Autumn 2022

MESSENGER

MECHANICAL ENGINEERING | UNIVERSITY of WASHINGTON

Supporting mobility in cerebral palsy, pages 6-7

Celebrating our students

When school started at the end of September, campus filled with the energy of new and returning students looking to make a difference. This fall, we welcomed ME's largest and most diverse class. It is great to see our students taking advantage of opportunities to enhance their education and pursue their dreams. Our award-winning student clubs are again engaging undergraduates to explore mechanical engineering: advanced manufacturing, robotics, electric vehicles, adaptive product creation and marine energy. In this issue, we spotlight how student clubs are returning to in-person designing, building and testing, and succeeding in competitions.

We are also proud to showcase stories about graduate students, postdoctoral scholars and faculty conducting world-class research funded by the National Science Foundation, the Departments of Energy and Defense and the National Institutes of Health. In these pages, you'll meet researchers who are improving cancer diagnostics through 3D imaging pathology, tracking how microplastics behave in the ocean and supporting mobility in cerebral palsy.

In addition, we have a Q&A with DEI Officer Corey Clay that highlights our department's commitment to equity, diversity and inclusion in education and research. Our goals include collaborating with departments in engineering and sciences to create and sustain a culture of excellence that is inclusive of all our students, and finding creative solutions to eliminate intergroup disparities in enrollment, retention and graduation. We are continuing our work to foster a safe, respectful academic environment where all are welcome and propelled to do their best work inside and outside the classroom.

Alberto Aliseda
Mechanical Engineering Chair
PACCAR Endowed Professor

DEPARTMENT NEWS

The AI Institute in Dynamic Systems, co-led by Professor **Steve Brunton** and Assistant Professor **Krithika Manohar**, welcomed its first postdoctoral fellows.

Postdoctoral researcher **Kim Ingraham** will become an assistant professor in the UW Department of Electrical & Computer Engineering in January.

McMinn Endowed Research Professor **Xu Chen** and Assistant Professor **Jeffrey Lipton** received faculty research awards from the UW + Amazon Science Hub to address real-world challenges in AI or robotics.

A National Institutes of Health grant will allow researchers, including Professor **Juan Carlos del Álamo**, to study the complex factors that lead to strokes.

UW researchers, including Associate Professor **Jae-Hyun Chung**, created ultrasensitive capacitive sensors that can be used with a new wearable eye tracker.

A team including Research Professor **Eric Seibel** and Affiliate Assistant Professor **Len Nelson** developed ThermoTape, a medical tape that becomes "unsticky" when it's time for removal. Recent clinical trials demonstrated that ThermoTape has better skin adhesion and less pain during removal when compared to the leading product.

Two members of Albert S. Kobayashi Endowed Professor of Mechanical Engineering **Kat Steele**'s lab, **Sasha Portnova** and **Maitraye Das**, became the first two postdoctoral fellows accepted into a National Institute on Disability, Independent Living, and Rehabilitation Research program.

WOT Associate Professor **Michael Bailey** has been promoted to WOT Professor. Associate Professor **Brian Polagye** has been promoted to Professor.

Student clubs win big

Husky Robotics wins second place in competition

The UW Husky Robotics team is making a triumphant return. In August, the team placed second at the Canadian International Rover Challenge (CIRC), with a perfect score in arm dexterity. The success of their aptly named robot, Resurgence, demonstrates the team's resilience despite pandemic setbacks.

"It was great to be able to meet new people, interact with them in-person and work together on this design," says ME student Sydney Stone.

Each year, Husky Robotics builds a mock Mars rover to compete in CIRC and the University Rover Challenge. During the competitions, teams simulate the experience of being an early colony on an extraterrestrial planet. The robots perform challenging tasks such as traversing rocky terrain, taking soil samples to find out which areas would be habitable and even completing a search and rescue mission.

Husky Robotics

ARUW wins RoboMaster competition

The interdisciplinary club Advanced Robotics at the University of Washington (ARUW) recently took home the championship title in the RoboMaster North America competition for the second year in a row. RoboMaster competitions are similar to multiplayer online battle arena video games. Each team builds a fleet of individually designed and constructed robots to compete against other universities. Robots battle by launching plastic projectiles at "armor plates" to deduct hit points, which "destroys" enemy robots and eventually their main base.

"Being able to travel and compete was fun and motivating, as it allowed our team members to reap the rewards of their year-long hard work," says Manoli Tramountanas, 2022-23 ARUW president and ME student.

ARUW members complete an end-to-end design process on each robot, and some perform advanced mechanical engineering skills such as structural analysis, system dynamics and controllability, and fiber composites design and manufacturing.

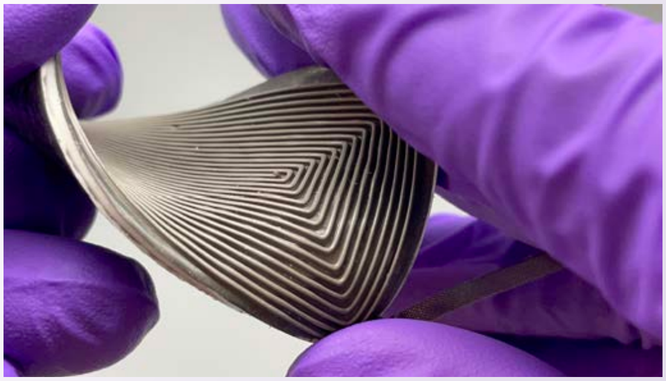
Advanced Robotics at the University of Washington

UWHPS wins Perseverance Award in England

During the summer, the UW Human Powered Submarine (UWHPS) club's submarine Orca competed in England at the European International Submarine Races. The team was among the top four competitors and won the Perseverance Award. Many students saw the submarine competing for the first time at the competition.

UWHPS members learn a variety of key skills as they participate in the design, manufacturing and testing phases of making the submarine, which operates like an underwater bicycle. They receive machine shop training and gain experience in 3D modeling software and composites. The club's scuba diving team became certified in scientific diving so they could gather data while underwater.

To help the clubs purchase materials, participate in competitions and pay other necessary expenses, donate to ARUW at **aruw.org/donate**, and donate to Husky Robotics and UWHPS at **bit.ly/uwmeclubs**



Left: The wearable thermoelectric generators are durable and can bend, twist and stretch. Courtesy of Mohammad Malakooti

Harvesting thermal energy to power wearable electronics

UW researchers create stretchable thermoelectric generators that convert body heat to electricity.

By Lyra Fontaine

Wearable electronics are part of our everyday lives – but finding ways to continuously power them is a challenge. UW researchers, led by ME Assistant Professor Mohammad Malakooti, have developed an innovative solution to this challenge: a wearable thermoelectric device that converts body heat to electricity.

By printing multifunctional soft matter and embedding inorganic semiconductors, the researchers have created first-of-its-kind thermoelectric generators (TEGs), which are soft and stretchable, yet sturdy and efficient – properties that can be challenging to combine. Unlike other flexible thermoelectric devices made of inextensible copper electrodes and carbon-based composites, these TEGs are durable for long-term use and can bend, twist and stretch. They remain fully functional even after more than 15,000 stretching cycles at 30% strain, which reflects the extensibility limitations of skin and therefore is a highly desirable feature for wearable electronics and soft robotics. The device also shows a 6.5 times increase in power density compared to previous stretchable thermoelectric generators.

"It's a 100% gain if we harvest thermal energy that would otherwise be wasted to the surroundings. Because we want to use that energy for self-powered electronics, a higher power density is needed," says Malakooti. "We leverage additive manufacturing to fabricate stretchable electronics, increase their efficiency and enable their seamless integration into wearables while answering fundamental research questions."

Helping assembly-line robots pick up almost anything

A tool developed by UW researchers can design a 3D-printable passive gripper and calculate the best path to pick up an object.

By Sarah McQuate

At the beginning of the pandemic, car manufacturing companies shifted production from automobiles to masks and ventilators. To do so, they relied on people working on an assembly line. It would have been too challenging for robots to make this transition because robots are tied to specific tasks.

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

A UW team has created a tool that can design a 3D-printable passive gripper and calculate the best path to pick up an object. The team tested this system on a suite of 22 objects. The designed grippers and paths were successful for 20 of them.

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

UW researchers tested the 3D-printable passive gripper on a variety of objects, including the items above. Photo by UW

Microplastics at the ocean surface

ME researchers use fluid mechanics to study microplastics in the ocean.

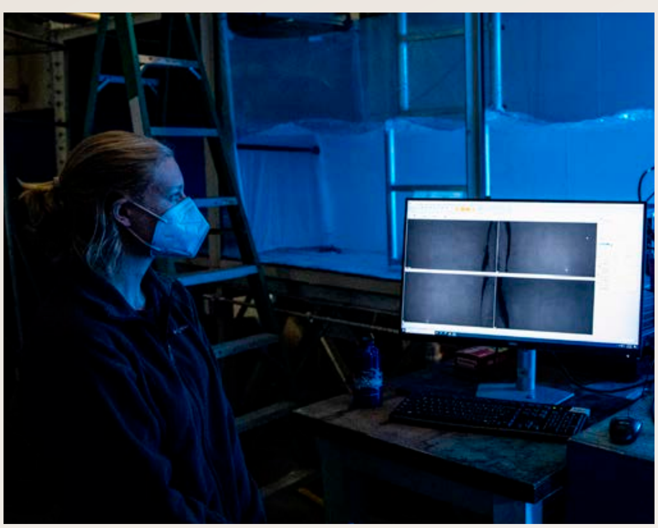
By Lyra Fontaine

Researchers are tracking how microplastics – tiny pieces of plastic less than five millimeters long – behave over large distances in a turbulent environment. The goal is to better predict microplastics' transport, distribution and degradation in the ocean. Understanding how the pieces move can inform the speed at which they break down and where they end up, which could provide insight about how to manage and mitigate plastic pollution in the ocean as well as where to remove it.

Plastic degrades slowly with sunlight, but how long it takes to degrade in the ocean remains unknown. Researchers know that the depth and orientation of the tiny pieces can determine how much sunlight each object receives. To track the particles, ME postdoctoral researcher Luci Baker images the particles' shadows projected onto a wall of the wave tank. She uses four cameras to track the shadows over long distances. Imaging and tracking the shadows provides particle depth and orientation information more efficiently than tracking the particles themselves.

"The implications of microplastics in the ocean are unclear, which is all the more reason to study it," ME Assistant Professor Michelle DiBenedetto says.

DiBenedetto says Baker's research could provide insight into how other particles behave in the ocean. It may also help validate and improve existing models that simulate how plastics behave at the ocean surface, and could help create new models for researchers to use.



Postdoctoral researcher Luci Baker images and tracks the particles' shadows. Photo by Dennis Wise

Destroying 'forever chemicals'

A reactor developed by UW researchers can destroy "forever chemicals."

By Sarah McQuate

"Forever chemicals" are a class of molecules that are ever-present in our daily lives, including food packaging and household cleaning products. Because these chemicals don't break down, they end up in our water and food, and they can lead to health effects, such as cancer or decreased fertility.

The U.S. Environmental Protection Agency recently proposed to give two of the most common forever chemicals, known as PFOA and PFOS, a "superfund" designation, which would make it easier for the EPA to track them and plan cleanup measures.

Cleanups would obviously be more effective if the forever chemicals could be destroyed in the process, and many researchers have been studying how to break them down. A UW research team led by ME Research Associate Professor Igor Novosselov has developed a way to destroy both PFOA and PFOS. The researchers created a reactor that can completely break down hard-to-destroy chemicals using "supercritical water," which is formed at high temperature and pressure. This technology could help treat industrial waste, destroy concentrated forever chemicals that already exist in the environment and deal with old stocks.

"Forever chemical contamination is a big problem, and it will not go away," says Novosselov. "We are excited to work on it and collaborate with regulators and leading groups in academia and industry to find the solution."

Above: The reactor (tube shown above) can completely break down hard-to-destroy chemicals. Courtesy of Igor Novosselov

Taking steps toward supporting mobility in cerebral palsy

Ph.D. student Alyssa Spomer is exploring how a robotic exoskeleton device paired with real-time feedback can enhance rehabilitation therapy for children with cerebral palsy.

By Lyra Fontaine | Photos by Mark Stone

Alyssa Spomer's graduate studies have been multidisciplinary, spanning ME and rehabilitation medicine. She uses her engineering skills to understand the efficacy of using robotic devices to target and improve neuromuscular control during walking.

"My research is a mix of characterizing the capacity for individuals to adapt their motor control and movement patterns, and evaluating the efficacy of devices that may help advance gait rehabilitation," she says.

Testing a promising new device

With support from a National Science Foundation (NSF) fellowship and the National Institutes of Health (NIH), Spomer researches the effectiveness of a new, non-invasive rehabilitation strategy for people with cerebral palsy, a disorder caused by a brain injury to the developing brain that impacts one's ability to control their muscles. Traditional therapies include orthopedic and neurosurgeries, walkers, orthoses and physical therapy. To improve mobility, individuals with cerebral palsy typically undergo multiple surgeries with long recovery periods before they are teenagers.

"Developing non-invasive strategies that may reduce the likelihood of surgical intervention, or ensure that outcomes of surgery are positive, is a huge need within cerebral palsy care," Spomer says.

In her work, Spomer is primarily evaluating how individuals adapt movement patterns while using a pediatric robotic exoskeleton paired with an audiovisual biofeedback system that she helped design. The

Above: Alyssa Spomer demonstrates how she monitors the ankle movement of people wearing a robotic exoskeleton device, worn by University of Arizona researcher Ben Conner.

exoskeleton device, developed by the Northern Arizona University Biomechatronics lab and commercialized by Biomotum, works to sense and support motion at the ankle during walking. It uses motors worn on a hip belt to provide either resistance or assistance to the ankles during walking. The audiovisual system is integrated into the device's app and provides the user with real-time information on their ankle motion alongside a desired target to help guide movement correction.

Spomer performed pilot testing with the device as part of her NSF Graduate Research Fellowships Program internship. Using motion capture and electromyography systems, she was able to precisely quantify how an individual's joint ranges of motion, muscle activity and motor control change with training.

"The goal is to better understand how individuals use biofeedback systems and what factors may predict whether or not someone will respond to the therapy," Spomer says. "Characterizing this will both inform future system design choices and aid clinicians in developing individualized rehabilitation strategies."

Early tests with the device have shown promise in reducing individuals' energy consumption and improving their motor control during walking.

Passionate about accessibility

Spomer was drawn to ME by the Steele Lab's focus on enhancing human mobility through engineering and design. Working with Kat Steele, the Albert S. Kobayashi Endowed Professor of Mechanical Engineering, has been a highlight of her time at the UW.

"The body is the ultimate machine, meaning that we as engineers can apply much of our foundational curriculum in dynamics and control to characterize its function," Spomer says. "The beauty of ME is that you are able to develop such a rich knowledge base with numerous applications which really prepares you to create and work in these multidisciplinary spaces."

Spomer has leveraged her technical expertise and industry experience to perform innovative Ph.D. research that bridges engineering and medicine, Steele says.

"Whether she is in the clinic, working with industry partners, or presenting at a conference, Alyssa is able to communicate with all audiences and unite different groups toward a common vision," Steele says.

Another significant part of Spomer's UW experience is her involvement and leadership in HuskyADAPT (Accessible Design And Play Technology). The student club works with needs experts in the community to develop solutions to accessible design challenges. It also hosts events to teach students, community members and industry partners how to modify toys to make them more broadly accessible.

"HuskyADAPT has been a natural extension of my work and allowed me to think more deeply about accessibility and equity," says Spomer.

Students in the club also hold donation events for all of the toys adapted at workshops – something that Spomer hopes to kick off at Gillette Children's Specialty Healthcare in Minnesota, where she will begin working this winter after she graduates.

Bringing an engineering perspective to a hospital

As a clinical scientist, Spomer will build a new research program in the Department of Rehabilitation Medicine at Gillette. She is primarily interested in studying acute recovery following intervention or neurological injury.

"We know very little about the early stages of recovery after neurologic injury," Spomer says. "I'm hoping to extend my dissertation work in order to better characterize recovery progression and the underlying plasticity of motor patterns, which I hope will help provide greater insight into the efficacy of existing protocols and continue advancing the development of novel rehab tools."

When Spomer first visited Gillette during her NSF internship, she learned about cerebral palsy care and observed surgical interventions. The experience piqued her interest in working at the children's hospital. She looks forward to working with doctors and physical therapists to identify clinical needs that will guide her research and ultimately advance care.

At Gillette, Spomer is excited to pursue research that aligns with her Ph.D. work. Her goal remains the same: "How can we advance and improve the accessibility of healthcare strategies to help promote independent and long-term mobility?"

Above: Alyssa Spomer examines the real-time output of Ben Conner's muscle activity during walking.

SHINING A LIGHT ON 3D PATHOLOGY RESEARCHERS

By Lyra Fontaine

In the Molecular Biophotonics Laboratory, led by ME Professor Jonathan Liu, students and researchers explore how to build an open-top light-sheet microscope, image specimens in 3D and computationally analyze massive 3D datasets. The 3D imaging method developed in the lab enables clinicians to see a complete view of certain tissue specimens, which could improve how diseases like cancer are treated.

Here, meet three former researchers from Liu's lab who are bringing their skills to unique fields. The lab enabled them to make a difference in science and medicine, as well as prepared them to pursue their next career step.

Adam Glaser

Senior Scientist at the Allen Institute for Neural Dynamics

When Adam Glaser joined Liu's lab in 2015 as a postdoctoral research associate, he didn't anticipate being part of a team that developed the first open-top light-sheet microscopy system for clinical pathology.

"It was a fantastic postdoc experience for me to start a new collaborative, clinically translatable research project focused on 3D pathology," says Glaser, senior scientist at the Allen Institute for Neural Dynamics. "Jon was bold and willing to take a risk on a new project, which was fun and inspiring."

Glaser, Liu and their collaborators co-founded Alpenglow Biosciences, a company that commercializes the 3D pathology devices and artificial intelligence analysis developed in the lab. Glaser played a lead role in developing the newest microscopy system, a hybrid open-top light sheet microscope, which is more versatile and able to perform rapid, automated imaging for multiple specimens.

"It's gratifying to see how far we've taken open-top light-sheet microscopy and hopefully it will be impactful in the clinical world outside of academic research soon," he says.

Glaser is now using his expertise in 3D microscopy in neuroscience, a field that's always interested him. At the Allen Institute for Neural Dynamics, his work contributes to getting a more holistic view of neural connections using large-scale imaging.

"Jon was a dynamic and supportive mentor and adviser," Glaser says. "From my time in his lab, I learned how to be organized, prioritize my work and set myself up for success. I'm excited to continue to push 3D microscopy further."

Lindsey Erion Barner

Scientist at NanoString Technologies

In 2017, Lindsey Erion Barner (ME Ph.D., '22) joined the Molecular Biophotonics Lab, drawn to the opportunity to work on hands-on projects and create devices that could improve the accuracy of cancer diagnoses.

Barner dove into hands-on experiments, gaining experience in computer programming, building hardware, preparing tissues and using imaging software. Her Ph.D. work focused on developing a new optical lens type and the first multi-resolution light-sheet microscope. She then used the new microscope for 3D pathology of lymph nodes for breast cancer staging.

"The microscope allows users and pathologists to rapidly transition between low-resolution and high-resolution views when looking at specimens," says Barner. "This capability makes the device more convenient for use in the real world."

For her dissertation, she investigated how the multi-resolution microscope could improve the staging of breast cancer. The researchers found that 3D pathology enabled them to more accurately identify lymph node metastases in breast cancer patients.

"It was really satisfying to develop technology that would improve the standard of care if it was used," says Barner, who was a National Science Foundation Graduate Research Fellow while in ME.

Barner's Ph.D. research directly relates to her work as a scientist at NanoString Technologies, where she explores using light-sheet microscopy to image RNA in tissue samples.

"I learned from the Molecular Biophotonics Lab how to communicate and break down a complicated scientific problem into smaller, manageable parts," she says. "I'm still using a lot of hardware and building devices, just for another exciting application."

Dominie Miyasato

Student at Harvard Medical School

Typically, surgeons remove tumors along with a margin of what they think is non-cancerous tissue around the tumor, known as the surgical margin. Discovering cancer cells at the margin may mean that the tumor wasn't completely removed. Currently, pathologists can examine only a small portion of the excised tumor's margin after surgery. Liu's lab is investigating how to use light-sheet microscopy to determine whether cancer cells are still present on the edges of surgically excised tumors.

Dominie Miyasato explored this application as a researcher in Liu's lab from 2021 to 2022, between graduating from the University of Southern California and attending medical school.

"The strength of our open-top light-sheet microscopy method is that we can sample the entire surgical margin," Miyasato says. "To do this, we image an entire excised tumor specimen on the microscope, looking for cancer cells at the margin, in a process that takes about 20 to 30 minutes. The goal is that pathologists will be able to let surgeons know if all of the cancer has been removed while the patient is still in the operating room."

Liu's lab provided opportunities for Miyasato, who hopes to become a physician-scientist, to do translational research and collaborate with clinicians.

"Developing my research skills at the UW was critical for me to have the opportunity to attend this program," says Miyasoto, who became a student in Harvard Medical School's Health Sciences & Technology program this fall. "Microscopy is a useful tool for any sort of research that aims to answer biomedical questions."

Meet Corey Clay

ME's new Diversity Equity and Inclusion Officer shares the experiences that led him to DEI work and efforts underway to increase representation in the department.

Since he became ME's first Diversity Equity and Inclusion (DEI) Officer — a position jointly created by the department and the College of Engineering's Office of Inclusive Excellence (OIE) — Corey Clay has been busy facilitating discussions, working with student groups and faculty and creating a long-term plan to improve representation in ME.

What led you to this role?

In 2020, my wife and I moved from Houston to Vancouver, B.C. Then George Floyd was murdered, and not long after I created the Pacific Northwest Institute for Racial Trauma. I give talks on racial trauma, anti-racism, allyship and workplace inclusion, with a focus on having conversations about the Black male form and what that entails, including the inherent dangers.

After moving to Seattle about a year ago, I worked at a homeless shelter while pursuing graduate studies and opportunities to focus on DEI work. As an academic, as well as a U.S. Army veteran and former law enforcement officer, I felt like I had this wealth of knowledge that I could use when working with students, faculty and staff to implement DEI into a strategy. I'm continuing to work on my Ph.D. in industrial and organizational psychology. That discipline pairs well with DEI.

What were your experiences like in the military and in law enforcement?

After college, I joined the army. While stationed in Hawaii, I experienced incidents of blatant racism. I was in the military for three years, then I used my G.I. Bill. Because I was infantry, on the front lines, I was qualified to do law enforcement type jobs, so for me that was a natural progression. I returned to my hometown in Texas and worked in the jail. That's when I began to see race-based disparities in who gets arrested for what and why, and who is let go.

Witnessing those massive inequities prompted me to go back to school and get my master's degree in criminal justice. Then I became a probation officer, where I saw even more systemic discrepancies about who gets probation versus who doesn't. I wondered how I could make a positive change.

How did you get interested in working in DEI and higher ed?

Once I realized that I wanted to focus on implementing change, it seemed that academia and academic administration would be a better fit for me. I taught at Warner Pacific University in Portland and the University of St. Thomas in Houston and at both I ended up being the DEI point person.

I taught courses in psychology and criminal justice. One focused on sentencing and corrections, and many students had no idea about the inequities that people who look like me go through in life. As the faculty advisor for the Black Student Union in Houston, I found myself advocating for marginalized and underrepresented students.

Learn more about diversity, equity and inclusion in ME: **me.uw.edu/about/diversity**

Through examining inequities, having discussions with students and mentoring students, I realized I was doing DEI work. I really enjoyed working with students and opening doors for them while helping them learn to avoid some of the pitfalls that I have experienced. That advising and teaching experience gave me insight into how I can engage students and be there for them.

What are some of your responsibilities as DEI officer?

My main goal is to create a strategic long-term plan for the department. It focuses on how to create a diverse workforce, grow the faculty and student body and ensure that ME is inclusive of who we represent.

This means looking at the data, identifying the numbers we want to increase and how we will go about doing that. Metrics will give us a baseline so that we can pinpoint our strategies to recruit underrepresented populations. Diversity isn't always about skin color; it's also diversity of thought and of different backgrounds. This fall quarter, I've also been teaching ENGR 401: Leadership Development to Promote Equity in Engineering Relationships, which gives students a framework to improve diversity across engineering.

I really enjoy the forums I facilitate. Last year, the forums were about George Floyd, disability and ableism and critical race theory. This school year, I'm hosting forums about topics such as trauma and xenophobia.

Why is it important for an engineering department to embed DEI in all that it does?

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

There's still work to be done, but I'm very encouraged by the ME department. Chair Alberto Aliseda and Associate Dean Karen Thomas-Brown have been incredibly supportive, and I've been impressed by the work of ME's Diversity & Outreach Committee and student groups, such as the American Society of Mechanical Engineers and the Mechanical Engineering Graduate Student Association. I've also been impressed by how much female representation there is among students, faculty and staff. ME is a very male-dominated field, so to see a department really working hard to expand representation is a good thing.

Clay presented at the Canadian Psychological Association Annual Convention in Calgary, Alberta in June 2022.

MECHANICAL ENGINEERING
UNIVERSITY of WASHINGTON

Mechanical Engineering Box 352600
Seattle, Washington 98195-2600

Alberto Aliseda, Ph.D.
Department Chair
PACCAR Endowed Professor

Lyra Fontaine
Communications Manager

Monique Heileson
Graphic Design

Send address corrections and comments to: mengr@uw.edu

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