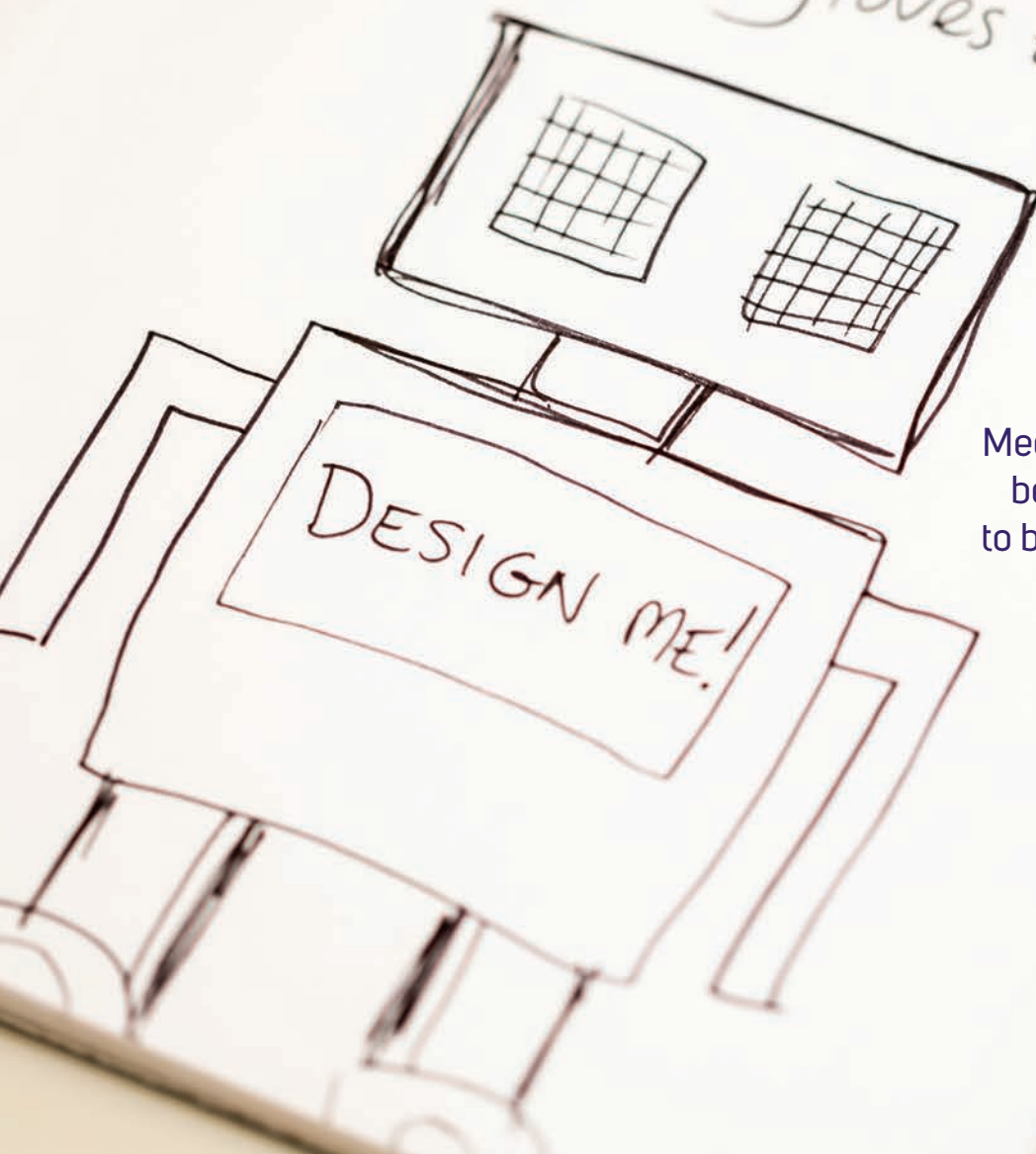


The Trend in **ENGINEERING**

UNIVERSITY OF WASHINGTON COLLEGE OF ENGINEERING NEWSLETTER SPRING 2018

the Lab - the EMAR
hub of EMAR,
"Capturing data in real-time
in the real world"
- #everybodylovesEMAR



Meet EMAR, a robot
being developed
to better understand
teen stress
Pages 4-5

FROM THE DEAN

Celebrating state support and student success

Greetings! I'm excited to open this issue with good news from the 2018 state legislative session: The College received \$600,000 in capital funds for pre-design of a new multidisciplinary engineering building. And, the Paul G. Allen School of Computer Science & Engineering received \$3 million to complete a goal of doubling the number of computer science degrees from 300 to 600 annually. This is a significant development that allows us to continue to pursue growth plans to meet student and industry demand. We appreciate the state's partnership and investment.

Last year, we featured a story about a new Direct to College (DTC) freshman admission process. I'm pleased to share that DTC offers went out for the class of 2022 in March. We expect to have over 700 students in the inaugural cohort and are busy preparing for their integration into the engineering community. Prior to arriving on campus, students will be paired with an engineering adviser and peer mentor to help guide them through their first year. The first-year program is designed to encourage exploration of engineering majors, build community and provide unique educational and leadership opportunities.

As student interest in STEM soars, so does attendance at Engineering Discovery Days, a two-day event held in April. This year we hosted over 10,000 elementary, middle and high school students on campus and introduced them to the exciting field of engineering. Discovery Days is a terrific experience for our state's K-12 students and is a valuable educational experience for our engineering students who are key to the event's success. Our students design and host exhibits and activities that range from the ever popular "Walk on Water" to the sold-out "Glowing Pickle." If you haven't experienced Discovery Days, I hope you'll consider joining us in the future.

Mike Bragg
Frank & Julie Jungers
Dean of Engineering



FACULTY HONORS

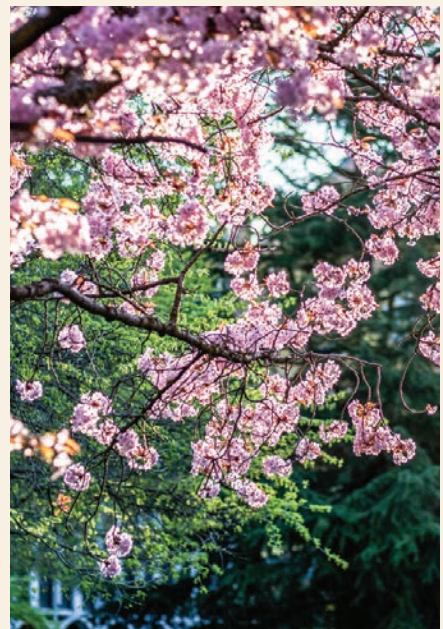
Maya Cakmak, assistant professor in the Paul G. Allen School of Computer Science & Engineering, and **Arka Majumdar**, assistant professor of electrical engineering and physics, received Sloan Research Fellowships.

Amazon Professor of Machine Learning **Emily B. Fox**, an associate professor in the Allen School and of statistics, received a Presidential Early Career Award for Scientists and Engineers.

Mechanical engineering professor **Dayong Gao** and **Anthony Waas**, professor and Boeing-Egtvedt Endowed Chair of Aeronautics & Astronautics, were elected to the Washington State Academy of Sciences.

James Riley, PACCAR Endowed Professor of Mechanical Engineering, was named as an American Association for the Advancement of Science fellow.

Bioengineering professor **Paul Yager** was elected as a National Academy of Inventors Fellow.





AR / VR innovation

The UW Reality Lab will develop next-generation augmented and virtual reality technologies and educate an industry workforce.

The UW has launched a new augmented and virtual reality research center — funded by Facebook, Google and Huawei — to accelerate innovation and educate the next generation of researchers and practitioners.

The \$6 million UW Reality Lab, funded with equal contributions from the three sponsors, creates one of the world's first academic centers dedicated to virtual and augmented reality. The new center in the Paul G. Allen School of Computer Science & Engineering will support research and education initiatives with potential to deliver game-changing breakthroughs in the field.

"Allen School faculty have produced pioneering research in many of the areas that underpin AR and VR technologies, including computer vision, graphics, perception and machine learning," said Hank Levy, Allen School director and Wissner-Slivka Chair in Computer Science & Engineering.

"Through our partnership with Facebook, Google and Huawei, the Allen School and UW will be at the forefront of the next great wave of AR and VR innovation — pursuing breakthrough research and educating the next generation of innovators in this exciting and rapidly expanding field," he added.

Small scale, big impact

The Institute for Nano-Engineered Systems (NanoES) brings together nanoscale science and engineering researchers with industry partners and entrepreneurs.

Housed in a new, multimillion-dollar facility on campus, the NanoES Institute will pursue impactful advancements in a variety of disciplines — energy, materials science, computation and medicine — at a technological scale a thousand times smaller than the width of a human hair.

"The UW is well known for its expertise in nanoscale materials, processing, physics and biology — as well as its cutting-edge nanofabrication, characterization and testing facilities," said Karl Böhringer, director of the new institute and a professor of electrical engineering and bioengineering. "NanoES will build on these strengths, bringing together people, tools and opportunities to develop nanoscale devices and systems."

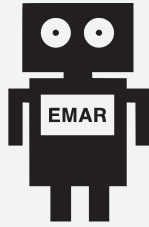
The institute's unique approach to innovation and industry collaboration will hasten the development of solutions to the field's most pressing challenges: the manufacturing of scalable, high-yield nano-engineered systems for applications in information processing, energy, health and interconnected life.

The institute's centerpiece is its headquarters, the Nano Engineering and Sciences Building, which houses 90,300 square feet of research and learning space and was funded largely by the College of Engineering and Sound Transit. In addition to featuring dynamic classroom and laboratory space, the building's location and design elements are intended to limit vibrations and electromagnetic interference so it can house sensitive experiments.

A ROBOT confidant

Meet EMAR, a robot being developed by UW researchers to better understand teen stress and emotional well-being.

By Chelsea Yates



“How many of you feel stressed at school?” When Elin Björling asks a group of Seattle high school students this question, every hand shoots in the air.

Björling, a human centered design and engineering (HCDE) research scientist who studies teen stress, is not surprised.

“Teens experience stress more so than any other age group, and that stress can negatively impact their mental and physical health,” she says.

Yet when it comes to stress research, more studies are needed to understand vulnerable adolescents. According to Björling, researchers lack quality data to understand how, when and why stress occurs in teens or what normal, healthy stress looks like.

Enter EMAR (Ecological Momentary Assessment Robot), a friendly little robot being developed by UW researchers with big hopes of disrupting this data void. Björling is leading this research team with UW Tacoma Interdisciplinary Arts & Sciences assistant professor and HCDE alumna Emma Rose, '11 PhD, and Maya Cakmak, an assistant professor in the Paul G. Allen School of Computer Science & Engineering.

Known as Project EMAR, their team is creating a social robot that will help schools better measure stress. Their goal is to design a robot that would live in a high school and collect data on students' emotional well-being. The project is supported by the National Science Foundation's National Robotics Initiative.

Why use a robot?

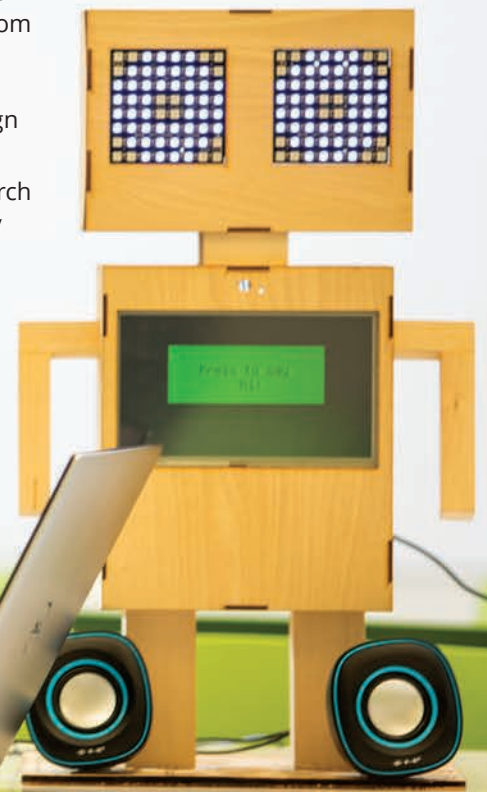
Although there is a great deal of research on human-robot interaction, including focused studies on specific age groups like children and seniors, little exists on teen-robot interaction. EMAR's researchers see this as an opportunity.

“Today's teens will likely be the first generation to spend a lifetime interacting with robots,” explains HCDE junior Wesley Muthemba. “So in addition to gathering important data related to stress, our project will help fill in some human-robot interaction research gaps, which is exciting.”

Muthemba is one of approximately 30 students who have helped shape Project EMAR through independent studies and directed research groups. Students from across the College of Engineering, the Information School and UW Tacoma have participated in all stages of research, design and robot prototyping.

The team is designing EMAR to use a research methodology called Ecological Momentary Assessment to gather real-time data.

“The team realized early on that if we're going to ask teens to share real-time feedback, we needed to provide them with a cool, interesting way to do so,” says Muthemba. “So why not give them a social robot to interact with?”





Cute, not creepy

To ensure that high school students will feel comfortable engaging with EMAR, the team has held multiple user-focused sessions with teens.

“High school wasn’t that long ago for me, and I thought I had a good idea of how teens would respond to EMAR,” says HCDE junior Rachel Ren, the project’s undergraduate research assistant. “But one of the first things we learn in HCDE is to let go of our assumptions and listen objectively, and I’m glad we’ve taken this approach because we’ve learned so much!”

For example, the team discovered that the students overwhelmingly preferred simple, approachable robot designs to sophisticated models, which could seem intimidating.

“Over and over again, we’ve been told that EMAR has to be cute, not creepy,” says Rose.

Based on teen input, the team has created two robot prototypes and is working on two more. EMAR’s first iteration, a squatty, boxy robot, has large round static eyes and a simple, hand-drawn smile. The second is taller with dynamic, digitally responsive eyes. Both feature a touch screen for information gathering.

Teens also reported a desire to know that EMAR cares about them. To convey awareness and expression, researchers have scripted EMAR’s eyes to move and blink. They’ve also programmed EMAR to respond verbally to teen input and are exploring the best types of verbal responses for it deliver.

“Do students want EMAR to suggest solutions that might help them feel better, or do they just want to be heard? What should EMAR’s voice sound like? These are some of

the questions we’re exploring right now,” says Rose.

The researchers have also learned that students are curious about EMAR’s race and gender.

“It never crossed our minds to design for race or gender, but it’s been interesting to observe how soon students want to know if EMAR is a boy or a girl,” says Björling. “This has prompted us to think about how race and gender are communicated and, as designers, how mindful we need to be about our roles in that process.”

Potential for impact

Using a robot to collect information about students raises privacy concerns. To address this, the data will be collected and stored anonymously.

“EMAR is an assessment tool,” explains Björling. “It isn’t intended to single out specific individuals but to compile and aggregate data that schools can use to better understand their student body as a whole.”

Keep up with EMAR at blogs.uw.edu/emar

School administrators and teachers will be able to use EMAR’s data to determine ways to implement change — introduce new after-school programs, host wellness events, increase counseling services, reduce students’ academic workload — and measure the effectiveness of their interventions. The data can also help teens develop more self-awareness and a deeper understanding of their school environment.

“EMAR will serve as a good reminder for teens to take a minute and pay attention to their stress, to talk to their friends or a counselor about it,” Björling adds.

Rooted in engineering

A Washington wine industry pioneer, alumnus Jim Holmes shares how he established a world-renowned vineyard thanks to engineering.

By Chelsea Yates



Spanning 120 acres on Washington's Red Mountain, Ciel du Cheval Vineyard is considered one of the state's first and finest vineyards. Since 1975, Ciel has provided grapes to some of Washington's most respected wineries — DeLille Cellars, Mark Ryan, Andrew Will and Cadence, to name a few.

Ciel represents more than 40 years of alumnus Jim Holmes's passion, determination and commitment to innovation. Holmes, who received his master's degree in materials science and engineering (MSE) in 1962, has owned and operated the vineyard since its inception. And, he says, it wouldn't exist were it not for UW Engineering.

We recently spoke with Holmes about how his engineering background has been integral to his vineyard's success.

Why did you decide to pursue a master's degree in MSE at the UW?

My family had always been interested in rock collecting, which led to my interest in metallurgical engineering and materials science. After graduating in 1959 with an engineering degree from the University of California, Berkeley, I accepted a job at Hanford. It was an exciting place to be for young engineers; there was a worldwide quest to develop nuclear power as an inexpensive energy source, and much of that work was happening at Hanford. My research team was investigating how structural materials behave in a reactor. I wanted to gain more knowledge of the fundamentals of material behavior, so I decided to pursue a master's degree.

It was a wonderful time to do so. The MSE department was transitioning its focus from traditional industrial approaches to emerging technologies in engineering research. The faculty members were young, smart, full of ideas and eager to collaborate with students. The grad student community was superb; we were very supportive of each other.

How did you become interested in wine?

I grew up in Northern California surrounded by good wine, so I just assumed that you could get good wine wherever you went. That was not the case in Washington in the early 1960s. Whenever I went home to California, I'd stock up on wine to share with my Hanford research partner and fellow engineer, John Williams. We developed a serious interest in wine but didn't really have any way to channel it until the early 1970s.

What happened then?

In 1972, John and I invested in some land for commercial purposes and bought 80 acres on Red Mountain. We had no plans to farm it. It was all desert. No one tried to grow anything there.

But we'd been following the work of Walter Clore at Washington State University's Irrigated Agriculture Research Extension Center. He believed — and demonstrated — that under the right conditions certain types of grapevines could be grown in central Washington. Following his lead, around 1975 we decided to plant a few on our land.

Wow, was it a good thing we were engineers! There was no water source, electricity or roads on our property, so we got to work at what turned out to be a big engineering project: transforming our desert into farmable land. We didn't have money to hire people so we did all the work ourselves — cleared the land, conducted a geological analysis to determine where to look for water below ground, brought power in from across the Yakima River, established our own irrigation system, did all our own calculations. At first our families thought we were nuts. But then vines started growing and producing grapes.

What was it like being an engineer by day and a viticulturist in your spare time?

Those two identities have always been intertwined for me since my interest in wine and grape growing developed in parallel to my engineering career. When I retired from Hanford in 1994, I was ready to devote myself — and my engineering skills — fully to Ciel.

Down to the soil, Ciel is rooted in science and engineering. Over the years we've developed an extensive network of sensors to monitor soil moisture. We regularly evaluate and analyze plant and soil samples for nutrients. All of this has allowed us to continuously experiment, learn about the land in detail and better understand our soil's unique composition.



You and your wife Patricia have been advocates for engineering students through your support of MSE graduate students and programs like the Capstone Fund. Why do you stay connected to the UW?

The engineering fundamentals I learned at the UW have provided the backbone for nearly everything at Ciel. I'm proud of the vineyard, and I'm proud to say that I can trace it all back to my engineering studies. I hope that the students we support will one day be able to look back on their time at the UW in a similar way.

We find it very satisfying to support young people interested in engineering research. We are continually impressed by the intellectual talent that we see in today's students. There is so much curiosity and drive to explore and try new things! It's very inspiring.

Learn more about Holmes's vineyard at cielducheval.com

The Husky experience is also a shared experience in our family. Our three sons are all UW alums with degrees in economics, education and political science. My son Richard recently started producing wine from our grapes under the label Côtes de Ciel. So, in a way, I guess you could say that the UW has been with us at every stage of our work — from the first planting to the latest pouring.





PASSION-DRIVEN ENGINEERING

WOOF 3-D introduces campus and community partners to 3-D printing's potential.

Undergraduates involved in WOOF 3-D — a student club housed in the mechanical engineering (ME) department — believe in 3-D printing's potential for impact across all disciplines.

"3-D printing is an incredibly accessible but underused technology that can be applied to any field," ME senior and WOOF club officer Casi Goodman says. "One of our main goals in WOOF is to help others understand its value and how it can enhance their work."

To do so, the club has taken on several projects with campus and community organizations, including:

Enhancing the Museum of Flight visitor experience

Club members are exploring how to replicate the museum's moon rock so that visitors can touch the replica to understand how the real moon rock feels, since handling the original is not permitted. They are also 3-D printing replicas

of broken and missing parts to complete a B-29 airplane for exhibition. A few students are collaborating with museum staff to 3-D scan and print small-scale replicas of aircraft and other artifacts for vision-impaired visitors to hold and feel on the museum's guided "Touch the Sky" sensory tours.

Follow the club at woof3D.net

Assisting the Burke Museum with collection display and study

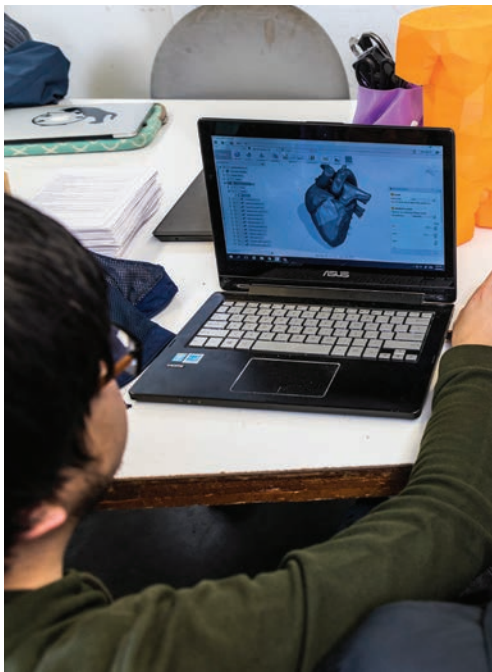
Since 2015, WOOF has collaborated with the Burke Museum of Natural History and Culture to 3-D scan and print replica bones to complete a Columbian Mammoth skeleton for exhibition when the museum's new building opens in 2019. Club members have also started investigating how to 3-D print in bronze a replica of a tooth from the Tyrannosaurus Rex skeleton unearthed by Burke paleontologists in 2016. Additionally, they are working with curator Sharlene Santana,

who researches how and what bats eat by examining their skulls and jawbones, to 3-D print enlarged replicas of bat skulls for better study.

3-D printing medical training materials with UW CREST

Club members are partnering with UW Medicine's Center for Research in Education and Simulation Technologies (CREST) to develop a mold for a synthetic human heart from biosynthetic material based on medical scan data from real human hearts. When finished, they will start on a detailed replica cross-section of a human arm — complete with synthetic skin, bones, tendons and arteries.

It's not common for student clubs to be committed to as many partner projects as WOOF is, and while that has presented



some challenges, it's also allowed for some unique opportunities.

"In WOOF we like to think of what we do as 'passion-driven engineering,'" says Goodman. "We're passionate about 3-D printing and the more we can share that passion with others, the better."

Innovations in health care

Engineering student teams sweep the 2018 Hollomon Health Innovation Challenge.

Student engineers and entrepreneurs dazzled at the 2018 Hollomon Health Innovation Challenge, hosted by the UW Foster School's Buerk Center for Entrepreneurship. Innovative prototypes and solutions to today's health-care problems were on display from twenty-two teams of college students — prompting many judges to call this year's competition "the best one yet."

The \$15,000 Hollomon Family grand prize went to A-Alpha Bio, a team of bioengineering doctoral students and recent graduates. A-Alpha Bio developed an AlphaSeq technology, which improves clinical trial success rates by helping pharmaceutical companies fully characterize their drug candidates in the pre-clinical stage.

The \$10,000 Herbert B. Jones Foundation second place prize went to OLA Simple. The team of bioengineering and electrical engineering graduate students developed a point-of-care technology platform that aims to revolutionize the diagnostics, predictive outcomes and targeted therapy for genetic disorders and conditions.

The Fenwick & West \$5,000 third place prize was given to ACBI (Automated Continuous Bladder Irrigation). The team of mechanical engineering and electrical engineering students created a device that makes continuous bladder irrigation treatment less time intensive and expensive, while reducing the risk of complications for patients.

Nanodropper, a team of pharmacology, bioengineering and business students, received one of the competition's three "Judges Also Really Liked" awards. They created an affordable, universal eye drop adaptor that aims to reduce the cost, waste and side effects frequently associated with expensive prescription eye medications.



INSPIRING FUTURE ENGINEERS

As Clean Energy Institute outreach ambassador, Gabriella Tosado encourages K-12 students statewide to pursue engineering and science.

Gabriella Tosado has melded her interests in sustainable engineering and community involvement through the UW Clean Energy Institute (CEI), where she's been coordinating K-12 outreach programs while pursuing a dual Ph.D. in chemical engineering (ChemE) and nanotechnology and molecular engineering.

Why did you decide to study at the UW?

I'm from Miami, Florida, where climate change isn't just real; it's personal. My hometown is seriously threatened by rising sea levels. I want to do my part to develop solutions to help fight climate change and encourage young people — our next generation of engineers and scientists — to do the same.

When I visited Seattle to check out UW's ChemE program, I discovered CEI, which is working to advance clean energy technologies through solar energy, battery and grid research. I decided that UW was the place for me when I realized that I could get in on the ground floor of CEI's innovative work.

What are you researching?

I'm working in ChemE professor Qiuming Yu's lab to develop and stabilize perovskite solar cells. Perovskite is an exciting material that's pretty new to the solar world. Its unique crystal makeup gives it a lot of interesting properties, and

it can be printed on flexible materials. There's hope that it may soon become a cheap, efficient, high performing alternative to conventional — and expensive — silicon solar cells. But in its current state, it's too unstable. We want to stabilize it so that it can be commercialized, ultimately making solar energy more accessible and affordable.

Tell us about your CEI outreach work.

I travel across Washington to teach K-12 students about clean energy and encourage them to consider going to college to study STEM. I'm proud to say that we've reached more than 40,000 students statewide to date.

I'm especially interested in encouraging underrepresented students to pursue STEM. We need dynamic solutions in STEM, and the only way to get them is to diversify the field. The more difference, the more opportunity to develop and implement new ideas.

It's important for girls and students of color to see women and people of color in STEM. I didn't have any women mentors in science to look up to when I was a kid. So I carved my own path. It would have been meaningful to have someone to look to and say, "She did this; I can do this, too." I'm now in a position where I can be that person for someone else, and that's really motivating.



#MemoriesInDNA

UW and Microsoft researchers want to store your photos in DNA for the benefit of science — and future generations.

Researchers from the UW's Molecular Information Systems Lab and Microsoft are collecting images to preserve indefinitely in synthetic DNA manufactured by Twist Bioscience. Known as #MemoriesInDNA, the project invites the public to submit original photographs to encode in synthetic DNA and make available to researchers worldwide.

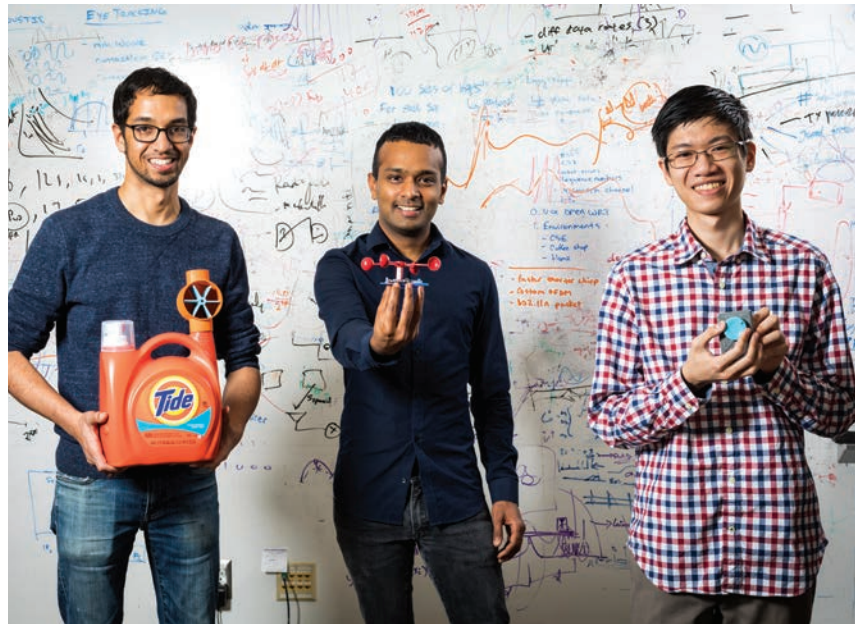
Contributors are also encouraged to share images on social media with the hashtag #MemoriesInDNA.

"We want people to submit something that they want the world to remember," said Luis Ceze, professor in the Paul G. Allen School of Computer Science & Engineering. "It's a fun opportunity to send a message to future generations and help our research in the process."

[Submit your photos at memoriesindna.com](http://memoriesindna.com)

DNA promises to be a revolutionary storage medium that lasts longer and is many orders of magnitude denser than current technologies. Currently the research team holds the world record for the amount of data stored in DNA. They have already encoded important compositions in DNA molecules, including The Universal Declaration of Human Rights, the top 100 books of Project Gutenberg and songs from the Montreux Jazz Festival.

The researchers are already able to retrieve and convert individual molecular "files" of images and video back into digital data. Their next challenge will be to perform data processing directly in DNA without converting the images back into their original form.



PLASTIC COMMUNICATION

Imagine a laundry detergent bottle that can sense when you're running low on soap — and automatically connect to the internet to order more.

UW researchers have become the first to 3-D print plastic objects and sensors that can collect data and communicate with other WiFi-connected devices entirely on their own.

With CAD models that the team is making publicly available, 3-D printing enthusiasts will be able to create objects out of plastics that can wirelessly communicate with other smart devices. That could include a battery-free slider that controls music volume, a button that automatically orders more cornflakes from Amazon or a water sensor that sends an alarm to your phone when it detects a leak.

To 3-D print objects that can communicate with commercial WiFi receivers, the team employed backscatter techniques that allow devices to exchange information. They replaced some functions normally performed by electrical components with mechanical motion activated by springs, gears, switches and other parts that can be 3-D printed — borrowing from principles that allow battery-free watches to keep time.

"Our goal was to create something for your 3-D home printers that can send useful information to other devices," said electrical engineering doctoral student Vikram Iyer. "But the big challenge is how do you communicate wirelessly with WiFi using only plastic? That's something that no one has been able to do before."

COLLEGE OF ENGINEERING

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DIAMOND AWARDS

Thursday, May 10, 2018, 6-9 PM, Husky Union Building, UW campus

Please join the College of Engineering as we honor six alumni and friends for their outstanding achievements.

Dennis Muilenburg, '90 MS, Aeronautics & Astronautics
Dean's Award

Since joining The Boeing Company in 1985, Dennis Muilenburg has served as the president, chief executive officer and chairman, making an indelible mark on the company and the broader aerospace community.

Jud Virden, '83 BS, '91 PhD, Chemical Engineering
Distinguished Achievement in Industry

As the associate laboratory director of the PNNL Energy & Environment Directorate, Jud Virden leads innovations in clean technology and global public-private partnerships that address complex energy and environmental challenges.

Tami Bond, '93 BS, Mechanical Engineering, '00 PhD,
Interdisciplinary Graduate Programs
Distinguished Achievement in Academia

Tami Bond's work to understand the worldwide effects of black carbon emissions on climate and human health has identified black carbon as one of the most significant contributors to manmade climate change.

Aaron Feaver, '07 PhD, Materials Science & Engineering
Entrepreneurial Excellence

As CTO of EnerG2, Aaron Feaver led the development of new low-carbon dioxide energy sources and renewable energy; today, EnerG2's technology is the single largest contributor to energy storage globally.

Irene Peden
Distinguished Service

As UW Engineering's first female faculty member, Irene Peden spent close to 60 years opening doors for female engineers and serving as an advocate for expanding the engineering education pipeline.

Kurtis Heimerl, '07 BS, Computer Science & Engineering
Early Career

Kurtis Heimerl's research is revolutionizing community cellular networks through the development of low-power, small-scale networks in rural and low-income regions to address the global inequality in cellular phone access.

Learn more about the honorees and the dinner at
enr.uw.edu/da