Spring 2019

MESSENGER

MECHANICAL ENGINEERING | UNIVERSITY of WASHINGTON

Assessing the impact of marine energy technologies on sea life, *Pages 4-5*

ENGINEERING EXCELLENCE

One of the most exciting aspects of ME is its diversity as a discipline. In the following pages, you'll cross several research areas — from clean energy and environmental engineering to mechatronics, health care and advanced manufacturing. And you'll meet some of our alumni, students and faculty who are making big waves in these fields.

Our students' passion, curiosity and excellence never ceases to amaze me. This spring the National Science Foundation (NSF) awarded its 2019 Graduate Research Fellowships; a record-breaking nine of them went to graduate students in our department. The University of Washington had the highest number of NSF Graduate Research Fellowship recipients out of all institutions, and ME had the second highest number of recipients at the UW.

Our undergraduates are just as driven. You'll meet a few of them here, like senior Karli Berger, who's pursued a ME concentration in mechatronics while also being a member of the UW's Cheer team, and Makoto Eyre, an architectural designer eager to design environments in space who decided he needed to build a foundation in mechanical engineering to do so effectively.

Of course, our work wouldn't be possible without support from our donors, alumni and partners. Our feature story is a wonderful example of research support and collaboration — ME researchers have been partnering across campus, with other academic institutions, and with governmental and national laboratories to develop marine energy conversion systems and better understand the impact they have on sea life. It's a great story of responsible innovation, and we're thrilled to serve as the hub for their work.

Per Reinhall
Mechanical Engineering Chair

ME External Advisory Board

The board provides counsel to the department, mentoring to students, and advocacy and vital connections to industry.

Thanks to the following alumni and friends for participating on the 2018-19 board:

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Gil Wootton, '89 BSME
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Jon Yourkoski, '96 BSME
Morgan Stanley & Co. Inc.

STUDENT NEWS

MOtiF Materials, an ME team led by doctoral student Elizabeth Rasmussen, took first at the 2019 Alaska Airlines Environmental Innovation Challenge. Their idea to make battery technology more sustainable electrified the judges who awarded them the $15,000 grand prize.

Master's student **Karley Benoff** and teammates Preston Pan and Melchizedek Mashiku won first place in the Center for Neurotechnology's 2019 Hackathon. They created a device to support strength, stability and balance for individuals recovering from spinal cord injuries.

DopCuff, an ME Engineering Innovation in Health team, received a "Judges Really Liked" award at the 2019 Hollomon Health Innovation Challenge. Their device aims to improve how nurses obtain blood pressure readings in patients with end stage heart failure.

Junior **Anika Hidayat** was named to the Husky 100, a UW program that recognizes students who are making the most of their Husky experience. She was also honored with a 2019 Brooke Owens fellowship, which connects 36 women nationwide each year with internships at leading aviation and space companies.

Doctoral student **Melanie Anderson** received a National Defense Science and Engineering Graduate Fellowship for academic excellence. She is developing a robot helicopter that can smell better than previous robots by using a moth antenna.

Nine graduate students — **Megan Auger**, **Charlotte Devol**, **Ty Higashi**, **Brittany Lydon**, **Marissa Miramontes**, **Alexander Novokhodko**, **Nataliya Rokhmanova**, **Alyssa Spomer** and **Angela Straccia** — have been awarded 2019 National Science Foundation Graduate Research Fellowships.

MOtiF Materials won first place at the 2019 Alaska Airlines Environmental Innovation Challenge. Photo by Matt Hagen / UW Buerk Center for Entrepreneurship

DIAMOND AWARDS

Join us in congratulating two ME alumni on being honored this spring for achievements by the UW College of Engineering with 2019 Diamond Awards.

Paul Skoglund,

'68 BSME

Entrepreneurial Excellence

Paul Skoglund's ingenious valve technology has advanced commercial industries in a range of business markets, and his products have helped reduce greenhouse gas emissions, promoted energy conservation and improved the safety and efficiency of the oil industry.

Patrick Shanahan,

'85 BSME

Distinguished Service

Throughout his 30-year career at The Boeing Company and in his service leading the United States Department of Defense, Patrick Shanahan has been dedicated to supporting current engineering students and fostering a culture of excellence in education.

Learn more about the Diamond Awards at engr.uw.edu/da

Environmental impact

By Sarah McQuate

Researchers are developing ways to better understand how emerging marine energy technologies impact underwater life.

Harvesting power from the ocean, through spinning underwater turbines or bobbing wave-energy converters, is an emerging frontier in renewable energy.

Researchers have been monitoring how these systems will affect fish and other marine life. But with most available technology, scientists can get only occasional glimpses of what's going on below.

So a team led by ME associate professor Brian Polagye and in collaboration with the UW Applied Physics Lab (APL) created a mechanical eye under the ocean's surface. The device, called an Adaptable Monitoring Package (AMP) lives near renewable-energy sites and uses a series of sensors to continuously watch nearby creatures. They're currently testing the latest version of their AMP at the Pacific Northwest National Laboratory-Marine Sciences Laboratory near Sequim, Washington.

"The big-picture goal of the AMP when it started was to try to collect the environmental data necessary to tell what the risks of marine energy were," says Polagye, who recently became the director of the Pacific Marine Energy Center, an academic consortium between the UW, Oregon State University and the University of Alaska Fairbanks. "But we ended up with a system that can do so much more. It's more of an oceanographic Universal Serial Bus. This is a backbone, and you can plug whatever sensors you want into it."

Seals, turtles, fish and more

The newest member of the AMP family has the biggest variety of sensors yet, including an echosounder, which uses sonar to study schools of fish. It also contains the standard set of instruments that all previous AMPs have supported, including a stereo camera to collect photos and video, a sonar system, hydrophones to hear marine mammal activity and sensors to gauge water quality and speed. This new system does more processing in real time than its predecessors.

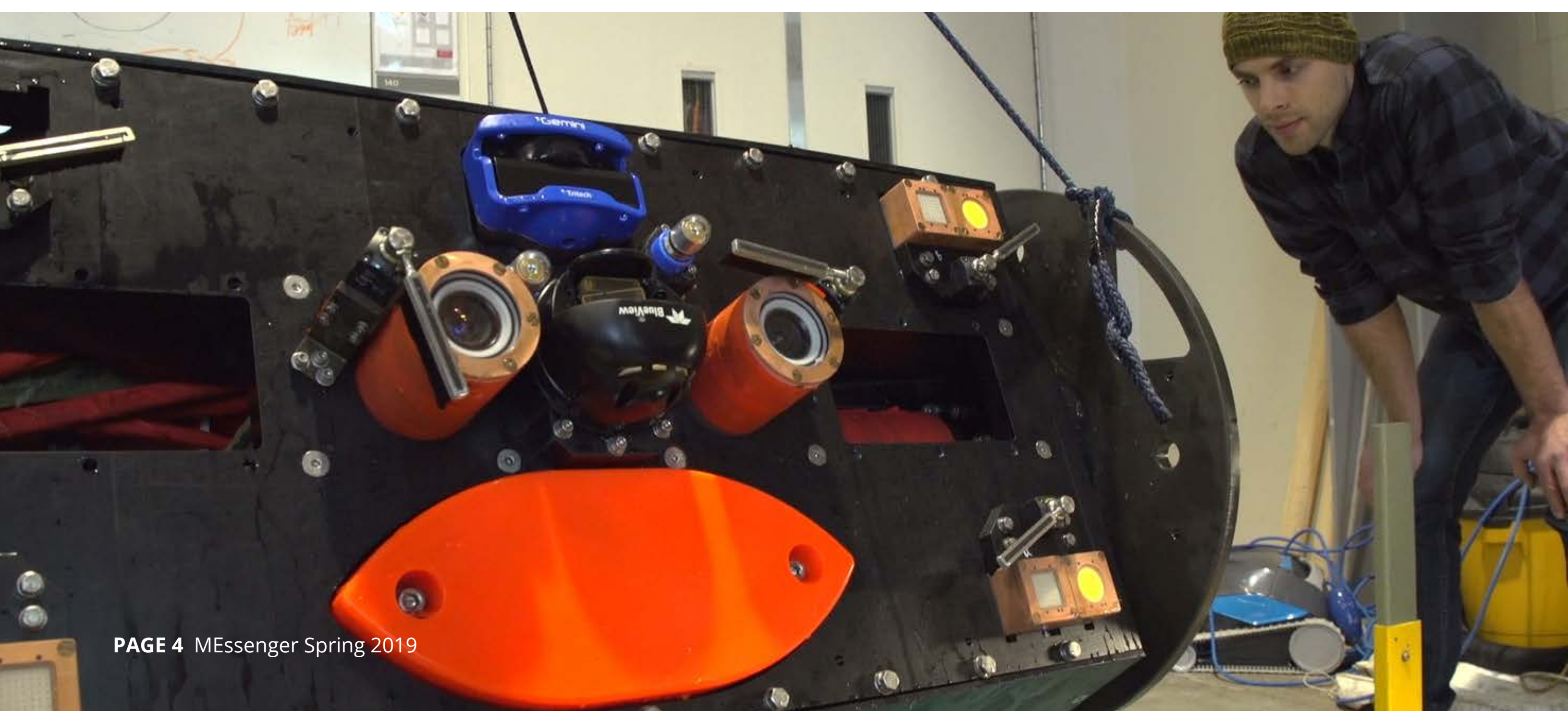
"We want the computer to not just collect data, but actually distinguish what it sees," says ME doctoral student Emma Cotter. "For example, we'd like to program it to automatically save images if sea turtles swim by the AMP."

Each sensor type generates a different type of data, so with the device in Sequim Bay, the researchers want to ensure that all the data streams can be analyzed collectively in real time.

More "AMP"plications

The team has developed additional AMPs that are more specific to other types of oceanographic research. Last fall, an AMP was deployed to survey sea life off the coast of Hawaii while powered by a yellow metal ring, called the BOLT Lifesaver, through a partnership with the Navy, the U.S. Department of Energy, University of Hawaii and the company Fred. Olsen.

"They were interested in what happens if whales and sea turtles encounter the mooring lines that connect the



Lifesaver to the seabed," Cotter says. "The best way to answer that question is with an AMP."

The Lifesaver is a wave-energy converter — a device that converts the bobbing of waves into electricity — that powered this AMP.

"This was the first example of using wave energy to power oceanographic sensors," Polagye explains. "Previously people collected wave energy and sent it back to shore. But this AMP was completely self-reliant."

The research group is also working on a vessel-based version of the AMP, which will ride aboard APL's newest research vessel, R/V Russell Davis Light. The team plans to test tidal turbines on the boat, so the vessel-based AMP will let the researchers see if anything happens to nearby fish.

They hope to commercialize the AMP platform through a UW spinout company called MarineSitu, founded by ME alumnus and APL mechanical engineer James Joslin, '15 PhD. That way other researchers can purchase AMPs with sensor packages specific to their goals.

"The renewable energy industry needs this technology to grow, so it's especially important to make it accessible and customizable to turbine developers and other marine energy companies," Joslin says. "Increased adoption of AMP technology will improve our understanding of marine environments and lower regulatory barriers to future projects."

Learn more about the research at pmec.us

This page: Emma Cotter and James Joslin retrieve an AMP from PNNL's underwater testing site at Sequim, Washington. Photo by Matt Hagen

Opposite page: UW Applied Physics Laboratory mechanical engineer Paul Gibbs, '10 BSME, inspects an AMP before testing. Photo by Kiyomi Taguchi

PMEC at the UW

Since 2008, the Pacific Marine Energy Center (PMEC) has been dedicated to advancing the responsible development of wave, tidal, in-river and offshore wind energy technologies.

The Center unites faculty and students from the UW, Oregon State University and the University of Alaska Fairbanks with marine energy technology developers, National Laboratory researchers, coastal community members, ocean users, federal and state regulators, and other government officials to address key challenges in the sector and accelerate its emergence.

In 2017, ME associate professor Brian Polagye became director of PMEC, and the Center's leadership rotated to the UW.

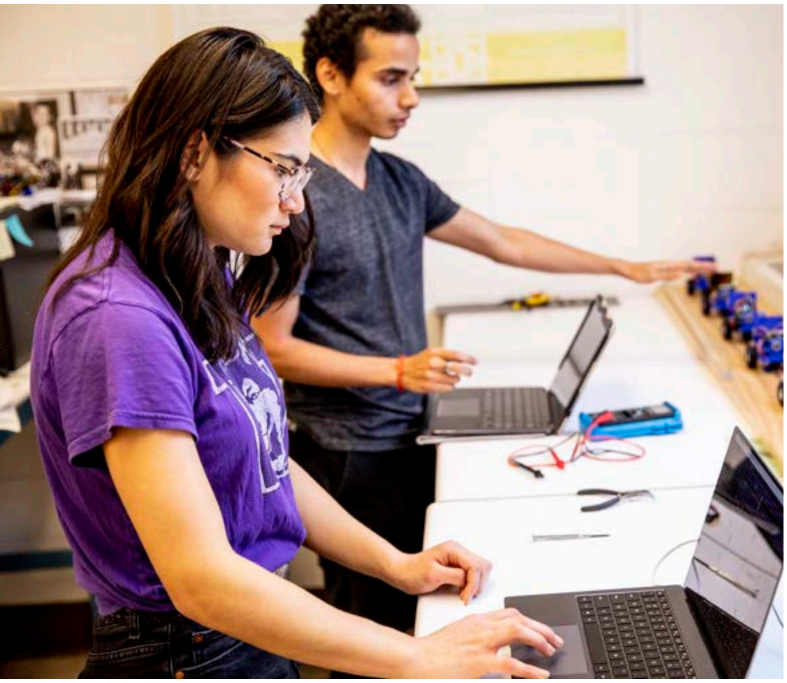
"Hosting PMEC in Seattle is beneficial for many reasons," he says. "Several marine energy companies have relocated to the area to be near the Center, and it's giving us more opportunity to deepen our research collaboration with the U.S. Department of Energy's Pacific Northwest National Laboratory."

Above all, he says, is the impact it's having on UW engineering education.

"PMEC has helped us attract terrific graduate students to ME," he adds, citing that half of the Center's graduate students are National Science Foundation fellowship recipients. "There's a wealth of hands-on research opportunities, so it's a great place for students interested in the convergence of tech, engineering, society and environment, who want their research to have real impact."

Passion never rests

Karli Berger shares how she's balanced her passions for mechatronics and cheer.



ME senior Karli Berger has made the most of her Husky experience since stepping on campus. She's been a member of UW's Cheer team and UW Engineering's Student Advisory Council while pursuing ME's mechatronics degree option. A competitive program that accepts 30 undergraduates annually, mechatronics immerses ME students in the integration of mechanical, electrical and computer technologies through courses and projects focused on robotics, automation, sensing and controls.

What interests you about mechatronics?

Mechatronics combines my interests in computer and mechanical engineering. I love to play with software, and my all-time favorite courses have been ME 373 and 374 — focused on system dynamics, analysis and design. Thanks to them, I decided to pursue mechatronics.

Any similarities between Cheer and ME?

Both Cheer and ME require a strong work ethic, and both have taught me the value of teambuilding. A successful cheer team relies on great teamwork, and the same is true for successful engineering teams. ME's mechatronics cohort feels like a team; many of us have discovered that it's much more beneficial to work together than to compete against each other. Both Cheer and ME can be hard — difficult practices and challenging classes — and it's good to share those experiences. Anytime I go into the mechatronics lab, I know I'll find other ME students to work with. It's nice to have that community.

What research are you working on?

I'm working in Professor Santosh Devasia's Precision Controls Lab with PhD student Anuj Tiwari on an autonomous vehicles and robotic systems control project. Imagine you're in a car stopped at a red light with a line of cars behind you. Once the light turns green, you accelerate, and so do the others. But there's generally a delay between the first and second cars, the second and third, and so on. The same is true for stopping. We're working to decrease the time delay in a network of robotic vehicles so they advance and brake at the same velocity. Applying this technology to self-driving cars will make them easier to control, more efficient and safer.

What advice do you have for ME students?

Stay focused and don't get discouraged by tough classes. There aren't many women in ME, and that can feel intimidating at times. But remember, you're here for a reason, and you can accomplish anything if you're passionate about it. Invest in friendships and build relationships with classmates; it's so much better to journey through engineering with a team instead of on your own.

Upper: Karli Berger works with ME PhD student Anuj Tiwari on an autonomous vehicles and robotic systems control project. Photo by Dennis Wise

Below: "Both Cheer and ME require a strong work ethic, and both have taught me the value of teambuilding," says Berger. Photo courtesy of UW Cheer

KITCHEN ENGINEERING

A novel course introduces first-year students to a menu of engineering disciplines — through cooking.

By Lindsey Doermann

Cooking is an art and a science. And if you ask professors Nate Sniadecki of ME and Lilo Pozzo of ChemE, it's also the perfect window into a smorgasbord of engineering concepts.

The two have created a culinary-focused first-year course called Kitchen Engineering to introduce students to fundamental concepts across all engineering disciplines. As incoming UW students can now be accepted directly into the College of Engineering, this class can help them make the best choice from their menu of engineering options.

"The kitchen is the first laboratory most of us are exposed to," Sniadecki says. "It's a great place to explore engineering concepts."

In a way, it levels the engineering playing field. Not everyone has access to a 3D printer or robotics club in high school, but nearly everyone is familiar with the kitchen.

Pozzo says that developing this course made her think about how cooking relates to more than just chemical engineering. Colloids, her research focus, show up everywhere in the kitchen in the form of foams (whipped cream), emulsions (mayonnaise), smoke and more. But chefs also need to know about the structure of muscle, as do engineers who work with the human body. And developing designs for stand mixers, microwaves, dishwashers and efficient kitchen layouts are, at their core, engineering problems.

Pozzo and Sniadecki collaborate with area chefs to present their lectures. The course is designed so that one class per week features cooking demonstrations, while the other focuses on the related engineering concepts. In the investigation of heat transfer, for example, chefs compare how cooking duck breasts differs by starting them skin up versus skin down. The results clearly show how the skin, when facing down first, insulates the meat and prevents it from overcooking. At the same time, the fat renders nicely and the skin crisps.

Sniadecki especially enjoys leading the class in a "Kitchenaid autopsy," during which students disassemble broken Kitchenaid mixers to investigate product design. "A lot of students have experience using appliances like mixers, microwaves and dishwashers but know very little about their 'guts.' So we take them apart and see what's going on inside," he says.

Outside of class, students must complete homework assignments in their own kitchens. For their final project, they're asked to propose a new kitchen device, technology or recipe based on topics covered throughout the quarter.

"Food is a great way to build community," Sniadecki says. "We learn about others and other cultures through food — why not extend that into the first-year engineering student experience?"

Above: Kitchen Engineering covers an array of engineering concepts: heat transfer, chemical reactions, fluids, mechanics, structures and more. Photo by Dennis Wise

SPACE ARCHITECT

Architectural designer Makoto Eyre talks about returning to school for a second bachelor's degree to pursue his passion: designing human environments in space.

Getting humans into space is a great challenge; understanding what their life will be like once there is even more complex. What will people need from their living and work environments, and who's going to design those spaces?

Makoto Eyre hopes he will. An architectural designer turned ME student, Eyre is building a foundation in biomechanics and engineering design through ME's post-baccalaureate (post-bac) program. Developed for students who have a bachelor's degree and want to work toward a second in another academic area, post-bacs give students the chance to fill in courses not taken during their initial degree program without having to start over from scratch.

Why did you decide to pursue an ME post-bac?

To deepen my interest in space architecture, I need a solid foundation in engineering and science to articulate the ideas of space habitation. ME's post-bac program allows me to augment my design background with STEM training.

ME researchers are doing great work in biomechanics and human factors — areas that are important when it comes to environmental design. They're not simply developing products and methods for users, but with them — incorporating users' input and experiences at all stages. It's great to be in an academic environment that appreciates this.

Insert: ME student Makoto Eyre

Background: Illustration of a multi-bedroom zero-gravity habitat. Courtesy of Makoto Hamamoto Eyre

What was it like to become a full-time student again?

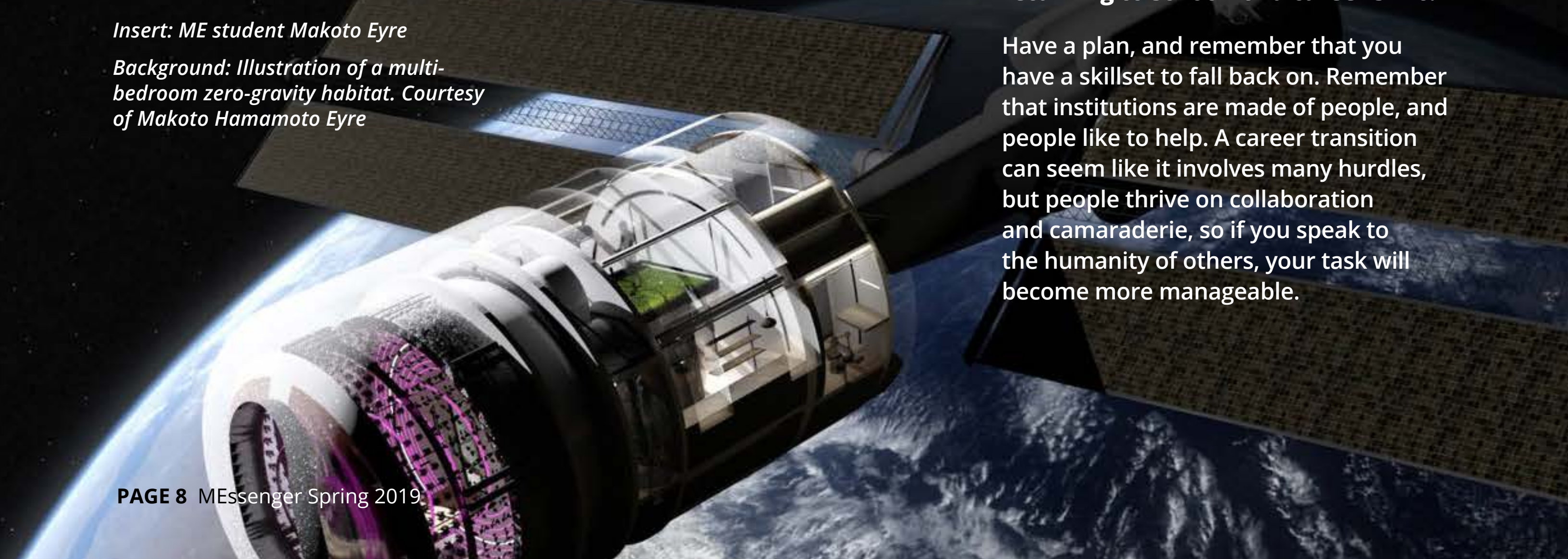
Leaving my job to go back to school seemed like a pretty big risk. But once I realized that returning to architecture is always an option, the risk dissolved. I first took engineering classes at North Seattle College and then applied as a transfer student to the UW. I knew I wanted hands-on research experience with biomechanics and human factors, so I connected with Professor Kat Steele's Ability & Innovation Lab. I've been grateful to work with her team the entire time I've been on campus.

How does your work in the Ability & Innovation Lab relate to designing environments for space?

In the lab I'm gaining experience with the tools, design processes, and prototyping necessary to investigate human biomechanics. We use electromyography and motion capture tools to understand how bodies work; these technologies apply to understanding how our bodies are influenced by physical environments, too, whether on Earth or in space.

Any advice for others considering returning to school for a career shift?

Have a plan, and remember that you have a skillset to fall back on. Remember that institutions are made of people, and people like to help. A career transition can seem like it involves many hurdles, but people thrive on collaboration and camaraderie, so if you speak to the humanity of others, your task will become more manageable.



ADVANCING A PARTNERSHIP

PACCAR and ME deepen their collaboration through a new campus workspace and undergraduate capstone projects.

The PACCAR Technical Center (PTC) — PACCAR's test and development site — and ME celebrated a new campus research space this spring. The PACCAR Advanced Research Center provides students a dedicated lab for PACCAR-sponsored capstone projects with goals of expanding into a collaborative research space for students, faculty and PACCAR engineers.

> "Partnerships like this support an exciting trend in engineering education where students learn by doing, through close interaction with industry."
>
> **- Per Reinhall, ME Professor and Chair**

"PACCAR is one of the world's largest truck manufacturing companies, and their projects present challenging opportunities for students interested in areas ranging from autonomous vehicle operations to advanced manufacturing to environmental impact," says ME professor and chair Per Reinhall.

This year PTC sponsored eight capstone projects representing transportation and manufacturing challenges in sensor technology and development, supply chain and assembly production, fuel efficiency and driver alertness monitoring.

The workspace and experiential learning opportunities build on several years of partnership. In 2001, PACCAR established an endowed professorship in ME, a position held by James Riley until his retirement and recently awarded to Alberto Aliseda. PTC's director of advanced powertrain Carl Hergart has served on ME's External Advisory Board since 2016. PTC has also been a longtime supporter of ME's EcoCAR and Formula Motorsports teams and has a history of hiring ME students from capstone projects as interns and engineers.

"Partnerships like this support an exciting trend in engineering education where students learn by doing, through close interaction with industry," Reinhall says. "It's a win-win for everyone: Students train using industry tools, faculty are exposed to industry needs, and industry gets access to our world-class researchers."

Research highlights

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

Bee backpacks

Farmers can use drones to monitor crop health, but drones can't get very far without needing to be charged. So a UW engineering team — including ME assistant professor Sawyer Fuller — has created a sensing system small enough to ride aboard a bumblebee. The package requires a tiny rechargeable battery that can last for seven hours of flight and then charge while the bees are in their hive.

UW researchers have created a sensor package small enough to ride aboard a bumblebee. Photo by Mark Stone

A stud finder for arteries

Since arteries aren't visible under the skin, clinicians must feel for a patient's pulse to know where to insert an IV needle before surgery. It's an imperfect method that often results in multiple pokes. With UW Medicine anesthesiologist Sheena Hembrador, ME professor Minoru Taya has developed a pocket-sized device that uses pressure sensors to identify arteries so clinicians know exactly where to place the needle.

Helping ER doctors

Emergency room doctors often have a few minutes to determine if patients need a blood transfusion. Currently there's no method to assess the health of one of the blood's most critical components: platelets, tiny blood cells that help blood clot after an injury. Working with UW Medicine, ME associate professor Nate Sniadecki and his team have created a system that measures platelet function to help doctors determine, within two minutes of a patient's arrival, if a transfusion is needed.

Health care **careers**

Three alumni working in health care reflect on their career pathways and share advice for those interested in this ever-growing field.

Scott Rewinkel, M.D. ('07 BSME)

Vascular Neurology Fellow, Oregon Health and Science University

Tell us about how you moved from mechanical engineering into neurology.

My first exposure to health care as an engineering field was when I enrolled in a bioengineering lecture series at the UW. I was fascinated by the idea of applying engineering principles to the human body. It started me thinking about careers in medicine. My interests were initially in orthopedics, but once in medical school I gravitated towards patients with neurological diseases. This led to a neurology residency and my current position as a vascular neurology fellow, where I specialize in the treatment and prevention of diseases that impact blood vessels supplying the brain and spinal cord — the most common of which is stroke.

How did ME help set you up for success in neurology?

The biggest skill that translates from ME to neurology is complex problem-solving. Additionally, there are applications of every major subdivision of ME within medicine, such as fluid dynamics, strength of materials and thermodynamics. A great example of fluid dynamics — one that I commonly see as a vascular neurologist — is how blood flows through damaged and narrowed blood vessels.

What advice do you have for MEs considering medical school?

You don't need a life-sciences degree to attend medical school. Start volunteering or job shadowing in a health care area that interests you. You'll learn what working with patients is like, and it will help you identify your interests within medicine. If you're a student, reach out to your pre-medical academic advising office, which can be very helpful for non-traditional pre-medicine students. And get involved in extracurricular activities. Student clubs and organizations provide opportunities to gain experience in leadership and project management — valuable skills no matter what career path you follow.

Shelby Brunke ('01 PhD)

Director of Program Management, EchoNous, Inc.

What's your role at EchoNous?

EchoNous is a medical device start-up devoted to delivering ultrasound-based tools that solve clinical problems. Typical ultrasound systems require dedicated clinical space and specialists to operate the equipment. By leveraging electronics miniaturization and artificial intelligence, we're making this technology portable and less reliant on expert knowledge, thereby making these tools accessible to more clinical users. I'm responsible for multiple aspects of medical device development, from high-level product definition to project execution and ensuring completion of the deliverables necessary to market a medical device.

What skills did you learn in ME that apply to your career?

Offering innovative technical solutions starts with a solid science and engineering foundation, which I built at the UW. As a graduate student, I learned how to learn — a skill I use anytime I approach a new clinical application or technology. In my field, engineers must be comfortable working through the ambiguity that is common when dealing with complex problems and prepared to adapt our work as new information presents itself.

Any advice for MEs interested in medical device development?

Build solid science and engineering skills and cultivate a life-long love of learning to stay abreast of technical developments. If you're a student, take advantage of all the UW has to offer — attend seminars and lectures, audit classes, secure internships, collaborate across disciplines. Regarding health care innovation, find ways to get immersed in the clinical space. Read journal articles on topics you find interesting or subscribe to podcasts by clinical experts. As an engineer in this field, you will work to bridge the gap to clinical application. The more familiar you are with clinical perspective, the more you'll connect with experts and understand the clinical need.

Minh Tran ('18 BSME)

Product Design Engineer, Philips Healthcare

How did you get interested in ME and health care?

In my first year on campus, I was set on studying nursing. However, after taking many general classes, I was drawn to engineering. Especially after ME 123, "Introduction to Visualization and Computer-Aided Design (CAD)," I developed an interest in using CAD for mechanical design. This continued to grow after seeing how I could apply classroom theories to design. That's when I saw the potential for aligning engineering design with my passion for health care.

> "If you're passionate about improving health care, keep working to develop your expertise. It's a rewarding field that welcomes individuals of all backgrounds."
>
> **- Minh Tran, Product Design Engineer, Philips Healthcare**

What projects have you been involved in?

I am new in my career but was lucky to be involved in several health-care device developments as an undergraduate. In ME, I worked in Professor Eric Seibel's Human Photonics Lab, where I used my design skills to fabricate a custom tooth mounting stage for microCT imaging to assist with the lab's fiber endoscope imaging research. During an internship at D.E. Hokanson Inc., I designed and built a blood flow simulator for use in product testing. While interning at Philips, I worked with a team of engineers on prototyping and testing internal components for their new automated external defibrillator. Now at Philips, I'm focusing on oral health-care product design and development, like toothbrushes and other cleaning products. Thanks to experiences like these, I understand that this field is not just about creating new products; it's about improving the quality of people's lives.

Any advice for ME students interested in health care?

Get involved with activities beyond the classroom, even if they don't seem directly related to engineering and health innovation. Stay inspired through learning from classmates and professors and by attending workshops and seminars. If you're passionate about improving health care, keep working to develop your expertise. It's a rewarding field that welcomes individuals of all backgrounds.

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2019 GRADUATION

We thank Jon Battles for delivering the 2019 ME graduation address. As Director of Worldwide Engineering Advanced Technologies at Amazon, Battles is responsible for developing the next generation of fulfillment technologies. Having been with Amazon for over ten years, he has overseen more than $3 billion in capital investments and tens of millions of square feet of real estate expansion.

ME's 2019 graduation speaker Jon Battles.

A recognized leader in the material handling industry, Battles shared with the ME Class of '19 his perspective on innovation, technology and society.

This year ME awarded nearly 180 bachelor's degrees, 150 master's and 25 doctoral degrees. We were also happy to be joined by members of the 1969 graduating class, who were honored with a 50th reunion reception and recognized during ME's graduation ceremony.

Thank you, speakers

Thank you to the alumni and friends who participated in ME's 2018-19 seminar series:

Leadership Seminar Series:
Ron Crockett, '61, Tramco; Billy Price, '02, Billy Footwear; John Major, '83, Palo Alto Research Center; Andy Choi, '95, The Boeing Company; Allison Headlee, '04, '09, Aerospace; Scott Korthuis, '82, OXBO International; Gretchen Reavis, '84, Ball Aerospace; Tim O'Neill, '81, '85, Measurement Technology Northwest; Gregg Patterson, '84, Demand Energy Systems; and Carol Bubar, '87, adaQuest.

Chair's Distinguished Industry Lecture Series:
Scott Glaesemann, Corning Glass; Harri Kytomaa, Exponent; Grant Castle, '95, T-Mobile; Ash Awad, '94, McKinstry; Joel Hiltner, Hiltner Combustion Systems; and Sun Kim, '84, Bill & Melinda Gates Foundation.

Boeing Advanced Research Center Series:
Tia Benson Tolle '86, Anne Kao, and Gary Georgeson.