNF). Part of the Institute for Nano-Engineered Systems at the UW and located in Fluke Hall, the WNF supports cutting-edge academic and industry research, prototyping and hands-on student training. Like many leading nanofabrication centers, it is part of the National Science Foundation's National Nanotechnology Coordinated Infrastructure, a network that shares expertise and resources.

Inside the WNF, which is the largest publicly accessible full-service cleanroom in the Pacific Northwest, researchers work in an ultra-clean environment. They wear full-body clean suits to prevent contamination. This protection isn't necessarily for the workers but for the environment — the items being made are so small that a speck of dust, strand of hair or drop of sweat could ruin them. The air is 1,000 times cleaner than an operating room, and parts of the facility are bathed in yellow light to protect ultraviolet and blue light-sensitive materials.

Unlike many university nanofabrication labs, which were started by small academic research teams, the precursor to the WNF was founded by the Washington Technology Center as an incubator for companies working in nanotechnology R&D and prototyping. This early investment secured advanced tools from the start. In 2011, the UW took full ownership, and after a six-year, $37 million investment, transformed the WNF into a fully operational cleanroom with over 100 specialized processing and characterization tools.

Today it is critical for advancing semiconductor and quantum research.

A hub for semiconductor innovation

Semiconductor chips power everything from cars to smartphones. The WNF provides the expertise needed to design, build and test these chips, which contain millions of microscopic transistors controlling electricity flow. These components are so small they must be inspected at the nanoscale. Researchers use advanced techniques like photolithography and etching to carve precise patterns on silicon wafers, layering materials to form semiconductors.

Primarily a Micro-Electro-Mechanical Systems (MEMS) fabrication facility, the WNF enables the creation of microscopic devices that integrate mechanical and electrical components to sense, control and actuate on a micro scale — generating macro-scale effects. MEMS devices, including microsensors, microactuators and microelectronics, are fabricated using techniques similar to those used for integrated circuits. Car airbags rely on MEMS accelerometers, while smartphones use MEMS microphones and filters. In addition to MEMS, the WNF has recently begun fabricating chips and integrated circuits for photonics and trains students in critical semiconductor manufacturing skills — essential for expanding U.S. chip production.

"Remember the pandemic-era chip shortage that made buying a car or smart appliance difficult? If we manufacture more chips domestically, then we'll be less reliant on importing them from other countries," says WNF Director Maria Huffman. "Chips are critical not just for consumer goods but also for telecommunications — data transmission and processing, 5G networks and IoT connectivity — as well as national security, military systems and supply chain resilience."

Enabling quantum research

Quantum technologies rely on nanoscale precision to explore and harness quantum phenomena. Quantum computers, for example, use qubits — basic units of quantum information — often built using superconducting materials. The WNF enables researchers to create some of these components with extreme accuracy, depositing ultra-thin layers of materials and fabricating structures at the atomic level.

Quantum systems depend on materials with special properties, such as superconductors — materials with zero electrical resistance — or 2D materials like graphene. Nanofabrication facilities allow researchers to customize the size, shape and composition of these materials. Quantum sensors also rely on nanofabrication for their development. They are used in applications such as ultra-precise timekeeping — including quantum clocks — and advanced navigation systems.

Collaboration on the nanoscale

Nanofabrication facilities like the WNF enable groundbreaking research, from next-generation semiconductors to quantum technology. But maintaining such a facility isn't cheap — the WNF relies on grants, industry partnerships and user fees to stay at the cutting edge.

"Advancing tomorrow's technologies isn't possible with decades-old equipment," says Huffman. "We need to be cutting edge to drive cutting-edge innovation." Industry partners like Micron and Intel have contributed funding, Meta has donated equipment, and many others pay to use the facility for R&D and prototyping.

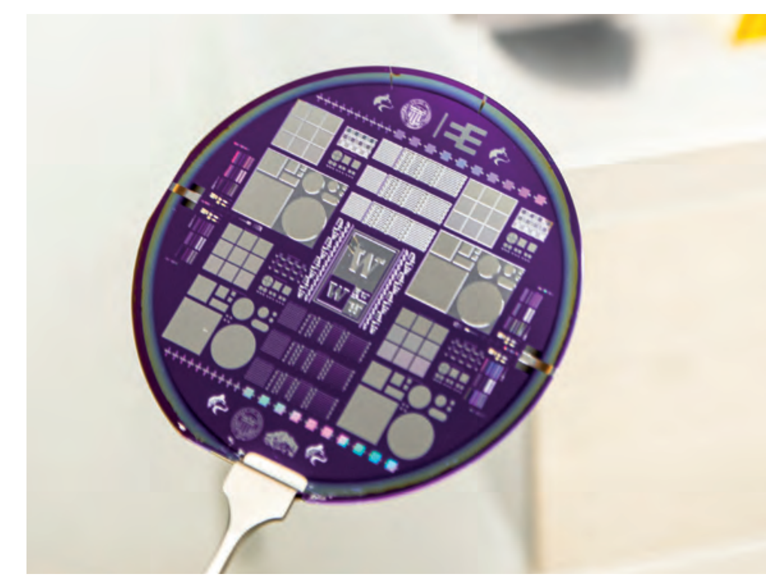
"Generally, companies aren't resourced to build their own experimental spaces or disrupt or stop their production lines to try something new," explains Darick Baker, the facility's engineering and business development manager. "This is where the WNF can help."

Beyond industry use, the WNF is deeply invested in education. With support from Micron and Intel, it was one of the first in the Pacific Northwest to pilot introductory semiconductor short courses, which have since been replicated at other universities. This spring, the WNF is hosting hands-on classes where undergraduates — from UW engineering students to veterans in a Bellevue College technical training program — build basic functional devices on silicon wafers.

"Industry needs people in many roles to be trained to work with nanomaterials — not just engineers and scientists but technicians, maintenance workers and more," Baker says.

Whether advancing semiconductor research, unlocking quantum potential or training future innovators, collaboration is key. At the WNF, researchers, students and industry partners work side by side, tackling nanoscale challenges to shape the future in big ways.

Advanced techniques like photolithography and etching create intricate patterns on silicon wafers like this one. A single 4- or 6-inch wafer can hold dozens of chips, depending on their size. University of Washington



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IMMACULATE CONSUMPTION

By Ed Kromer

Juming Tang is developing a revolutionary method of processing foods that controls pathogens, extends shelf life and preserves their natural taste, texture and nutrition.

The distinguished food engineer Juming Tang is aware of the coincidence — and the irony — of sharing a name with one of the most engineered "foods" ever concocted.

While Tang (the powdered orange juice substitute that early NASA astronauts took into space) was developed as the most artificial of edibles, Tang (the new Frank Jungers Endowed Chair of Industrial & Systems Engineering) has developed a revolutionary way to process *real* food.

This new method harnesses a technology that you'll find in almost every kitchen: the microwave.

Over decades of development, Tang has demonstrated that applying a precise frequency of electromagnetic energy to a cornucopia of packaged foods prevents contamination, extends shelf life and preserves organic taste, texture and nutrition. Best of all, this FDA-approved method is conducive to commercial applications and industrial scale.

"By using an old technology in a new way, we can preserve food and control pathogens while producing ready-to-eat food that remains as close to its natural form as possible," Tang says. "This is a unique opportunity to vastly improve the food supply through engineering."

Becoming a food engineer

Tang grew up in southeastern China, the son of university professors. "I was a city boy," he says. "I never thought about agriculture."

That changed after high school when he and his classmates were dispatched to a remote village to spend three years farming rice and vegetables. "The experience was hard, but it helped me understand agriculture," he says. "And I saw the need for advanced technologies to harvest, process and preserve perishable produce."

After earning a bachelor's degree in mechanical engineering in China, Tang pursued graduate studies in food engineering at the Universities of Guelph and Saskatchewan. His research, initially focused on food dehydration, expanded into a broader quest to invent better methods of processing and preservation.

Microwave power

Humans have processed foods since the Stone Age. The more recent inventions of canning, pasteurization, freezing and refrigeration gave rise to the modern $10 trillion food industry.

Juming Tang joined the UW last year with joint appointments in industrial and systems engineering and mechanical engineering. Amy Sprague

But this industry consumes enormous amounts of energy and natural resources. And its products remain susceptible to harmful pathogens like *Clostridium botulinum*, *Salmonella*, *E. coli* and *Listeria*.

Tang resolved to innovate the process. While studying the U.S. military's long-running MRE (Meal, Ready-to-Eat) program at Washington State University (WSU) in the late 1990s, he began experimenting with the microwave — a technology first deployed to spot enemy ships during World War II — as an alternative means of sterilization.

Unlike conventional thermal processing, electromagnetic microwaves heat food volumetrically, which dramatically reduces the time and temperature required to eradicate pathogens. "We were trying to achieve more uniform heating throughout the package," Tang says.

At the frequency of 915 MHz, they did just that.

Like minds

To develop this application of microwave technology, Tang received support from the U.S. Departments of Defense and Agriculture and partnered with food producers and packagers ranging from the U.S. Army to NASA to Kraft, Hormel, General Mills and PepsiCo.

"Many organizations had tried and failed to develop their own microwave-based technologies," he says. "So, we became an aggregator within the industry."

At WSU, Tang led an industry consortium and a center of excellence that developed commercially viable microwave technologies to sterilize shelf-stable, refrigerated and frozen foods.

Prometheus, plus

Early ads for the Amana "Radarange" — the first domestic microwave oven — invited consumers to "make the greatest cooking discovery since fire." Tang's innovations may amount to the greatest *processing* discovery since fire.

In addition to sterilizing foods, processing with microwaves rather than conventional heat expends less energy, extends longevity and preserves the sensory properties of appearance, texture, taste and smell.

Picture, for example, a polymer-packaged filet of firm, pink roast salmon — a vast improvement over the mushy grey matter you'll find in a tin. Or a shelf-stable packet of jambalaya without excessive salt or preservatives dulling its vibrant colors and flavors.

More recently, Tang's lab has expanded research to understand why pathogen outbreaks have increased in low-moisture foods such as spices, grains, nuts, dried fruits, baby formula and baked goods. In addition to developing new industrial strategies to keep bacterial pathogens out of these foods, he has begun experimenting with radio frequency energy to control pests in agricultural commodities.

For his many contributions, Tang has been elected to the National Academies of Engineering and of Inventors. He recently received a Lifetime Achievement Award from the International Association for Engineering and Food.

But he is far from finished.

Engineers test an early prototype of the microwave-assisted pasteurization system that Juming Tang developed at Washington State University. Sabrina Zearott, WSU/CAHNRS Communications

Toward a circular bioeconomy

Since joining the UW last year with appointments in industrial and systems engineering and mechanical engineering, Tang is amplifying his efforts to foster a "circular" bioeconomic system that makes food production and distribution more sustainable, resilient and environmentally friendly.

He's excited to do so in Seattle, a global center of tech and industry, and in collaboration with world-class colleagues from around the College of Engineering and many other disciplines at the UW.

For his part, Tang envisions a global network of regional processing hubs — cloud-based, AI-driven, microwave-assisted — that deliver foods from farm to table more efficiently, safely and palatably.

"My vision is to decentralize food production with a platform that captures freshness while extending shelf life, bringing value to consumers more directly from farmers rather than across a long distribution chain," Tang says.

"That's why my dream is to develop a smart processing machine that anybody can use."

Unlike most dreams, Tang's has a hard deadline. He's giving it ten years.

Almond Lau, a graduate student in mechanical engineering, pitches CureXsco to investors at the Environmental Innovation Challenge. UW Buerk Center for Entrepreneurship

A springtime showcase for entrepreneurial engineering students

By Ed Kromer

The buzz is unmissable. Irresistible. Up and down cavernous expo halls, enterprising students unleash full-throated pitches of their industry-altering innovations to throngs of roving investors during the seasonal slate of startup competitions masterminded by the Buerk Center for Entrepreneurship at the Foster School of Business. These resonating rites of spring, drawing teams from around the Pacific Northwest, serve as showcases for students across the College of Engineering.

Take this year's Hollomon Health Innovation Challenge (HIC), which featured UW engineering students in 19 of 22 finalist teams vying for more than $50,000 in prize money. Among them were auto-zooming glasses for the visually impaired (DynamEye), a filter for volatile gases exhaled during surgery (EnviroTech), a universal female torso attachment for gender-inclusive CPR training (ReviveHer) and a machine learning-enabled detector of deep-vein thrombosis (VenoSense).

Others drew from undergraduate capstone projects submitted to the interdisciplinary Engineering Innovation in Health program, including a novel sterilization method for oral surgery (Root Sense), a high-fidelity catheter insertion trainer (PracIV) and a non-invasive treatment for eye floaters (VitreaClear).

UW engineering students also comprised many finalists in the Environmental Innovation Challenge (EIC). Teams competing for more than $40,000 in prize money included a novel battery material to enhance delivery drones (JanuTech), an EV utility trailer for more efficient towing (Elementrailer), an autonomous navigation technology for commercial vessels (VaranaSEA Robotics) and a sustainable enhancement for solar cell performance (Solar IndusTrees).

The HIC grand prize was awarded to Luminova, a non-invasive, AI-powered jaundice detection system for newborns of every skin tone that was developed by a UW electrical and computer engineering student with partners from the Foster School.

And top honors at the EIC went to Voltair, a team of UW undergrads in electrical and computer engineering, computer science and engineering, finance and information systems developing a self-charging, AI-guided drone service to inspect power lines.

But prizes are not the *only* point. These competitive crucibles incubate innovation and inspiration. And they provide an organic, urgent capstone, demanding students across the College of Engineering to draw from their entire education and expertise — often in collaboration with the expertise of many other disciplines.

Just as in real life.

"We're all grateful for this opportunity to work on a project that has the potential to really impact people," says VitreaClear co-founder Devin Brown, a senior studying mechanical engineering en route to dentistry. "Beyond getting to do the engineering, it's really cool to understand a problem we're trying to solve at a deeper level, consider existing solutions and market opportunities. It's all encompassing."

The team of engineering and business undergrads behind Voltair, an automated utility inspection service, won the grand prize at the Environmental Innovation Challenge. UW Buerk Center for Entrepreneurship

Averting erosion on the wing

By Amy Sprague

The work of Mira Tipirneni, right, may help aircraft manufacturers predict and prevent wing erosion.

Over time, rain can damage the "skin" of an aircraft — and especially its wings. For the global aerospace industry, the critical challenge of predicting rain erosion requires extensive and expensive physical testing.

But Mira Tipirneni, a doctoral student and the 2025 Varanasi Scholar in aeronautics and astronautics (A&A), is developing computational models that can accurately predict rain erosion on aircraft surfaces — potentially transforming the way that aircraft manufacturers test and develop protective aircraft coatings.

"Mira's research is crucial for the future of aerospace engineering," says A&A Professor Antonino Ferrante. "By moving away from expensive physical testing towards verified, validated and highly accurate computational models, we are enabling the development of more durable and efficient aircraft."

Tipirneni's novel approach to modeling how water droplets impact aircraft surfaces is part of a comprehensive approach developed in partnership with Boeing that combines material testing, adhesion measurement and computational fluid dynamics. Tipirneni's model has demonstrated remarkable predictive accuracy.

The research has important implications for both commercial and military aircraft. By improving the accuracy of rain erosion prediction while reducing development costs, Tipirneni's work could accelerate the introduction of more durable aircraft coatings.

Underwater robot critical to ocean ecosystem health

By Justin Horne

A decade ago, an unprecedented marine heatwave decimated California's sunflower sea star population, triggering a cascading crisis for the entire ocean ecosystem. Ever since, researchers at the UW's Friday Harbor Labs have raced to understand how to restore balance to the fragile ecosystems along the Pacific Coast.

To aid their work, students in the UW Global Innovation Exchange (GIX) developed an underwater robot and an AI-powered dashboard to improve the tracking of sea star and urchin populations critical to maintaining healthy kelp forests.

Doing this work manually is expensive and inefficient. So, the GIX team — Kaiwen Men, Sam Cole, Haokun Feng and Ziqi Gao — worked with the UW Applied Physics Laboratory and Friday Harbor Labs to develop and test a low-cost, semi-autonomous remotely operated vehicle (ROV) that significantly increases measurement accuracy and speed.

The project has been especially meaningful for Cole, who recalls the vibrant marine life of the thriving kelp forests he encountered on childhood visits to the Monterey Bay Aquarium. "That ecosystem is basically gone," he says. "And now, I get to work on a project that can maybe bring it back? That's really cool."

Launched in 2017 with support from Microsoft, GIX is the UW's engineering and business institute for technology leaders. It is jointly supported by the College of Engineering and Foster School of Business.

GIX students prepare their underwater robot for action in the waters near Friday Harbor Labs. Justin Horne

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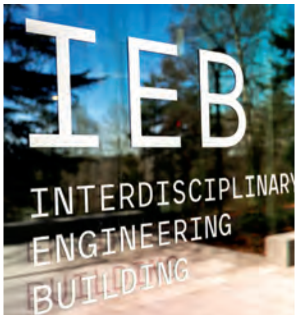

The IEB: A new hub for engineering students

Early this spring, in concert with the Quad's famed cherry blossoms, came the soft opening of the much-anticipated Interdisciplinary Engineering Building (IEB).

The 76,000 square-foot facility, nestled in a stand of towering evergreens opposite the Husky Union Building (HUB), has quickly become the nexus of collaborative learning and career exploration for undergraduate students across the College of Engineering.

It's a hub across from the HUB.

The IEB's five stories contain classrooms, project team rooms and social spaces, plus student advising, academic support, career services and the Office of Inclusive Excellence — not to mention glorious views.

Beyond its dedication to an inclusive student experience, the $106 million construction — funded by a public-private partnership of the State of Washington and federal government, the UW and a coalition of individual and corporate donors — is also a demonstration of sustainable design.

Look for a comprehensive tour of the IEB in the fall issue of The Trend.