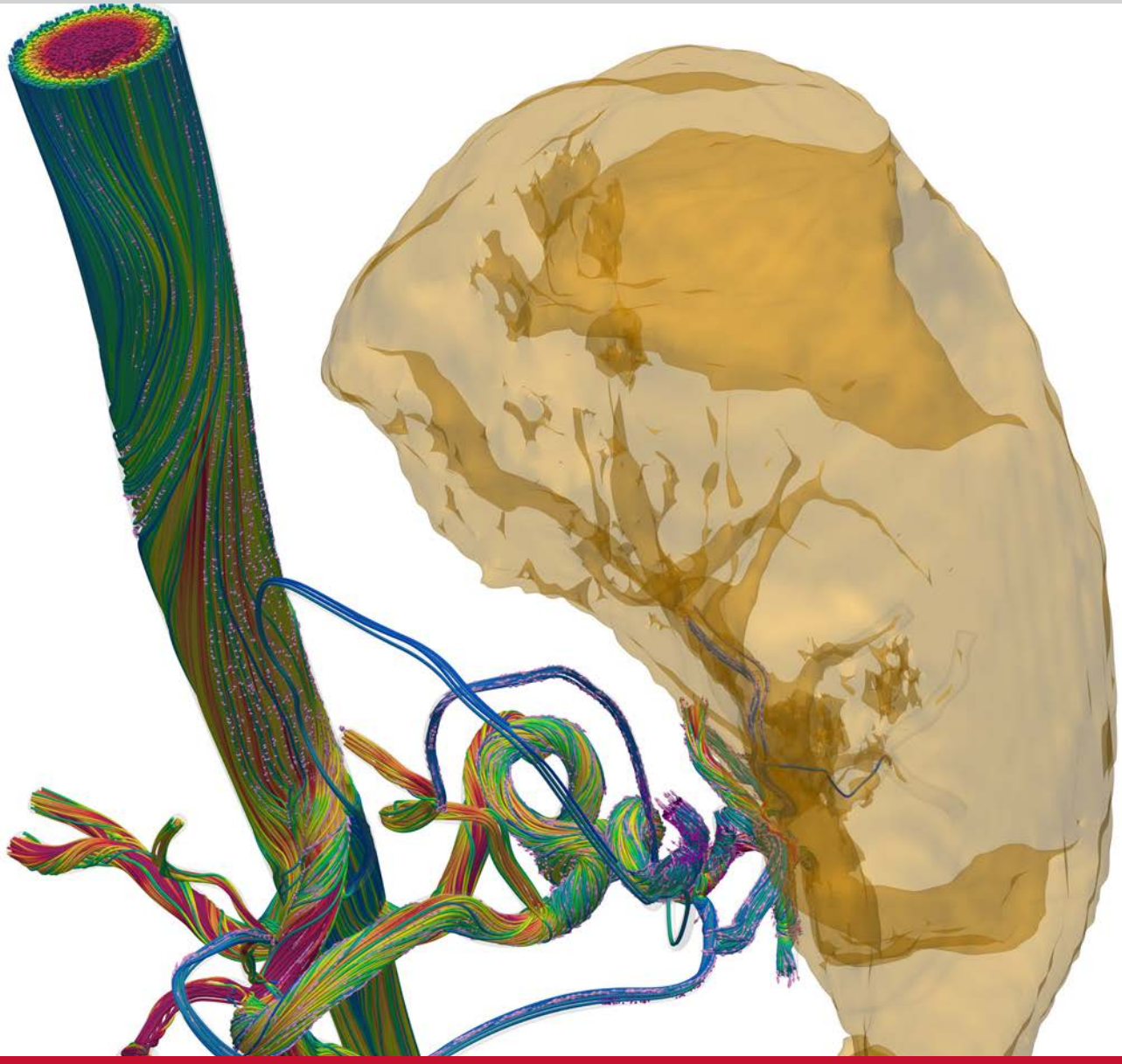
Department of
MECHANICAL ENGINEERING
THE UNIVERSITY OF UTAH

newsletter



FOSTERING INNOVATION

2025

Chair's Message

Dear Friends of Mechanical Engineering,

We are thrilled to welcome you to this edition of the U's Department of Mechanical Engineering newsletter! Whether you're a long-time member of our community or a new face just beginning your journey with us, this message is for you—a celebration of connection, curiosity, and innovation. Please look inside to see what our students, faculty, and staff have been up to!

The past year has been both amazing and chaotic – all at the same time. This last year we enrolled our largest freshman class ever (double the size of five years ago) and the incoming class this year is expected to be even larger. We are grateful there is so much interest in our undergraduate program and look forward to welcoming so many new students. We hope your family and friends are some of them! There will be a lot of mechanical engineers graduating soon.

We are proud to announce our new MS in Aerospace Engineering that will join our recently launched MS and PhD in Robotics, MS in Systems Engineering, and an MS in Engineering Management. We have hired several great Aerospace related faculty to help drive this program and supplement our great aerospace materials and aerospace controls faculty that are already here. With all the growth and excitement around aerospace in Utah, we hope to be able to make a big difference in the growth of our industry partners.

As you may have heard, changes initiated by federal and state government leadership are leading to many changes in our programs. The state is pushing to grow things like engineering at the University of Utah, which should help us to educate even more students, but we are experiencing growing pains with larger classes and packed laboratories. We'll have to invest well to be able to help all of these incoming students! The Federal government's cuts to research funding also has big implications for our future research efforts in the department. As you will see in this newsletters and on our website, our research has big impacts across the world and we are worried some of these changes will lessen our ability to develop innovative approaches. Our research has real world impact or all of us in areas like aerospace, robotics, advanced manufacturing, energy, and biomechanics. We encourage you to let your legislative leaders know engineering research is important to you!

We are excited to be implementing a new approach to our senior design projects that will hopefully increase their impact and the experience of our students. We are making changes to ensure that the teams have even better advising and a more "professional" industry experience. If you'd like to get involved, please let us know!

Finally, we are grateful to all of you for your continued support and interest in Mechanical Engineering. We hope you will take the opportunity to join us on campus for a workshop, seminar, or Design Day. Come interact with our great students and faculty and see what the future holds!

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

CFD Simulations of Blood Flow Patterns

About the Cover:
The front image is from patient-specific computational fluid dynamics (CFD) simulations, demonstrating blood flow patterns in the abdominal aorta and the surrounding vasculatures. It was used to optimize treatment of a patient with an enlarged spleen.

Courtesy of Amir Arzani and the Computational Biomechanics Group

Highlighted Grants

Over 40 new projects awarded, more than $7.2 million in funding since last September!

Jake Abbott – Frontier Innovations, 6 mos, "Magnetic Induction in Nonmetallic Objects"

Amy Lenz – Shriners, 36 mos, "Weight bearing CT Imaging: Applications to Pediatric Flatfoot Deformity"

Tianli Feng– DOE, 11 mos, "Microstructure-Based Predictions of Plasma-Facing Material Property Degradation"

Bruce Gale– EBS, 9 mos, "EBS Subcontract: Next-Generation Cardiovascular Risk Assessments Via State-Of-The-Art Lipoprotein Characterization"

Laura Hallock – UURF, 12 mos, "A Robotic Platform and Scaffolded Learning Method for High-Degree-Of-Freedom Assistive Device Control"

Jake Hochhalter – ARCTOS, 72 mos, "Multi-scale Model Development for Ceramic Matrix Composites with Scientific Machine Learning with High-performance Computing"
HRL, 21 mos, "Rapid Certification of Additive Manufactured Components Using ML/AI And Physics-Based Modeling"

Jay Kim – MEPSGENUS inc, 12 mos, "Development and validation of cornea chip for ocular drug development"

Steven Naleway – NSF, 24 mos, "Mixed-Energized Field (MEF) Freeze Casting: Manufacturing with Energized Fields and Their Interactions"

Alex Novoselov – NSF, 60 mos, "CAREER: Turbulent Boundary Layer Flashback of Lean Hydrogen Flames"
ACS, 24 mos, "Reduced-Order Modeling of Mixed Detonation/Deflagration Combustion"

Shad Roundy – DOD, 10 mos, "Self-charging, Medical-grade Wearable Smart Insole Technology for Real-Time Non-Invasive Bio-Sensing, Physical State Monitoring, Health Protection, and Safety Monitoring using Edge and Cloud Computing"

Ashley Spear – DOE, 7 mos, "A High-Fidelity Fatigue-Life Modeling Framework Using FFT"
DOE Sandia, 7.5 mos, "Accelerating Microstructure-Based Fatigue Property Predictions with Deep Learning"

Rob Stoll – USDA, 4 yrs, "Pathogen Monitoring and Disease Management with a Vineyard FRAMEwork"

Tommaso Lenzi – Ottobock, 14 mos, "Joint Research and Development of a Lightweight Active Knee Prosthesis"
Ottobock, 14 mos, "Development of a Semi-Active Ankle/Foot Prosthesis"
Ottobock, 14 mos, "Development of Active Lower-Limb Orthoses
NIH, 60 mos, "Lightweight Powered Prosthesis for Above-knee Amputees"

Scott Uhlrich – Myotonic Dystophy Foundation, 24 mos, "Novel digital functional outcome measures for myotonic dystrophy using smartphone video"

SIME Program Highlights

- 22 Graduate Systems Engineering Certificates since Summer 2024
- First 3 Graduates with a Master of Science in Systems Engineering
- 32 Students pursuing the MSSE Degree
- 11 Students pursuing the MEM Degree
- MEM And MSSE Degrees are offered on-campus and online
- 32 Student Qualified for the INCOSE Academic Equivalency
- Hosted two professional panels in partnership with the INCOSE Wasatch Utah Chapter with 70+ attendees at each
- Two flagship courses had record enrollment this year, including 70+ students in Fundamentals of Systems Engineering and 90+ in Systems Engineering and Integration

Find out more about our Systems, Industrial, and Management Engineering programs at:

systems.utah.edu

ME Takes Second at Fluid Power Vehicle Challenge

At this year's Fluid Power Vehicle Challenge, a team of six Department of Mechanical Engineering undergraduate students took second place overall in the competition, along with taking first place in the sprint race and second in the endurance and efficiency races. The team included students Jon Dromey, Talon Rencher, Chris West, Cole Huseby, Jonathan Moriel, and Johnny Vaughey. Professor M Dillon mentored the team.

FPV Team with the boxed vehicle

The Fluid Power Vehicle Challenge is sponsored by the National Fluid Power Association (NFPA) and gives teams from universities across the country an opportunity to compete. Teams build a vehicle that combines a human-powered vehicle with fluid power. These vehicles include an accumulator for storing energy, an electronic control system for the vehicle, and regeneration technology.

The students were able to start with the work done by the previous year's team, as well as taking their advice to "get to the testing phase as early as possible." While some of the components were reused from the previous year, the bike was almost entirely rebuilt.

"We tried to start getting our hands dirty as early as possible," said Jon Dromey. "We started putting things together and testing them before we had our full design planned out and this testing informed some of our design decisions and helped us home in on the best approach."

The group used a wide range of skills as they worked on the project, including CAD, fluid dynamics, piping and instrumentation diagrams, and manufacturing. This pushed the group to try new things and problem-solve as they worked through building the bike.

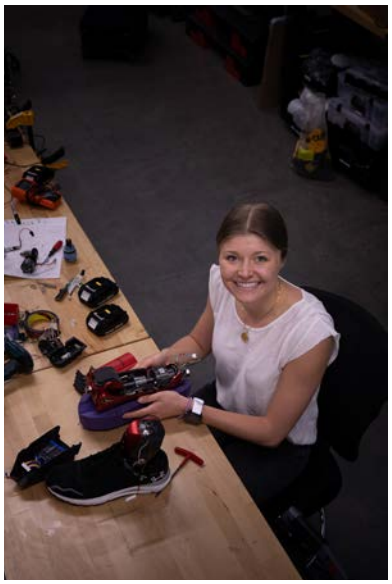
"The most challenging part of the build was getting the drive train to work reliably," said Dromey. "We had problems with chains grinding on things, not aligning, coming loose, and even falling off. It took a few tries fabricating the drive train parts to get it to work well."

Despite these challenges, and an issue with the bike being too top heavy when they arrived at the race, the team was able to overcome these challenges and did well across multiple challenges, ultimately placing second overall.

"The event was an amazing experience," said Dromey. "It was great to meet the students at the other schools and see the wide variety of approaches they took. Everyone on the team had a lot of fun building the bike and competing. The NFPA did an outstanding job putting it together and making a great experience for everyone."

Two Ph.D. Students Receive NSF GRFP

Mechanical engineering graduate students Karen Walker and Gwyn O'Sullivan, both students in the HGN Lab for Bionic Engineering, are recipients of the National Science Foundation's Graduate Research Fellowship Program (NSF GRFP). This prestigious fellowship supports outstanding doctoral and research-based master's students doing research in science, technology, engineering and mathematics, or STEM, disciplines.



Walker working on a prosthetic

Established in 1952, the NSF GRFP is the oldest fellowship program of its kind. The 2025 fellows receive a three-year annual stipend of $37,000, a $16,000 cost of allowance for tuition and other costs, and numerous research and professional development opportunities.

This fellowship highlights the impressive work these two students are doing. Walker is doing in investigating the impact of prosthetic devices on the biomechanics and mobility of individuals with lower-limb amputations. O'Sullivan's research is focused on developing a 'semi-active' prosthetic ankle.

Walker had the opportunity to volunteer at a prosthetics and orthotics clinic during her undergraduate studies and saw firsthand how resilient people with mobility impairments can be. She also witnessed the powerful role that assistive devices can play in restoring independence and changing someone's life, which motivated her to pursue research that helps others stay mobile and healthy.

"What excites me most about this research is the potential to make a real difference in the lives of people with amputations," said Walker. "The work I'm doing could play a pivotal role in shifting the way we approach mobility for amputees, by showcasing the benefits of powered assistive devices. This is a step toward creating prosthetic devices that are not only functional but truly enable independence and enhance quality of life. It feels like we're on the cutting edge of something that can have a big impact."

Walker plans to continue doing research that supports individuals with mobility impairments. Her goal is to help optimize devices that enhance mobility so users can walk more naturally, efficiently, and pain-free. This research will contribute to innovations that make assistive devices feel like a true extension of the body, bridging the gap between function and freedom, to play a role in expanding what's possible in assistive technology.

O'Sullivan's interest in prosthetics isn't new. She grew up watching sci-fi movies and TV shows with her dad that were full of high-tech medical devices. As she got older, she was drawn to advanced biotechnology and prosthetics in specific. Working in the HGN Lab will give O'Sullivan the opportunity to work in research and development while also learning more about academia.

O'Sullivan working on a design

"Some powered prosthetic ankles have been developed," said O'Sullivan, "however, they tend to be heavier, noisier, and more expensive than their passive counterparts. The semi-active ankle would bridge the gap between these. It will store and return energy like a passive ankle while walking but will have a small motor that adjusts spring stiffness. This will allow it to adapt to different activities and provide the adaptability of a powered device while being much lighter and cheaper."

She has always wanted to be involved in prosthesis design and this project will give her the opportunity to really sink her teeth into every stage of the process.

"My favorite part of the design is eventually getting to hold the device that was, once, just an idea," said O'Sullivan. "I can't wait to have that moment with my prosthetic ankle. That moment is the 'carrot on a stick' that drives me. And while I've never made a prosthetic ankle before – my literal dream – my research doesn't end there. I'll be able to have an amputee actually walk on a foot I designed. Just thinking about it blows my mind."

CAREER Award: Alex Novoselov is Fighting Flashback for Clean Energy

Assistant Professor Alex Novoselov

Industrial turbines that burn natural gas currently generate about 40 percent of the US's electricity — and nearly 15 percent of its carbon emissions. However, natural gas isn't the only option for turbines. Pure hydrogen is a highly flammable fuel option that produces mainly water vapor when burned, qualities that would seem to make it an ideal green power source for these sorts of plants.

The problem is that hydrogen is too flammable to be readily used as fuel. Gas turbines are specifically designed for the combustion properties of natural gas. Hydrogen is a much more reactive fuel, and is much smaller on a molecular level, making its flames much harder to control without damaging the turbine itself.

"One of the main obstacles slowing the transition to hydrogen use in gas turbines is flame flashback, a phenomenon wherein the flame proceeds upstream of the thermally protected combustor with catastrophic consequences," says Price Engineering's Alex Novoselov.

Novoselov, assistant professor in the Department of Mechanical Engineering, has received a National Science Foundation CAREER Award to study this phenomenon. He's using advanced computational simulations in a search for the fundamental physics that govern flashback, as well as for ways to design around it.

Many natural gas plants already have the capability to mix hydrogen into the flow of burning hydrocarbon gases, cutting the net carbon emissions per watt generated to a small degree. However, cutting additional carbon emissions requires blending even more hydrogen which is a challenge for most existing systems.

"While gas turbine manufacturers anticipate 100 percent hydrogen utilization in the future, current industrial turbines have the potential to operate closer to 50 percent hydrogen by volume," Novoselov says. "Beyond that, the risk of boundary layer flashback is too high for the turbine to operate safely."

Managing a turbine's flame means carefully balancing the flow of fuel and air into the combustor with the speed at which the flame propagates. One complicating factor is that the flow moves more slowly along the walls of the combustor than in the middle; a too-fast flame can burn through this slower boundary layer, potentially escaping the combustor entirely.

"Because hydrogen is more reactive and mixes faster, the more hydrogen we add into the fuel, the faster the flame speed," says Novoselov. "At some point, the flame speed becomes faster than the flow, especially along the boundary layer, increasing the likelihood of flashback. And only the turbine's combustor is designed to handle the intense temperatures involved, so this has the potential to damage or destroy the rest of the equipment. "

Novoselov's CAREER Award will support foundational research into boundary layer flashback, and critically, how it can be avoided.

"We're interested in determining what triggers this instability," says Novoselov. "Can we understand the physics that turns a stable flame into something potentially dangerous? If so, we can then build models that will tell us how much hydrogen is safe to add to a given system."

Beyond the ability to better predict the safety tolerances of existing equipment, Novoselov's simulations could eventually aid in designing next-generation turbines, purpose-built to run on much higher concentrations of hydrogen.

Some of these projects have already begun to take shape. For example, the Intermountain Power Agency's IPP Renewed Project, based in Delta, Utah, aims to run off of pure hydrogen by 2045.

"IPP is currently aiming to run at 30 percent hydrogen this year, giving them 20 years to make up that difference," Novoselov says, "With our fast, reliable models of flashback, we think we can significantly accelerate that progress across the field."

Sameer Rao Named Presidential Societal Impact Scholar

Sameer Rao, assistant professor in the Department of Mechanical Engineering, has been named a Presidential Societal Impact Scholar.

Assistant Professor Sameer Rao

This prestigious award recognizes faculty members who excel in translating their scholarly work into impactful contributions beyond academia. Supported by a gift from University of Utah Professor Randy Dryer, the award was launched in 2022–23, with the selection of five inaugural scholars. In addition to Rao, this year's class of Presidential Societal Impact Scholars includes. David Wetter, Matthew Basso, Divya Chandrasekhar and Tino Nyawelo.

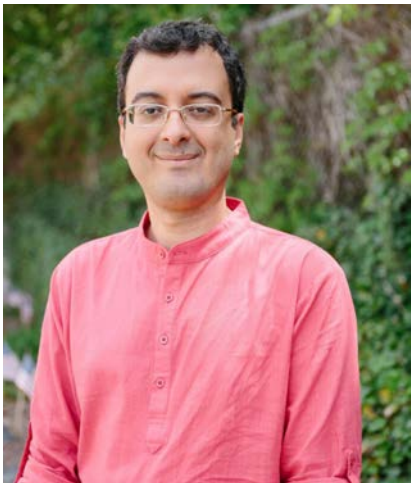
Rao's research focuses on advancing atmospheric water harvesting technology. Together with graduate student Nathan Ortiz, Rao developed a device that extracts water from the air using adsorbent materials and converts it into liquid by applying heat to release the molecules. Their prototype, designed with support from the DEVCOM Soldier Center, demonstrates a significant breakthrough in generating clean drinking water, especially in arid, water-insecure regions.

"As we were designing the system, I think we also had perspective of the broader water problem. It's not just a defense issue, it's very much a civilian issue," said Rao, highlighting the device's versatility and efficiency in producing 5 liters of water per day per kilogram of adsorbent material.

As a Presidential Societal Impact Scholar, Rao will receive a $10,000 honorarium and support from the U's Marketing & Communications office for media promotion and engagement. He joins a cohort of scholars committed to enhancing public welfare through their research and innovation.

Arzani Receives PECASE Award

Earlier this year, the White House's Office of Science and Technology Policy announced the recipients of the 2025 Presidential Early Career Award for Scientists and Engineers (PECASE), including associate professor Amir Arzani from the Department of Mechanical Engineering.



Associate Professor Amir Arzani

Established in 1996, the award honors outstanding scientists and engineers who are at the start of their independent research careers, marking their potential to become leaders in their fields. It is the highest honor bestowed by the U.S. government for early-career scientists and engineers. The award was last given in 2019.

"Coming directly from the President makes it very special to me and a lifetime honor I will never forget," said Arzani. "I want to thank my family, lab members, colleagues, mentors, collaborators, and also NSF for nominating me. In the past 7.5 years, I have been very fortunate to have experienced a very supportive environment with excellent students at NAU and Utah."

Through NSF funding, Arzani explores scientific machine-learning approaches for modeling blood flow. You can find out more about his research through the Computational Biomechanics Group website: bio.mech.utah.edu.

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New Aerospace Degree at the U

Beginning this fall, the U will offer a new Master of Science in Aerospace Engineering. Aerospace Engineering is a big part of Utah already, with over 900 aerospace and defense companies in Utah, employing over 30,000 people according to the Governor's Office of Economic Opportunity. This degree will help train more engineers to support this industry, as well as supporting research efforts.

Student interest matches industry interest, with over 120 undergraduate students already pursuing an aerospace emphasis on their mechanical engineering degree. By offering an MS degree as well, these students will be better situated to support this growing industry with advanced knowledge and skills.

"The University of Utah has had a vigorous program of aerospace engineering research, in the Department of Mechanical Engineering and elsewhere in the Price College of Engineering, for many years," said Dr Mark Maier, Director of the MSAE program. "The MSAE program gives our students a great way to focus their graduate education and get recognition for their expertise in the aerospace engineering field. We believe this will particularly appeal to engineers working in the rapidly growing Utah aerospace industry."

This degree program will also tie into the other efforts the ME department is pursuing to grow its aerospace program. In addition to several faculty members already engaged in related research, the department has brough on three new tenure track faculty members in aerospace. These efforts have also been supported by the University through seed money to support an Aerospace Research Hub.

Students Blake Rhodes, Andrew Wan, Jenica Pierce, and Vinit Dudani of the Utah Rocket Club competed at this year's Spaceport America Cup. This is the team's second year participating at the competition where students design, build, and fly rockets to target altitudes of 10,000 or 30,000 feet

"The Aerospace Hub at The University of Utah consists of an interconnected group of a faculty, students, administration, and research infrastructure," said Dr Jacob Hochhalter, director of the Hub. "Additionally, the Hub helps establish multi-disciplinary research initiatives, linking together students and faculty across multiple colleges, such as engineering, medicine, and science."

You can find out more about the Aerospace program, as well as how to apply, by visiting http://aerospace.utah.edu