MECHANICAL ENGINEERING | UNIVERSITY of WASHINGTON AUTUMN 2016

The MEssenger

NEWSLETTER

CHAIR'S MESSAGE

Welcome to the autumn issue of the MEssenger! Whether they're creating orthoses for children or building Hyperloop pods, racecars and submarines, ME students are excelling in innovative design and research. So are ME faculty. Many have received major awards recently (we've highlighted a few here) and are making a difference in diverse sectors such as energy, manufacturing, environmental engineering, information systems and health.

Speaking of health, our department has a rich history of advancements in biomechanics and health technologies, from the work of pioneers such as emeritus faculty Albert Kobayashi and Colin Daly and alumnus Dr. Savio Woo, '66, '71, to current professors Eric Seibel, Kat Steele and Nathan Sniadecki, to name a few.

We continue to expand our research due, in large part, to our generous donors and partners in industry and health care. For example, through our Engineering Innovation in Health (EIH) program, students work alongside faculty and clinicians to develop medical devices aimed at lowering health care costs. I'm happy that our EIH students were able to share their work with ME alumnus Frank Alberti, '44, this summer and thank him in person, from all of us, for his longtime support. You'll read more about Frank later in this issue.

Our feature story highlights another chapter of ME's history in biomechanics and health technology — our longstanding partnership with the Puget Sound Veterans Association Health Care System (VA). For more than 15 years, ME has partnered with the VA's Center for Limb Loss Prevention & Prosthetic Engineering, a collaboration that has created valuable research opportunities for ME students. It's thrilling to see this work continue to grow in new directions here at the UW.

Per Reinhall
Mechanical Engineering Chair

Student news and updates

Members of the **EcoCAR Team** participated in *The Atlantic's* "What's Next?" Tech Summit in October. The summit highlighted advances in science and technology with presentations from 75 top STEM students who are shaping the future of their fields.

The **Formula Motorsports Team** won second place out of more than 100 teams at this year's Formula SAE state-side challenge. First and second place were separated by a mere .5 points in their final scores, out of 1,000 points total.

The **Human Powered Sub Team** placed third in this year's international submarine races and first in the category of "top speed by a female pilot." The team was also featured in the October 2016 issue of Alaska Airlines' in-flight magazine, *Beyond*.

JikoPower, a student team developing a way to convert wasted energy from cookstoves and fires into electricity to charge phones and other small devices, won first place in the 2016 UW Business Plan Competition.

PlayGait, a team of students, engineers and clinicians, was awarded a 2016 Target Challenge grant to continue development of a pediatric exoskeleton for children with cerebral palsy. The team came together through ME's Engineering Innovation in Health program last year.

Hyperloop team heads to SpaceX in January

Imagine traveling from San Francisco to Los Angeles in under 30 minutes at transonic speed. Sound unreal? A team of UW students known as UWashington Hyperloop has been working hard to actualize this process. In January, they will head to SpaceX headquarters in Hawthorne, California, to test their progress.

The team was created by ME students Malachi Williams and David Coven and applied physics major Michael Chamerski after SpaceX announced a special competition for student teams in 2015, inviting them to work through Elon Musk's Hyperloop concept — a ground transportation theory allowing people to travel at hypersonic speed via pods inside vacuum tubes — from design to fabrication. The UW team now consists of more than 70 students from across campus.

In January 2016, they participated in phase one of the competition, which took place at Texas A&M University and focused on design concepts. UWashington Hyperloop won the Safety Subsystem Technical Excellence Award and the chance to advance to the next leg of the competition, where they will test their pod on SpaceX's one-mile track. Competition weekend has been scheduled for January 27-29, 2017.

"I'm looking forward to seeing our pod make it down the track and knowing, in that moment, that all of our hard work and dedication came together and made it possible," says ME student and team member Jaclyn Rainey.

UWashington Hyperloop is one of 30 teams competing in the second phase. For the final competition, pods will be 3/4 scale and, though fully functioning, they won't carry any passengers. It's not expected that any of the student pods in the competition will reach Hyperloop's theoretical full speed of 760 miles per hour; however, the UW students hope their pod will reach at least 300 mph.

Keep up with their work at hyperloop.io.

Faculty honors and awards

Alberto Aliseda's team is part of a $7.5 million Multidisciplinary University Research Initiative (MURI) grant and will collaborate with scientists at five universities to control the tiny liquid droplets that make up sprays.

Nicholas Boechler is a part of a research team that will investigate non-reciprocal elastic wave propagation in solid-state media through a $2 million National Science Foundation Emerging Frontiers in Research and Innovation grant.

Dayong Gao was elected as a Fellow of the Society for Cryobiology (International Society for Low Temperature Biology and Medicine).

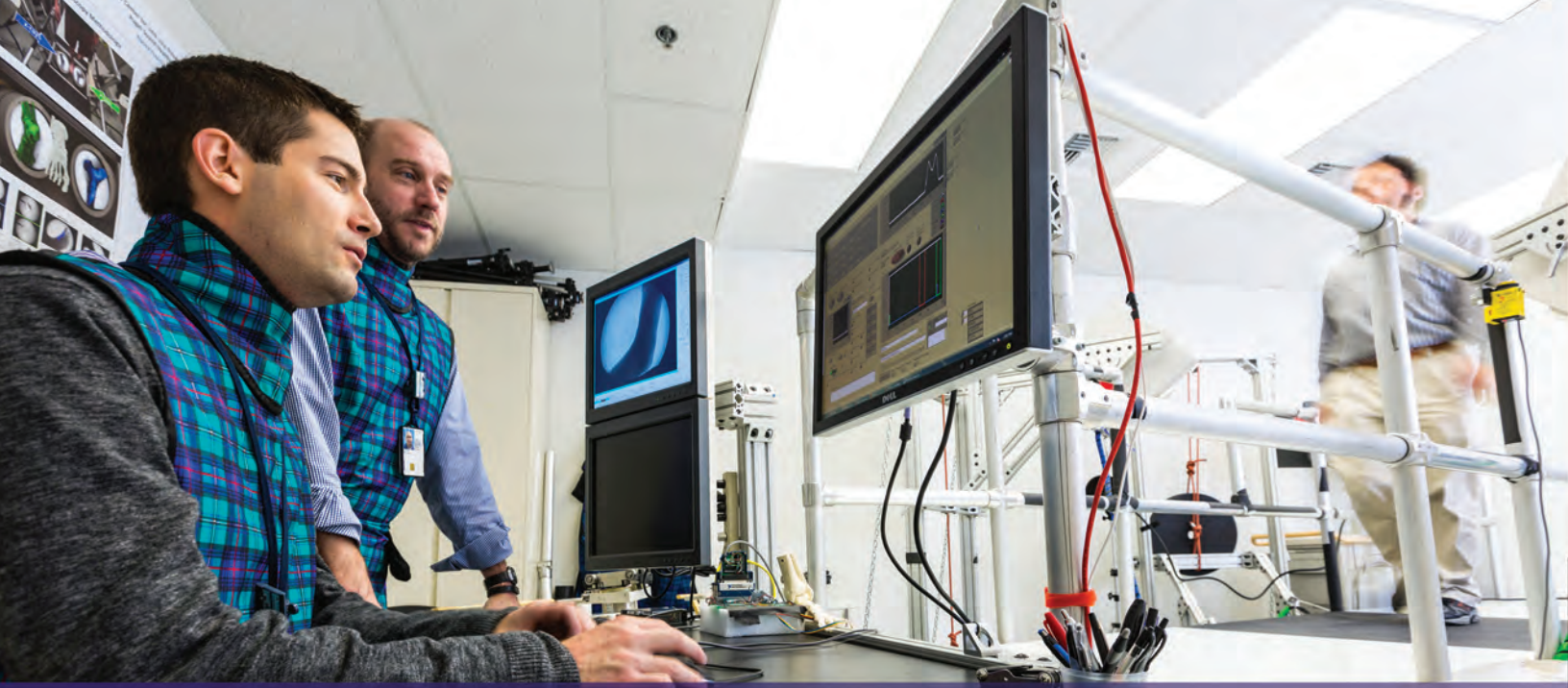
Brian Polagye's research team received two awards totaling $2.1 million from the U.S. Department of Energy to develop advanced instrumentation for the study of marine energy's environmental effects.

Jonathan Posner and **Per Reinhall** were honored along with **Dr. Sam Bowd** with UW Medicine's 2016 Inventor of the Year Award for their collaborative work developing football helmets designed to mitigate the forces thought to contribute to concussions.

James Riley was honored at this year's International Symposium on Stratified Flows. The symposium has recognized only six people since its first meeting in 1972.

Steve Shen received the 2017 N. O. Myklestad Award from the American Society of Mechanical Engineers for his contributions to vibration engineering.

Minoru Taya is leading a research team that will explore nanorobotics design based on magnetically-active helices for cancer diagnosis and treatment through a $1.5 million National Science Foundation Nano Robotics Initiative grant.



ME and the Seattle VA: Empowering possibility

by Chelsea Yates

For over 15 years, ME has partnered with the Seattle VA's Center for Limb Loss Prevention & Prosthetic Engineering. This collaboration has resulted in hands-on research opportunities for more than 50 ME students and has helped propel UW biomechanics research in new directions.

PhD student Lynda Brady always knew she wanted to work in the medical field but wasn't interested in becoming a doctor. While completing her bachelor's degree in bioengineering from Syracuse University, she decided to explore graduate programs with strong biomechanics concentrations.

"When I learned about UW Mechanical Engineering's partnership with the VA's Center for Limb Loss Prevention & Prosthetic Engineering, I applied right away," she says. "In fact, I chose to attend the UW because of the opportunities the Center provides to students."

Brady is one of ten ME graduate students pursuing research projects this year through the Center, which was established in 1997 to help improve the quality of life and functional status of veterans and service members who have either undergone or are at risk of undergoing lower limb amputations.

Leading-edge graduate student experience

Glenn Klute, '86, '99, is a research investigator at the Center; he also holds an affiliate professorship in ME. "The Center's work is concentrated in three areas," he explains. "One is prevention — the more we understand body mechanics, the more we are able to prevent limb loss for at-risk patients. Another has to do with prostheses; when amputations occur, we assist patients as they begin using prosthetic devices and try to reduce discomfort and limitations in mobility. And last is rehabilitation — working with patients through long-term care."

Supporting students has always been at the Center's core. Klute himself started working at the VA as a graduate student and joined the Center as an investigator shortly after completing his PhD at the UW. "The Center is committed to advancing solutions and conducting research to help people," he says. "A major part of this is training the next generation of researchers to set them up for success. It benefits everything — the research, our patients, health care and society."

Because the VA is an intramural granting authority, it can contribute funding for project-oriented research, which is often the sort of research that benefits masters and doctoral students the most. The projects can be shorter-term, and large projects can be broken into smaller parts that students can tackle. At the VA, students design devices and experiments, run tests, build prototypes and work directly with volunteer patients, who are often veterans.

Brady, who is in her second year, is studying the effect of diabetes on the human foot. She's building on research that was initiated by a former student. "People with diabetes have a higher risk of

ME-VA partnership At-a-glance 2000-2016

88 Conference abstracts co-published by VA researchers and ME faculty or students

44 Articles co-published by VA researchers and ME faculty or students

41 ME graduate students who have held research assistantships at the Center

16 Conference papers co-published by VA researchers and ME faculty or students

10 ME undergraduates who have worked on capstone research projects through the Center

7 Courses taught by VA researchers at the UW

6 VA researchers who have held affiliate faculty appointments in ME (5 current)

3 ME post-docs who have held research appointments at the Center

developing ulcers on their feet, and in severe cases, they may need to have their feet amputated," she explains. "Using ultrasound and a gait simulator, we can investigate the structural properties of foot muscles and soft tissue — the foot mechanics, so to speak — to better understand why this happens and hopefully, ultimately, prevent the need to amputate."

It's research that merges mechanical engineering and physiology, and the Center is the perfect site for this sort of interdisciplinary exploration.

"It makes my research seem more real."

"I'm grateful for the VA Center," says ME PhD candidate Jonathan Realmuto, who's held a research assistantship there for six years.

"Honestly, I couldn't do my work without it. Because it's a research lab in a hospital, I have access to doctors, prosthetists and engineers with a variety of specializations, not to mention our volunteer patients."

Realmuto is developing a powered ankle prosthesis that will adapt to the user's individual walking style. To do this, he is developing a learning algorithm that tries to optimize the user's gait symmetry.

"Everyone walks differently, including people with amputations," he explains. "Our approach is to create an individualized learning controller that adapts to any user."

Patient feedback is a crucial part of Realmuto's work. "It's been very rewarding to create a device, have someone put it on and then talk to me about it — how it feels, what works, what doesn't," he explains. "Our patients have an active role in the creation of our devices, and that's essential."

Brady agrees. She finds great value in being in a hospital environment. "It makes my research seem more real," she says.

Expanding health technologies together

"Just a few years after the Center was up and running, we started working with the ME department," says William Ledoux, also a research investigator at the Center and an affiliate ME professor. "ME faculty like Randal Ching and Santosh Devasia were doing important work in biomechanics, and it seemed like a wasted opportunity not to collaborate."

In addition to graduate research assistantships, the ME-VA partnership has also fostered joint research and teaching opportunities for ME faculty and VA staff. Since the early 2000s, Ledoux and Ching have co-taught graduate-level biomechanics survey courses. More recently, ME undergraduates interested in biomechanics and mechatronics have also benefitted; the Center has hosted students working on their capstone projects through ME's Engineering Innovation in Health program.

ME is not the only UW department that partners with the VA; Center staff also work closely with students and faculty in electrical engineering and, at UW Medicine, in orthopedics and radiology. But Klute and Ledoux agree that the growth opportunities through ME are unique.

"Faculty members like Kat Steele and Nate Sniadecki, who've joined ME in recent years, are expanding the department's biomechanics research in new directions, and we're excited to work with them," Ledoux says. Last year, ME faculty started a biomechanics research group that meets monthly. VA researchers and affiliate professors regularly attend.

Collectively the group is working to strengthen ME's graduate curriculum in biomechanics and, with the department, they are planning to institute an undergraduate certificate in biomechanics.

They believe that one of the best ways to advance research is to set students up for success. "We're working together to educate future leaders," says Klute. "Today's students will be transforming lives tomorrow; it's our responsibility to equip them with the knowledge, experience, training and support they need."

Student research spotlight: Bradley Wachter

ME senior Bradley Wachter is featured in "Helping the body heal, feel and move again," a multimedia story about 10-year-old Jayna Doll, a participant in the Ability & Innovation Lab pioneered by ME assistant professor Kat Steele. Bradley is working with Jayna to design body-powered orthoses to enrich not just her own life, but the lives of others.

We recently spoke with Bradley about his UW experiences and why he's studying ME.

ME: What inspired you to study ME?

BW: In high school, I took an anatomy and physiology class which inspired me to pursue a career as a doctor. Entering college, though, I became more interested in applying physics and math to the medical field and designing medical devices. Mechanical engineering has been the perfect choice for me because, through courses in biomechanics and mechatronics, I can prepare to enter the medical device industry.

ME: How did you get involved with the Ability & Innovation Lab?

BW: I told a friend that I was interested in medical devices and he recommended I contact Dr. Kat Steele, who directs the lab. I volunteered in the lab when I was a sophomore. The next year, Dr. Steele invited me to work on a project with ME student CJ Smith and lab manager Keshia Peters designing a 3-D printed orthosis for a little girl who had gone through a hemispherectomy, which is a procedure where half of the brain is removed to alleviate seizures.

ME: Tell us more about your experience working with her.

BW: Well, the procedure helped her overcome the seizures, but she developed some side effects, including impairment of her left wrist and fingers. The orthosis we've designed stabilizes her wrist and assists her in simple tasks like grasping a marker cap or playing with toys through the use of a hook. The device is body-powered and cable-driven, meaning it uses a cable that translates the movement of her elbow to open and close the hook.

ME: What do you like best about working in a lab that's exploring how to best use 3-D printing to create orthoses?

BW: Many more options are available for those in need of prostheses (devices that replace missing or amputated limbs) than for those in need of orthoses (devices that are worn over existing limbs to provide support or give function). When developing an orthosis, we're designing something around part of the human body that may or may not have function or feeling. This poses a major issue: how do we design a singular device that can accommodate the needs of many?

The reality is that, unfortunately, no such device exists and probably never will. However, we can strive to make devices more customizable and accessible for those who need them. Dr. Steele's lab provides students opportunities to explore current problems in biomechanics and health, and she encourages us to apply what we learn in ways that will have a positive impact on people's lives.

Learn more about Bradley and the Ability & Innovation Lab at washington.edu/boundless/inclusive-engineering.

Honoring Frank Alberti, '44: Students take Engineering Innovation in Health design showcase on the road

In August, three students traveled to Lacey, Washington, to present their Engineering Innovation in Health (EIH) projects to Frank Alberti, '44.

Alberti, who spent his career enhancing safety through forensic engineering, passed away on September 30, 2016. He was 99 years old.

A longtime friend of the department, Alberti had recently made a major commitment to support ME's advancements in engineering and health.

EIH is one example of the department's expansion in this area. A year-long program in which students partner with engineering faculty and medical professionals to develop working, cost-effective solutions to today's pressing clinical challenges, EIH prepares the next generation of engineers in medical device development and innovation.

The program hosts a symposium each spring, at which student teams present their designs and prototypes. Alberti had hoped to attend last spring's showcase but was unable to do so.

To show gratitude for his contributions to engineering and health research, ME professor John Kramlich, ME students John Ahn and Jessica Zistatsis, and rehabilitation science major Elizabeth Halsne took three of this year's EIH projects on the road to share with Alberti and his wife, Reta. The projects included a support harness for parastomal hernia, an improved gastronomy tube device and PlayGait, a therapeutic exoskeleton for pediatric rehabilitation.

Shortly after the students' visit, Alberti wrote that his own experiences in receiving care had persuaded him of "a need for support of engineers who would focus on health care issues, especially for the elderly." In response to the EIH student presentations, he said, "Let the good work continue."

Class of '66 grads honored at ME's 2016 graduation

Thanks to the Class of '66 graduates who joined us at the June 2016 graduation celebration! The following alumni were honored with a 50th reunion reception and recognized during ME's graduation ceremony:

Back row, left to right: John Nylander, MS; Robert Cline, MS; Allen Storaasli, BS; Martin Snoey, MS; William Trippett, BS

Front row, left to right: Gerald Hughes, BS; David Utela, BS; Robert Gerttula, MS; William Thayer, MS; Michael Spann, BS

For those interested in information about future 50th reunion gatherings, contact Sue Brennan at suemb7@uw.edu or (206) 685-1378.

What you care about can change the world

We develop creative thinkers and advance innovation to solve society's most pressing problems. From developing devices to revolutionize health care to producing clean energy to protect our environment, the new generation of mechanical engineers has the knowledge and drive to transform the world. We are poised to have a remarkable impact on the grand challenges of our time – but only if you join us.

To find out how you can make a difference, contact Steve Wald at swald@uw.edu or (206) 543-8779.

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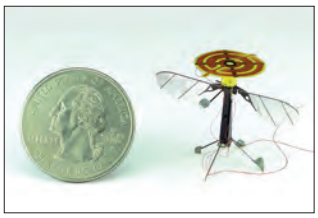
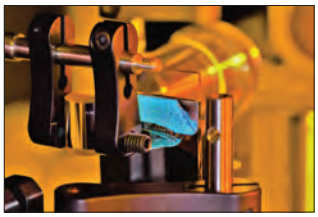
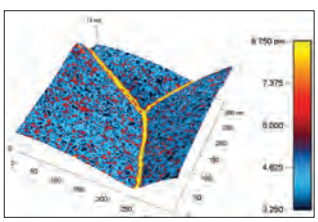
RESEARCH UPDATES







Using static electricity, insect-sized flying robots can land and stick to surfaces

A team of roboticists, including assistant professor Sawyer Fuller, has developed a flying, insect-sized robot, nicknamed the RoboBee, which can perch on surfaces like wood or leaves using static electricity. The amount of energy required to perch is 1000 times less than that required to hover, so this breakthrough could dramatically extend the flight time of these tiny drones.

ME team first to measure microscale granular crystal dynamics

Assistant professor Nicholas Boechler and UW engineers have, for the first time, analyzed interactions between microscale granular crystals. Understanding how microscale granular crystals self-assemble in response to forces could enable faster and less expensive ways to manufacture microstructured materials like spacecraft shielding.

Tiny probe could produce big improvements in batteries and fuel cells

Professor Jiangyu Li and colleagues have developed a tiny probe capable of reading variations in the nanoscale particles that power batteries and fuel cells. The rate at which these particles react determines how fast batteries charge and how much power they can provide. This new probe could improve understanding of electrochemical systems, thus enabling the development of higher performance batteries and fuel cells.

Read more ME research news at me.washington.edu/news.