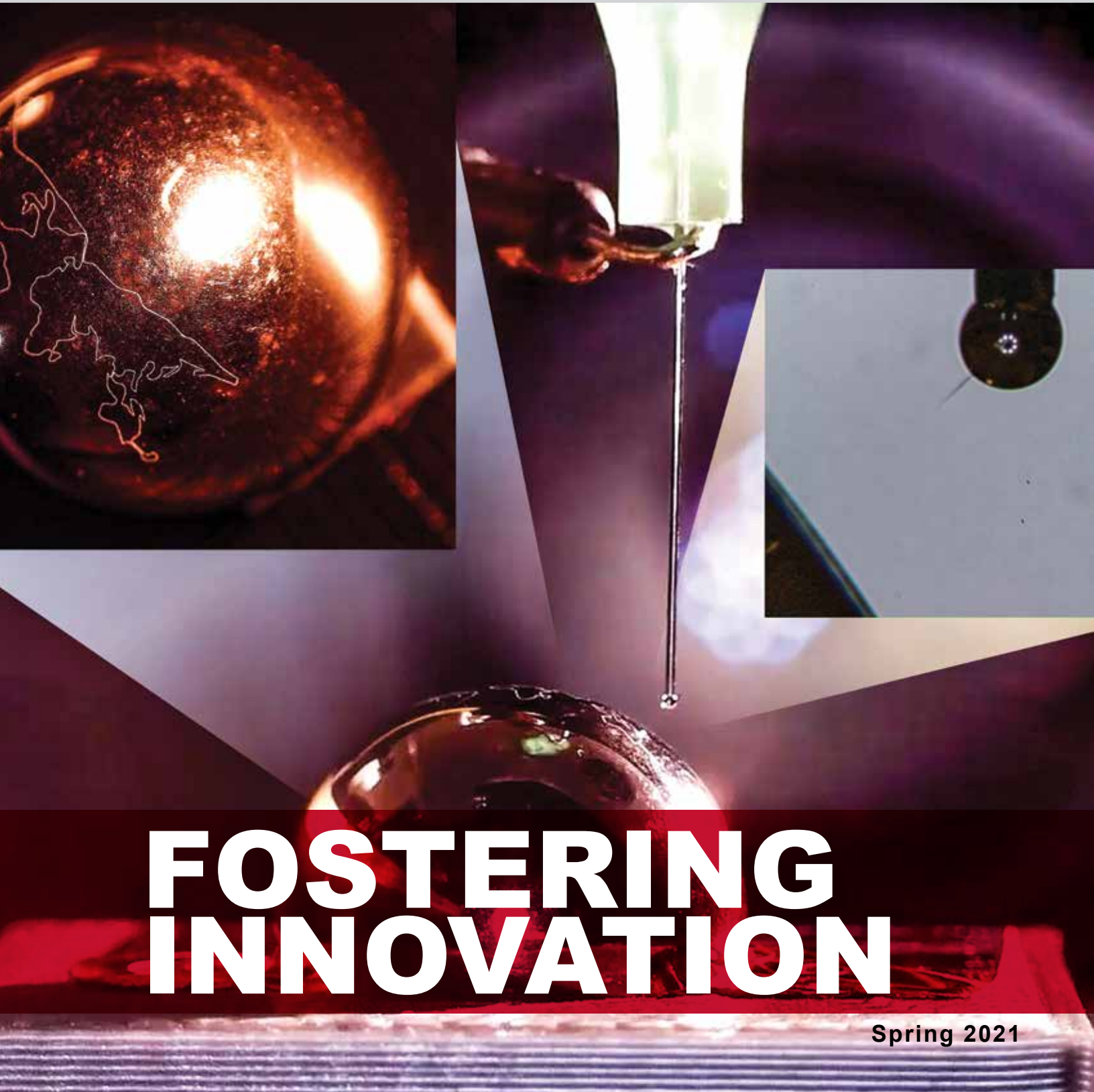
Department of
MECHANICAL ENGINEERING
THE UNIVERSITY OF UTAH

newsletter



FOSTERING INNOVATION

Spring 2021

CHAIR'S MESSAGE

Dear Friends of ME,

Greetings from my home office, where I have spent most of the past year. I suspect many of you have done the same thing. Even with the challenges of the pandemic, many good things have happened in our department and our students, faculty, and staff have completed some amazing work, even in the face of these difficulties. We are looking forward to an "in person" Fall semester and hope to see many of you face-to-face.

Our students at both the graduate and undergraduate level continue to do amazing work. Several of their stories are highlighted in this newsletter. While online classes have been tough, we have seen many students thrive in the online teaching environment, and some classes report better than ever learning outcomes thanks to the efforts of instructors and students. We've had virtual labs, home-built mechatronics robots, socially distant design competitions, and lots of Zoom presentations. My congratulations to the students, faculty, and staff who have responded so well to the various challenges. We are planning to celebrate at an in-person engineering convocation (graduation) ceremony at the football stadium on May 7. All 2020 and 2021 graduates are invited!

This issue highlights lots of other good news. On the research side, several of our faculty have received prestigious awards for excellence in research, including two CAREER Awards from NSF. We also highlight one of our outstanding alumni, Julie Kramer White, who has done some amazing work at NASA.

Looking to the future, construction is now well underway on the addition to our Mechanical Engineering building, the Rio Tinto Kennecott building. Currently we are expecting to move into the building in January 2022. We are busily planning a senior design laboratory (how many of you dreamed of that!) so that every team can have their own space and won't need to take over a research lab or a student's garage. We will also be building several new research labs including one for Tommaso Lenzi, who is highlighted in this issue. Plan to take a tour next year!

The legislature recently provided some money to expand our Systems Engineering program. Many thanks to our industrial advocates for this program. Amazingly, employers in the state of Utah estimate a need for over 500 systems engineers in the next few years, so we will be working hard to expand our courses and students in this area, and will be hiring faculty immediately. If you are interested in joining us in this effort, please contact me. We have a Systems Engineering certificate that is being expanded and improved, and that should lead to some great new opportunities for students who complete the program with several of the large employers in the state.

We are all looking forward to being back in the MEK this summer. Please come and join us as we welcome several new faculty, new teaching and research labs, and what will likely be our largest freshman class ever! Engineering is all about making the world a better place; come and help us make it happen.

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

NANOFIBER ON A THREE DIMENSIONAL SURFACE

ABOUT THE COVER: Electrospun functional nanofibers are emerging in flexible and wearable electronics. The cover images shows direct-writing of 100nm in diameter PEO nanofiber on a three dimensional surface. The nanojet self-aligns along the maximum electric field formed between the droplet and the surface of the metal ball.

Image was provided by Prof. Jiyoung Chang and his student, Dongwoon Shin.

Supporting Manufacturing in Utah

The Utah Industry Resource Alliance (UIRA) is a public/private partnership working to help Utah manufacturers grow and thrive. This group is led by the University of Utah Manufacturing Extension Partnership Center (MEP) based out of the Department of Mechanical Engineering and part of a national network of 51 centers across the country. Together with their partners across the state they implement proven solutions that produce measurable results using a team of all-star coaches, practitioners, and industry experts.

UIRA has been busy in the last year both continuing with its core mission, as well as providing specific resources to manufacturers during COVID-19. One major push has been promoting a Utah-developed supplier database called ConneX, a supply chain database tool for Utah. Along with supporting Utah manufacturers, this national database will support the Buy American Executive Order of the Biden administration, pushing federally funded procurement contracts toward American-made supplies. UIRA has received national attention as a leader on this initiative and helping Utah makers become more interconnected, keeping more business inside Utah.

"We are in a golden era of manufacturing awareness and collaboration," said Steve Black, Managing Director of UIRA. "Sourcing supplies to address COVID has put a national spotlight on the need for domestic manufacturing as both a national security issue and as a source of stable jobs with above-average wages."

Despite challenges over the last year, Utah is seeing a large influx of manufacturing companies from California, as well as homegrown startups. To support this growth, the UIRA continues to deliver new services and expanded capability, including CyberSecurity for Defense Suppliers and Food Safety Certifications for Food Manufacturers.

In 2020, UIRA worked with 75 clients, helped create or retain over 1,740 jobs, and created an additional $12.7 million in state tax revenue. By providing access to manufacturing specialists, application engineers, and research professionals from top organizations and universities in the state, UIRA will continue providing services across Utah.

To find out more, you can visit the UIRA website: *https://utahira.org/.*

New Grants

22 new projects, more than $6.6 million since November!

Claire Acevedo – NSF, 5 yrs, $561,491, "CAREER: Discovering the Mechanisms Governing Fracture in Fragile Bones"

Marc Calaf, Steven Naleway, Jake Abbott, Henry Fu –Army Research Office, 1yr, $78,500, "Thermal Infrared Imagery: Products for characterizing the near surface conditions"

Brittany Coats, Ashley Spear – DOJ, 3 yrs, $291,330, "Forensic tool to identify fall characteristics in infant skull fracture"

Michael Czabaj – NASA, 3 Yrs, $488,381 , "Novel Experimental and Numerical Tools For Accelerated Qualification and Certification of Bonded Composite Structures Containing Defects and Manufacturing Variability"

Ken d'Entremont – L3Harris, 1yr, $17,500, CAPSTONE: Vibration Isolation with Thermal Conductivity

L3Harris, 1 Yr, $17,500, CAPSTONE: Compliant EMI Cover

Bruce Gale – Electronic Bioscience Inc, 1 yr, $40,000, Rapid, "Multiplexed, Idealized Antiepileptic Drug Monitoring"

Electronic Bioscience Inc, 9 mos, $50,000, "Multiplexed and High-Throughput Protein Ion Channel Characterization"

Sprightly Health, Inc, 1 month, $30,000, "Fabrication and Development of Rapid COVID Diagnostic"

Jay Kim – SubAward of UCBerkeley, 2 yrs, $193,054, "Flight Testing of a Microfluidic Biochemical Analysis Lab-on-a-Chip"

Yong Lin Kong – NIH, 3 yrs, $605,800, Trailblazer Awd: "3D Printed Resonant-Enhanced Sensors for Total Joint Arthroplasties"

TMS, 2021 FMD Functional Materials Division Young Leaders Professional Development Award

3M, $15,000, 3M Non-Tenured Faculty Award

Kam Leang – L3Harris, 1.5yr, $55,000, "Optimized distribution of UAV swarms for emergency response missions"

Nevada Nanotech Systems (USAF), 2 yrs, $250,000, STTR Phase II: "Small Unmanned Aerial Systems (UAS) Compatible Chemical, Biological, Radiological, Nuclear, and Explosives (CBRNE) Sensors"

Tommaso Lenzi – NSF, $584,258 , CAREER: "Bio-inspired Multi-joint Design and Control for Efficient and Lightweight Wearable Robots"

DOD, 4 yrs, $1,499,885, Remote ACL Reconstruction Rehabilitation with a Smart Motorized Orthosis

Andrew Merryweather – DOD, 2 yrs, $1,276,120, "U-COVER: University of Utah Containment Ventilation for Exposure Reduction"

Andrew Merryweather, Shad Roundy – Analog Devices Inc, 6 mos, $39,928, "Quantifying Human Posture with a Motion Sensing Garment (MSG) System," Phase I

Steven Naleway – Army Research Office, 3 yrs, $454,158, "Combining Controlled Magnetic Fields and Freeze Casting For Structured Advanced Ceramics and Composites"

Ashley Spear – ASTM Int'l Additive Mfg Young Professional Award

Rob Stoll – Oregon State Univ, 4 yrs, $122,279 , A Systems Approach for Managing Bacterial Blight of Carrot

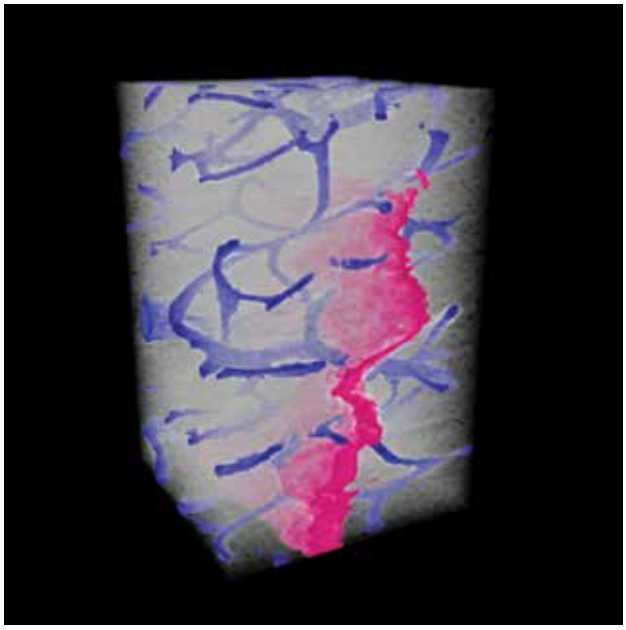
Acevedo Receives 2021 NSF CAREER Award

Department of Mechanical Engineering Assistant Professor Claire Acevedo has been awarded a National Science Foundation Faculty Early Career Development Program (CAREER) award. The CAREER program is one of the NSF's most prestigious award programs, offering five years of support of early career faculty with potential to serve as academic role models in research and education. The research grant, entitled "Discovering Mechanisms Governing Fracture in Fragile Bones" will improve our understanding of the mechanistic origins of fragility fracture in aged and diabetic bones.

When most people think of a bone fracture, they imagine an impact like a fall. However, this may not explain the cause of all catastrophic fractures. It overlooks the role of day-to-day repetitive loading. What if falls in the elderly and diabetic population are the consequence of fracture rather than its cause? What if bones accumulate damage over time under daily (fatigue) loading until they can no longer carry the load, leading to a fall?

"Cyclic fatigue is the most prevalent mechanism of failure in all engineered structures," said Acevedo, "but its relevance to the field of bone tissues has been neglected. These fatigue fractures are common in young athletes, especially in dancers. The mechanisms of cyclic fatigue allowing damage to slowly grow under physiological cyclic loading might also be the key to understanding fragility fracture, for example in the elderly and diabetics."

Professor Acevedo's research will advance the development of new bone fracture mechanics by using a novel combination of synchrotron radiation micro-computed tomography and specific machine learning algorithms to capture the 3D damage evolution during mechanical loading. This is typically not achievable by standard synchrotron micro-computed tomography imaging, which involves high radiation doses and causes deterioration of mechanical properties. This project can reveal the origins of damage mechanisms in all types of collagenous tissues and has the potential to lower the radiation level and improve image quality of medical scans. The results will ultimately be used to prevent fragility fractures.



Synchrotron radiation microCT image of the crack evolution (in pink) defleting and twisting around the canals (in purple) of bone microstructure

In addition, this research will be integrated into a long-term educational plan to attract the next generation of female engineers through dance class and other creative learning supports. In collaboration with the University of Utah Tanner Dance Program, a dance-science classroom geared for K-12 students will be developed to teach them about anatomy and skeleton functions.

For more information on Prof. Acevedo's research, visit the Laboratory of Fracture and Fatigue of Skeletal Tissues website: *https://acevedo.mech.utah.edu/.*
You can also view the award abstract on the NSF website:
https://www.nsf.gov/awardsearch/showAward?AWD_ID=2045363.

Lenzi Receives 2021 NSF CAREER Award

Department of Mechanical Engineering Assistant Professor Tommaso Lenzi has been awarded a National Science Foundation Faculty Early Career Development Program (CAREER) award. The CAREER program is one of the NSF's most prestigious award programs, offering five years of support to early-career faculty with the potential to serve as academic role models in research and education. The research grant, entitled "Bio-inspired Multi-joint Design and Control for Efficient and Lightweight Wearable Robots" will provide new knowledge related to wearable robotics by using bio-inspired actuation systems that concurrently assist multiple joints, much like human muscles.

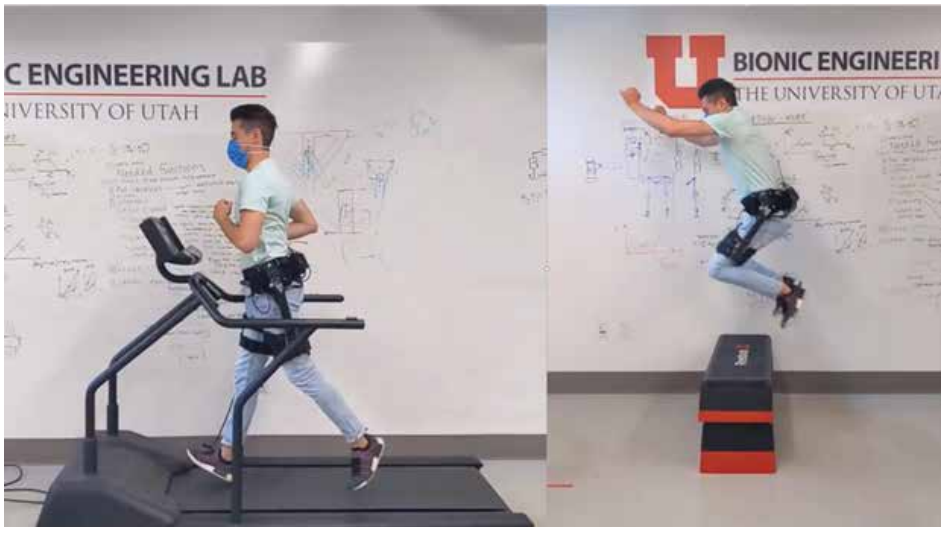
Existing exoskeletons are heavy and inefficient, which makes them impractical for use in everyday life. The main source of that weight is the many electrical motors used for each limb, for example three to four motors for each user's leg with each motor adding substantial weight. With more than 10 million Americans living with a physical disability, creating lighter and more efficient robots has the potential to improve their mobility and independence.

Human ambulation is already highly efficient and stable, making it a valuable model to imitate in creating a more efficient system. The passive dynamics of the leg and the elastic properties of the muscles combine with muscles spanning multiple joints, actively transferring energy between them. Lenzi will be studying how humans adapt to the assistance concurrently provided by a powered exoskeleton to multiple leg joints, on different anatomical planes, or during different ambulation activities. This will allow him to create prosthesis and exoskeletons that will optimize the energy exchange across multiple joints, using a single motor to assist multiple joints, much like in the human body.

"We want to make prosthesis and exoskeletons so lightweight and practical to use that people will want to wear them every day," said Lenzi. "I am excited about taking the powered exoskeleton from the lab to the real world where people need them the most."

Professor Lenzi is the Director of the Bionic Engineering Lab at the University of Utah, which was founded in 2017. Their research aims to develop bionic technologies and systems to help people move and live independently.

For more information about Prof. Lenzi's research, visit the Bionic Engineering Lab website:
https://belab.mech.utah.edu/
You can also view the award abstract on the NSF website:
https://www.nsf.gov/awardsearch/showAward?AWD_ID=2046287



Gathering data on running and jumping with a powered hip exoskeleton developed by Dr. Lenzi's research team at the Bionic Engineering Lab

Alumni Spotlight - Julie Kramer White

Julie Kramer White is the Director of Engineering at NASA Johnson Space Center and a University of Utah Department of Mechanical Engineering alum. She has over 30 years contributing to NASA Human Spaceflight programs, working in structural design, analysis, certification, and vehicle systems engineering. In her current role, Kramer White manages people, solves technical issues, and works on future strategic initiatives for NASA.

Kramer White knew in high school that she wanted a career at NASA. Her first step was a B.S. in Aerospace Engineering from Purdue University. During that time, she was selected for a cooperative education internship at NASA Johnson Space Center, which led to a full-time position after graduation. She started in the Structural Mechanics Division, and her interest in the mechanics and materials of aging aircraft led her back to the school.

"By discovering the wonderful world of aging aircraft, through the eyes of David Hoeppner, I was able to re-spark my desire to return to engineering school," said Kramer White. "And through the University of Utah's Mechanical Engineering department, I was able to mold the specific, unique program I wanted and was passionate about."

After graduate school, Kramer White started working on failures in other systems, such as propulsion and controls systems. "My structures, loads, and materials background was very helpful in these situations," she said. "I loved integrating teams across multiple disciplines, solving really complicated problems, under the pressure to having to get back to flying. There's really nothing like it. It's chaotic and stressful but rewarding technically and from a leadership perspective."

Kramer White worked in the space shuttle orbiter systems engineering office until the Columbia accident in 2003. After leading the failure analysis activities during the investigation, she was asked to join the newly formed NASA Engineering and Safety Center, where she set up a team of experts in mechanical analysis representing all 10 centers. That broad agency network, coupled with her strong systems engineering background, led her toward her job as Chief Engineer on Orion, then on to the Directors Office.

These days, besides the day-to-day management of a large organization, the biggest part of Kramer White's day is taken up with challenges associated with operational spaceflight programs. These challenges are varied, from closing out the final issues of Commercial Crew Program flights for SpaceX and Boeing, or the Artemis unmanned flight test in the fall, sprinkled in with more strategic leadership issues such as NASA's role in future human space flight initiatives in Low Earth Orbit, or what technology work NASA should be doing now to enable capability for future lunar or Mars exploration campaigns.

"I think that changing gears from people management, to immediate technical needs, to future strategic initiatives, back to managing people, in back-to-back meetings, is one of the biggest challenges of the job. Most days are 10+ hours and not a lot of time for lunch!" said Kramer White.

Despite the long days, Kramer White's enthusiasm for her work is clear. She shared this advice for those currently studying engineering. "Find something you are passionate about because you are going to spend the rest of your life doing it! And be open minded. You never know where your experiences will lead you."

Senior Design Projects

Here are just a few examples of the projects from Fall 2020.

Do-It-Yourself Automated Aeroponic System

by ME seniors Sam Burbidge, Jacob Gonzalez, Brooke Hadley, Alex Kratville, Hannah Lagerquist, Jon Matheson, Mechaela Maxwell, and Pat Zitting, advised by Dr. Kam Leang

Robot Assisted Coupon Loading

by ME seniors Juan Altuna, Michaylo Chubak, John Goodman, Rodrigo Leon, Bryce McCormick, and Sergio Nunez, advised by Dr. Jacob Hochhalter

Off-Road Recreational Walker

by ME seniors Chad Andersen, Morgan Barron, Reid Gardner, Jordy Osborne, Arthur Steur, and Rulon Stitzer, advised by Dr. Andrew Merryweather

You can view presentations and posters from all of our Design Day participants at:
https://mech.utah.edu/virtual-design-day-fall-2020 and https://www.mech.utah.edu/virtual-design-day-spring-2021/

Searching for Life in Space with Microfluidics

Space travel and exploration have been interests of PhD student Zachary Estlack since he was a kid. Now, his research is focused on micro/nanosystems development for space exploration. Specifically, he is currently working on the development of a highly sensitive and automated chemical analyzer for searching for signs of life in outer space.

Estlack grew up tinkering with household items, building BMX jumps, and helping his dad on computer programming projects for fun. This made engineering a natural fit and eventually led him to focus on microfluidics, the manipulation of small volumes of fluids for a variety of applications.

"Microfluidics is uniquely positioned for space-bound systems," said Estlack. "By design, it requires small volumes of samples, low-power consumption, and a small footprint, all of which are important. The idea of having something I have personally fabricated or a derivative of a design I made going into space is incredibly exciting."

Working in Dr. Jungkyu (Jay) Kim's Biomedical micro/nanodevice lab has given Estlack the opportunity to learn a wide range of skills beyond just those highlighted in his research work. One example is working to recreate organs on tiny microfluidic devices, which could replace animal testing with more accurate and cheaper platforms. This could also provide testing that otherwise wouldn't be possible. Through this, Estlack has learned biology, anatomy, cell culture techniques, and organic chemistry.

PhD student Zachary Estlack

"Zachary's multidisciplinary project requires knowledge on micro/nanofabrication, control, and fluid mechanics, all of which are a great fit for his strengths. With his dedication and engineering knowledge, I am confident that he will be a leader in micro/nanosystems field and be a great representative of the U's engineering program," said Dr. Kim.

Visit the Biomedical Micro-Nano Systems lab website to learn more: https://biomems.mech.utah.edu

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Congratulations to this year's graduates!

New Senior Design Space Under Construction

We are excited to highlight the new senior design laboratory currently under construction as part of the Phase III addition to the Rio Tinto Kennecott building. With over 3100 square feet of dedicated maker space, project teams will have their own work benches as well as access to specific tools for project prototyping. This is an exciting addition to the department's growing capstone program and will help continue to grow and enhance the program.

In addition to space for individual teams, the space is designed to be reconfigurable to adapt to future program growth. It will serve as a multi-functional lecture space, prototyping environment, and project test space. The space will also be home to a wide range of tools and equipment to facilitate project prototyping, including: 3D printers (FDM and stereolithography), laser cutter, benchtop CNCs, drill press, soldering station, low power microscopes, oscilloscopes, power supplies, foam cutter, vacuum former, sander, grinder, and various hand tools.

Located off the atrium on the lower level of the building, the new space will have natural lighting and an open ceiling, making it both an inviting space for the students as well as a great highlight of the work being done in the capstone program. We are looking forward to offering this new level of support to all of our senior design projects, as well as continuing to highlight the great work done by these teams.

New senior design projects kick off in both spring and fall semester, and we are always looking for new industry partners. If your business has a project that you think might be a good senior design project, let us know! You can learn more about the program and submit new industry projects on our website: *https://mech.utah.edu/capstone/*

Rendering of the new Senior Design Space.