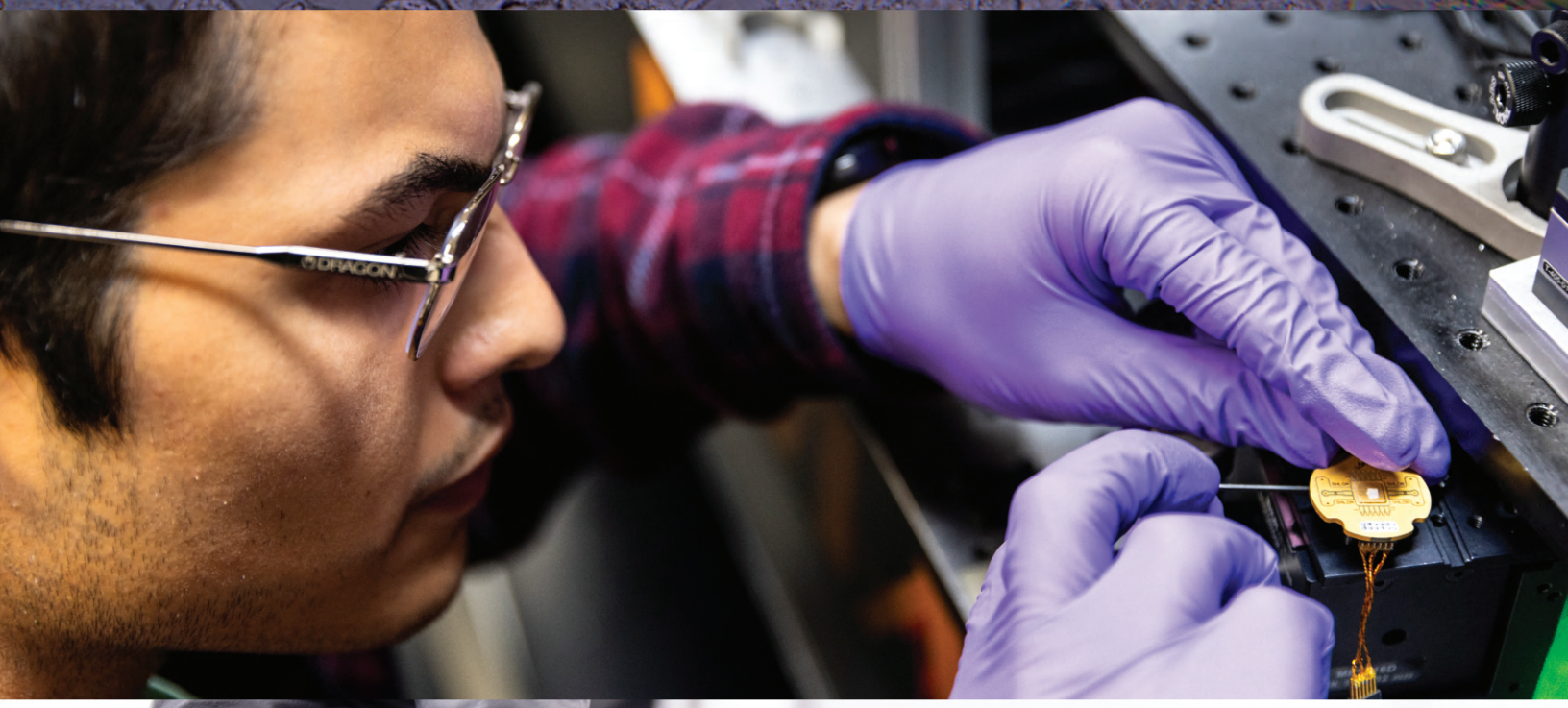
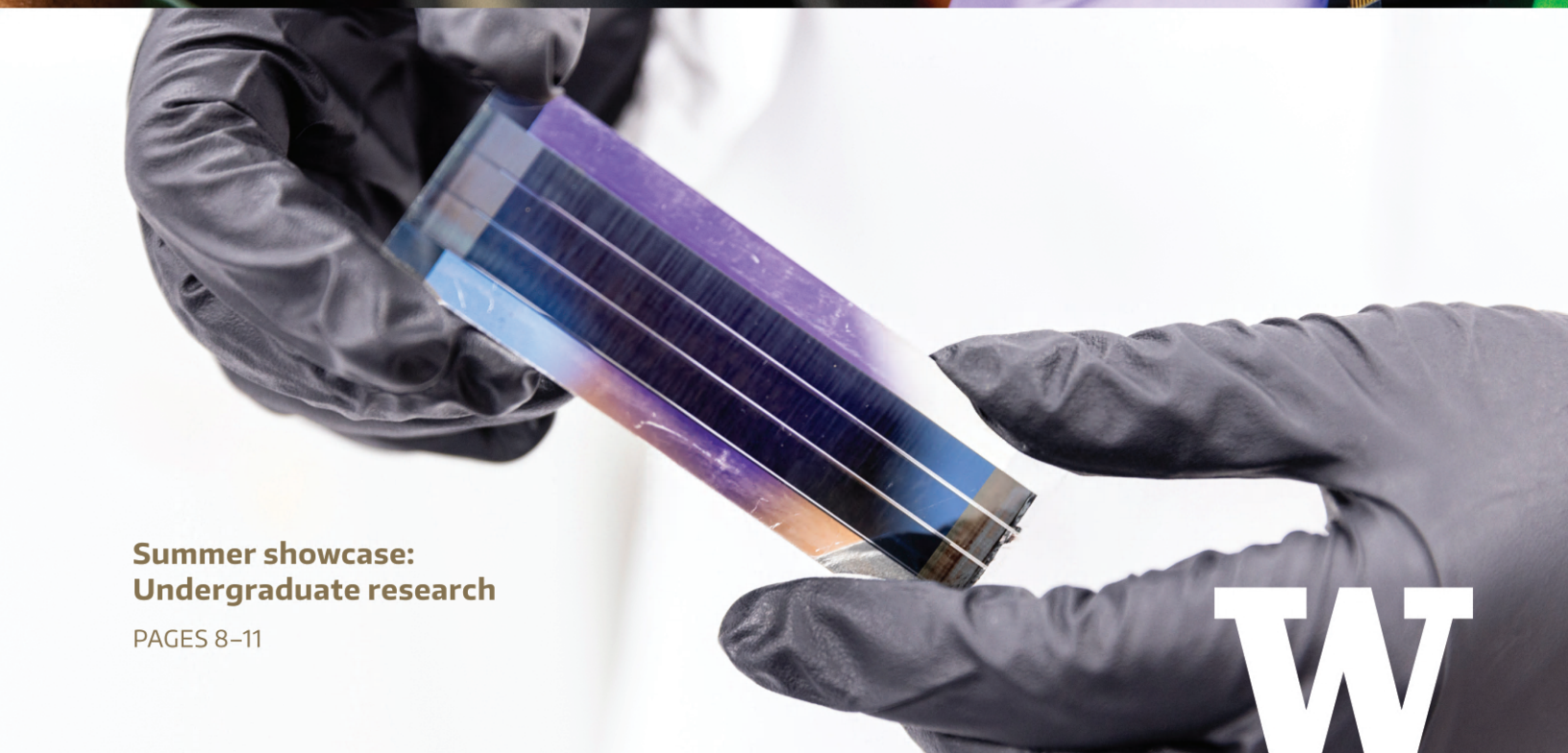
The Trend in ENGINEERING

UNIVERSITY OF WASHINGTON COLLEGE OF ENGINEERING NEWSLETTER / **AUTUMN 2023**





Summer showcase: Undergraduate research

PAGES 8–11

FROM THE **DEAN**

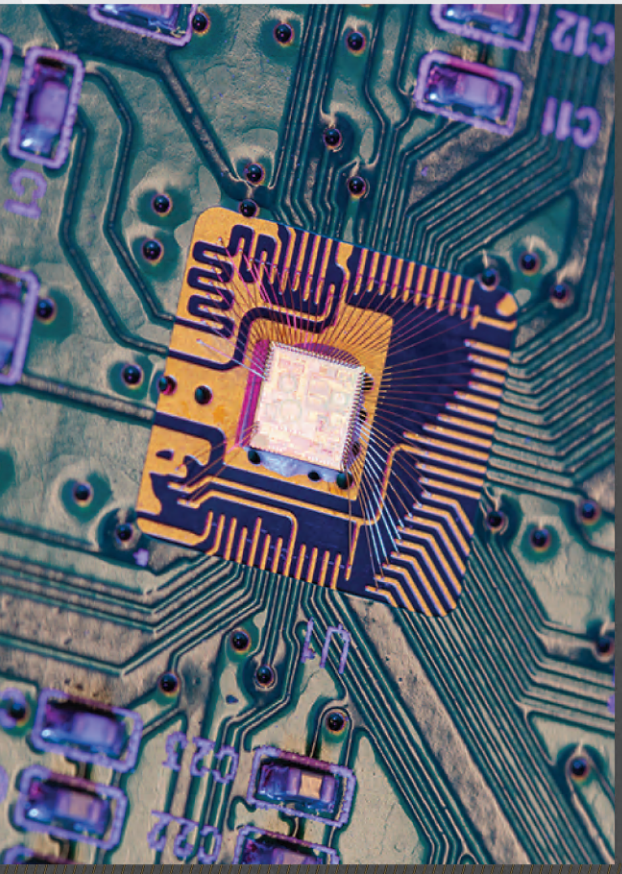
An engineering education from the UW College of Engineering opens doors to an extraordinary future. We're working to ensure that students from all backgrounds succeed, from the day they step into campus to their post-college careers. Engineering education must prepare students to create significant societal impact, helping to shape a healthier and better world. This issue is full of examples of our students and alumni doing just that.

Our cover story highlights undergraduate research that occurred across our labs this past summer. From quantum to clean energy, neonatal to environmental health, engineering students gain hands-on experience working on interdisciplinary teams alongside faculty, research scientists and graduate students. This opportunity enriches engineering education by helping students develop critical thinking, problem-solving and communication skills as well as technical skills.

You'll also read about Engineers Without Borders, a student group that develops engineering projects to help communities around the world. You'll meet the UW's newest Student Regent, and you'll hear from three alums about how their undergraduate experiences with the College's WE Rise program (formerly known as WiSE) launched them into engineering careers and instilled in them the drive to give back. We're also excited to share a construction update about the Interdisciplinary Engineering Building, which will be a home for all engineering undergraduates once it opens in 2025.

In short, we're dedicated to engineering excellence for the public good — educating and training outstanding engineers, driving discovery and forging partnerships to create transformational, sustainable and equitable impact for our state, nation and planet.

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



Answering the call of the CHIPS and Science Act

In August 2022, the federal government passed the CHIPS and Science Act to reaffirm America's commitment to domestically manufacturing semiconductors, also known as microchips. Though poised to grow rapidly in the U.S., the semiconductor industry faces intense deficiencies in the size and diversity of the workforce. The UW is partnering with other institutions and industry to meet this developing need.

In June, the UW joined the Northwest University Semiconductor Network. Established by Micron Technology, Inc. — one of the world's largest semiconductor companies — the partnership focuses on developing the next generation of the U.S. semiconductor industry's workforce. The network will drive research to increase students' opportunities for experiential learning across the semiconductor ecosystem, with equitable access for underrepresented students, including those in rural and tribal communities.

Another recent partnership is the University Partnership for Workforce Advancement and Research & Development in Semiconductors (UPWARDS) for the Future, which began in September. UPWARDS brings together six U.S. universities — of which the UW is one — and five Japanese universities with Micron Technology to provide advanced training and research opportunities that will grow the semiconductor workforce and help the U.S. and Japan build more of the microchips that both nations need.

A recently designed microchip from the lab of Chris Rudell, a professor of electrical and computer engineering. Photo by Ryan Hoover

From camp to college

Bringing STEM education to a rural community helps youth get college-ready.

By Brooke Fisher

While constructing a Rube Goldberg inspired machine at a summer camp, 16-year-old Aliyah Taylor learned to see the engineering potential of everyday items — from an Amazon shipping box to a red Solo cup — to become pulleys and infrastructure. In the process, she also came to see the engineering potential in herself.

"To make these Rube Goldberg machines, we have to think about so many different concepts and parts and put them all together to make a huge machine," says Taylor, one of 60 campers attending a Science, Technology, Engineering and Math (STEM) summer camp in early August.

The attendees, all of whom will be entering grades 9–12, completed a hands-on engineering design project inspired by the engineer-turned cartoonist Rube Goldberg, famous for his depictions of simple tasks completed in complex chain-reaction processes. The annual summer camp, held at W. F. West High School in Chehalis, Washington, draws students from rural communities in the greater Lewis County area. The camp is a partnership between the College of Engineering, UW Medicine, Chehalis Foundation, Chehalis School District and Chehalis Tribe.

"In the rural community, we have kids who have never been to Seattle, or worked with a college professor," says W. F. West High School assistant principal Tommy Elder. "It's a big deal to have that experience and break down those barriers."

ENGINEERING EXPERTISE

This year's lead instructor, Alex Prybutok, an assistant teaching professor in chemical engineering, drew on her own unfamiliarity with engineering as a youth, as well as 17 years of summer camp experience.

"I assume most of the students will not have had exposure to engineering," Prybutok says. "Maybe they've heard of engineering, but don't know much about it."

Lessons focused on the College's areas of impact, which include health and medicine, robotics and manufacturing, air and space, and more. The campers learned essentials such as the engineering design process, as well as the importance of collaboration and teamwork.

SEEING RESULTS

Preparing students for college is not only a priority in the Chehalis community — it's a success story that's just beginning to be realized. In less than a decade, there has been a 35% increase in students enrolled in post-secondary institutions.

The Chehalis Foundation joined forces with the Chehalis School District to establish a Student Achievement Initiative in 2013. In addition to the STEM summer camp, a partnership was formed with nearby Centralia College and a career and college counselor was funded at the high school. As a result, the capstone for engineering-bound students, a physics course, has seen a 100% increase in enrollment.

"We had a parent say at a school board meeting 'My kid is going to UW in the fall in engineering because of what he was exposed to at the STEM camp,'" says J. Vander Stoep, who serves on both the Chehalis Foundation and school board, and initiated the collaboration with the UW in 2018.

From left: A team puts the finishing touches on their machine before a competition; Reading from her engineering notebook, camp attendee Aliyah Taylor presents her team's arcade-game themed Rube Goldberg machine; Students work on their Rube Goldberg inspired machine; Faculty Alex Prybutok and Eli Williams, the College's recruitment and youth engagement program manager, assist students. Photos: Raymond Smith and April Hong/University of Washington

James Carothers named interim chair of Chemical Engineering

In June, James Carothers began a two-year appointment as interim chair of Chemical Engineering. Carothers is the Dan Evans Career Development Associate Professor of Chemical Engineering, co-director of the UW Center for Synthetic Biology and a member of the Molecular Engineering & Sciences Institute.

Since joining the UW in 2012, Carothers has been the lead researcher of $22 million of funded awards. Currently, he is leading a project to advance CRISPR gene regulation technologies and improve bioproduction with engineered microbes. His work has been supported by grants from the U.S. Department of Energy, the National Science Foundation and private industry.

Previously, Carothers was a postdoctoral fellow at the University of California, Berkeley, and the U.S. Department of Energy Joint BioEnergy Institute. He earned his Ph.D. at Harvard University. Carothers is a founding member of the scientific advisory board of biotechnology startup Wayfinder Biosciences. He has received the University of Washington Presidential Innovation Award and the Alfred P. Sloan Research Fellowship.

Xu Chen appointed director of the Boeing Advanced Research Collaboration

Xu Chen, Bryan T. McMinn Endowed Associate Professor of Mechanical Engineering, began his appointment as director of the Boeing Advanced Research Collaboration (BARC) in September. He will help develop the vision and mission for this collaboration, integrating the Boeing Advanced Research Center, the AI Center for Dynamics and Control Research & Education, and industry capstone and sponsored research programs.

BARC is the next advancement in the College's long-standing partnership with Boeing. It builds on the Boeing Advanced Research Center, where since 2014 Boeing engineers have worked alongside engineering faculty and students on projects in aircraft manufacturing and assembly. Chen leads the collaboration's efforts to make a substantial impact in new materials research, manufacturing and workforce development.

Chen joined the UW as an assistant professor in 2019. His research in dynamic systems and controls aims to better understand and engineer smart machines and autonomy, and his research in sensing, actuation and energy transformation focuses on facilitating novel manufacturing processes for automated inspection in the aerospace industry.

UW is a core member of the New York Climate Exchange

New York City Mayor Eric Adams and the Trust for Governors Island announced last spring that a consortium, led by Stony Brook University and including the UW, will develop a first-of-its kind international center for dynamic solutions to our global climate crisis. The New York Climate Exchange will be located on Governors Island in the city's harbor.

"Working as part of this global team, we see great opportunities to accelerate the energy transition through equitable deployment strategies," says Daniel Schwartz, director of the UW Clean Energy Institute and Boeing-Sutter Professor of Chemical Engineering.

The exchange will convene climate experts, host green job training programs and partner with institutions to address challenges created by climate change. It will also feature an interactive living laboratory with 400,000 square feet for research, mitigation technologies and more.

An aerial rendering of the New York Climate Exchange campus, to be built on the eastern edge of Governors Island.

ENGINEERING PH.D. STUDENT NAMED Student Regent

Jay Cunningham has been appointed by Washington Governor Jay Inslee to serve this year on the UW Board of Regents.

By Leah Pistorius

"As a student, I have been the beneficiary of countless opportunities and resources provided by the University. I believe it is my duty to give back to the community that has given so much to me," says Jay Cunningham, a fifth-year Ph.D. candidate in human centered design and engineering (HCDE), who joined the UW Board of Regents as Student Regent in July.

The UW Board of Regents consists of 11 citizens appointed by the Washington State Governor. The Regents govern the University and select and evaluate its President. As guardians of the public trust, the Regents set institutional missions, establish policies and ensure the University's financial stability and academic quality. The Student Regent brings a student perspective to difficult decisions that may involve balancing the interests of current and future students, faculty and staff.

Cunningham has dedicated his doctoral research to understanding and addressing technology's role in racial equity and works to incorporate community-based research methods to promote responsibility and fairness in AI and machine learning systems, inclusive algorithmic design and human-centered data science. He is particularly interested in addressing the challenges posed by the intersection of intelligent systems and machines, such as AI-automated decision-making, natural language processing and computer vision.

To the Board of Regents, he brings the unique perspective of being a UW student before, during and since the COVID-19 pandemic. "As a student, mentor and teaching assistant, I have seen how students are feeling more isolated than ever before on our campus. The pandemic has strained critical health and well-being resources, leaving students to feel underserved by our community," he says.

Cunningham hopes to address gaps in cultural and ethnic-based counseling and resources and work toward equitable access across the UW's campuses in Seattle, Tacoma and Bothell. He hopes to develop dialogue workshops for the communities across the three campuses that are tailored to their specific needs.

He is also passionate about the recruitment and retention of faculty of color. "It's hard to be your best, academically or professionally, if you don't have a community or if you can't find the resources you need," he says. "We want everyone to feel supported here, met with the resources they need, and proud to be part of the Husky family."

HCDE Professor and Chair Julie Kientz says she couldn't think of any student better poised to represent the University: "Over the nearly four years I've had the pleasure of working with Jay, he has demonstrated the most exceptional ability at networking, leadership and advocacy as any student I have ever met."

SPOTLIGHT ON inclusive excellence

Associate Dean of Diversity, Equity & Inclusion **Karen Thomas-Brown** shares what the College of Engineering's Office of Inclusive Excellence has been up to in its first two years.

What is 'inclusive excellence'?

For our team, inclusive excellence means centering inclusion and equity practices in an educational environment in ways that ensure all students, faculty and staff feel they have the opportunity to be successful and advance. Inclusive excellence is not just for students. It's for everyone in the UW Engineering community.

What does the Office of Inclusive Excellence (OIE) do?

OIE addresses structural practices of exclusion and inequity and the lack of diversity across the College. We work to provide strategic planning, training, services and support for faculty, staff and students to build an inclusive and welcoming culture. Our work aligns with the College's Strategic Plan. We focus on the entire College, not just certain groups within it, and we don't consider just one way to address emerging issues — we look at them from multiple angles. We have expanded some College programs, and we have introduced new services, too.

Tell us about some of the programs for engineering students.

Our Pathways for Inclusive Excellence (PIE) programs — Engineering Dean's Scholars, Allen School Scholars Program and STARS — create more pathways to engineering for more Washington students. These programs focus on increasing recruitment and retention of underserved students from across the state by providing support for students who need additional STEM and college preparation. Since 2021, 280 students have been offered placement at the UW through PIE and 238 have enrolled — and we have retained 98% of them into their second year. These are 238 Washington students — now future engineers — who likely wouldn't have been accepted into the College if these programs didn't exist.

Last year we rebranded Women in Science & Engineering (WiSE) as Women Engineers Rise (WE Rise) and refreshed its programming. For decades, this program has been dedicated to centering the experiences of women in the College of Engineering. We've expanded it to also highlight nonbinary engineers. Open to all students, each spring it hosts a conference that brings together students and engineering leaders across the UW and in industry. Last year alone, WE Rise served 543 students, provided 108 mentorship opportunities, hosted 226 students at our conference and celebrated more than 246 students at graduation events.

What other services does OIE offer?

We've introduced an incident reporting system. This tool is for anyone in the College to share concerns about non-emergency incidents. A trained advocate from the OIE team follows up on each report. In the first year after introducing this system, we received 28 formal reports from faculty, staff and students. All were resolved or, when needed, escalated.

We've also launched a Council of Diversity Advocates to foster collaboration and build diversity, equity and inclusion (DEI) knowledge and skills across academic departments. This group of 10 faculty and 20 staff helps us develop and pilot DEI trainings and resources for faculty, staff and teaching assistants.

The OIE team played a big role in the Interdisciplinary Engineering Building design. What did that entail?

We helped bring student insight into the building design process. Inclusion was a fundamental vision for the building, but the architects couldn't quite get the input they needed from students. So the OIE team created questions for students in a way that ensured students felt comfortable sharing information. The student feedback we gathered shifted the design plan to include visual art, designated space for student groups, a prayer room and a lactation room. The team's work in this space was recognized by the American Society for Engineering Education last December.

What's next for OIE?

Where do I start?! We are working on a recruiting and hiring dashboard to introduce more DEI best practices into faculty searches. And thanks to donors, we're starting an Inclusive Excellence Faculty Fellowship program this year. College faculty fellows will have access to resources on integrating intercultural competence and inclusive teaching practices into their curriculum with the goal of facilitating impactful changes in their units and across the College.

We'll be launching another PIE program: South Sound Scholars will be for high school students in south Puget Sound areas, particularly in schools that have 40 to 50% free and reduced lunch rates, who are interested in engineering. We're also developing Elevate, a program to support graduate students in the dissertation phase. This can be a very lonely time, so Elevate is focused on providing social and emotional support, as well as connections to industry for postdoctoral job opportunities. Last fall we partnered with Meta to host a trial Elevate networking event, which was a great success. We're looking forward to building out this program.

Last, I'll mention our DEI officer program, which involves hiring and placing DEI staff in more academic departments. We've been piloting this program with Mechanical Engineering. The department's DEI officer works with students, faculty and staff to promote inclusive and equitable policies and practices. We're eager to develop similar positions with more engineering departments.

Any final thoughts you'd like to share?

By now most people know that organizations are most innovative and productive when their members represent and draw upon a variety of backgrounds and respect the perspectives that arise from these differences. This is why DEI is central to the College's mission of producing outstanding engineers. We want to prepare students for a diverse workforce and to better train them as engineers who will be innovating in a diverse world. Inclusive excellence is not a catch phrase or a political agenda; simply put, it's the right thing to do.

Learn more about OIE:
engr.uw.edu/about/diversity

Left: Engineering Dean's Scholars tour The MILL, a campus makerspace and learning facility. Right: Attendees at the 2023 WE Rise conference.

SUMMER SHOWCASE

Undergraduate RESEARCH

By Brooke Fisher

Bit by qubit

Advancing quantum computing

This past summer, undergraduate Enrique Garcia dealt with diamonds. More specifically, he designed an antenna for a diamond quantum processor, a promising technology for the next generation of computing.

"This level of learning is not something that I've previously had at an internship," says Garcia, a senior in electrical and computer engineering. "This is a lot more exciting, it feels like I'm actually problem-solving on my own."

Working in the Quantum Technologies Training and Testbed (QT3) lab, Garcia helped to accelerate research in the growing field of quantum computing, which aims to process information more quickly than classical computers.

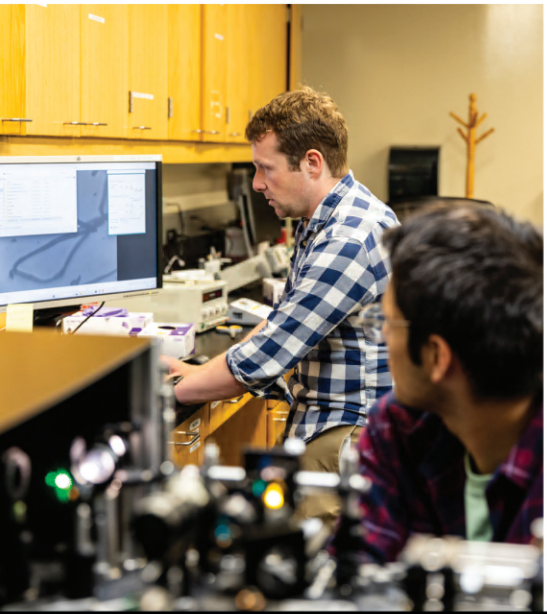
"The quantum computer is still at a transition stage — it was developed by physicists, but the hard work is now in the engineering realm," says Max Parsons, who directs the QT3 lab.

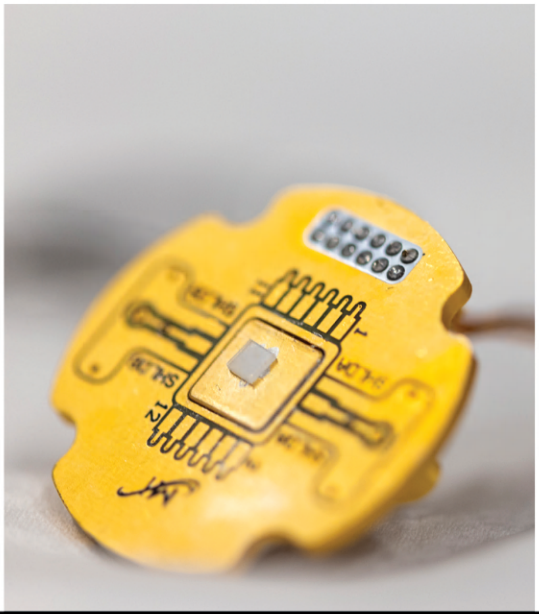
The antenna will be used for radio-frequency control of quantum bits, called qubits, which are naturally found in the impurities in diamond. Much like traditional computer bits that are represented by either a zero or one, qubits have the potential to store and transfer information. One challenge is controlling the qubits' spin properties in order to manipulate the transfer of information.

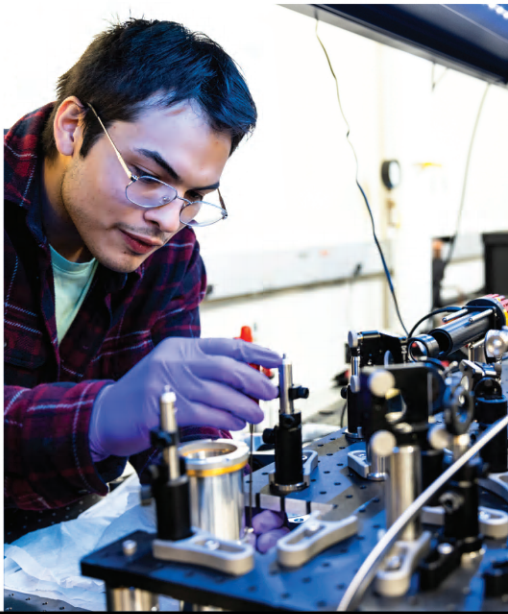
"The point of the antenna is that it's able to transmit microwave magnetic fields and with those fields it can cause oscillation between different spins and we use that as the zeros and ones of our qubits that we are trying to define," explains Garcia.

By the end of summer, Garcia planned to have his design fabricated onto a two millimeters squared diamond sample. But his quantum research didn't end there — Garcia is working in the lab this school year before pursuing a career in photonics, which he says "may eventually lead me back to quantum."

From left: Max Parsons and Enrique Garcia examine a diamond sample via a confocal microscope; A close-up of the diamond sample on which an antenna will be fabricated; Garcia prepares to remove the diamond sample from the quantum processor, where it is mounted in a temperature-controlled cryostat. Photos: Dennis Wise/University of Washington



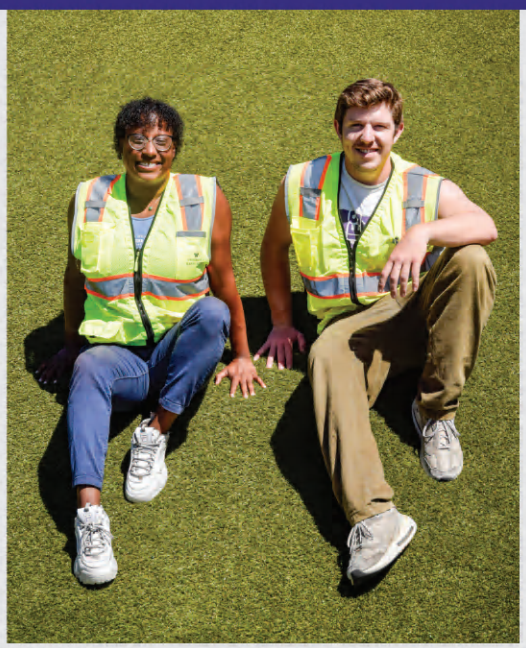




At a top-tier research institution like the UW, research doesn't take a summer break. Many College of Engineering labs host undergraduates during the summer months, giving the students a unique, hands-on experience conducting cutting-edge engineering research alongside faculty.

The exchange is a win-win: Undergraduates can pursue ideas and interests that they're passionate about, and in the process they sharpen their analysis, communication, design and fabrication skills. They play an important role in supporting faculty-driven research and advancing the College's areas of impact.

Here, four students share highlights from their summer research experience and how it helped prepare them for future engineering aspirations.



From left: Aaliyah Morris places a garbage bag over an orange bucket with a CO2 sensor inside, to help shelter it from the sun for more reliable data; Morris and her research partner Jack Sanfilippo sit in front of a hill of artificial turf at Yesler Terrace Park; Sanfilippo measures how long it takes the artificial turf to absorb water.

A hot topic
The impact of artificial turf

It's not uncommon to frequent parks during the summer, but for environmental engineering undergraduate Aaliyah Morris the reason was a bit different — she was researching the temperature effects of artificial turf.

"We are investigators and surveyors," explains Morris, who collaborated with undergraduate Jack Sanfilippo from the UW School of Environmental and Forest Sciences. "The project overall is about understanding artificial turf and the environmental relationships it has with our communities."

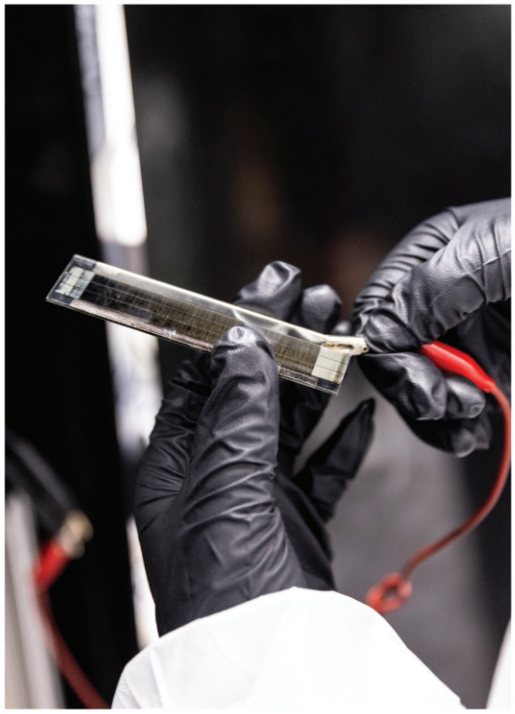
Since little is known about the temperature effects of artificial turf, such as the amount of heat it may generate, the goal of the research is to enable community groups and designers to make informed decisions about material choices. Funded by a Spark Grant, the project originated from conversations between civil and environmental engineering faculty Becca Neumann and David Butman, who noticed an increase in both public and private residences with artificial turf.

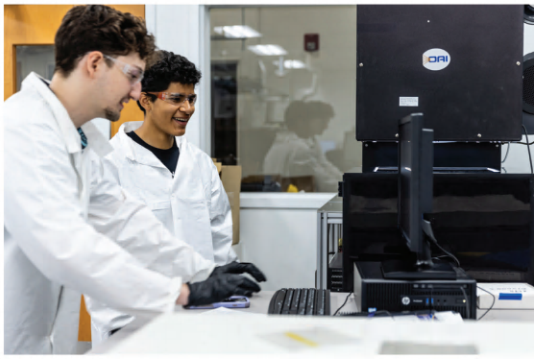
"Although some people may contend it saves water resources, it might not all be positive because this replaces grass with a petroleum-based product. You're also ripping out an entire ecosystem below ground," says Butman, who has noticed via satellite imagery that the hottest areas of Seattle have artificial turf, like stadiums.

At Seattle's Yesler Terrace and Mount Baker parks, the students gathered data about turf, as well as wood chips and grass for comparison. Data included temperature variations, carbon dioxide fluxes, water-holding capacity and light reflectance. Since the turf can reach temperatures as high as 160 degrees Fahrenheit, Morris also interviewed park users about their experiences on hot days.

The hands-on project aligned with Morris' passion for the environment and public health. Post-college, she hopes to positively impact the community: "My goal is to nurture Seattle today, for a better Seattle tomorrow," she says.

Undergraduate





An enlightening opportunity

Solar scalability

Advancing the future of clean energy is a powerful experience. Just ask mechanical engineering (ME) undergraduate Sebastian Bustos-Nuno, who worked this summer at the UW Clean Energy Institute's Washington Clean Energy Testbeds to advance the next generation of solar cells, called perovskite photovoltaics.

"It's pretty awesome. All of this is a first-time experience — it's my first time working with a professor and a Ph.D. student," says Bustos-Nuno, who first became interested in solar cells in the fifth grade during a field trip to a community college.

Funded by UW's Alliances for Learning and Vision for Underrepresented Americans program, Bustos-Nuno helped advance a promising new technology, which crafts solar cells from the mineral perovskite, rather than silicon. While perovskite offers greater flexibility as a thin film and is lower cost, one hurdle to widespread use is scalability. As the footprint of thin film solar modules expands, it becomes increasingly difficult to extract the high currents without losing some of the energy produced.

"For clean energy to have an impact, it has to be commercialized. Closing that gap is a way to make the region a hub for clean energy," explains Washington Research Foundation Professor of Clean Energy and Associate Professor of ME and Materials Science & Engineering Devin MacKenzie, who is the Testbeds' technical director. "Sebastian's work centered on how to more efficiently pull power out of solar cells, which is one of the hardest but potentially most impactful parts from an engineering perspective."

To evaluate the electrical properties of the perovskite modules, such as the current generated, and enable repeatable measurements, Bustos-Nuno designed and fabricated a testing device called a continuous probe bar station. But his work didn't end there — Bustos-Nuno is continuing on in the lab this fall as a junior, and envisions a career either in clean energy or the aerospace industry.

"I gave him a textbook and he's been reading it like a novel. He's super invested," says ME Ph.D. student Ethan Schwartz, who mentored Bustos-Nuno.

From left: Sebastian Bustos-Nuno holds the culmination of his work: a testing device for perovskite modules called a continuous probe bar station; Alligator clips are placed on a perovskite module for solar simulator testing; Bustos-Nuno and Ph.D. student mentor Ethan Schwartz power up and run a solar simulator to test the perovskite module efficiency; Bustos-Nuno and Schwartz in front of a whiteboard filled with notes about the summer research project. Photos: Dennis Wise/University of Washington

RESEARCH

A healthy challenge

Developing targeted drug delivery for infants

Extracting RNA from slices of brain tissue isn't your typical summer job. But for undergraduate Sofia Dahlgren, it was part of a summer research project that drew from both her head and heart.

"I had a fantastic chemistry teacher in high school and he had Parkinson's disease, so a lot of my interest in pursuing chemical engineering and studying neurological disease came from that," says Dahlgren, who is a sophomore studying chemical engineering (ChemE).

Over the summer, Dahlgren helped to develop therapeutics for the treatment of neurological disease and brain injury sustained during the perinatal birth period, which is immediately before and after birth. She worked in the Nance Lab, which recently expanded its drug delivery system research to include RNA-based drugs. These show promise in targeting specific components of a cell.

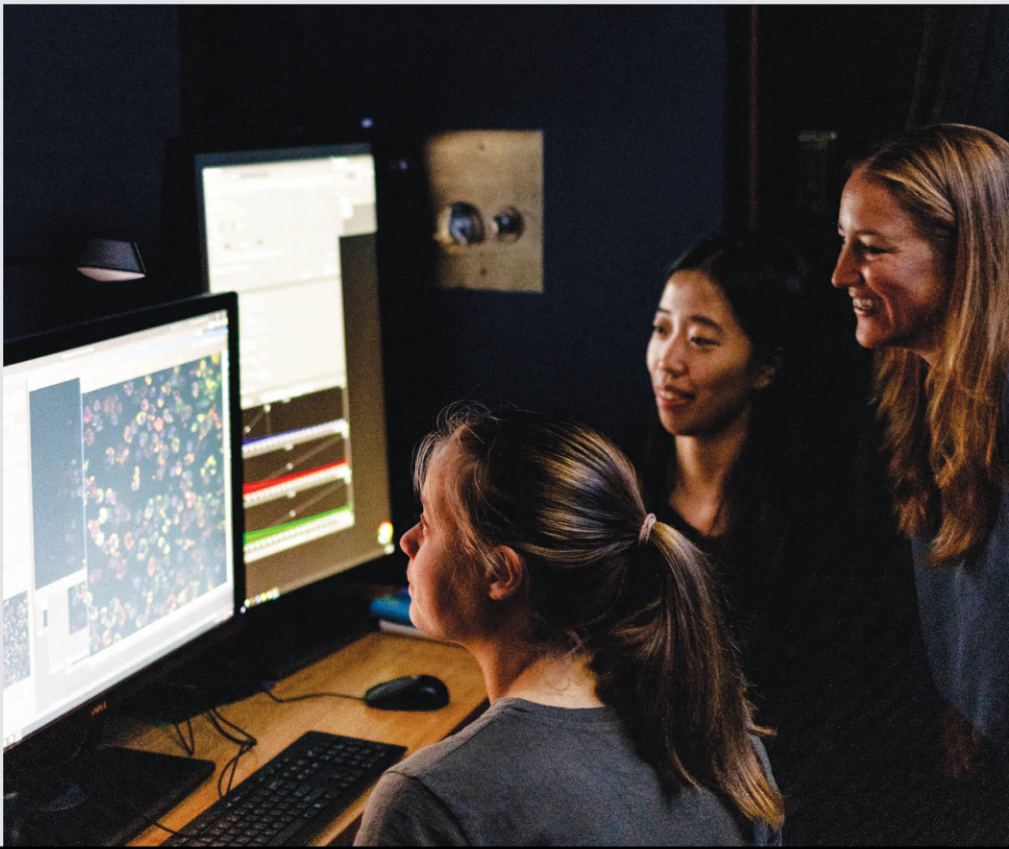
"My lab has spent a lot of time working on how to engineer systems to get into the brain and into injured cells, and not affect otherwise normal cells," explains Elizabeth Nance, an associate professor of ChemE. "That's where Sofia's project came in — she thought about the design of the formulations, and how to get the delivery system into regions that are injured in the brain."

Working closely with mentor Ruby Jin, a ChemE Ph.D. student, Dahlgren learned to encapsulate RNA-based drugs into delivery systems, which are tested on tissue samples to determine the performance on specific disease states. They have preliminary data for improved outcomes in hypoxic-ischemic injury, a type of brain damage caused by a lack of oxygen to the brain before or after birth.

"There's big potential for impact on a newborn's quality of life," explains Dahlgren, who is already considering graduate school and continues to work in the lab this fall. "A big reason the lab focuses on this area is because it's an underserved population and a lot of therapeutics that exist are for adults."

Learn more about engineering undergraduate research:
engr.uw.edu/undergradresearch

Top left: To form drug-encapsulated nanoparticles using a double emulsion, Sofia Dahlgren places a solution in a sonicator. Bottom left: Dahlgren removes a brain slice sample insert from a well plate. Right: Using confocal microscopy, Dahlgren, Ruby Jin and Elizabeth Nance, from left, review the cellular uptake of nanoparticles in a stained cell culture sample. Photos: Dennis Wise/University of Washington



HOW MUCH ENERGY DOES ChatGPT USE?

By Sarah McQuate

Just training a chatbot, such as ChatGPT, can use as much electricity as what 1,000 U.S. households consume in a year. Large language models learn to mimic humans by analyzing huge amounts of data, but there is a sizable network of computer processing units that support training and running the models. An expert on networking for AI and machine learning supercomputing, Sajjad Moazeni, who is an assistant professor of electrical and computer engineering, shares his insight:

How do large language models, such as ChatGPT, compare to cloud computing energy-wise?

These models have become so large that you need thousands of processors to both train the models and then support the billions of daily queries by users. All this computing can only take place in a data center. In comparison, conventional cloud computing workloads, such as online services, databases and video streaming, are far less computationally intensive.

Can you describe these data centers?

In today's data centers, there are hundreds of thousands of processing units that can talk to each other using a large number of optical fibers and network switches. These processors (in addition to memory and storage devices) are stored in server racks. There are hundreds of such data centers across the world and they are mainly managed by big tech companies like Amazon, Microsoft and Google.

How much energy do these large data centers use to run these large language models?

In terms of training a large language model, each processing unit can consume over 400 watts of power while operating. Typically, you need to consume a similar amount of power for cooling and power management as well. Overall, this can lead to up to 10 gigawatt-hour (GWh) power consumption to train a single large language model like ChatGPT-3. This is on average roughly equivalent to the yearly electricity consumption of over 1,000 U.S. households. There are also hundreds of millions of daily queries on ChatGPT. This many queries can cost around 1 GWh each day, which is the equivalent of the daily energy consumption for about 33,000 U.S. households. As models become more sophisticated, they get larger and larger, which means the data center energy for training and using these models can become unsustainable.

What are some potential solutions to this issue?

Researchers have been trying to optimize the data center hardware and processors to become more energy efficient for these types of computation. My group specifically focuses on the networking aspect. In data centers today, processors send electrical signals to bring in or send out the data for computing. We are building the next generation of optical interconnect solutions, which entails converting these electrical signals to optical signals. These optical signals have significantly lower loss and this minimizes the energy consumption.

Photo by Sanket Mishra/Unsplash

New biodegradable plastics are compostable in your backyard

By Sarah McQuate

The problem comes when we're done using something plastic — it can persist in the environment for years. And biodegradable plastics must be processed in commercial composting facilities, which are not accessible in all regions of the country.

A team led by UW materials science and engineering researchers has developed new bioplastics that degrade on the same timescale as a banana peel in a backyard compost bin. These bioplastics are made entirely from powdered blue-green cyanobacteria cells, otherwise known as spirulina. The team used heat and pressure to form the spirulina powder into various shapes, the same processing technique used to create conventional plastics. The UW team's bioplastics have mechanical properties that are comparable to single-use, petroleum-derived plastics.

"The bioplastics we have developed, using only spirulina, not only have a degradation profile similar to organic waste, but also are on average 10 times stronger and stiffer than previously reported spirulina bioplastics," says Eleftheria Roumeli, an assistant professor of materials science and engineering.

To create a more robust product than what other researchers have produced, the team optimized microstructure and bonding by altering their processing conditions — such as temperature and pressure — and studying the resulting materials' structural properties. Although the bioplastics are not ready to be scaled for industrial usage, as they are fairly brittle, the team plans to continue refining the materials.

Mallory Parker, materials science and engineering doctoral student, holds up a bioplastic cube made from spirulina. Mark Stone/University of Washington

A team has developed the first underwater 3D-positioning app for smart devices, such as the smartwatch pictured here. University of Washington

With a new app, smart devices can have GPS underwater

By Stefan Milne

Even for scuba and snorkeling enthusiasts, the plunge into open water can be dislocating. Divers frequently swim with limited visibility, which can become a safety hazard for teams trying to find each other in an emergency. Yet even though many dive with smartwatches designed to go to depths of over 100 feet, accurately locating mobile devices underwater has confounded researchers.

Now, a team of researchers from the Paul G. Allen School of Computer Science & Engineering has developed the first underwater 3D-positioning app for smart devices. Since signals from the above-water network of satellites fade quickly underwater, the app relies on sound, which travels faster and farther in water than it does in air. When at least three divers are within about 98 feet (30 meters) of each other, their devices' existing speakers and microphones contact each other, and the app tracks each user's location relative to the leader. This range can extend with more divers, if each is within 98 feet of another diver.

"Mobile devices today can work nearly anywhere on Earth. You can be in a forest or on a plane and still get internet connectivity," says Tuochao Chen, a doctoral student in the Allen School. "But the one place where we still hadn't made mobile devices work was underwater. It's kind of the final frontier."

A TIMBER TRIUMPH: Seismically resilient and sustainable

By Brooke Fisher

It may sound like a tall order: a seismically resilient and sustainable mid-rise building constructed entirely out of timber. But a team of researchers is proving that this is indeed feasible by testing the tallest structure to date, a 10-story building designed to withstand Seattle-area earthquakes.

"There's a need in urban areas like Seattle for mid-rise buildings. We are trying to make these new developments more sustainable and seismically resilient," says Jeffrey Berman, professor of civil and environmental engineering (CEE).

The project is paving the way for more widespread use of mass timber — layers of wood bonded together — in taller structures, particularly in earthquake-prone regions. Since the seismic performance of taller buildings crafted out of mass timber is not well understood, the building undergoing testing was designed to be located in the heart of Seattle — the Capitol Hill neighborhood.

The CEE team joined researchers from across the country in May to test the 10-story building at one of the world's largest shake tables at the University of California San Diego. The project broke ground on numerous fronts. Not only was it the world's tallest building to be tested on a shake table, but the structure was crafted entirely out of timber, including a unique rocking wall system designed by the UW team.

Ph.D. student Sarah Wichman, Professor Jeffrey Berman and master's student Davis Wright, from left, in front of the building being tested. Photo courtesy of researchers

New 'eyes' for self-driving cars

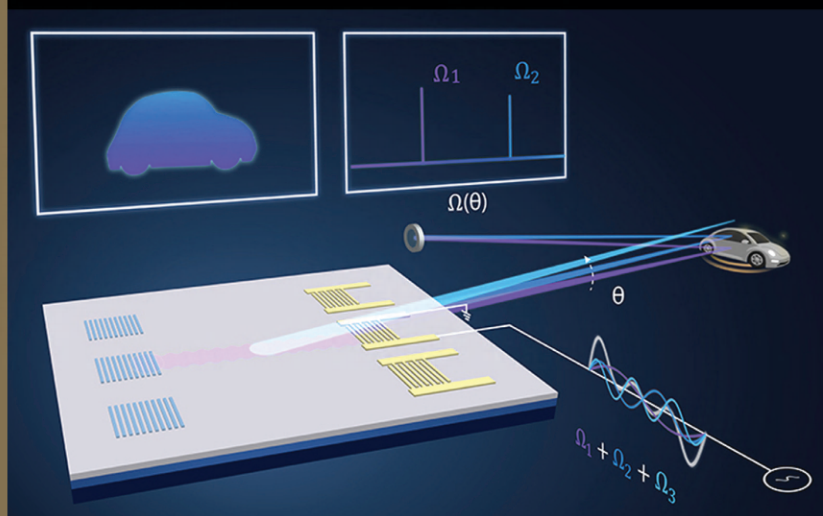
By Wayne Gillam

To help self-driving cars "see" distant objects with clarity and precision, a UW electrical and computer engineering (ECE) research team has invented a new type of light detection and ranging, or LiDAR, system. At the core of their innovation is a laser beam-steering device that is roughly 1,000 times smaller than its counterparts currently in the marketplace. The device is integrated into a computer chip, which makes it compact, sturdy, relatively easy to fabricate and cheap to produce.

"We have invented a completely new type of laser beam-steering device without any moving parts for scanning LiDAR systems and integrated it into a computer chip," says Mo Li, a professor of ECE and of physics. "It can detect and image objects in three dimensions from over 100 meters away."

The research team developed the technology specifically for chip-based scanning LiDAR systems, in which a single, powerful (but eye-safe) laser beam is sent out from the system to scan for objects in the distance. Various beam-steering technologies have been developed over the years, but the mechanical devices continue to be bulky, fragile and expensive to produce. In comparison, the UW team developed a non-mechanical and innovative technique called "acousto-optic beam steering" for guiding the scanning laser beam by sending sound wave pulses across the surface of the computer chip. When the beam reflects off objects in the distance, software processes the data and develops an image.

An illustration depicts a new technology that helps autonomous vehicles "see" distant objects. Illustration by Bingzhao Li and Qixuan Lin



An app can transform smartphones into thermometers

By Stefan Milne

A fever is an early sign of many viral infections. For quick diagnoses and to prevent viral spread, a temperature check can be crucial. Yet accurate at-home thermometers aren't commonplace.

To address this issue, a team of researchers from Paul G. Allen School of Computer Science & Engineering and UW School of Medicine has created an app called FeverPhone, which transforms smartphones into thermometers without adding new hardware. It uses the phone's touchscreen and repurposes the existing battery temperature sensors to gather data that a machine learning model uses to estimate people's core body temperatures. When the researchers tested FeverPhone on 37 patients in an emergency department, the app estimated core body temperatures with accuracy comparable to some consumer thermometers.

"We decided to measure fever in an accessible way. The primary concern with temperature isn't that it's a difficult signal to measure; it's just that people don't have thermometers," says Joseph Breda, a doctoral student in the Allen School.

Clinical-grade thermometers use tiny sensors known as thermistors to estimate body temperature. Off-the-shelf smartphones also contain thermistors to monitor the temperature of the battery, which the researchers used to track heat transfer between a person and a phone. The app, which is the first to use existing phone sensors to estimate fevers, is still a prototype and requires more training data to be widely used.

Ph.D. student Joseph Breda demonstrates how to measure temperature with a smartphone. Dennis Wise/University of Washington

BREAKTHROUGHS

Researchers make a quantum computing leap

Essential for storing and processing information in quantum computers, qubits suffer from a common problem: they tend to be vulnerable to outside disturbances. In experiments with semiconductor materials, a team led by Xiaodong Xu, a professor of materials science and engineering, detected signatures of "fractional quantum anomalous Hall" states. These can host quasiparticles that are stable against small disturbances.

The 'breath' between atoms — a new building block for quantum technology

Atomic "breathing," or the mechanical vibration between two layers of atoms, has been detected by researchers observing the type of light the atoms emitted when stimulated by a laser. Led by electrical and computer engineering and physics Professor Mo Li, the researchers will use the sound of this atomic "breath" to encode and transmit quantum information. Ultimately, this discovery could serve as a new type of building block for quantum technologies.

Researchers put a new twist on graphite

It's possible to imbue graphite — the bulk, 3D material found in No. 2 pencils — with physical properties similar to graphite's 2D counterpart, graphene, according to researchers led by Matthew Yankowitz, assistant professor of materials science and engineering. The breakthrough came after stacking 2D sheets at a small twist angle, an approach the team believes could be used on other bulk materials, possibly fueling technological revolutions.

Addressing drug-resistant pathogens by targeting their protective biofilms

Antimicrobial resistance is one of the top 10 global public health threats. In response, bioengineering faculty Valerie Daggett and James Bryers have developed an approach to bypass antimicrobial resistance by inhibiting the formation of amyloid fibrils, which stabilize the bacteria's protective biofilm coating. They are focusing their work on E. coli, which has developed significant resistance to multiple broad-spectrum antibiotics in recent years.

INTERNATIONAL

In a Nicaraguan community, Engineers Without Borders students improve infrastructure.

By Brooke Fisher

When a group of students arrived in Nicaragua this past spring, their first stop wasn't a typical tourist attraction. They headed straight to the hardware store.

"We took a bus from the airport to the community of Tortuga, which was a three-hour bus ride. We stopped along the way for some tools and supplies," says aeronautics and astronautics undergraduate Kyra Dugan.

The six students, who are members of the UW chapter of Engineers Without Borders (EWB), had no time to waste, or even sightsee. With nine days ahead of them, and numerous projects to complete — from water improvements to compostable latrines — every second was valuable. This was the UW chapter's seventh visit to Tortuga, after forming a partnership with the community in 2016.

With up to 50 members in the UW chapter of EWB, students travel internationally on a rotating basis. During the academic year, the students complete the majority of work on campus — from conducting research to writing pre-implementation reports. During the almost-annual visits, the students continue to chip away on multi-phase projects that focus on water and sanitation needs in the community.

"As a university student, I was worried about how much impact I would be able to have, as I'm still learning about engineering. But we are still able to make a difference in people's lives," Dugan says.

A FLOW OF WATER IMPROVEMENTS

Manually turning on and off the water pump that supplies the community's main water system has been a daily task for residents for more than a decade. But that has recently changed, after automating the process for drawing water from a central well to fill three water tanks.

During their recent visit, students coordinated with a contractor to install float switches, which monitor the water level in the tanks and trigger the pump when levels get low. Automating the pump, which was also newly replaced, required digging a 500-foot-long trench for electrical cables that extend from the bottom of the hill, where the well and pump are located, to the water tanks at the top of the hill.

"It was a huge effort, and the ground was hard to dig. A lot of community members came out, which was incredible, and we helped dig with them as well," Dugan says.

This page: Students and community members work on the foundation for a composting latrine. Opposite page, clockwise from top left: Students and community members work on the chambers for a composting latrine; The EWB team outside the home where they stayed in the village; EWB students dig a trench from the pump house to the community's three water tanks; EWB members in front of a trench they helped dig to house electrical cables. Photos courtesy of Engineers Without Borders

IMPACT

CREATING COMPOSTING LATRINES

Many residents use pit latrines, which can drain into wells located on private property and contaminate groundwater. Since other options, such as septic tanks, are expensive, the students worked on the second phase of implementing composting latrines — one for a family in the community and a second for a family in a neighboring town.

Since the adoption of two composting latrines that were installed during 2019 was a "mixed-bag," even after careful planning and community meetings, the students increased communication with the families slated to receive the latrines.

"This time around, we tried to talk to the beneficiaries as often as possible to make sure they really wanted a composting latrine," says mechanical engineering undergraduate Avocet Nagle-Christensen. "We had a few sons helping at one site and a group of kids and a mom at the other site, so that was a good sign that they are interested and want to use them."

The students poured a concrete foundation for the latrines, which have below-ground chambers for solid waste collection. Dry material like leaves is frequently added to help the waste decompose. Liquids are diverted outside to a bed of gravel to allow the wet waste to evaporate or percolate into the ground. A local mason will construct walls for the structures.

CONFERRING WITH THE COMMUNITY

Since hearing from community members helps guide the team's continued work, three students went door-to-door with questions in hand. They wanted to know what residents thought of the water system upgrades, and also how they feel about having a nonprofit working in the community.

"In general, the response was very positive. It gave me a good sense of the impact we are having," Dugan says. "A lot of people said how they previously lost water access very frequently before our organization was able to work alongside the community."

Before departing, the students conducted a training session with the water and sanitation committee in Tortuga, called the Comité de Agua Potable y Saneamiento (CAPS). Since the community doesn't have the financial resources to hire a contractor for repairs, CAPS members were taught how to troubleshoot inevitable malfunctions.

"It was a really unique experience and was mostly on-site learning — I've never done implementation of an engineering project like this before," says Monika Kaneshige, an environmental engineering undergraduate student. "The community members were all super nice and inviting and gave us fruit and coffee. I think we made a good connection with them."

Women engineers rise

THREE UW ENGINEERING ALUMS SHARE HOW WE RISE HELPED SET THEM UP FOR THEIR CAREERS AS ENGINEERS AND WHY THEY CONTINUE TO STAY INVOLVED WITH IT TODAY.

Since the 1980s, Women Engineers Rise (WE Rise) has been dedicated to centering the experiences of women in the College of Engineering. Recently, the program expanded to also highlight nonbinary engineering professionals. Formerly known as Women in Science & Engineering (WiSE), WE Rise is open to all students and offers mentorship opportunities, advising and tutoring, leadership development and community building.

Learn more and support WE Rise:
engr.uw.edu/we-rise

Sirena Merfalen

Customer Engineering Manager, The Boeing Company
B.S., 2013, and M.S., 2018, Industrial & Systems Engineering

What do you do at Boeing?

I manage engineering teams that support our airline customers worldwide. When customers place orders for airplanes, we work with them to customize our products to fit their needs. From curating the passenger experience to addressing accessibility concerns with restrooms on board, we're involved from start to finish — from the initial design conversations to final take-off.

What do you remember most about WE Rise?

Industry nights with guest speakers, teas and luncheons to practice networking and communication skills-building, resume writing workshops, mock interviews — the list is long! I especially appreciated the thoughtfulness that went into speaker selection. Guest speakers weren't afraid to be candid about their experiences as students and in the workplace. Often I could see myself in many of them. WE Rise introduced me to a community of women supporting other women. I am still friends with many people I met in the program.

Why have you stayed involved?

I got through college because of services like those offered through WE Rise. Cathryne Jordan, who directs the program, supported me at every step in my engineering journey. Because of that support, I vowed to pay it forward. Last spring I served on a panel with other Boeing women at the WE Rise annual conference. I've also represented Boeing at WE Rise career fairs and in industry nights and other networking events. I stay involved because I want my field and the place I work to look different. I want to see more women, especially women of color, in engineering.

Uloma Okoro

Data Analyst and RPA Bot Developer, AT&T
B.S., 2017, Electrical Engineering

Tell us about your work at AT&T.

My first team at AT&T focused on radio frequency engineering. Then I became interested in robotic process automation (RPA) bots — software applications that run automated tasks. I needed to brush up on my coding skills to pursue bot development, so I got certified and moved to my current role where I help teams across the company automate processes.

Tell us about your experience with WE Rise.

I wouldn't have become an engineer without it! I excelled at math in high school but knew very little about engineering. I participated in a WiSE summer program before starting at the UW. It introduced me to engineering majors I had no idea existed, like electrical engineering. My involvement grew from there. I attended and helped organize workshops and other events. For two years I worked part-time as a WiSE student program assistant.

Why do you continue to volunteer?

I fought hard for my footing at the UW and as an engineer. I owe it to my role models and mentors — Cathryne Jordan from WE Rise, Gail Cornelius from the UW Engineering Career Center and Eve Riskin, who was a UW electrical engineering professor when I was a student. These women encouraged me, and they inspired me to give back. Today I serve on the WE Rise Advisory Board. I help organize networking events, high school outreach, career fairs and the annual conference. I'm proud to say that I've attended 10 and have helped run eight of them! I want to show up for today's students and empower them as best I can.

Yuliana Flores

Doctoral student and research assistant, UW Human Centered Design & Engineering
B.S., 2018, Human Centered Design & Engineering, M.Ed., 2020, Policy, Organizations & Leadership

What are you studying in graduate school?

I'm interested in engineering education, guided by the question of how we might develop an engineering curriculum that is more responsible for creating equity in our society. I want to provide students with a historical perspective of engineering to help broaden their understanding of what engineering is and learn to reflect on their knowledge and commitments so they won't contribute to the kinds of inequities we have seen in the past.

What did you learn from WE Rise?

WE Rise instilled in me the value of having a community to lean on, one that not only knows the resources and the tools that help you get ahead, but will make it possible to stay and grow.

I'm the oldest of five and the first in my family to attend college. Growing up I didn't have role models in science and engineering. But WE Rise — and programs like it, such as the UW Society of Hispanic Professional Engineers and Math Academy — changed that. Through lab visits, I got to see what "doing research" meant. I also learned about the difference between preparing for careers in academia and industry.

Why should students participate in programs like WE Rise?

These programs provide resources students don't know they need. Engineering curriculum trains students to problem solve, while WE Rise and programs like it provide support students need outside of the classroom and beyond. WE Rise is the trampoline that can launch students into spaces that weren't traditionally designed for them, and it teaches students how to excel when they get there.

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A foundation for the future

The new 70,000 square foot Interdisciplinary Engineering Building (IEB) is taking shape, quite literally. This past summer, the concrete foundation was poured for the floors and exterior walls. This fall, the roof will be placed followed by work on the interior space.

"Everyone is feeling giddy about this. It was a hole in the ground for a long time and now there's a building. There's a sense of growing excitement, because it's going from an idea to a reality," says Daniel Ratner, the College's associate dean of academic affairs. "This is a building of the students, for the students and by the students — it's entirely student focused."

Located along Stevens Way, east of the Husky Union Building, the new five-story IEB will be an academic home for all undergraduate engineering students, providing state-of-the-art spaces for learning and collaboration. The first classes are anticipated to be held in the IEB in 2025. Watch the progress via the live feed: **engr.uw.edu/about/ieb**

Views of the construction of the five-story Interdisciplinary Engineering Building in August. Photos: Mark Stone/University of Washington