Department of
MECHANICAL ENGINEERING
THE UNIVERSITY OF UTAH

newsletter

Fostering Innovation

Summer 2020

CHAIR'S MESSAGE

Dear Friends of ME,

We have had quite an amazing ride the last few months with the changes necessitated by the pandemic. It has been amazing to watch our students, faculty, and staff respond in so many positive ways. I am grateful for all the effort, patience, and creativity issued by all of those involved in converting our classes, research, and scholarly work to remote activities. We know the changes have been hard on many in our community and we want to help if there are any additional challenges.

Last month we had our first ever virtual commencement for all of our graduates. We are disappointed that we couldn't meet with all of our graduates in person (over 270 of them, a new record!), but please join with us in wishing them a hearty congratulations and the best of luck for successful careers. We hope to see our graduates at our convocation, which was delayed until December. Graduates, please come and walk then and get the recognition, congratulations, and well wishes that you deserve. So many of our faculty cherish the opportunity to see the students that have meant so much to us over the past few years.

We also had a virtual Design Day in April where we were able to showcase the work of our senior design teams. Their work was incredible, especially considering the conditions in which they had to finish. The creativity, engineering skill, and analysis that was demonstrated was something we are very proud of as a department. Some of these projects are highlighted in this newsletter and you can view the virtual presentations online at: mech.utah.edu/virtual-design-day-spring-2020/

We had a new faculty member join us in January. Robert Parker, Ph.D., comes to us from Virginia Tech University. Rob brings expertise in nonlinear vibrations and dynamics, with special expertise in helicopters, jet engines, and energy harvesting from waves. He brings significant experience to our department with leadership experience both at U.S. and Chinese institutions. We are excited to have him with us.

We have started the addition to our Rio Tinto Kennecott Mechanical Engineering Building and are in the advanced planning stages. We hope to begin construction this summer and finish in November of 2021. Please come and get a tour of our ever-expanding building, a symbol of the department's tremendous growth. We are expecting to have new space for senior design, mechatronics courses, freshman design, and several new research labs and offices.

I'd like to express my personal thanks to all of our students, alumni, industrial and government partners, faculty and staff for helping this department 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 fall, hopefully in person. I hope many of you will come and join us whether it is in person or online.

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

Fan Array Subsystem - Fire Wind Tunnel

ABOUT THE COVER: Mechanical Engineering Senior Capstone students Walt Sorensen, Abdullah Zamzami, Abdulrahman Yousuf, and Trevor Smith, advised by Profs. Eric Pardyjak and Rob Stoll, Dr. Adam Kochanski, and Ph.D. student Matthew Moody, built a Fan Array subsystem for the fire wind tunnel housed in the Environmental Fluid Dynamics lab as part of a wildfire study. The project was showcased at the Dec. 3, 2019, Fall Design Day. The fan array is capable of simulating various realistic wind conditions such as wind speed, wind shear, and gusting. With the addition of the fan array, the incendiary wind tunnel will be used to study wildfire burn rates for varying slopes and wind condition combinations.

New Faculty

Robert G. Parker | Professor

Parker joined the University of Utah's mechanical engineering faculty in January 2020, moving from his position as L.S. Randolph Professor at Virginia Tech. Before Virginia Tech, Parker served as the Executive Dean at the University of Michigan-Shanghai Jiao Tong University Joint Institute in Shanghai (2008-2012). He received M.S. and Ph.D. degrees from the University of California, Berkeley. Parker has given keynote lectures at conferences worldwide and held prominent professional leadership and editorial positions. He is a Fellow of ASME and the American Association for the Advancement of Science.

Parker's research area is vibration and dynamics, with special focus on high-speed systems. Currently, Parker concentrates on high-speed aircraft engine gear vibrations and cyclically symmetric systems (e.g., turbine blades). He is looking to collaborate with others at the U on acoustic meta-materials and vibration of bio-inspired systems with unique material properties.

New Grants

14 new projects–more than $1.4 million since October!

Jake Abbott – AFRL, $116,684, "Air Force Research Lab Education Partnership Agreement 2020"

Ken dEntremont – (1) DOE LANL, $17,500, "Design, Analysis, and Prototype of 30 Gallon Metal Shipping Container", 1 year; (2) L3 Harris, $17,500, "Automatic Dependent Surveillance", 1 year

Bruce Gale – Medic.Life, $19,000, "Development of a Medic.Life Toilet Compatible Calcium Testing Chip", 4 months

Jake Hochhalter – DOE, $56,250, "Rapid Fatigue Life Estimates of Shell Structures", 6 months

Yong Kong – (1)Analog Devices Inc., $80,000, "Integration of Biocompatible Microneedles and Micropump for Continuous Glucose Monitoring System", 1 year; (2) UURF, $28,125, "3D Print Electronic Bone Graft", 1 year

Pania Newell – DOE Sandia, $78,500, "Stress Birth and Death: Disruptive Computational Mechanics and Novel Diagnostics for Fluid and Solid Transitions", 1 year

Eric Pardyjak – (1) Colorado DOT, $147,648, "A networked low-cost distributed weather and snowfall sensor array demonstration project for improved avalanche hazard mitigation in Little Cottonwood Canyon, Utah", 2 years; (2) Nordmin Engineering USA, $27,774, "CFD modeling of airflow in a hoisting mine shaft", 10 months

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

Shad Roundy – (1) Solve ME/CFS Initiative, $45,000, Defining the Postural Contributors to Post-Exertional Malaise in ME/CFS", 1 year; (2) NSF, $224,523, "SitS NSF-UKRI: Wireless In-Situ Soil Sensing Network for Future Sustainable Agriculture", 2 years

Roseanne Warren – NSF (CMMI, Advanced Manufacturing), $500k, "CAREER: Roll-to-Roll Fabrication of Porous Materials Using Nanobubble Templates", 5 years

Roseanne Warren, Ph.D.
Receives NSF CAREER Award

Department of Mechanical Engineering Assistant Professor Roseanne Warren has been awarded a National Science Foundation Faculty Early Career Development Program (CAREER) award. The CAREER program is one of NSF's most prestigious award programs, with awards of up to $500,000 over five years in support of early-career faculty with potential to serve as academic role models in research and education. The research grant, entitled "CAREER: Roll-to-Roll Fabrication of Porous Materials Using Nanobubble Templates," will explore new methods of fabricating templated porous materials that are compatible with high-throughput, scalable manufacturing protocols, including roll-to-roll fabrication.

"In many applications, controlling pore sizes and distributions at the nanoscale is critical to material performance," explains Warren. "Electrochemical energy storage–including batteries and supercapacitors–is one of those applications. There is an urgent need to increase the energy density of rechargeable batteries for electric vehicle applications. In addition to battery chemistry, electrode structure including porosity and pore size distribution should be optimized to maximize ion and electron conductivity through the cell. We need to find new manufacturing approaches that can achieve this, and these manufacturing approaches need to be compatible with large scale manufacturing approaches, such as roll-to-roll fabrication currently used in the battery industry."

Professor Warren's research will explore a new porous material manufacturing approach that uses nanoscale bubble templates in place of traditional hard templating materials, thus enabling precise control over the resulting porous structure while eliminating process complexities and waste associated with removal of the hard-templating material. The research is integrated with an educational plan that supports the training of graduate and undergraduate student researchers, enhances educational opportunities in the field of nanomanufacturing, and creates new opportunities for underrepresented minority groups in STEM, with a focus on Native Hawaiian and Pacific Islander students through collaboration with the University of Utah's Pacific Islands Studies program.

For more information on Prof. Warren's research group, the Advanced Energy Innovations Lab, please visit: https://advancedenergy.mech.utah.edu.

For the NSF award abstract, please visit: https://www.nsf.gov/awardsearch/showAward?AWD_ID=1943907

Fall 2019 Design Day

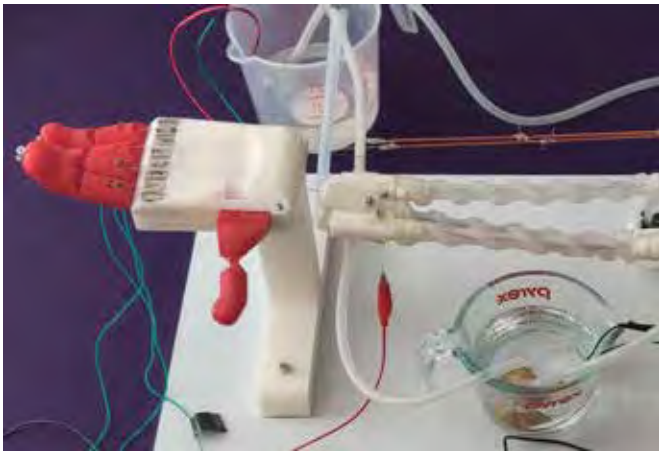
In Decemeber, 14 senior design projects were showcased during our annual Design Day event. Below are a few examples of the projects presented.

ME seniors Paul DeMann, Monica Downing, Hannah Roberts, and Katherine Vega, advised by Prof. Dan Adams and Dr. Scott Haupt, designed and manufactured a surgical device, the Central-Suction Electrosurgery Pen, that combines suction and cautery capabilities in one device.

Mechanical engineering students Natalia Dominguez, Gabriel Milla, Daniel Mochizuki, and Travis Simpson, advised by Prof. Bruce Gale and Dr. Raheel Samuel, worked on an andrology clinic in a box to help couples in rural areas who are having problems with infertility.

Spring 2020 Design Day

With the move to distance learning, we also moved to a virtual event for Design Day. You can view presentations and posters at:
mech.utah.edu/virtual-design-day-spring-2020/
Below are a few examples of the projects presented.



Nathan Bennett, Corban Bothell, Matt Brown, Radit Nopcharoenwong, Zach St. Clair, and Justin Szymanski, advised by Prof. Stephen Mascaro used super coiled polymers to control and actuate a robotic hand. These polymers are inexpensive and exhibit strain similar to human muscle.

Elliot Befus, Alex Bingham, Matthew Goodell, Stevie Marston, Brett Smiley, and Takara Truong, advised by Prof. Kam Leang, built an autonmous light assessment drone to measure skyglow light and measure light sources to help autonomously collect light pollution data.

Alumni Spotlight
Tim Fuller, Ph.D.

Tim Fuller, Ph.D. is a research scientist with the Sandia National Laboratories where he works on developing finite element codes used in production and in national security-related applications. Additionally, he teaches ME courses at the U from time to time. He has taught five different courses, some multiple times, including Advanced Finite Element Method, Computational Mechanics, and Solid Mechanics.

Fuller received his Ph.D. in Mechanical Engineering from the University of Utah in 2010. As a graduate student, he studied solid mechanics, with a focus on solid mechanics. Working under Dr. Brannon's supervision, his research was focused on thermodynamically consistent formulations in finite-deformation loading regimes. His doctoral thesis described the requirement supported by thermodynamics that certain classes of isotopic materials must have an anisoptropic elastic stiffness.

"I found myself gravitating towards numerical analysis and applied math courses from the Math, Physics, and Computer Science departments," said Fuller. "However, Continuum Mechanics literally changed the trajectory of my career and led me to where I am now."

After graduation, Fuller's work focused on computational models for quasi-brittle materials subjected to high-loading-rate, which led to an NNSA Defense Program Awards of Excellence in 2013 for modeling ferroelectric impact fuzes. He also developed advanced computational models for solid propellants used in NASA's Space Launch System, as well as other government solid propellant motors.

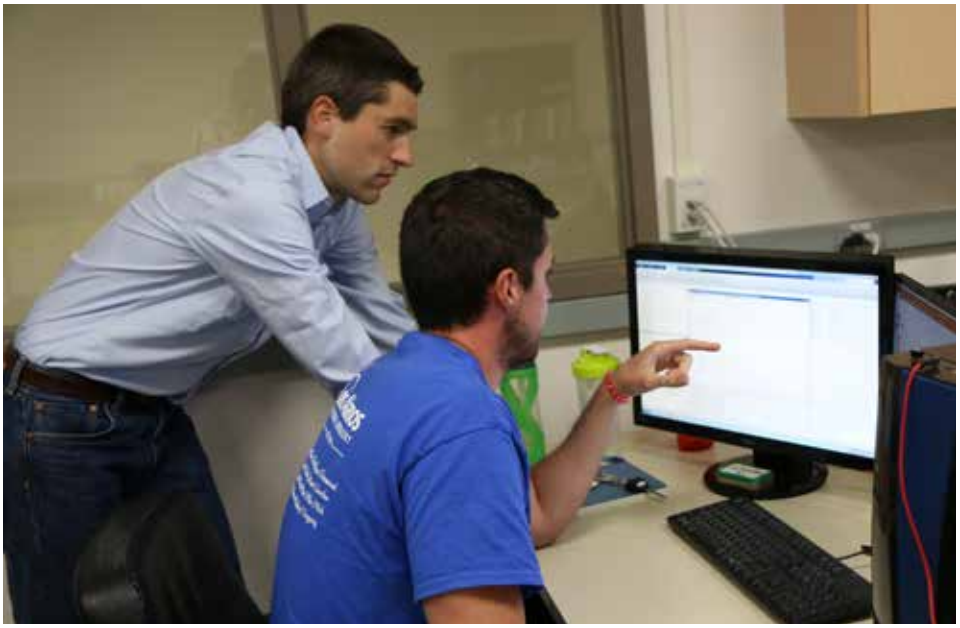
In 2016, Fuller returned to Utah and resumed working with Sandia National Labs. "My work is split primarily between two completely different fields: computational material modeling and parallel linear algebra," said Fuller. "Most of the work I do would be unseen by the general public. Lots of work writing lower level mathematics and physics codes." He also added that while he is reporting to Sandia, the work ends up going to the Department of Energy and other government organizations, where it influences policy decisions.

Additionally, since 2014 Fuller has served as an adjunct faculty member in the Department of Mechanical Engineering. In addition to periodically teaching courses, he has served on several masters and Ph.D. student committees and continues to fill that role. As a Utah alum working at one of the largest Department of Energy research labs, he is in a unique position to provide career opportunities to U students. He has helped students find permanent and temporary positions at Sandia in the form of summer internships, post-doctoral, and full-time staff positions.

"As a student, I would encourage you to get to know your professors: use office hours, participate in class, etc.," said Fuller. "Also, reach out to other professionals in fields you are interested in and ask their advice, most will be happy to share it. For many engineers, it is difficult to break out of their introvert shell (it is for me!) but it is worth the time and effort."

Raeymaekers Elevated to ASME Fellow

Mechanical Engineering Associate Professor Bart Raeymaekers was recently elevated to the grade of fellow of the American Society of Mechanical Engineers (ASME). The ASME fellow grade recognizes "exceptional engineering achievements and contributions to the engineering profession." The title of fellow has been awarded to only about three percent of over 100,000 ASME members.



Raeymaekers' research interests span two areas; tribology with an emphasis on micro- and nanoscale lubrication, and materials manufacturing with an emphasis on directed self-assembly. Furthermore, Raeymaekers is passionate about interaction between academia and industry and has founded a manufacturing center at the University of Utah, funded by the U.S. Department of Commerce, which interacts with small- and medium-sized manufacturing companies in Utah, attempting to bridge the gap between academic research and engineering practice.

Tribology is the science of friction, wear, and lubrication. The research of Prof. Raeymaekers and his students spans multiple length scales and involves both lubricated and dry contact. Of special note is his work on lubrication in prosthetic hip joints. A prosthetic hip joint lasts for approximately 15 years before failing due to a variety of possible reasons, including wear. This limited longevity causes many patients to outlive their prosthetic joint and require a revision surgery. Raeymaekers and his students have designed and manufactured engineered, patient-specific prosthetic hip bearing surfaces that stimulate the formation of a lubricant film and reduce wear of the prosthetic joint. "With this work, we aim to impact patient quality of life, by reducing their chance of needing a risky and costly revision surgery," Raeymaekers says.

He has also worked on materials processing research to manufacture engineered materials with tailored properties. The ability to design and manufacture multi-functional materials with tailored properties, including optical, thermal, electrical, acoustic, and/or mechanical properties, is of interest to the scientific community because of the game-changing impact it can have on many engineering applications. Raeymaekers and his students develop scalable material synthesis techniques based on ultrasound directed self-assembly, i.e., using ultrasound waves to make large quantities of particles organize themselves into user-specified patterns within a matrix material.

Raeymaekers received his B.S. (2002) and M.S. degree (2004) in mechanical engineering in his native Belgium, and moved to the U.S. in 2004, where he completed another M.S. (2005) and a Ph.D. (2007) degree at the University of California San Diego, also in mechanical engineering. After finishing his Ph.D. he obtained a full-time MBA (2009) at the Massachusetts Institute of Technology, and was hired as the first "entrepreneurial post-doc fellow" at the Los Alamos National Laboratory in 2009. He joined the University of Utah since 2010 and says, "The Department of Mechanical Engineering at the University of Utah is a great place to do research, and I have been lucky to work with very talented, hard-working students in my group, which makes it exciting and rewarding."

Learn more about Raeymakers' research at: mech.utah.edu/tribology/

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Congrats to our graduates! www.coe.utah.edu/graduation/mechanical-engineering-spring-2020/

ME Undergraduate Truong Receives Outstanding Undergraduate Research Award and NSF Graduate Research Fellowship

Undergraduate Takara Truong is the recipient of the Outstanding Undergraduate Research Award for the College of Engineering from the U's Office of Undergraduate Research. Truong has also received the prestigious fellowship from the National Science Foundation's (NSF) Graduate Research Fellowship Program (GRFP). Truong's current research is developing Human-Robot Interaction (HRI) technologies. Truong is advised by Associate Professor Mark Minor and works with Professor Dave Carrier (Biology) and Professor John Hollerbach (Computer Science). Truong is part of the Robotic Systems Lab.

The Outstanding Undergraduate Researcher Award honors a student from every college. The award is based on commitment to developing research skills and knowledge, evidence of independent and critical thinking, active participation in research-related activities on campus, and positive contributions to the research culture of the department, college, and university.

The NSF Graduate Research Fellowship recruits high-potential, early career scientists and engineers and supports their graduate research training. The award provides three years of financial support within a five-year fellowship period, leading to a research-based master's or doctoral degree in a STEM field.

The spark that ignited that interest in research came in 2011, when a youth outreach initiative gave him the opportunity to intern at the Robotics Systems Lab. "The sheer excitement I felt walking through the lab doors was matched only by my enjoyment in helping record experiments of a bi-pedal robot and solder components," said Truong.

Truong continued his research pursuits, finding his way back to the Robotics Systems Lab and working with HRI technologies, including highly interdisciplinary projects spanning mechanical and electrical engineering, biology, and physical medicine and rehabilitation. The overarching focus of Human-Robotic interaction is the interactions between humans and robots and includes areas such as methods for perceiving humans, motion planning, learning, manipulation and many others. The goal of this research is generally to improve human-robot interactions and has applications in manufacturing, personal and assistive robotics, and rehabilitation.

As part of his research, Truong worked on a project to create a smart helmet to reduce the risk of traumatic brain injuries. As part of this, he created several HRI systems that involved virtual reality, a tether-based impactor, and helped develop and manufacture a smart football helmet. Additionally, he worked on HRI systems involving gait rehabilitation and the creation of a mechanical harness for patients.

"In the future, I envision a world where robots are fully integrated into home and industry," said Truong. "These robots will have the intelligence to interpret tasks given by natural human commands and correctly work with humans or other robots to complete the task."

To learn more about Truong and his research visit his website: www.takaratruong.com/.