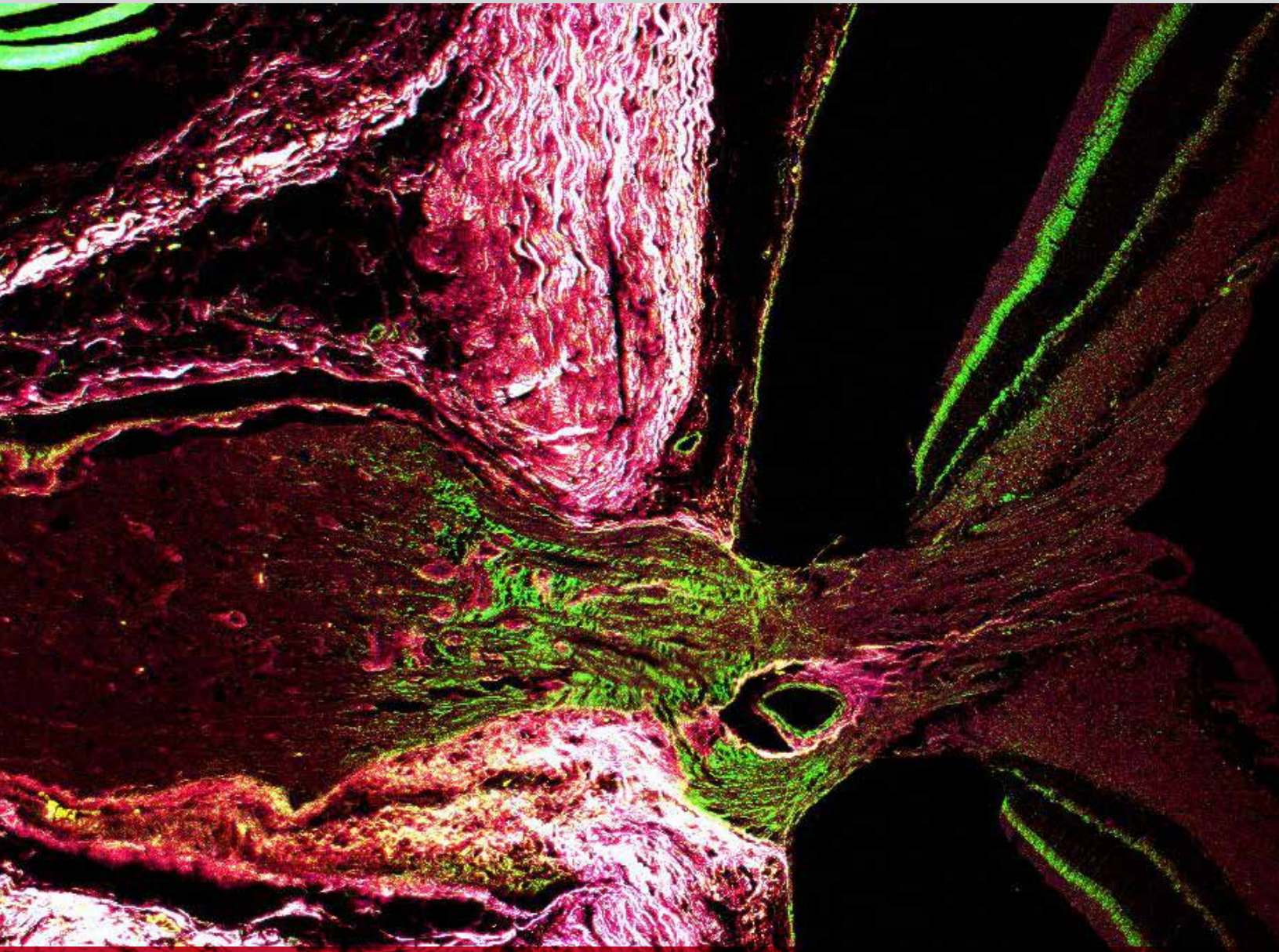
Department of
MECHANICAL ENGINEERING
THE UNIVERSITY OF UTAH

newsletter



FOSTERING INNOVATION

Fall 2020

CHAIR'S MESSAGE

Dear Friends of ME,

While the pandemic continues, teaching, research, and learning continue unabated. It has been amazing to watch our students, faculty, and staff adapt to the challenges we have seen for most of the last year. I have been so impressed with the resiliency of our students and their ability to overcome a wide variety of challenging situations, from difficulty juggling multiple family, work, and school efforts that have become enormously complicated, to being a foreign student in a new environment with limited opportunities to meet new people and build a social network. Many of our team projects, such as mechatronics and senior design, have had to make significant adaptations, but great work is still being done. While the challenge seems unlikely to end immediately, it is clear that sustained efforts like those we have seen will enable us to come out stronger than ever.

Construction has started on the new addition to our Mechanical Engineering building, the Rio Tinto Kennecott building, and will continue as we move into next year. We are so grateful to the Steve and Lynda Jacobson Foundation for their naming donation for the new pavilion, and that will enable a wonderful design experience for our undergraduate students. We are expecting to have new space for senior design, mechatronics courses, freshman design, and several new research labs and offices. Please come and get a tour of the great growth opportunities the department will experience as the building grows.

Please take the opportunity to explore in this newsletter some of the great things that have happened over the past few months. Several of our faculty have received awards for excellence in teaching and research, as well as their impact on the mechanical engineering profession. We have been able to recognize one of our outstanding alumni, Dr. Abigail Hunter; she has done some amazing work since graduating from our department in 2006. Research has continued to grow, and we have some highlights of exciting work that was recognized by NIH from Dr. Kong. Finally, we have some adventurous students who have continued to break ground (and sky!) in their engineering efforts.

I personally express my thanks to all of our students, alumni, industrial and government partners, faculty and staff for helping this department to succeed. As a group we can continue to make a difference in this state and across the world. We look forward to seeing many of you in the future, even if it is on Zoom. Many of our seminars are now available virtually, so come and join us there if you can't do so in person. For those of you interested, we are also hiring faculty in the areas of Robotics, Aerospace, and Systems Engineering. Come and join our team! While Spring semester is likely to be mostly online for all of us, we don't expect that to last forever; we hope to see you in person sometime soon.

Best regards,
BRUCE K. GALE, Ph.D.
Professor and Chair

Autofluorescence of the Optic Nerve Following Blast Exposure

ABOUT THE COVER: Following traumatic injury, the structures of the eye fluoresce and decay at different rates. The cover image shows changes to the optic nerve of the eye (green) following blast exposure using fluorescence lifetime microscopy imaging.

Mascaro Honored with Beacons of Excellence Award

Congratulations to mechanical engineering Director of Undergraduate Studies Debra Mascaro, who is one of this year's recipients of the University of Utah's Beacons of Excellence Awards, given to a person or program that achieves "transformative educational experiences" for students.

Mascaro, who is also an associate professor (lecturer), was honored during a luncheon on Oct. 29. The award was introduced in 2012 through a partnership between the Office of Undergraduate Education and the Division of Student Affairs.

She received a bachelor's degree in physics from Gustavus Adolphus College in St. Peter, Minn., and a doctorate in Materials Science and Engineering from the Massachusetts Institute of Technology. Her research interests include organic electronics and optoelectronics, microfabrication, and stretchable electronics.

"Debbie is a fantastic instructor that makes the teaching of her undergraduate class her highest priority," said University of Utah mechanical engineering chair Bruce Gale. "She spends countless hours working to improve the class and readily responded when the class moved online. Her efforts to make the class as valuable online as it was in person were impressive and made for a seamless and effective transition. She is highly deserving of this award."

This year's other recipients include: Juan Rios, Administrative Assistant, Student Success and Empowerment; Megan Randall, Career Coach, Career & Professional Development Center; College of Social & Behavioral Science Student Success Center; Fine Arts Fees (FAF) Grants program; Refugees Exploring the Foundations of Undergraduate Education in Science (REFUGES) Bridge program; and the University of Utah School of Medicine Office of Health, Equity, Diversity, and Inclusion.

NEW GRANTS

21 new projects, more than $4.1 million since May!

Steve Black – NIST, 4 months, $153,340, "COVID Cares Act Utah"

Jiyoung Chang – (co-PI Wenda Tan) NSF, 3 yrs, $401,948, "Patterning of Nanofibers on Three-Dimensional Surfaces Using Self-Aligning Nanojets Driven by Electrostatic Forces"

Michael Czabaj– Nammo Composite solutions, 6 months, $12,285, "Conventional Compression Testing of Kevlar Composite-At-Lug-Interface Samples for Nammo Talley, Inc."
HARP, 4 months, $29,939, "Innovations in Designing Damage Tolerant Rotorcraft Components by Interface Tailoring"

Mathieu Francoeur – NSF, 3 Yrs, $392,709, "CDS&E: Multi-scale, many-body simulations of near-field radiative heat transfer between micro/nanostructured materials"

Henry Fu – NSF, 3 yrs, $242,532, "Collaborative Research: Elucidating the diversity of bacterial flagellation and motility through mechanics"

Bruce Gale – L3 Harris Technologies, 5 months, $39,996, "A reconfigurable microfluidic antenna"
Nanonc Inc., 6 months, $57,419, "Systems for rapid generation of zebrafish mutants and zebrafish embryo handling"
Espria, 2 Yrs, $322,613, "Espira Army SBIR Phase II Sequential Subcontract Pathogen Detection from Food"
Electronic Bio, 1 Yr., $40,000 "Rapid, Multiplexed, Idealized Antiepileptic Drug Monitoring"

Jacob Hochhalter – DOE, 4 months, $42,500, "Physics-Informed Machine Learning for the Development of Microstructure-Sensitive Deformation and Damage Models in Engineering Applications"
DOE Sandia, 1 Yr, $102,730, "Physics-Informed Machine Learning for the Development of Microstructure-Sensitive Deformation and Damage Models in Engineering Applications"

Yong Lin Kong – NIH, 2 Yrs, $591,496, "3D printed resonant-enhanced sensors (PRES) for total joint arthroplasties"

Ken Monson – NSF, 3 yrs, $568,663, "Defining Multiscale, Rate-Dependent Damage Mechanisms in Blood Vessels"

Pania Newell – DOE Sandia, 1 Yr, $39,500, "Isotopic fractionation as in situ sensor of subsurface reactive flow and precursor for rock failure"

Bart Raeymaekers – (co-PI Steven Naleway), NSF, 1 yr, $100,000, "EAGER: Synthesizing nanocomposite materials using fused deposition modeling and ultrasound directed self-assembly

Himanshu Sant – 109 Therapeutics, 9 months, $56,118, "Novel injectable long-acting local anesthetic for postoperative pain management"

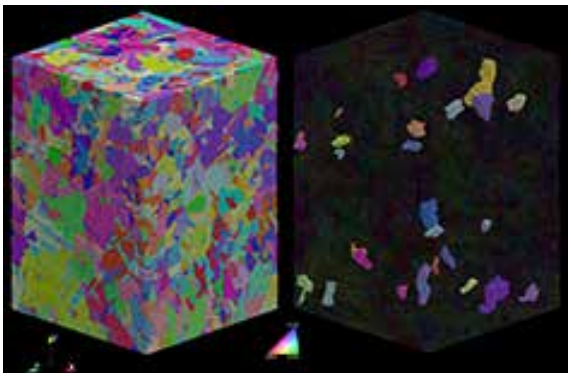
Rob Stoll – USDA, 1 Yr., $243,412, "Modeling the epidemiology disease caused by airborne fungal plant pathogens"

Wenda Tan – NSF, 3 Yr, $213,643, "Collaborative Research: Modulating Powder Bed Cohesion to Reduce Defects in Binder Jetting"

Roseanne Warren – NSF, 5 Yr, $472,623, "CAREER: Nanobubble Manufacturing for Roll-to-Roll Fabrication of Templated, Nanoporous Materials"
NSF, 5 Yr, $27,377, "REU for CAREER: Nanobubble Manufacturing for Roll-to-Roll Fabrication of Templated, Nanoporous Materials"

U Led Team Wins Additive Manufacturing Modeling Challenge

University of Utah mechanical engineering associate Professor Ashley Spear, undergraduate researcher Carter Cocke, Prof. Anthony Rollett from Carnegie Mellon University, and Dr. Ricardo Lebensohn from Los Alamos National Laboratory are a U led team and awardees of the America Makes and Air Force Research Laboratory (AFRL) Additive Manufacturing Modeling Challenge Series. The goal of the Challenge Series was to improve the accuracy of model predictions for metal, using INCONEL® nickel-chromium alloy 625 (IN625). The Utah team won the Micro-scale Structure-to-Properties Predictions challenge.



Entire microstructure (left) and the challenge grains inside the microstructure (right)

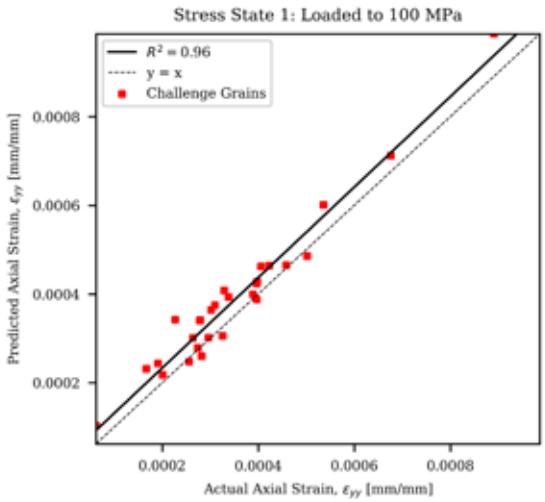
The challenge was launched in November 2019 and comprised of four individual challenges divided between macro-scale and micro-scale, as well as process-to-structure and structure-to-properties predictions. Challenge participants were provided high-pedigree calibration and validation data sets needed to develop new models as it directly related to predicting the internal structure and resultant performance of AM metallic components.

Spear and colleagues worked to predict the strain components of specific "challenge grains" within a microstructure at 6 macroscopic stress states. The team was given the texture of the initial state and the global/macroscopic stress-strain response to use for predictions. The 6 strain components (1 axial, 2 transverse, and 3 shear components), 6 incrementally larger macroscopic stress states, and 28 challenge grains required a total of 1008 predictions. Of those predictions, Spear's team had the lowest overall error compared to actual values.

Spear and Cocke began working on the challenge in November, but initially were unsure they would be able to match the loading scenario of the challenge due to the multiple unloading steps needed. The team worked with Rollett and Lebensohn, both experts in the crystal plasticity code (EVPFFT), to develop their predictions.

"These results are great news for the FFT-based approach we used, which is less widely used than the FEM-based method," said Cocke. "This entire experience has been extremely valuable in improving our modeling abilities, and we have since identified a few improvements to our model that we can carry forward."

Visit the Multiscale Mechanics and Materials Laboratory website (mmm.mech.utah.edu) to learn more about Spear's work.



Plot showing the actual axial strain vs. the predicted axial strain at stress state 1

U Mechanical Engineering Undergrads Aim High

Last year Patrick McNally and Zach Rohovit launched their first high powered rocket. They built every component from scratch, including the solid rocket motor. It flew just over 14,000 feet (relative to sea level). This year they are both first year students in the Mechanical Engineering department here at the University of Utah. In addition to starting their undergraduate engineering studies, they have launched a non-profit called Uinta Suborbital Solutions with a goal of inspiring a new generation of University of Utah students to engage with the global scientific community of atmospheric and suborbital scientific research.

With their first year of college just around the corner, McNally and Rohovit spent last summer investigating undergraduate rocketry programs around the country. After learning about the goals and successes of other programs, McNally and Rohovit, joined by fellow bio medical engineering student Aksel Anderson, found their own vision for the future of collegiate level rocketry: providing a platform for researchers. Their goal is to provide a reusable launch vehicle capable of carrying up to 50 lbs (~23kg) of scientific equipment to an altitude of approximately 125 (~200km) miles.

McNally and Rohovit both began their undergraduate studies in mechanical engineering to continue pursuing their interests educationally as they work on their non-profit. They see a wide range of opportunity with the department, including passionate engineers and connections to faculty.

"The reason we think rockets are so fascinating is because they encompass so many different kinds of engineering," said Rohovit. "As mechanical engineers, we can pursue a wide range of studies, which will allow us to make informed decisions as we work to solve problems."
Additionally, the t
eam is working with the Lassonde Institute to learn about funding opportunities and how to comply with state and federal tax laws. In the coming months, they hope to bring new engineering onto the team focusing on subsystems like avionics, payload integration, recovery systems, and more.

For more information, you can reach out to McNally (pacomcnally@gmail.com) and Rohovit (Rohovit) by email.

Mechanical Engineering Alum of the Year 2020

The U's Department of Mechanical Engineering and its External Advisory Board are proud to recognize Dr. Abigail Hunter as this year's Alum of the Year. Hunter is a scientist at Los Alamos National Laboratory (LANL) where she is part of the Materials and Physical Data Group and Deputy Director of the Institute for Materials Science. Her work focuses on computational physics with an emphasis on modeling and code development related to materials science applications. She is also well known for her dedication in mentoring junior researchers and giving back to the broader community, mentoring 22 students and post docs since joining LANL.

Hunter received her Bachelor of Science degree in Mechanical Engineering from the University of Utah in 2006, then her Ph.D. in Mechanical Engineering from Purdue in 2011. After graduation, she joined LANL as a postdoctoral researcher and it was not long before she transitioned to staff member.

"One of the reasons I chose mechanical engineering was to pick a major without picking a major," said Hunter. "I liked that I could learn about a lot of different topics." In pursuing those varied topics, Hunter took a materials science class that she really enjoyed because of the focus on real world application. She also found herself drawn to related classes in statics and strength in materials.

After graduating from the U, Hunter pursued her Ph.D. at Purdue University. She was then a postdoctoral research at LANL before becoming a scientist and eventual Deputy Director of the Institute for Materials Science. Her focus is on mesoscale (microstructural scale of 10's to hundreds of nanometers) through the macroscale (microns, millimeters, or higher depending on the applications) models.

One of Hunter's current projects is working on modeling asteroid impacts on the surface of the Psyche Asteroid as part of NASA's study. "Using earth-based measuring techniques, we know there are two large impact craters on Psyche.," said Hunter "We can model these crater formations and depending on what materials we use for Psyche, we can test and see if the crater dimensions match. This will hopefully let us pinpoint Psyche's composition including its porosity."

Hunter has shown a passion for teaching and working with students, including undergraduate, graduate, and post docs. In 2018 she received LANL's Distinguished Mentor Award, a lab wide award recognizing excellence in mentoring. "I have a lot of fun mentoring," said Hunter. "You get to do research, but it's more collaborative. With research, you're looking at questions people haven't looked at before. Hopefully, working with students and post docs, they learn how to come up with and design their own independent studies. They bring their own excitement and curiosity."

Hunter's dedication and expertise are clear, including a passion for educating new scientists and engineers. She continues to collaborate with the U and other organizations not only in mentoring students, but also in participating workshops and collaborations. Last year she joined the Computational Mechanics and Sciences workshop that was co-organized with LANL and the U. She is also currently serving as an associate Editor for ASME's Journal of Engineering Materials and Technology.

"With STEM, people start to question their abilities because of stress," said Hunter. "People don't realize that a lot of us feel that way because these are challenging fields to be in. Don't give up on yourself. Don't be shy about asking questions. You're doing better than you think. Interact and collaborate. Work together."

Hunter will be presenting a virtual seminar on "Living in a Material World" on December 4th from 3-4pm. Additional details on the talk are available on our website: mech.utah.edu.

Leang Elevated to ASME Fellow

Congratulations to University of Utah mechanical engineering associate professor Kam Leang, who has been elected a Fellow of The American Society of Mechanical Engineers.

Founded in 1880, the ASME is a not-for-profit professional organization "that enables collaboration, knowledge sharing and skill development across all engineering disciplines, while promoting the vital role of the engineer in society." Only 4% of the 83,000 ASME members are elevated to the grade of Fellow.

"Being named ASME Fellow is quite an honor for me," Leang said. "I am especially thankful for being able to work with incredibly talented students, and also for the support of my colleagues, community, and university."

Leang earned a bachelor's and a master's degree from the University of Utah and a doctorate from the University of Washington, all in mechanical engineering. He was an assistant professor of mechanical engineering at Virginia Commonwealth University in Richmond, Va, and an associate professor of mechanical engineering at the University of Nevada, Reno. He then joined the U in 2014. He has published more than 135 technical papers and is currently an associate editor for the Mechatronics journal (Elsevier) and the ASME Letters in Dynamic Systems and Control.

He has received the Professor of the Year Award from Virginia Commonwealth University and the College of Engineering Senior Scholar Mentor Award and the College of Engineering Faculty Excellence Award from the University of Nevada, Reno. He also was honored with the Nevada System of Higher Education Board of Regents' Rising Researcher Award and was the William R. and Erlyn J. Gould Distinguished Lecturer on Technology and the Quality of Life at the U in 2018.

Leang's research focuses on dynamic systems, control, mechatronics, and robotics. Applications of his research include nanotechnology (nanopositioning and scanning probe microscopy), precision mechatronic systems, electroactive polymer-based actuators for soft mechatronics and robotics, and unmanned aerial vehicles for emergency response and environmental monitoring.

Learn more about Leang and his research at kam.k.leang.com/acadmics/

Staff Engineer Brings Industry to the Lab

Quinton Christensen, U graduate, has brought his experience in industry back to the Mechanical Engineering Department to manage labs, incorporate new technologies, and apply industry standard practices for controls and automation. In addition, he hopes to help the department develop curriculum that integrates industry standard hardware, techniques, and software systems into the Mechanical Engineering Department's controls program.

Christensen started his career in IT. During that time, he worked with his brother to build a go-cart. The project sparked his interested in pursuing a degree in engineering to further the skills he was learning on the project. As he began pursuing his degree in engineering, he read about the work being done by Sarcos Robotics and his interest focused in on robotics and control systems. He completed his master's degree at the University of Utah in 2011.

Since then, Christensen has worked in industry, applying his engineering knowledge to create a variety of systems involving multiple engineering disciplines and integrating complex control systems. This spring, he brought that experience back to the U as a staff engineer. He now manages the MEEN 1010 and 3230 labs, the large and small robotics labs, has applied his experience to help the Manufacturing and Extension Partnership Center with their automation and COVID-19 recovery initiatives, and advises the Utah Student Robotics Team.

"The diverse nature of my experience allows me to perform a broad assortment of tasks to support the labs and projects in the robotics group," said Christensen. "I hope to share with students what I have learned in industry. Every engineering project they undertake relies on the fundamentals they are learning now."

Christensen has continued to apply his creativity and experience here at the U. Soon after joining the department, the initial round of COVID-19 measures shifted everything remote, including the very hands-on labs Christensen was helping run for students. Christensen and the professors adapted quickly in spring semester. When summer began, they took what they learned during spring semester to begin building plans for fall, including being prepared to shift fully remote with very little notice.

"We are creating lab kits that can provide a full learning experience from home, if it becomes necessary," said Christensen. "This includes lab experiments and a modified competition project for the end of the semester."
Even with these challenges, Christensen shows obvious pleasure from sharing his experience with students and helping enhance their education. "Industry is starving fore engineers with walk-in ready controls experience," he said. "I'm excited for the opportunity to bring my experience to the program."

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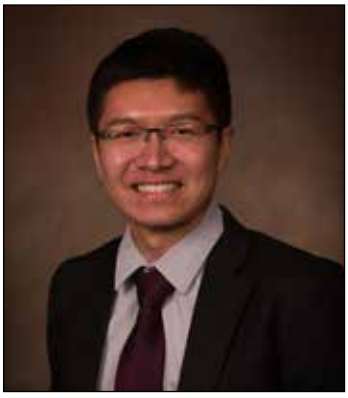
ME is hiring in the areas of Robotics, Aerospace, and Systems Engineering! Visit our website for more details.

Kong Receives NIH Trailblazer Award

University of Utah mechanical engineering assistant professor Yong Lin Kong has received the National Institutes of Health Trailblazer Award to research an innovative 3D printing process that integrates wireless sensors in total joint arthroplasties (TJAs).



A TJA, also known as a total joint replacement, is a procedure to replace the arthritic or dysfunctional joint with a prosthetic device. It aims to replicate the movement of a normal joint, to reduce the pain caused by the damaged or arthritic joint, and to restore mobility of the patient who no longer responds to non-surgical therapies.

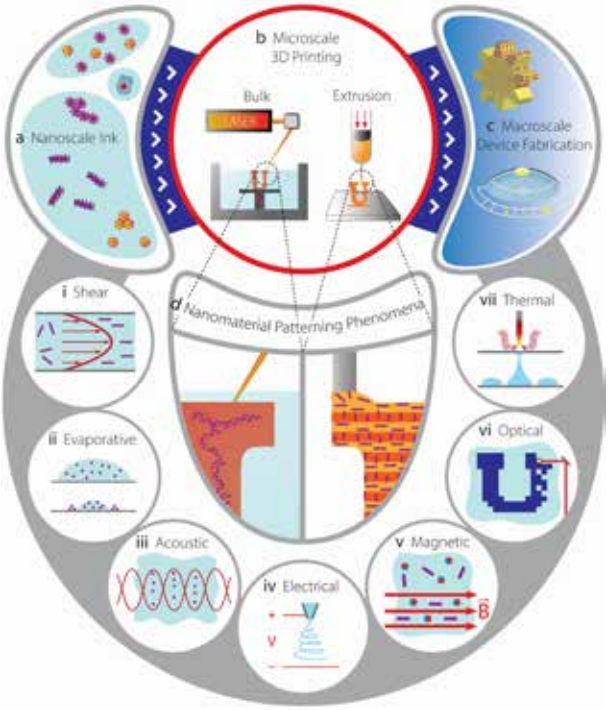
While a TJA can be helpful for patients, these devices can fail for a variety of reasons. For example, fibrotic tissue at the bone-implant interface can prevent it from remaining secure, leading to excessive wear.

Kong proposes a process of 3D printing custom wireless sensors that can measure important data such as strain, force and pressure on the prosthetic. This information could help doctors determine an optimal placement for the device, aid the patient in postoperative rehabilitation, and provide important data in the development of future designs. The sensors can be directly printed on existing arthroplasty components, eliminating the need to modify the implant.

"I am extremely excited for the opportunity to establish a fundamentally new research program that can potentially address a broad range of unmet clinical needs," Kong said. "The ability to integrate electronics mechanisms to existing TJA implants can transform osteoarthritis treatment, and the award provides critical resources needed to achieve this vision."

Kong has been with the University of Utah since 2018. He earned his doctorate degree in mechanical engineering and materials science from Princeton University. The NIH Trailblazer Award is for three years, with a total awarded amount of $605,800.

To learn more about Kong and his research visit his website: kong.mech.utah.edu



Pictured Right: *Multiscale 3D printing of functional devices with nanomaterials: a) the synergistic integration of nanoscale functional materials with b) a wide range of micrometer-scale 3D printing technologies, classified here as "bulk" and "extrusion" based printing c) can enable the creation of architecture and devices with an unprecedented level of complexity and functional integration. d) Multiscale 3D printing can be achieved via the patterning of nanomaterials integrated with 3D printing processes, driven or assisted by leveraging physical phenomenon such as i) shear, ii) evaporative, iii) acoustic, iv) electrical, v) magnetic, vi) optical, or vii) thermal phenomena. (Color legends: Red: patterning phenomena; light blue: 3D printing medium; purple: nanomaterials; and dark blue: cured/sintered ink.) B. Elder, R. Neupane, E. Tokita, U. Ghosh, S. Hales, Y. L. Kong*, Nanomaterial Patterning in 3D Printing, Advanced Materials 1907142 (2020).*