2021-22 ANNUAL REPORT

MIZZOU ENGINEERING

Engineering a Better World

College of Engineering
University of Missouri

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College of Engineering
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I've always had a passion for history, so the celebration of our 150th anniversary has been a highlight of the year. Mizzou Engineering was officially incorporated in 1871, however our roots stretch back much further, to 1849 when we became the first university west of the Mississippi River to offer an engineering course. And we have celebrated many firsts since, including the first public exhibition of incandescent electric lighting in Missouri in 1883, giving rise to our Department of Electrical Engineering—one of the oldest in the country—two years later.

Noah D. Manring
Dean,
Ketcham Professor

In the 1950s, we were among the first to begin offering nuclear engineering courses. Later, we became the first public university in Missouri to offer biomedical engineering. And in more recent years, Mizzou Engineering was one of the first to incorporate Spot, the agile mobile robot from Boston Dynamics, into our undergraduate curriculum.

But being first isn't just about making history; it's about leading the way. It's about learning, through trial and error, what works.

Today, our faculty are leading the way in critical areas. In the new MU Materials Science & Engineering Institute (MUMSEI), researchers from across campus are exploring metamaterials, nanomaterials and quantum materials that will advance our technological capabilities. In the Missouri Water Center, collaborators from the College of Agriculture, Food & Natural Resources are working with our engineers to come up with solutions to preserve our water resources. In this publication, you'll learn about the many ways in which Mizzou Engineers are making new discoveries for the betterment of society.

We make sure our students have opportunities to work alongside those faculty members in the lab. As early as their freshman year, students can roll up their sleeves and get involved in research. And they excel, as you'll see from the projects they've worked on this past year.

That hands-on experience combined with a strong engineering curriculum has proven to be key in preparing our graduates to go on and become leaders in the field. So many of our alumni have served or are serving as presidents and CEOs, vice presidents and C-suite executives at top companies such as Dow, Burns & McDonnell, Boeing, Procter & Gamble and more. You'll meet some of those incredible alumni later in this report.

We have a long legacy of excellence in research, scholarship and leadership and a proud tradition of engineering the future.

MIZZOU 150 ENGINEERING YEARS

150 Years of Engineering Excellence

In 1849, the University of Missouri became the first institute of higher education west of the Mississippi to introduce engineering education, offering a course titled, "Surveying, Leveling and Classical Topography." Two decades later, the School of Engineering was incorporated. Mizzou Engineering has been educating engineering leaders, advancing technology and improving lives ever since.

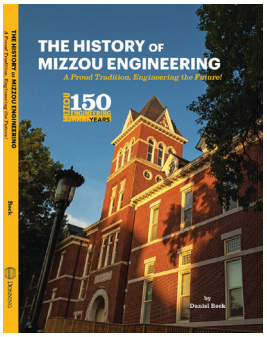
There have been numerous milestones along the way. In 1882, inventor Thomas Edison donated an electric dynamo to Mizzou, leading to the establishment of the third oldest electrical engineering department in the world. Three years later, we established a mechanical engineering program.

And our students were the first to "discover" that St. Patrick was an engineer. In 1903, students declared St. Patrick's Day a holiday, a "skip day" that would become a week-long celebration for engineers that continues today.

We would go on to expand offerings in biological and chemical engineering, computer engineering and computer science, industrial and manufacturing systems engineering and information technology and would be the first public university in the state to offer a biomedical engineering degree.

As you will discover in the pages of this report, Mizzou Engineering continues to build upon our legacy of engineering excellence with innovative research, hands-on learning opportunities for students and extraordinary alumni successes.

In honor of the 150th anniversary of incorporation, a new history was published in the fall. "Mizzou Engineering: A Proud Tradition, Engineering the Future!" is a comprehensive look back at the people, places and milestone events that shaped the legacy of engineering at the University of Missouri. Books are available for sale online at themizzoustore.com.



MUMSEI: A New Era of Materials Research at Mizzou

A new institute that opened at Mizzou this past spring will advance collaboration around materials research and education across campus.

The MU Materials Science & Engineering Institute (MUMSEI) is a partnership between Mizzou Engineering and the College of Arts & Science and includes faculty from 10 academic departments. Matt Maschmann, associate professor of mechanical and aerospace engineering, and Tommy Sewell, professor of chemistry, co-direct MUMSEI.

"The study of materials intersects engineering, physics, chemistry, biology and more," Maschmann said. "We expect this institute to lead to numerous opportunities for joint projects and proposals as material development is of significant interest to government agencies and industries."

Ultimately, the goal is to create smarter, safer and more efficient ways of living, said Sewell, who is also an adjunct instructor in mechanical and aerospace engineering.

"Material is in every aspect of our daily lives," Sewell said. "We're excited to explore ways in which we can analyze and develop materials that can be used to improve society."

"Our College is built on the very idea that our students would be prepared to work with sciences around the development of materials to advance society."

—Noah Manring

MUMSEI includes the new Materials Characterization and Fabrication (MCF) facility — a clean room and lab space on the third floor of Lafferre Hall and houses cutting-edge equipment to fabricate and characterize the properties of diverse material systems. Adjacent to the MCF facility, materials researchers will share lab spaces to promote collaboration and build a cohesive materials community.

While MUMSEI will open new avenues of research, the study of materials has been a priority for the College of Engineering since it was incorporated 150 years ago, Dean Noah Manring noted during his remarks at a grand opening event.

"Our College is built on the very idea that our students would be prepared to work with sciences around the development of materials to advance society," Manring said. "That was true in the 1870s when students were studying the best materials to use for roads and bridges. It was true in the 1950s when Mizzou researchers were investigating design of microwave absorbing materials. And it's true today as we investigate the metamaterials and nanomaterials that will revolutionize the world as we know it."

John A. Rogers

Rogers Delivers Keynote at MUMSEI Symposium

Mizzou Engineering celebrated the opening of MUMSEI in May with a Ribbon Cutting and Symposium featuring keynote speaker John A. Rogers.

Rogers is director of the Querrey-Simpson Institute for Bioelectronics at Northwestern University. He is among fewer than two dozen individuals in history to be elected to all three United States national academies — the National Academy of Engineering, the National Academy of Science and the National Academy of Medicine.

Rogers is widely recognized as the father of the field of bio-integrated electronic technologies, which are soft, biocompatible devices that naturally interface with the human body to provide continuous, clinical-grade information on physiological status and/or deliver therapies that accelerate rates of recovery from injury and disease. Rogers has more than 80 patents and patent applications around technologies that address challenges in maternal, fetal, neonatal and pediatric health, as well as neurodegenerative disorders.

Engineering Faculty Lend Expertise to NextGen Precision Health

The Roy Blunt NextGen Precision Health building opened on the MU campus this past fall, an interdisciplinary research facility focused on precision health solutions.

Mizzou Engineers will help clinicians and medical professionals at NextGen Precision Health better analyze the large volumes of information coming from sophisticated MRI and other imaging equipment, as well as determining how best to store that information securely.

The engineering team brings together expertise from a number of specialty fields. Professor Kannappan Palaniappan and Assistant Professor Filiz Bunyak Ersoy — both from electrical engineering and computer science — have spent years developing methods to train AI to analyze images. Greg L. Gilliom Professor of Cyber Security Prasad Calyam is an expert in cyber defense and cloud computing. And Associate Professor Matt Maschmann in mechanical and aerospace engineering specializes in AI-driven manufacturing of nanomaterials and material characterization.

"We have a lot of experience in intelligent image analytics in our College where we can help," Calyam said. "We all bring different skills to the table for these image analytics projects that require significant computation resources and expert collaborations to speed up discovery and create necessary innovations."

The team has several preliminary tasks. First, researchers want to come up with the best way to collect the data generated from the imaging instruments at NextGen. Given the large volumes of data and the high demand

on the time available on the expensive instruments, efficient data collection will be essential.

Then, they must decide how best to manage that data, such as moving it to the cloud where complex algorithms can begin to automate analysis processes. They also need to determine the best way to protect that information from cyber threats.

Finally, the group is creating frameworks to manage data collection and processing.

The team is building on collaborations that are ongoing with experts in imaging and radiology including Professor Talissa Altes in the Department of Radiology, Professor Mahesh Thakkar in the Department of Neurology, Associate Professor Teresa Lever in the Department of Otolaryngology and Professor Michael Chapman, Chair of the Department of Biochemistry.

Through the UMKC and MU joint efforts on the NextGen Data Science and Analytics Innovation Center, the team will also work with Professor Russ Waitman on extending collaboration activities to other relevant NextGen stakeholders across the UM System. Waitman is associate dean for informatics and director of medical informatics for NextGen Precision Health.

Wan Investigates Influenza at New NextGen Center

As director of the NextGen Center for Influenza and Emerging Infectious Diseases, Henry Wan, a virologist with a joint appointment in electrical engineering and computer science, aims to customize the annual influenza vaccine into personalized medicine. The $6.5 million project includes space for replicating both extreme hot and cold climates, which is an important factor in the study of infectious disease transmission.

"We want to look at how we can improve our influenza vaccination by studying both the animal and the human sides of this disease," Wan said. "Both aspects are equally important in allowing us to execute the necessary research and vaccine improvements. Our work will help us better understand how the disease transmits between humans and animals, how these viruses mutate and affect hosts differently, and how we can make the influenza vaccine better and stronger."

Henry Wan

Wan holds joint appointments in the School of Medicine and College of Veterinary Medicine. He is also an investigator at the Christopher S. Bond Life Sciences Center.

BBCE

Biomedical, Biological & Chemical Engineering

Kevin Gillis
Chair

Biomedical, Biological and Chemical Engineering

"Since our founding a century ago, we have continued to provide a high-quality, interdisciplinary education with a focus on finding solutions to the challenges of today."

Thirty-two years after its incorporation, the College of Engineering at the University of Missouri established the chemical engineering program. Decades later, biological engineering was added, then we became the first public university in Missouri to offer a degree in biomedical engineering. Today, these programs provide the foundational understanding and technical know-how that graduates need in these ever-important fields.

At Mizzou, BBCE students and faculty work alongside our colleagues in the MU School of Medicine, the School of Health Professions, the College of Agriculture, Food & Natural Resources and more to conduct innovative research. We have several faculty members who have relocated to the Roy Blunt NextGen Precision Health building, where they collaborate closely with practitioners to develop life-saving treatments. We worked with peers from our civil engineering department and with the MU College of Agriculture, Food and Natural Resources to form a new Missouri Water Center. We received funding from the National Institutes of Health to investigate previously unknown disease. With support from the Missouri Department of Higher Education and Workforce Development, we partnered with Siemens Healthineers to implement an online certificate program in clinical engineering. And we continued to find new ways to use bioelectronics to help individuals monitor their health.

Since our founding a century ago, we have continued to provide a high-quality, interdisciplinary education with a focus on finding solutions to the challenges of today.

Discovering a New Disease

NIH Awards $2.3 Million Grant for Work

During his decade-long study of a metabolic enzyme, Professor Shinghua Ding might have identified a previously unknown disease. Now, Ding has received a five-year, $2.3 million grant from the National Institutes of Health (NIH) to work with collaborators on further mechanistic investigation.

Ding is Cramer W. LaPierre Professor and studies NAMPT, a critical metabolic enzyme involved in processes such as NAD+ synthesis, energy metabolism and cellular function.

In 2017, he published a ground-breaking study in Cell Reports that found NAD+ synthesis in neurons critically relies on NAMPT. In that study, Ding observed that deleting neuronal NAMPT in mouse models led to neuronal death, motor dysfunction, paralysis and ultimately proved fatal. NAMPT reduction was also related to ALS, a devastating motor neuron disease.

Following publication of the paper, Ding was contacted by a physician scientist in Europe who, after ruling out other possibilities, suspected something similar was happening in human patients.

"The physician saw two patients who reported similar symptoms and asked me if I thought it could be related, so we began collaborating," Ding said. "We think this is a neural disease that causes paralysis and muscle atrophy affecting the whole body."

The researchers will use the funding to create mouse models and human skin cells-derived stem cells to determine what causes the disease, the pathology of the disease and how it progresses.

"This is a disease that has not been identified yet," Ding said. "It's a new genetic disease for this molecule that has never been reported in any publication or clinical case before."

Missouri Water Center Centralizes Resources, Expertise

The University of Missouri this past spring opened the Missouri Water Center, a central hub for research on the state's water resources. The new academic center will combine existing resources and improve coordination across campus — tackling emerging water quality issues and factors that contributed to record flooding in 2019 and years of persistent drought — as well as facilitate new collaborations among faculty, government and industry partners.

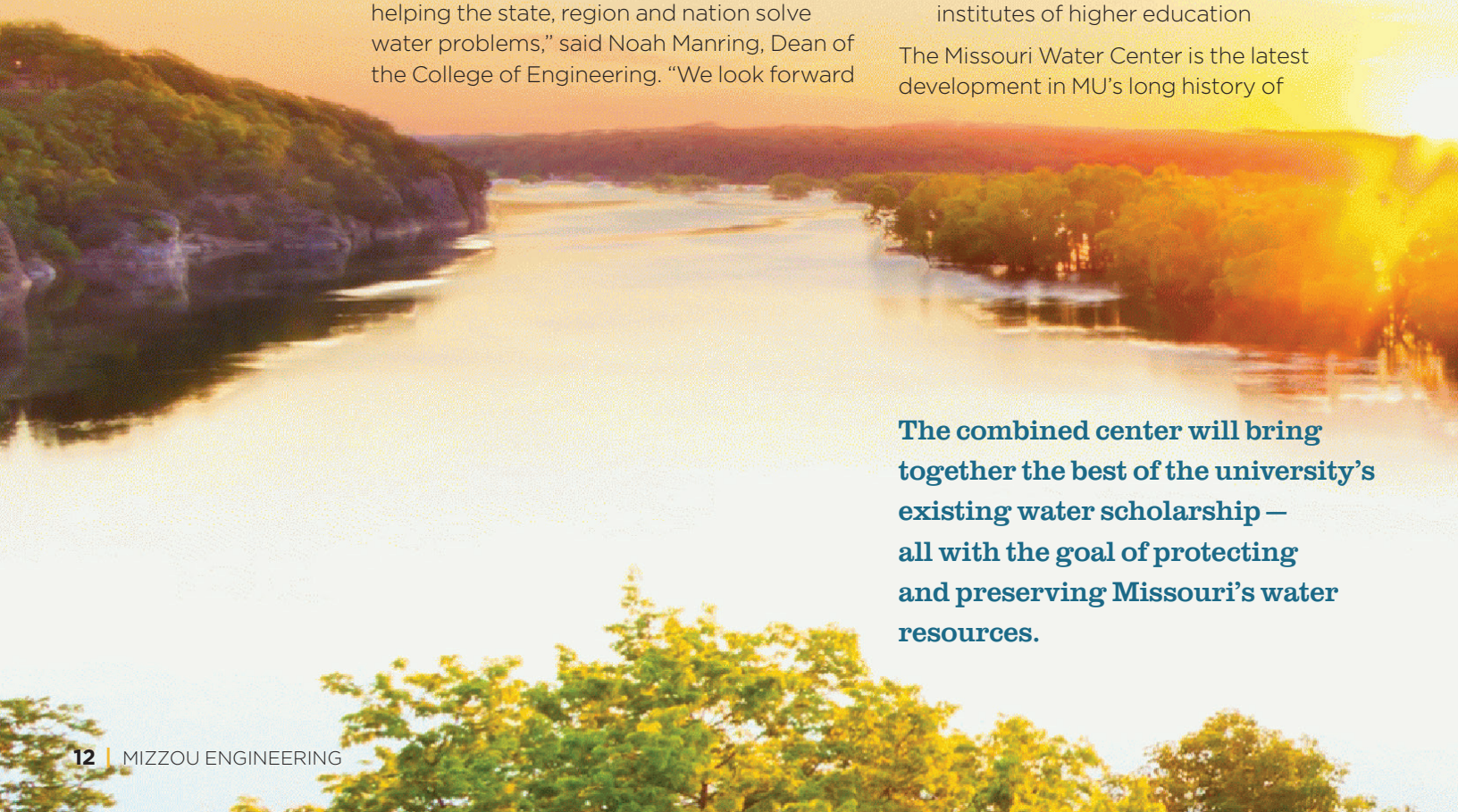
The Missouri Water Center was created by merging two existing centers at MU: The Missouri Water Resource Research Center in the College of Engineering and the Center for Watershed Management and Water Quality in the College of Agriculture, Food and Natural Resources (CAFNR). The combined center will bring together the best of the university's existing water scholarship — all with the goal of protecting and preserving Missouri's water resources.

"Mizzou Engineering has a proud tradition of helping the state, region and nation solve water problems," said Noah Manring, Dean of the College of Engineering. "We look forward to leveraging that expertise and working with cross-campus peers to further contribute to the health and usability of our water resources."

The center is guided by an external advisory committee made up of leaders in Missouri's water management communities. The center will have four core activities:

- Serving as the authority for Missouri's water research needs through coordination with partners such as the Missouri Departments of Natural Resources and Agriculture — developing new statewide networks that will enhance water quality and provide better protection from floods and droughts
- Coordinating large water-related grants across MU and UM System universities
- Sharing expertise with stakeholders, MU faculty, MU Extension specialists and public agency partners
- Developing new collaborations with other institutes of higher education

The Missouri Water Center is the latest development in MU's long history of



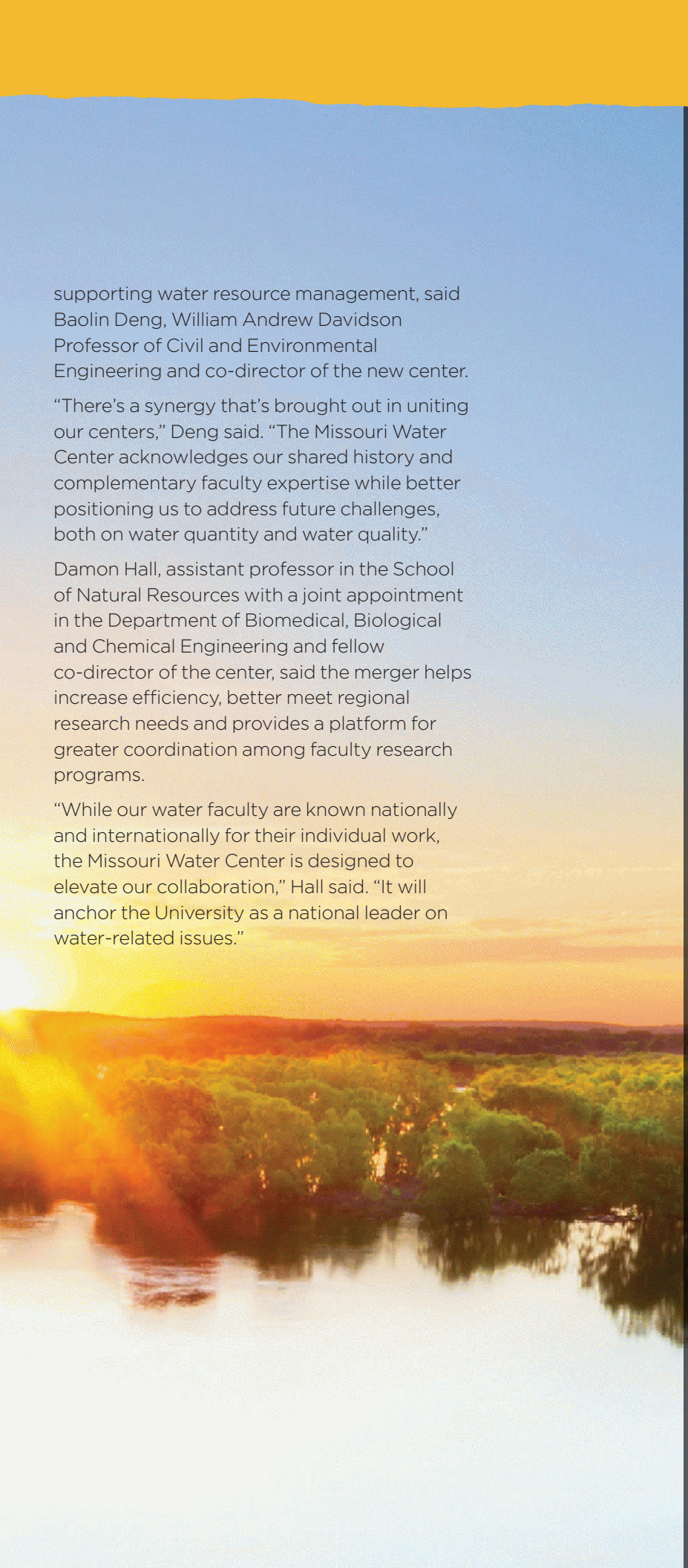
The combined center will bring together the best of the university's existing water scholarship — all with the goal of protecting and preserving Missouri's water resources.

supporting water resource management, said Baolin Deng, William Andrew Davidson Professor of Civil and Environmental Engineering and co-director of the new center.

"There's a synergy that's brought out in uniting our centers," Deng said. "The Missouri Water Center acknowledges our shared history and complementary faculty expertise while better positioning us to address future challenges, both on water quantity and water quality."

Damon Hall, assistant professor in the School of Natural Resources with a joint appointment in the Department of Biomedical, Biological and Chemical Engineering and fellow co-director of the center, said the merger helps increase efficiency, better meet regional research needs and provides a platform for greater coordination among faculty research programs.

"While our water faculty are known nationally and internationally for their individual work, the Missouri Water Center is designed to elevate our collaboration," Hall said. "It will anchor the University as a national leader on water-related issues."



Hall Pens Book on Sustainability

Assistant Professor Damon Hall this past year co-authored "Bringing Sustainability to the Ground Level: Competing Demands in the Yellowstone River," which provides a case study for how communities can protect their environments while still preserving their economies and ways of life.

Hall, who has a joint appointment in the School of Natural Resources, published the book with co-author Susan Gilbertz, a professor of geography at Montana State University in Billings. It's the culmination of 15 years of research Hall and Gilbertz have conducted along the nearly 700-mile Yellowstone River. While it's specific to that region, the concepts are universal and can be used to help readers think through the dynamics of pressing sustainability challenges.

Team Studying Missouri River

Assistant Professor Noel Aloysius is leading an interdisciplinary team tasked with creating innovative, practical and balanced ways to manage the Missouri River's water resources. The group will spend the next five years studying practices and policies, developing new techniques to use water resources more sustainably, developing adaptation plans for extreme weather and training students to continue that work.

"We've been managing the Missouri River for more than 100 years, and we want to make sure it stays healthy and accessible to people for the next 100 years," said Aloysius, who has a joint appointment in the School of Natural Resources and is the MU Principal Investigator on the project.

The project is part of a cooperative agreement with the U.S. Department of Agriculture-Agricultural Research Service (USDA-ARS).

Mizzou Introduces Online Certificate in Clinical Engineering

Researchers at the University of Missouri are partnering with Siemens Healthineers to address the shortage of qualified clinical engineers. With a $2.6 million grant from the Missouri Department of Higher Education and Workforce Development (MDHEWD), the two organizations developed and implemented one of the first online certificate programs in the U.S. for clinical engineering.

Clinical engineers provide the technical expertise needed to manage health care technology, such as X-rays, CT scans and MRIs.

Nanci Wozniak, vice president, education services at Siemens Healthineers, said the grant will help increase the number of trained and qualified clinical engineers in the workforce not only for the state of Missouri, but also beyond.

“Clinical engineering is a critical element of health care technology management and is responsible for the application, implementation and servicing of medical technology to optimize health care delivery,” Wozniak said.

Noah Manring, Dean of the College of Engineering, said this is an exciting opportunity to help both students and working professionals gain the skills they need to be competitive in the workplace.

“As engineers, we’re on the front lines of studying emerging technologies, so it’s important to provide students with an opportunity to work with complex systems such as leading-edge medical imaging,” Manring said. “We’re excited to be a part of this collaboration to equip students with these specialized clinical skills and meet them where they are.”

Yan Designs Wearable Bioelectronic Masks, Devices

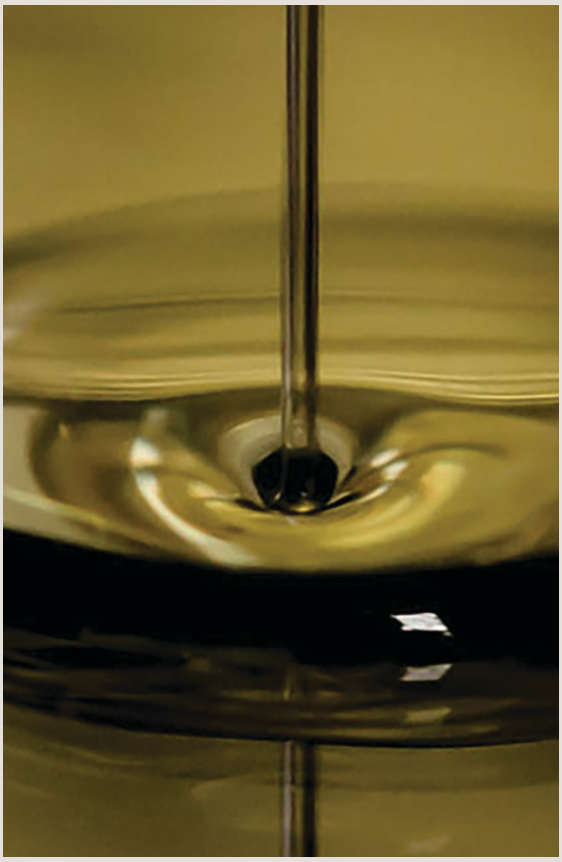
Assistant Professor Zheng Yan recently published two studies demonstrating different ways to improve wearable bioelectronic devices and materials to provide better real-time monitoring of a person's health, including vital signs.

Yan's lab develops breathable soft bioelectronics, which were incorporated into a breathable face mask that can monitor people's physiological status based on the nature of their cough. The findings were published in ACS Nano, a journal of the American Chemical Society.

"Different respiratory problems lead to different cough frequencies and degrees," Yan said. "Taking chronic obstructive pulmonary disease (COPD) as an example, the frequency of cough in the early morning is higher than that in the daytime and night. Our smart face mask can effectively monitor cough frequencies, which may assist physicians with knowing disease development and providing timely, customized interventions."

Wearable bioelectronics could also benefit from utilizing a laser-assisted fabrication approach, Yan said.

"Laser-assisted fabrication is simple, scalable, cost-effective and easily customizable," Yan said. "This can lower the cost of wearable electronics and benefit both their practical, one-time use and personalization by providing customized devices for health care applications."



Young Studies Ways to Prevent Gum Formation in Fuel

Over time, some components of unused fuel and crude oil can oxidize and form gum-like deposits through a process called autoxidation. Scientists understand the chemical steps for this process, but they aren't sure why it happens in some cases but not others. Assistant Professor Matthias Young has received funding from the American Chemical Society's Petroleum Research Fund to find out.

Specifically, Young will study how nitrogen-rich molecules in fuel interact with the vessel or container that the fuel is stored in to see if surface chemistry is the culprit behind differences in gum formation.

"Previous studies have found that different surfaces lead to different rates of gum formation in fuel," Young said. "When fuel is in contact with some materials, gums form rapidly, and for other materials, gums don't form at all, but we currently don't understand why. For this project, we aim to understand specifically what properties of the material surface impact pyrrolic gum formation."

Eventually, this knowledge could be used to develop container surfaces or fuel additives that block the autoxidation process and give fuel a longer shelf life.

CEE

Civil & Environmental Engineering

Praveen Edara
Chair

Civil and Environmental Engineering

"The first engineering graduates in 1856 were civil engineers, and since then, we have educated thousands of students who have gone on to build the roads, bridges, buildings and other basic civil infrastructure we all rely upon today."

While Mizzou Engineering celebrates its 150th anniversary of incorporation as a College, civil engineering dates back much further. In 1849, Mizzou introduced the first engineering course west of the Mississippi. The first engineering graduates in 1856 were civil engineers, and since then, we have educated thousands of students who have gone on to build the roads, bridges, buildings and other basic civil infrastructure we all rely upon today.

And we continue to grow and evolve to meet the needs of society. This past year, we formed a Construction Management Industry Consortium, allowing us to bring in leaders from top construction firms to provide industry insights as we expand program offerings in this area. This means our students will not only be prepared to be part of the unprecedented federal and state infrastructure initiatives, but they will also be equipped to lead and manage those projects.

As you'll read in this report, our faculty have had a busy year studying ways to make buildings more blast resistant, investigating driver behavior in work zones and using innovative ways to classify pavement distresses. On the environmental side, researchers are demonstrating ways to produce customized diatoms, investigating dynamics of underwater gas and testing hormone levels in water.

Congratulations to William Baker, BS CiE '75 for receiving a 2021 Faculty Alumni Award. As you'll read, Baker is a great example of how our graduates go on to build a better world.

Department Creates Construction Management Consortium

The Department of Civil and Environmental Engineering this past year created a new Construction Management Industry Consortium made up of top construction firms in the country. The goal is to expand and enhance program offerings for civil engineering students who want to pursue construction-related careers.

And the timing couldn't be better, said department Chair Praveen Edara. He pointed to the passage of a major federal infrastructure and jobs bill and an increase in Missouri gas taxes, both of which will provide significant funding revenues for roads, bridges and other infrastructure construction projects.

"Our state and the entire country are going to need a lot more trained civil engineers," he said. "The job opportunities are great."

The consortium will provide industry guidance to ensure that course offerings and student experiences align with workforce needs. Inaugural members are Kiewit, Burns & McDonnell, ARCO Construction, P&D Electric and Emery Sapp & Sons. Each has made a financial commitment to help fund new and revamped courses, as well as provide networking and career opportunities for students.

"We're trying to enhance the construction management experience in terms of course offerings, mentoring opportunities for students and career guidance," Edara said. "We just need more resources to launch these student-centered programs. We appreciate these industry partners for stepping up and making that investment into the future."

The consortium could also open career doors for students. Edara envisions industry partners providing information sessions and guest lectures, inviting students to visit their sites and mentoring students through hands-on capstone projects.

"We are creating opportunities for students to have real-world, meaningful interactions with industry leaders," Edara said. "I'm excited for our students as this will be something that sets civil engineering at Mizzou apart from other schools."

The consortium will also work with faculty to identify potential research opportunities, share best practices and partner to test equipment such as drones, radar, lidar and virtual reality.

"Faculty will be able to learn more about industry needs and key issues facing industry, and our corporate partners will hear about our expertise and areas where we can conduct research and help with new technologies," Edara said. "So, industry will also benefit from this consortium in multiple ways."

The consortium will provide industry guidance to ensure that course offerings and student experiences align with workforce needs.

Civil Engineering and industry representatives from left: Professor Carlos Sun; Deborah Thornburg (BS IE '06), President, P&D Electric; Jeff Cook (BS CE '83), Co-Founder and President, ARCO; Chip Jones (BS CE '88), Vice President/Branch Manager, Emery Sapp & Sons; Justin Bloss (BS ME '04), Project Manager, Burns & McDonnell; Jamie Miller, District Environmental Manager, District Quality Manager, Kiewit Infrastructure South Co.; and Professor Praveen Edara, Department Chair.

Blast-Resistant Innovations

Team Receives Grant to Improve Blast-Resistant Curtain Walls

Hani Salim

Professors Hani Salim and Zhen Chen, along with collaborators from Missouri S&T, have received a $3 million grant from the U.S. Army Engineer Research and Development Center (ERDC) to improve the blast resistance of curtain walls.

"Flying glass can injure people not only in the targeted building but also those who are in the vicinity of the blast," Salim said. "We are looking at novel ideas to improve the material and response. We will be developing innovative new laminated glass and will also look at the connections and frames around the glass — how the frame is anchored. Essentially, we want to improve existing designs so they withstand powerful blast loads."

This project will advance current state-of-the-art glass and curtain wall systems by developing laminated and insulated glass and improved anchorage designs for shock isolation and blast protection.

Researchers will investigate emerging interlayer polymers, explore innovative glass lamination designs, develop robust simulation models and develop an extensive experimental database of materials, components and system levels under static and blast loads.

Ultimately, the team will create an Engineering Analysis and Design Guide for Curtain Walls and Anchorage Systems under Blast Loading that will help inform construction standards for building protection and design.

"We're hopeful that our findings will ensure they have an added layer of protection for those inside and around them," Salim said.

Team Tests Blasting of Sandwich Walls

A team of Mizzou Engineers this past year wrapped up a series of test explosions to find out how well sandwich walls hold up in the event of a blast. In the first-of-its-kind study, Professor Hani Salim and his team worked with government and industry to conduct full-scale lab experiments to see how various types of sandwich walls withstand the pressure of an explosion.

While they have been shown to provide energy efficiency, there has been little study around how sandwich walls respond to potential explosions, Salim said.

"We can do a lot of modeling and computer simulations, but the government and blast community will not really trust it unless you demonstrate through full-scale experiments," he said. "It's expensive to do blast testing, so we worked with industry partners and the Air Force Research Lab to perform most of the testing in our labs and a few tests in the field using live explosives. It was good work that came together that could lead to new building standards and guidelines for government construction."

Right now, design guidelines are restrictive around construction of these walls to ensure both efficiency and blast resistance. But it's possible the guidelines don't have to be as restrictive in order to ensure blast resistance. The goal of the study was to see whether those guidelines can be relaxed based on how the concrete/foam walls responded during the static testing performed by the Mizzou team and explosion testing in the field.

Making Roadways Safer

Studying How Motorists Respond to Truck Platoons in Work Zones

Professor Carlos Sun recently led a study investigating how motorists behave in work zones when faced with truck platooning — which uses automated technologies to group trucks together. Using his simulation lab, ZouSim, Sun was able to capture human responses in a safe, virtual setting.

"Because we have a trucking simulator, we can actually get into more of the behavior of drivers and how they react," Sun said. "We're interested in how the rest of the world reacts to truck platooning so we can all co-exist safely around work zones."

Desirable motorist behavior depends on the situation. Ideally, Sun said, drivers would prioritize safety while allowing for the efficiency of platooning. Too many vehicles opting to follow the platoon, for instance, could cause bottlenecks.

The main finding of the report is that education is key. After learning about truck platoons, drivers were more likely to safely pass the platoon, properly treating the fleet as a single unit.

The report was sponsored by the Smart Work Zone Deployment Initiative under the Federal Highway Administration and financed in part by the Iowa Department of Transportation.

Reviewing Work Zone Markings

Mizzou Engineers this past year reviewed the materials states use to temporarily direct drivers through highway work zones and the various methods they rely on to remove those markings. Henry Brown, a research engineer, and department Chair Praveen Edara released their findings in a synthesis published by the National Academies of Sciences, Engineering, and Medicine. The work was under the umbrella of the National Cooperative Highway Research Program (NCHRP).

This first-of-its-kind research is critical to helping departments of transportation (DOTs) understand best practices as they make decisions around work zones, Edara said.

The 323-page book outlines what every state DOT in the country is doing around temporary pavement markings and removal practices in work zones, including both success stories and cases that weren't successful.

A Smarter Way to Identify Pavement Cracks

Traffic engineers could have a smarter way of identifying asphalt problems and prioritizing pavement projects, thanks to innovative research from Mizzou Engineering. The team is training a machine to automatically classify types of cracks and potholes on streets in Kansas City.

Historically, city employees have had to rely on expensive equipment or manually view and identify various types of pavement cracks.

"The goal is to use machine learning to do that," said Assistant Professor Yaw Adu-Gyamfi. "We're currently in the process of training students to know the types of distresses so they can teach the machine learning model how to do it."

The group is inputting data into the computer model based on images of surface distresses from the city, Google Street images and other sources.

While pavement can visibly exhibit dozens of types of deteriorations, some of those distresses can indicate underlying issues, said Bill Buttlar, the Glen Barton Chair in Flexible Pavement Technology in CEE.

"Sometimes we get clues that the problem is not with the new surfacing we just installed but a deeper foundational problem," Buttlar said.

Testing Hormone Levels in Water

Fidalgo

Associate Professor Maria Fidalgo is working on a way to produce sensors that could quickly detect hormone levels in ponds, lakes and rivers.

Specifically, Fidalgo is partnering with U.S. Geological Survey's Columbia Environmental Research Center to measure levels of testosterone, which can impact the growth and reproduction abilities of fish. Additionally, traces of testosterone in water can indicate larger contamination problems that harm humans and wildlife.

"USGS has advanced analytical capabilities, but it's difficult to bring samples back to the lab when you're working with small organisms," she said. "They also have to wait weeks for results. We want to know whether we can have a fast tool that lets us know in the field what we are finding in terms of hormone contamination in the environment."

With a field deployable sensor, USGS could focus resources on testing only areas where high levels of hormones are detected. The sensors include porous polymer films that reflect light at different wavelengths when certain molecules are detected. A spectrometer is then used to measure slight changes in those colors.

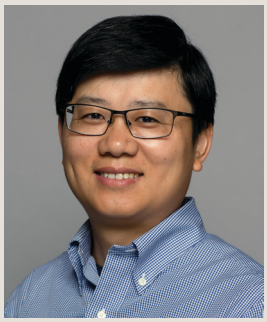
Customizing Diatoms

Hu

William Andrew Davidson Professor Zhiqiang Hu, an AAAS Fellow, and recent PhD graduate Yan Li demonstrated how to produce customized diatom microstructures by varying a bioreactor operating parameter known as solids retention time, or SRT.

By changing SRT, the team was able to alter characteristics of diatoms such as their shape and micro/nano pore size in order to optimize their properties, control their growth and mass produce them. They published their findings in the journal Water Research.

"Diatoms live naturally in the environment, but there's no systematic way from an engineering approach to harvest them for large-scale controlled cultivation," Hu said. "For the first time, we tried to show how using standard engineering operational practices — important parameters such as SRT — can make attainable structures that can be used for industrial and consumer products in the future."



Wang

Wang Selected for Research Fellowship

Assistant Professor Binbin Wang is one of six scientists from across the country selected for an Early-Career Research Fellowship (ECRF) from the Gulf Research Program of the National Academies of Sciences, Engineering and Medicine. Specifically, Wang will work with the Offshore Energy Safety track of the program, contributing to the advancement of safer, more reliable and more efficient offshore energy operations in the U.S. Gulf of Mexico.

As part of the Fellowship, Wang will investigate the dynamics of underwater gas blowout from its orifice to the surface using laboratory modeling and experiments.

Wang's research area became a hot topic among non-scientists when the ocean caught on fire in July 2021. The "eye of the fire" — the center of the underwater blaze in the Gulf captured in video and images that went viral — was caused when lightning struck flammable hydrocarbon gas. Predicting locations of future fire risks is just half of the story, though. Underwater gas also poses a hazard to offshore energy production because gas coming from oil spills or gas leaks is highly buoyant.

With the Fellowship, Wang plans to further his work for gas plumes, quantifying flow around gas bubbles using laser techniques and images of particles.

Edara and Team Study Evacuation Routes

Edara

While minor earthquakes along the New Madrid Fault occur regularly without incident, there's a small chance another large quake could rattle Missouri and surrounding states. That's why Mizzou Engineering has teamed up with the Missouri Department of Transportation (MoDOT) to begin to understand how residents in St. Louis could best evacuate the area.

Praveen Edara, professor and chair of civil and environmental engineering, received funding from MoDOT to see how roads, bridges and other infrastructure might be impacted by a major earthquake. The St. Louis region has two seismic zones, including the New Madrid Fault line, which last caused a series of major earthquakes in the early 1800s.

The project involves several steps over a two-year period. First, Edara's team will survey residents to see where they would go were they to be displaced by an earthquake and which routes they would plan to take. At the same time, researchers are accounting for incoming traffic that might be bringing first responders and supplies into the area.

Sarah Orton, associate professor of civil and environmental engineering, will assess bridge structures along those routes using National Bridge Inventory Data and data from the US Geological Survey (USGS). Edara and Orton are partnering with researchers from Missouri S&T and Wood on this project.

Improving Construction Practices in India

Gopalaratnam

Professor Vellore Gopalaratnam received a Fulbright-Nehru Academic and Professional Excellence Award to study ways to improve construction practices in India — work that could have sustainable impacts on the country's economy.

The research award has a "Flex" option that allowed him to travel to India to work with collaborators from the Indian Institute of Technology-Madras.

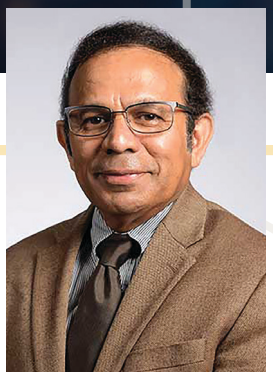
Gopalaratnam's studies are focused on facilitating the more widespread implementation of precast, prestressed concrete for transportation infrastructure and housing applications. Unlike the U.S., where this type of technology is common, India relies heavily on cast-in-place construction, which means concrete structures are constructed on site.

Cast-in-place is not only a more expensive option, but it also takes longer to finish projects, requiring roads to be closed for longer periods of time.

Gopalaratnam spent January reviewing India's current policies and practices, working with academic, government and industry officials. Then in 2023, he will spend three months sharing recommendations on ways to facilitate more widespread use of the precast, prestressed technology in infrastructure projects in India.

EECS

Electrical Engineering & Computer Science



Syed "Kamrul" Islam
Chair

Electrical Engineering and Computer Science

"As we have throughout our history, EECS is on the forefront of technological advancements that have the power to change the world."

The University of Missouri was one of the first to establish a department of electrical engineering in 1885, and we've been leading the way since. The Department of Electrical Engineering and Computer Science leads Mizzou Engineering in terms of research and expenditures, and our faculty continued that trend this past year.

Our researchers are leaders in the area of geospatial intelligence, with EECS being home to the Center for Geospatial Intelligence. This past year, faculty members devised a way to provide detailed health information that provides geospatial context around big data. Another team partnered with a non-profit to help locate rural populations in east Africa.

We made strides in artificial intelligence, machine learning and cybersecurity, as well. And, as in years past, our faculty collaborate with researchers across campus to understand protein behavior, decode DNA sequences and develop non-invasive treatments.

Several of our EECS faculty were honored this past year. Kannappan Palaniappan was named a Curators' Distinguished Professor, the highest honor bestowed by the University of Missouri System. Jianlin Cheng was elected to the American Institute for Medial and Biological Engineering and Chi-Ren Shyu was honored with a Faculty Alumni Award from the Mizzou Alumni Association. Congratulations, also, to Michael Melton, BS EE '81, JD '84, who received the 2022 Missouri Honor Award, and to Lorraine Stipek, BS EE '86, for receiving the College's 2022 Citation of Merit Award.

As we have throughout our history, EECS is on the forefront of technological advancements that have the power to change the world.

Making Geospatial Data Accessible

New Website Provides County-Specific Data

A Mizzou Engineering team has developed a web resource that allows users to sort and view health, socioeconomic, accessibility and population data by county. The Geospatial Analytical Research Knowledgebase (GeoARK) was supported by a RAPID grant from the National Science Foundation. Leading the effort is Chi-Ren Shyu, Paul K. and Dianne Shumaker Professor and director of the MU Institute for Data Science and Informatics.

While COVID-19 brought urgency for the implementation of this work, the project has wider applications and allowed researchers to demonstrate how they can turn massive amounts of geospatial data into accessible information within a single user-friendly interface. GeoARK provides context by showing both compiled and individual potential risk factors. Visitors to the site can select a county and find the population density per square mile, cancer rates, poverty rates, air quality and dozens of other parameters.

"For the first time, we can really address context, and by addressing context, I think we'll be better able to understand and position society, if you will, with regards to disparity, inequities and other big driving questions," said Tim Haithcoat, Deputy Director of the Center for Geospatial Intelligence at MU.

Shyu and Haithcoat have collected the same type of data from the U.S. Census, national databases and other public sources. The team outlined their work in JMIR Medical Informatics.

Team Uses AI to Identify Rural Bomas

There's a large swath of land in east Africa populated by homesteads known as bomas. While it's estimated that more than a million Maasai people occupy this area, these bomas are made up of between 10 and 200 occupants, many of whom lack access to health care, education and clean water. The non-profit organization Humanity for Children (HFC) has mobile health clinics and resources that could help, however some bomas are so remote, the group doesn't know where to find them.

Now, Assistant Professor Grant Scott and Keli Cheng, a PhD student in computer science, have devised a way to train artificial intelligence (AI) to identify bomas using Google Earth. To apply machine learning, researchers manually scanned Google Earth imagery of Tanzania and determined criteria for positively identifying bomas and the fences that surround them. Cheng trained machine learning algorithms and applied geospatial AI components to produce maps from the massive collection of imagery, pinpointing exact locations of bomas across thousands of square miles.

Collaborators from the Center for Applied Research and Engagement Systems (CARES) at MU Extension stood up a specialized web mapping interface to deliver the geospatial AI results to HFC.

"This is a great opportunity to show how geospatial AI systems can be developed and leveraged to benefit humanity, even half a world away," Scott said.

The research team published their process and results in IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing.

A New Era of Artificial Intelligence

Using AI to Develop New Materials Faster

Mizzou Engineers are using artificial intelligence to reduce the time it takes to develop new materials. Supported by a two-year, $4.875 million grant from the U.S. Army Engineer Research and Development Center (ERDC), Associate Professor Derek T. Anderson is developing a theoretical framework around "explainable AI" to describe how the next-generation of AI can be integrated into the innovation process for designing new and existing materials — while also securing the trust of humans along the way.

He's working with Matt Maschmann, an associate professor of mechanical and aerospace engineering. While Maschmann focuses on the integration of AI and machine learning into materials processing, Anderson is working to help make AI more intelligent by determining how to better integrate human knowledge into the artificial world. For instance, Anderson said while material scientists, chemists and physicists have vast knowledge about the physical world, most AI and machine learning do not yet share that same level of intelligence.

"Therefore, we're looking at how do we design the next-generation of AI and machine learning to take advantage of the existing knowledge that people have," Anderson said. "Then, we want to use that knowledge to intelligently grow AI to be able to design smarter materials. While our efforts are focused on the 'explainability' side and helping scientists and domain experts understand how these processes work, we hope to make AI smarter for everyone's benefit in the process."

Training AI with Simulated Data

Mizzou Engineers are hoping to lead artificial intelligence (AI) into a new era by foregoing real-world data in favor of simulated environments.

"State-of-the-art AI is based on a 70-year-old combo of neural networks and supervised learning. This approach is flatlining, in part, because it's not scalable," Associate Professor Derek T. Anderson said. "We are at a technological convergence point where simulation software, content and computing resources are available and can be used to make photorealistic computer-generated imagery that can fool a human and can be used to train AI."

The problem is that it's difficult to get large amounts of diverse, accurately labeled data to train general-purpose AI. First, getting AI to recognize an object currently requires someone to collect and label thousands of images to feed into a network.

The other problem with real-world imagery is that it doesn't provide "ground truth." Labels are spatially ambiguous, material properties are not always recorded, and shadows are not annotated. Without that ground truth, researchers do not know where AI works or breaks.

These are a few of the reasons why Anderson's team in the Mizzou Information and Data Fusion Laboratory (MINDFUL) have begun using gaming components, instead. In a simulated world, researchers can manipulate environments to train the computer to recognize an object or learn a behavior in any number of scenarios. And they've found that they can collect and label data in weeks as opposed to years.

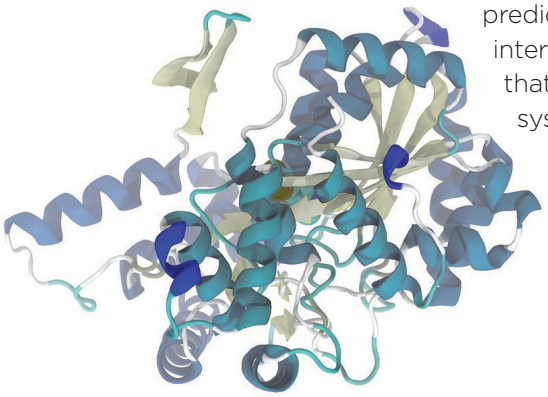
"It takes a lot of time and money to collect and label the data," said Brendan Alvey, a PhD candidate working in the MINDFUL lab. "Simulation makes it a lot easier."

Protein Prediction

System Would Speed Drug Development

Professor Jianlin "Jack" Cheng has proposed a new deep learning system that would speed up drug development by more accurately predicting how drugs and proteins interact.

Cheng, William and Nancy Thompson Distinguished Professor, outlined the system in a recent paper published by Oxford University Press' Briefings in Bioinformatics. In the paper, he and his team examined existing computational approaches to predicting protein-ligand interactions and concluded that a more comprehensive system is needed.



To understand how a protein will respond to a ligand, researchers must solve three problems. First, they must know how the molecule will bind to a target protein. For a drug to effectively block activity, it has to bind strongly to a specific protein such as the spike protein in the coronavirus. Secondly, they need to know where the ligand will bind within the protein. Finally, they need to know what 3D structure the protein and ligand will take once they become a complex, as that shape determines the cellular response.

"Current machine learning methods tend to treat the three problems as separate problems," Cheng said. "But we think these three things are correlated, and we are proposing that they should be studied as a whole."

The research team is now working on developing such system.

"This will be an end-to-end system with everything automatically done by deep learning from beginning to end," Cheng said.

Tool Predicts Protein Localization

Curators' Distinguished Professor Dong Xu is developing computational tools that can be used to predict where proteins will localize within a cell. Using highly advanced deep learning, the resource could help researchers better understand how proteins function or, if positioned incorrectly within a cell, misfire and cause problems.

Xu received nearly $650,000 from the National Science Foundation for the work. Ultimately, he hopes to create informatics infrastructure such as open source software and a web server that can be used for other protein localization studies.

Over the past couple of years, scientists have developed effective neural networks to predict what shapes proteins will fold into. However, it's also important to know where a protein will be located within a cell once it forms into the structure.

"Localization plays a key role in protein function," Xu said. "If a protein somehow localizes in a different position or incorrectly, it may cause diseases."

Current experimental methods used to determine subcellular location of proteins — such as tagging them with fluorescent biomarkers — are costly and time consuming.

Xu's system is the first to use graph-based neural network techniques to provide interpretable results for protein localization. Using leading-edge machine learning technology and protein sequence data, protein-protein interaction information and single-cell data, the system is expected to provide more accurate, higher resolution insights into the localization process.

Specifically, the framework will help predict localization at the single-cell resolution. That will allow researchers to quantitatively predict the impact of protein mutation and interaction alteration for different cell types.

Team Devices Non-Invasive Heart Assessment

A Mizzou Engineering research team has devised a way to non-invasively assess whether a person's heart is in balance with the circulatory system. This could allow people with heart problems to monitor their condition from home.

Professor Giovanna Guidoboni and EECS collaborators, including PhD student Mohamed Zaid and cross-campus partners, are studying ventricular-arterial coupling (VAC), the interaction between the heart and the system of blood vessels that carry blood from the heart to the body and back.

Essentially, the team demonstrated that it's possible to get interpretable, trustworthy data from non-invasive ballistocardiography (BCG). Last year, the team captured BCG data using non-invasive sensors on patients in the intensive care unit, proving that the data could be interpreted using a mathematical model.

"First, we showed that measurements are possible, even in extreme conditions," said Guidoboni, who is associate dean for research in engineering with a joint appointment in mathematics. "This work is saying, 'We saw that these measurements are possible, now we want to show you that we know what they mean and how to interpret them."

If the work is confirmed, the team would have the first way to non-invasively assess whether the VAC ratio is too high and determine whether the problem is with the peripheral circulation.

Decoding DNA Sequences

Associate Professor Praveen Rao is working on a way hospitals and clinics could better manage diseases by pinpointing how an individual's body will respond to treatment.

Rao has spent the past two years developing a software system for others to analyze and compare genomes more easily. This past year, he received a two-year grant from the National Science Foundation (NSF) to expand upon that work.

Because of their size, decoding human genomes requires massive amounts of computational power and storage and comes with a hefty price tag. But the information is vital to treating, curing and even preventing disease.

"This idea of precision health care revolves around taking into consideration not only factors such as demographics but also genetic makeup and lifestyle," Rao said. "The power of biology and genomics combined with the power of computer science can make a huge difference to human life and how we look at and prevent or treat diseases."

The current grant allows him to leverage NSF's new FABRIC infrastructure, which is an adaptive programmable research infrastructure. Within FABRIC, Rao will take advantage of graphic processing units and programmable hardware to accelerate analyzing mass amounts of genome data.

"Our eventual goal," he said, "is that MU researchers and a broader community will be able to use the software platform to do large-scale, whole-genome sequence analysis."

Detecting Shadows

A Mizzou Engineering team has designed a physics-based model to automatically detect shadows in large-scale aerial images — a development that could lead to improvements in self-driving cars, drones and autonomous robotics. The research team, led by Curators' Distinguished Professor Kannappan Palaniappan, published and presented their findings at the International Conference on Computer Vision (ICCV) Workshop on Analysis of Aerial Motion Imagery.

To train the neural network to recognize shadows, the group used aerial images of downtown Albuquerque, New Mexico, and Columbia, Missouri. The data set was unique in that it provided images at an altitude between low-flying drone images and high-resolution satellite images. But unlike satellite images that depict scenes looking straight down, the city-scaled images were collected from all angles, providing 360-degree representation of cities and more continuous temporal coverage. The team used those images to create accurate 3D point cloud reconstructions of the urban environment that can then be used in a game-engine or similar simulation environment to render shadows, generating accurate shadow masks to train the AI system.

Securing IoT Devices

Calyam

A Mizzou Engineering team is devising a way to provide additional security for Internet of Things devices such as virtual assistants and appliances. Prasad Calyam, Greg L. Gilliom Professor of Cyber Security, received a grant from the National Security Agency to develop a flexible, add-on security feature that allows different types of smart devices to intelligently learn from past cyberattacks while having a minimal need for direct human intervention. Their approach will also incorporate a collaborative network among the developers of these devices for sharing solutions to better respond against potential attacks in the future.

Calyam, who also directs the Center for Cyber Education, Research and Infrastructure at Mizzou, said commercial developers do not yet have the security techniques needed to keep up with the changing nature of cyberattacks, which furthers the need for this type of research and related technologies.

Mizzou Joins C2SHIP

Skubic

Mizzou has become the fifth university to join the Center to Stream Healthcare in Place (C2SHIP), a National Science Foundation (NSF) consortium focused on helping patients monitor and manage their health at home.

Marjorie Skubic, a Curators' Distinguished Professor in electrical engineering and computer science, along with co-principal investigators, were awarded NSF funding to lead the effort.

Skubic is the director of the Center for Eldercare Rehabilitation and Technology (CERT), which will now be under the C2SHIP umbrella.

CERT opened in 2006 with the goal of helping older individuals remain independent. Through CERT, researchers develop sensors that can detect fall risks, bed sensors that monitor vital signs and other devices that allow patients to track health issues while aging in place.

"From the beginning, one of the missions we had was to address the needs of older consumers through innovative technology, and to give them access to this new technology requires the research to be translated into the commercial marketplace," Skubic said. "This is exactly the framework NSF has set up."

C2SHIP is an NSF Industry-University Cooperative Research Center (I/UCRC), an initiative aimed to connect academic teams with industry innovators and government agencies.

Palaniappan Named Curators' Distinguished Professor

Palaniappan

Kannappan Palaniappan from the Department of Electrical Engineering and Computer Science has been named a Curators' Distinguished Professor, the highest honor bestowed by the University of Missouri System.

Palaniappan's groundbreaking work is in computational video analytics, including computer vision, deep learning, remote sensing, data visualization, high performance computing and biomedical imaging. He is director of the Computational Imaging and Visualization Analysis (CIVA) lab, which develops theory, algorithms, tools and software for visual scene perception and understanding across scale.

His work has been funded by the National Institutes of Health, the Air Force Research Laboratory, the Army Research Laboratory, the Naval Research Laboratory, NGA, NASA, NSF and others. Palaniappan has several U.S. patents jointly with colleagues and students, including a patent for moving object detection using the flux tensor split Gaussian model and another for fast bundle adjustment to accurately estimate the pose of airborne camera sensor systems.

Earlier this year, Palaniappan was the inaugural recipient of the James C. Owens Excellence for Research Collaboration Award.

Cheng Elected AIMBE Fellow

Cheng

Jianlin "Jack" Cheng — William and Nancy Thompson Distinguished Professor — has been elected to the American Institute for Medical and Biological Engineering (AIMBE) College of Fellows. Cheng is internationally known for his work around using machine learning and artifical intelligence methods in bioinformatics, specifically deep learning models to advance the field of protein structure prediction.

Shyu Receives Faculty Alumni Award

Shyu

Professor Chi-Ren Shyu was honored with a 2022 Faculty Alumni Award from the Mizzou Alumni Association. Shyu is internationally known for his work around geospatial data science and informatics. His research encompasses health care, explainable artificial intelligence, quantum computing and spatial big data analytics.

EIT

Engineering & Information Technology

Hani Salim

Interim Chair

Engineering and Information Technology

"Over the past four years, enrollment in the IT program has grown by nearly 40%, as we have expanded offerings both on campus and online."

Mizzou Engineering this year established a new Department of Engineering and Information Technology with plans to build on our legacy of success and innovation around emerging technologies. That includes photogrammetry and motion capture technologies to convert two-dimensional images into realistic 3D models, integrating virtual and augmented realities into educational settings and working with autonomous systems such as Spot, the robot from Boston Dynamics.

While the EIT department is new this year, we've been offering a bachelor's degree in information technology since 2005. And at Mizzou, IT goes well beyond the Help Desk. Here, students gain a foundational understanding alongside hands-on experiences applying technology to real-world problems. Students learn to design, develop and deploy mobile and web applications with an understanding of how users interact with graphics, animation and other digital components. They learn modeling and animation to help build the virtual, augmented and mixed-reality environments that are becoming more prevalent in our society.

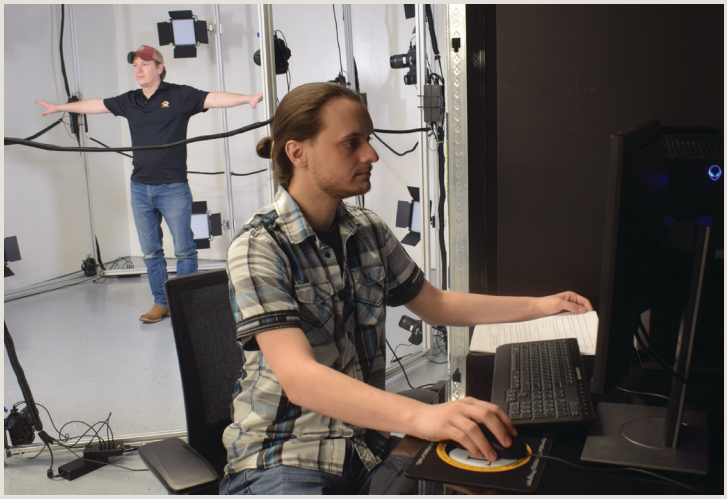
Students have taken note of the unique opportunities they have at Mizzou Engineering. Over the past four years, enrollment in the IT program has grown by nearly 40%, as we have expanded offerings both on campus and online. Currently, we offer undergraduate certificates in cybersecurity, mobile and web app development, media technology and design and information systems and technology. These certificates are designed for both traditional students and working adults.

I'm excited to be interim chair of the EIT department at Mizzou Engineering as we mark another significant milestone in our 150-year history.

Building the Metaverse

A new IT lab at Mizzou Engineering will give students access to the latest technology allowing them to turn images of large objects into 3D digital assets.

It's called the Collaborative Research Environment for Extended Reality, or CREXR Lab, and it gives students and faculty the ability to transform real-world objects, scenes and even individuals into components that can be integrated into virtual, augmented and mixed-reality settings.



The lab prepares students to work with photogrammetry and motion capture technologies. Photogrammetry equipment is used to turn two-dimensional images into realistic 3D models. A motion capture system uses multiple cameras to take images of people and objects from all different angles to provide lifelike assets.

"Virtual, augmented and other extended realities are rapidly being integrated in our society, not only in gaming and entertainment but also for applications in education and training, healthcare, transportation and more," said Fang Wang, director of the lab and an associate teaching professor in the EIT Program. "It's exciting to have these technologies to ensure our students have the tools they need to not only explore the metaverse, but also help build it."

The CREXR Lab opened this fall and will be more fully integrated into the curriculum over the coming semesters.

Hello, World.

Faculty and students in the IT Program at Mizzou Engineering are bringing Missouri to the world one VR headset at a time. A virtual, interactive art exhibit they created is now available in the Oculus Rift Store.

Associate Teaching Professor Fang Wang, with assistance from EIT faculty Chip Gubera and Scott Murrell, worked together to create the museum for a celebration of Missouri's 200th year of statehood in 2021.

The virtual gallery features 98 paintings from the MU Museum of Art and Archeology. The Scruggs-Vandervoort-Barney Collection, originally called Missouri: Heart of the Nation, was commissioned in 1946-47 to represent urban and rural landscapes across Missouri.

To create the virtual museum, students determined how best to display the works, then met with museum curators for feedback and adjustments. Some students created virtual frames around the pieces, while others "mounted" images of the works directly onto digital walls. They created lighting effects, determined wall colors to match themes of the artwork and assisted with the modeling of digital benches, ceilings and flooring. Students also created interactive labels, giving users the option of reading more details about each piece of art.

"This project allowed students to apply their skills in a real-world setting," Wang said. "We're thrilled that it's now available in the Oculus store where people around the world can download and consume the content they created."

In the Spotlight

It's been a busy year for Spot, the robotic dog from Boston Dynamics that's now embedded in the EIT program at Mizzou Engineering.

In October 2021, undergraduate programmers teamed up with Marching Mizzou and the Golden Girls to incorporate Spot into a first-of-its-kind halftime show. Engineering students were responsible for Spot's drill movements during the show and pre-programmed one choreographed dance. The performance became an instant sensation on social media, where outlets such as ESPN shared video clips of the dancing robot, attracting the attention of millions across the world.

Kristofferson Culmer, assistant teaching professor, was appointed director of the Autonomous Systems Lab in 2021. The lab houses Spot, as well as drones and other types of autonomous equipment.

When it's not dancing, Mizzou's Spot can be found solving real-world problems, automating inspections in industrial settings, performing data collection, keeping people out of harm's way in disaster recovery scenarios and much more.

"If you can imagine it, it can probably do it," said Trevontae' Haughton, a senior IT major. "You could mount a gas leak or carbon monoxide sensor and have it run through a facility autonomously, for example. With Spot having a dog-like structure, it can also go through all sorts of terrain — walk up stairs, crawl into places you wouldn't think it can go, and carry payloads of up to 30 pounds."

Mizzou Engineering students are making Spot a little smarter each day, programming the robot to navigate campus autonomously, customizing the robot's software development kit and learning to work with industry partners to deploy Spot on important missions.

During the 2021-22 academic year, Assistant Professional Practice Professor Kristofferson Culmer and his students partnered with Ameren to improve Spot's connectivity and networking capabilities. Over the coming year, the team will work to strengthen Spot's connectivity through a Wi-Fi booster or by configuring an external router to ensure the robot seamlessly transitions from one access point to the next.

While projects vary, the collective work around Spot is giving Mizzou students a competitive edge, Culmer said.

"We're one of the only colleges allowing undergraduate students to get their hands on a real-world autonomous system and explore all of its features," he said. "When students graduate, they will be ready to help industries start to integrate autonomous systems into their day-to-day operations. Students are excited to be part of implementing these emerging technologies."


BostonDynamics
UNIVERSITY OF MISSOURI
TIGERS

IMSE

Industrial & Manufacturing Systems Engineering

Jim Noble
Chair

Industrial and Manufacturing Systems Engineering

"One of the strengths of IMSE at Mizzou Engineering is the way we connect students and faculty to industry leaders."

The Department of Industrial Engineering at Mizzou was established in 1958, but our history dates back to 1924 when the College added courses such as factory organization and management, employing problems, labor supply and factory and shop production. Today, our program continues to prepare students for the workforce of today and tomorrow, as we equip graduates with the skills to lead projects, teams and organizations.

One of the strengths of IMSE at Mizzou Engineering is the way we connect students and faculty to industry leaders. The Center for Excellence in Logistics and Distribution (CELDi), a graduated National Science Foundation I/UCRC, allows researchers from six universities to collaborate with member organizations and provides opportunities for students to network with professionals. This past year, we also started a mentorship program that pairs graduating seniors with alumni who are leaders in industry.

Our research reflects the broad nature of industrial engineering. This past year, we studied supply chain logistics, explored the use of augmented reality for engineering education and worked with collaborators to study long-term effects of mental health.

Congratulations to Bob Thumser, BS IE '82, MS IE '90, for receiving the 2022 James E. "Bud" Moulder Award and to Doug DeMaire, BS IE '68, MS IE '69, for receiving a 2022 Missouri Honor Award. As you will read, these two leaders exemplify industrial engineering at Mizzou.

CELDi Brings Industry, Academic Partners to Mizzou

The IMSE department at Mizzou hosted the annual Center for Excellence in Logistics and Distribution (CELDi) Research Symposium this past spring. About 45 industry leaders, faculty from several universities and industrial engineering students participated in the event, which focused on research and collaboration around pressing issues such as supply chain problems.

CELDi is a graduated National Science Foundation I/UCRC comprised of six major research universities and a wide range of member organizations.

The conference gave companies the opportunity to learn more about faculty and student work, and how they might benefit from that research, department Chair Jim Noble said.

"They were excited to see the different areas we're working on and what our capabilities are," he said. "It was an opportunity to make connections, learn about resources and see the raw talent we have to address logistics and supply chain problems. That was the goal, and I felt we achieved that."

The event featured two keynote speakers and an industry panel that allowed attendees to delve deeper into specific issues both from a supplier and consumer perspective. Some of the most valuable exchanges, though, happened informally, Noble said. He observed several side conversations where company representatives explored ways in which they could work together.

PhD student Zeynab Oveysi took first place in the poster competition for her work around optimizing inventory for research and development operations. Mizzou's Erik Starrenburg won the CELDi Outstanding Undergraduate Student Achievement Award, and Garrett Robinson took honorable mention in the Outstanding Graduate Student Achievement category.

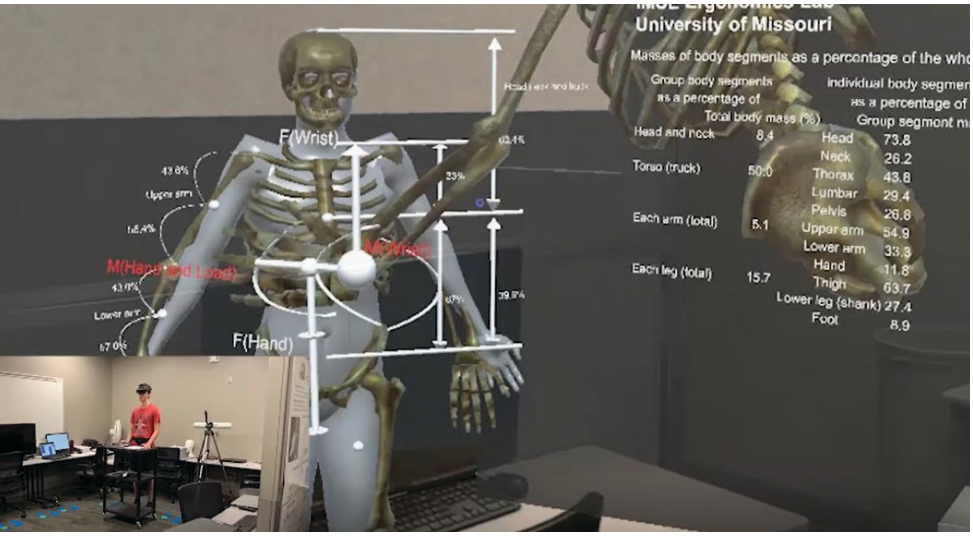
CELDi is a graduated National Science Foundation I/UCRC comprised of six major research universities and a wide range of member organizations.

Engineering a Better AR Experience

Kim

In theory, augmented reality (AR) has the potential to transform online learning, allowing students to interact with virtual components in their own physical settings. In reality, however, the technology falls short. Now, a Mizzou Engineering team has devised a way to improve AR so that it can be better used to enhance educational experiences.

Unlike virtual reality — which immerses a user entirely in a simulated environment — AR superimposes virtual objects over the user's real environment through goggles or a smartphone screen. So far, though, AR hasn't proven to be effective in engineering educational settings. Previous studies have shown that students lose attention or feel uncomfortable with complex augmented materials. That's because the virtual components don't always show up at the right place at the right time, said Jung Hyup Kim, an associate professor in the Department of Industrial and Manufacturing Systems Engineering.



"Everybody expects that if you wear AR glasses, the physical objects will be harmonized with the virtual objects perfectly without any flaws," he said. "But there are a lot of gaps between the computer-generated 3D images and the real objects. If you want to learn something through AR, you might be more confused because the 3D images appear in different positions."

To combat those issues, Kim developed a more advanced AR system that uses indoor GPS tracking to better position objects with the user's physical space. They tested the system using engineering materials, such as interactive modules and lectures notes. Instead of a student having to find or pull up individual augmented components, an entire lesson plan could be spread out within a user's view.

By tracking the person's location and movements, researchers were able to reduce the amount of time it took students to get from one educational component to another and improved the user's experience.

Kim and his team outlined their findings at the International Conference on Applied Human Factors and Ergonomics.

Mizzou Made Mentoring

The IMSE department this past spring implemented an innovative program designed to help seniors and new graduates transition from college to the workforce.

"We think this new mentoring program will greatly benefit current and future IMSE students," Professor and Chair Jim Noble said.

The program connects an industrial engineering senior with a member of the IMSE Hall of Fame, which honors distinguished alumni.

"We want both mentor and student to benefit from one another," said Karen Hamilton, BS IE '87. "For students, the benefit is to expand their personal and professional networks while getting professional insights from an IMSE graduate. For the mentor, they get to learn from someone with a different background who grew up in a different generation."

The mentor-mentee program lasts through a student's first six months in the workforce.

Noble Honored With Kemper Fellowship

Noble

IMSE Chair Jim Noble says he was "totally surprised" when he received a 2022 William T. Kemper Fellowship for Teaching Excellence, one of the highest awards bestowed at Mizzou.

Those who know him aren't surprised at all. Students routinely praise him for being enthusiastic, caring and knowledgeable; "one of the best professors on campus," as one student said. Colleagues say he exemplifies the best qualities of an instructor-researcher.

And those who nominated him for the honor gave example after example of ways in which he's gone the extra mile, be it hosting a listening session for Black students following the death of George Floyd or reaching out to a student who suffered a personal tragedy.

Over the course of his 30-year career at Mizzou Engineering, Noble has earned a reputation for being an inspiring educator passionate about preparing the next generation of industrial engineers. Outside of the classroom, he conducts research and works with industry, all with students in mind. He also founded the Mizzou site of the Center for Excellence in Logistics and Distribution (CELDi).

But it's his compassion that students notice.

"There is no question that Dr. Noble is an outstanding teacher," Sheila Connelly '20 wrote in a letter supporting his nomination. "What makes Dr. Noble even more impressive, though, is that his character outside the classroom walls is awe-inspiring."

Study Finds Adolescent Well-Being Connected to Adult Cardiovascular Problems

Srinivas

Assistant Professor Sharan Srinivas and a collaborator have demonstrated that a long-term association exists between an adolescent's psychological well-being and their risk of cardiovascular disease as an adult.

Srinivas and Anand Chockalingam, a professor in clinical medicine, analyzed data from study participants involved with the National Longitudinal Study of Adolescent to Adult Health.

Srinivas believes this study could help clinicians develop a personalized approach to lower someone's cardiovascular risk by integrating problem-solving techniques currently used by industrial engineers that place an emphasis on prevention and early detection.

"There are several step-by-step techniques established by industrial engineers that help with early detection of problems in the manufacturing and service industries," said Srinivas, who has a joint appointment in marketing. "This is an opportunity to adapt some of these techniques to enable health care practitioners to monitor the well-being of an adolescent over time, because that's the formative stage where your outlook on life is established, and it doesn't change much after that."

The study was published in Benchmarking: An International Journal.

MAE

Mechanical & Aerospace Engineering

Hongbin "Bill" Ma
Chair

Mechanical and Aerospace Engineering

"And in everything we do, we work hard to ensure students are equipped with skills they need to become leaders in the field."

Mechanical engineering was one of the earliest engineering departments at Mizzou, having been established in 1891. Today, we have 27 MAE faculty members and more than 700 undergraduate students. This past year, we added another milestone with the opening of the MU Materials Science & Engineering Institute (MUMSEI).

MAE researchers at Mizzou have developed an artificial material that can respond to its environment, developed a machine learning model to predict vital signs and designed an automated system to get oxygen to premature babies. On the aerospace side, faculty continue to investigate condensation in zero-gravity environments and the best strategies to land on Mars.

We also continue to build upon the undergraduate curriculum, adding an Introduction to Manufacturing Processes course to give students hands-on experiences with lathe and milling machines. Over the past several years, we have added four labs around manufacturing processes, instruments, material and manufacturing and thermal/fluid dynamics. And in everything we do, we work hard to ensure students are equipped with skills they need to become leaders in the field.

The department celebrated several achievements this past year. John Clark, BS ME '75, was honored with a Faculty Alumni Award from the Mizzou Alumni Association. Several students received national and local awards. And, personally, I was honored to be named a Curators' Distinguished Professor.

These successes build on a 100-plus-year legacy of excellence around mechanical engineering at Mizzou. We look forward to continuing that momentum into the future.

Studies in Space

Comparing Landing Strategies

There's no single perfect method to landing a space craft on Mars. One strategy might get a rover there faster but demand a lot of computational power on board. Another might land with more precision but take longer to reach its destination, requiring more fuel. Complicating the issue is that technology is advancing rapidly, meaning scientists and engineers have to keep up if they want to optimize planetary landings.

"We still need to develop more advanced guidance strategies for future planetary exploration missions," Professor Ming Xin said. "We need to take advantage of these technological advancements and design new strategies to achieve better performance to make future exploration safer, more accurate and more efficient."

To help guide that process, Xin and his collaborators conducted a comprehensive study of five popular guidance laws and strategies for power descent planetary landings. They published their findings in Acta Astronautica, a journal sponsored by the International Academy of Astronautics.

To compare the guidance strategies and various considerations, Xin's team developed simulated models using data from the Mars Science Laboratory, a robotic space probe mission NASA launched in 2011.

"In the past, these guidance strategies have been intensively researched, but nobody has done a very comprehensive comparison among the guidance strategies," Xin said. "In this paper, we found some strategies are better in one aspect but not other aspects. Every guidance strategy has its own pros and cons."

Chen Team Returns to Zero-Gravity Facility

Professor Chung-Lung "C.L." Chen received a continuation of grant funding from NASA to send his research team to G-FORCE ONE, a zero-gravity facility in Florida to continue research around water in space.

During previous trips, students conducted experiments around electrowetting, a technique that uses electric fields to improve condensation on surface areas. With a device developed in Chen's lab, the team was able to significantly enhance condensation, which could lead to effective ways to harvest water on spacecraft such as the International Space Station.

The electrowetting technology also allows better control of water droplet dynamics. Rather than falling downward as they do on earth, water droplets move in different directions via electrowetting without gravity.

"When we use electrowetting to make a specific spot of surface wet, we can become more strategic in time and space with patterned hybrid surface.," Chen said. "If we know more about fundamental mechanism of condensation dynamics, we can control it and change surface wettability adaptively."

On board a space station, this would give astronauts control over limited moisture. For instance, they may want droplets close to computational devices or instrumentation to absorb the heat from those electronics.

With a device developed in Chen's lab, the team was able to significantly enhance condensation, which could lead to effective ways to harvest water on spacecraft such as the International Space Station.

Special Delivery: Device Automates Neonatal Care

Associate Professor Roger Fales helped design a device that can deliver oxygen automatically to premature babies in neonatal intensive care units. Fales, along with co-inventor, Dr. Ramak Amjad, a neonatologist at Studer Family Children's Hospital in Pensacola, Florida, developed the device, which is now in clinical trials in research with collaborator Dr. John Pardalos, a neonatologist at MU's Women's and Children's Hospital. The research has been funded by the MU Coulter Partnership and the National Institutes of Health (NIH).

Currently, nurses must manually turn a knob to raise or lower the level of oxygen as needed. This device would automate that process by using a small computer that can receive an alert signal coming from a vital signs monitor and then adjust the amount of oxygen to the changing needs of the child. The goal is to improve health outcomes for premature babies by stabilizing their blood oxygen levels.

"We're automating the process of adjusting the amount of oxygen that the baby receives to keep their blood oxygen saturation constant," said Fales, who is also associate dean of student services. "The more consistently we can control the oxygen, the better the baby is, and the faster the baby is going to be able to develop. Plus, there will be fewer events that are detrimental to the baby's health."

Tracking Vital Signs

Associate Professor Jian Lin and his team are developing a system that will monitor vital signs and may someday be able to alert people when they need to seek medical care. The system includes a finger clip with two sensors that use optical light to penetrate blood vessels, said Lin, who is also William R. Kimel Faculty Fellow. It then measures how fast blood flows from one sensor to the other, providing information that can then be used to calculate blood pressure, heart rate, blood oxygen saturation, respiratory rate and temperature.

Lin and Richard Byfield, a PhD student, demonstrated its ability to predict blood pressure on 26 student participants. The system predicted systolic, or maximum, blood pressure with 88% accuracy. They outlined their results in IEEE Sensors Journal, under the umbrella of the Institute of Electrical and Electronics Engineers.

2022 Center of the Year

The Midwest Industrial Assessment Center (IAC) at Mizzou Engineering was honored with the 2022 Center of the Year Award by the U.S. Department of Energy (DOE). Professor and Midwest IAC Director Sanjeev Khanna accepted the award at the DOE Directors' annual meeting in Denver this summer. The Midwest IAC provides manufacturers with free energy assessments.

Ma Named Curators' Distinguished Professor

Ma

Hongbin "Bill" Ma, Chair of the Department of Mechanical and Aerospace Engineering, has been named a Curators' Distinguished Professor, the highest honor bestowed by the University of Missouri System.

Ma is president and founder of ThermAvant Technologies, which provides the OHP thermal control technology to the top defense companies in the U. S. More recently, his innovations include heat transfer products, such as drink-now coffee mugs and thermoelectric heat pipe dehumidifiers.

Ma's research has provided the foundation in ground-breaking applications of OHPs in aerospace engineering and helped to make the OHP become the fourth Generation of Spacecraft Thermal Control Technology in the U.S.

Ma was founding director of the ISoTherM (Innovative Solution of Thermal Management) consortium, which was supported by Intel to develop innovative cooling technologies for laptop and desktop computers.

Many of his fundamental findings, which are summarized in his book, "Oscillating Heat Pipes," have resulted in numerous breakthroughs and demonstrate his leadership in the field of thermal science.

Designing Next-Generation Materials

In a study published in Nature Communications, a journal of Nature, Professor Guoliang Huang and collaborators developed an artificial material that can respond to its environment, independently make a decision and perform an action not directed by a human being.

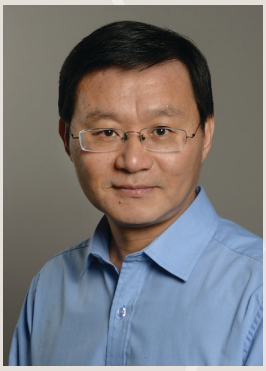
Huang, Huber and Helen Croft Chair in Engineering, said the mechanical design of their new artificial material incorporates three main functions also displayed by materials found in nature — sensing; information processing; and actuation or movement.

"Basically, we are controlling how this material responds to changes in external stimuli found in its surroundings," Huang said. "For example, we can apply this material to stealth technology in the aerospace industry by attaching the material to aerospace structures. It can help control and decrease noises coming from the aircraft, such as engine vibrations, which can increase its multifunctional capabilities."

The material uses a computer chip to control or manipulate the processing of information that's needed to perform the requested actions, then uses the electrical power to convert that energy into mechanical energy. The researchers' next step is to implement their idea in a real-world environment.

In a separate study, Huang discovered a way to control sound waves in the quantum realm, publishing those findings in Nature Communications, as well. Huang and Hui Chen, a post-doctoral fellow, built a simulated environment using a type of material that conducts electricity on the edges while insulating the inside. There, they observed the acoustic waves in four-dimensional space.

The work builds on research around topological insulators, an exciting field with fundamental interest as well as practical applications in optics, light, acoustics and quantum computing.



Huang

Mizzou Engineering Welcomes 14 New Faculty

Mizzou Engineering welcomed 14 new faculty members, including 11 tenure-track faculty who bring expertise in areas such as pollution remediation, manufacturing and computational material science.

"We're excited to bring in this group of educators and researchers who will make tremendous contributions to the College," Dean Noah Manring said. "Students will, no doubt, benefit greatly from their teaching and research expertise."

Joining Mizzou Engineering are:

Melissa Collins will serve as First Year Engineering coordinator and an assistant teaching professor in biomedical, biological and chemical engineering. Collins has a PhD from Texas A&M University and a bachelor's from the University of Nebraska. She has a background in vascular biomechanics and spent several years working in the medical device field supporting surgical navigation devices within the neurosurgery field. As First Year Engineering coordinator, Collins will coordinate Engineering 1000 and 1050 courses and associated peer mentoring.

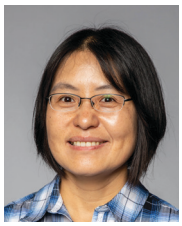
Maryam Salehi is an assistant professor of civil and environmental engineering. An NSF Early CAREER awardee, Salehi's technical focus is in contaminant fate and transport, drinking water quality and plastic pollution, and she applies her expertise to investigate pollutants' fate within the environment. She previously served as an assistant professor of civil engineering at the University of Memphis. Salehi has PhDs from Purdue, where she completed her postdoctoral studies, and from Amirkabir University of Technology in Iran, where she also earned a master's degree. She also holds a master's from the University of South Alabama and a bachelor's from Yazd University in Iran.

Filiz Bunyak Ersoy was promoted to assistant professor of electrical engineering and computer science. Her research interests include image processing, computer vision, artificial intelligence and machine learning for biomedical image analysis and visual surveillance with special emphasis on motion analysis, level set and deep learning methods. She has more than 100 publications in high-impact conferences, journals, and books and has been granted two U.S. patents. Ersoy has a PhD from Missouri S&T and a master's and bachelor's from Istanbul Technical University in Turkey.

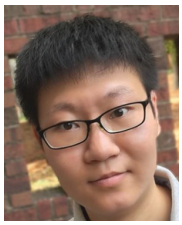
Qingyun Huang is an assistant professor of electrical engineering and computer science and is the PayneCrest Faculty Scholar in Power Engineering. Huang, whose research focus is power electronics, has a PhD from the University of Texas at Austin, where he was part of the Semiconductor Power Electronics Center. Huang's research will be applied to electric vehicles, renewable energy, power generation, solid-state-transformers and computing power conversions.

Mert Korkali is an assistant professor of electrical engineering and computer science. Before joining MU, he worked as a Research Staff Member at Lawrence Livermore National Laboratory (LLNL), where he served as a principal investigator (PI) and co-PI on several projects on power grid operations and planning, solar-grid integration and extreme event modeling. Korkali's research focus is in power systems. He has a PhD from Northeastern University, a master's from Northeastern University and a bachelor's from Bahçeşehir University.

Ali Shiri Sichani is an assistant teaching professor in electrical engineering and computer science. Shiri Sichani has PhDs from the University of South Florida and Purdue University, a master's from the University of South Alabama and a master's and bachelor's degree from Islamic Azad University, Najafabad Branch.



Peifen Zhu is an assistant professor of electrical engineering and computer science. Previously, she was an assistant professor in the Department of Physics and Engineering Physics at the University of Tulsa. She received a PhD from Lehigh University. An NSF CAREER Award recipient, her research work covers the theoretical and experimental aspects of photonics, optoelectronic devices, optical physics and electronic/photonic materials for energy efficiency and renewable energy.

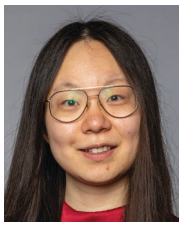


Yi Wang is an assistant professor of industrial and manufacturing systems engineering. His primary research interests include advanced micro/nano manufacturing technology, brain-machine interface development, biomedical sensors and devices development, ultrasonic-assisted machining, and computer-aided design and manufacturing. Wang has a PhD from North Carolina State University and a master's and bachelor's from Tianjin University in China.

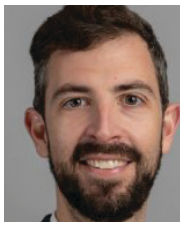
Jiaming Jiang is an assistant teaching professor in engineering and information technology. Before that, she was a lecturer at UC Davis. She has taught a variety of courses, including Python, C, Haskell, Prolog, data structures, and semantics of programming languages. Her research focus during her PhD was on formal methods. She has developed a model of a security access control systems using mathematical logics. Her technical focus areas include formal methods and various programming languages, including Python, C++, C, Rust, Haskell and Prolo.

Scottie Murrell is an assistant professional practice professor in the engineering and information technology. Murrell's focus is on computer programming and computer systems design. His research is in the field of Extended Reality and how it applies to the field of education. His previous work as a adjunct instructor for virtual reality and networking was also at the Mizzou, where he obtained his master's and bachelor's degrees.

Yue Jin is an assistant professor in mechanical and aerospace engineering. Before joining Mizzou, he worked as a postdoctoral research associate at MIT. His research interests span multiple areas of thermal-fluid sciences and nuclear engineering, including fluid flow mass and heat transfer, reactor thermal hydraulics, design, modeling and optimization of complex energy systems. He received his PhD from the Pennsylvania State University.



Mushuang Liu is an assistant professor from the Department of Mechanical and Aerospace Engineering. Before joining Missouri, she worked as a postdoc at the University of Michigan, Ann Arbor. She received her PhD from University of Texas at Arlington and a bachelor's from University of Electronic Science and Technology of China. Her research interest lies in control and optimization for multi-agent systems using techniques from control theory, game theory and machine learning.

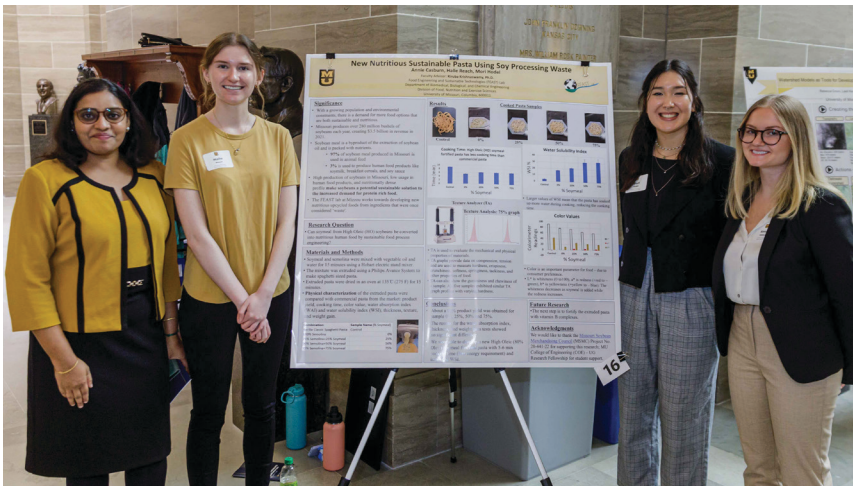


Christopher O'Bryan is an assistant professor of mechanical and aerospace engineering. He received his PhD, master's and bachelor's from the University of Florida. His research focuses on exploring the instabilities that arise at the interface between soft materials, leveraging these instabilities to design new biomaterials and developing new design principles for soft matter manufacturing.

Yao Zhai is an assistant professor with the Department of Mechanical and Aerospace Engineering. His research interest is in design, fabrication and characterization of optical materials and opto-electronic devices for energy, infrared imaging and biomedical engineering. He has a PhD from the University of Colorado-Boulder, a master's from University of Massachusetts-Lowell and from Chinese Academy of Science and a bachelor's from Tianjin University.

UNDERGRADUATE RESEARCH

Students Present at Undergraduate Research Day



Several engineering students presented their work at the University of Missouri System's Undergraduate Research Day at the Capitol, an annual event that illustrates student accomplishments and allows elected officials to hear more about exciting innovations happening on campus.

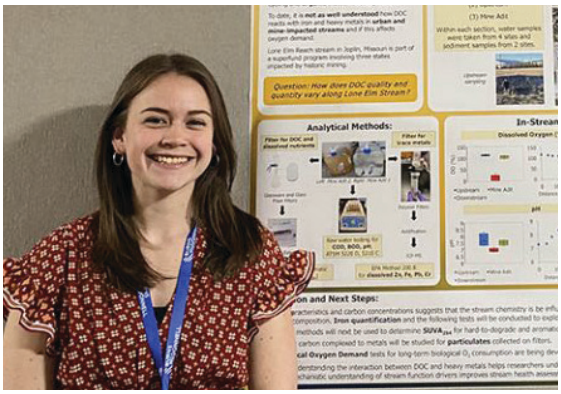
Biological engineering students Annie Casburn, Mori Hodel and Halle Reach presented their work using soymeal to make a new type of fortified pasta with high Oleic content. Rebecca Croon, a biological engineering major, presented work around water quality impairment in several Missouri watershed in hopes of developing land management plans to reduce pollution.

Calvin Davis, an architectural studies student working on a computer science team, presented 3D modeling and simulation using synthetic environments for smart city applications.

Senior Uses Engineering to Create Award-Winning Art

Emily Werner, from mechanical engineering, won an Award of Merit in Applied Design at MU's Visual Art and Design Showcase in April. Her pieces, which used engineering techniques to transform two-dimensional materials into 3D objects, were displayed at the Columbia Art League.

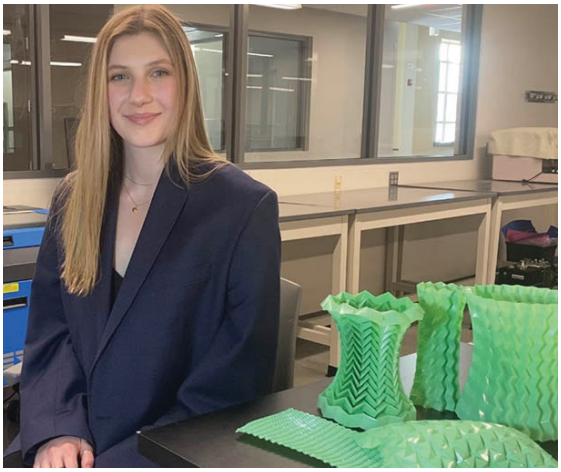
The Visual Art and Design Showcase is a venue for undergraduate students to display and discuss scholarly work in an exhibition setting. For the event, Werner created a pair of origami sculptures defined by mathematics and inspired by hyperbolic surfaces. In both, the geometry and curvature of the sculptures are dependent on the two-dimensional folding pattern, creating features the material otherwise could not exhibit.



Civil Engineer Studies Complex Contamination

Elli Castonguay, a senior in civil engineering, was part of an interdisciplinary team studying water quality in southern Missouri, where historic pit mining for lead, zinc and barium has resulted in water pollution and decades of unsuccessful cleanup attempts. Specifically, they are trying to unravel the complex interactions of heavy metal contamination, iron and dissolved carbon reactivity and natural microbial respiration to better manage pollution's impact on an otherwise healthy system.

Castonguay presented early findings from that work at a Joint Annual Meeting between the Missouri Section American Water Works Association (AWWA) and Missouri Water Environment Association in March.



Bond Awarded DoD Scholarship

Graham Bond was awarded a full-tuition scholarship that guarantees him two years of civilian employment with the Department of Defense immediately after he graduates. Bond learned of the scholarship as a sophomore last spring just days before giving a student piano recital at Sheryl Crow Hall on campus.

When he's not working in Associate Professor Jian Lin's advanced manufacturing lab, Bond is minoring in music, taking piano lessons from award-winning pianist Peter Miyamoto and oboe lessons from composer, arranger and performer Dan Willett, both of whom are professors in the School of Music.

"One of the reasons I chose Mizzou is because I can be a mechanical engineering major and do all of this undergraduate research while simultaneously taking music lessons from world-class faculty. You can't do that at many universities," he said. "And through the Honors College Discovery Fellows Program, I was able to start in the lab right when I got to campus. You can't do that at a lot of universities, either."

Bond is one of just three Mizzou students in the University's history to receive the Department of Defense Science, Mathematics and Research for Transformation Scholarship. The award provides students with full tuition for up to five years, guaranteed summer internships, a stipend and full-time employment with the Department of Defense after graduation.

Study on Nurses' Pandemic Travel Earns First-Place Award

Industrial and manufacturing systems engineering students Maggie Dimler and Reegan Spicer won the department's inaugural IMSE Undergraduate Research Competition with research focused on the travel distance of intensive care unit (ICU) nurses at University Hospital.

Dimler and Spicer hypothesized that nurses would travel more overall during COVID than before. However, their research found nurses traveled nearly the same total amount, but travel distance shifts had occurred in some locations. Dimler and Spicer concluded that nurses put on personal protective gear to go into rooms and thoroughly clean, increasing their travel distance in rooms, while decreasing it in other areas of the ICU.

Meet Three Engineering Graduates

Jackson
Apple

Riley Jackson, who earned a degree in electrical engineering in May, went to work for Apple, where she leads a team of engineers as a project manager in new product introduction. It's a similar role she had as an intern the year prior.

"Being a project manager sounds intimidating, especially when you're an undergraduate leading a team of professional engineers," she said. "But I had gained leadership experience by serving as president for different organizations. Research was extremely beneficial, too, and helped me develop problem solving and critical thinking skills."

At Mizzou, Jackson gained hands-on experience working in the Analog/Mixed-Signal VLSI and Devices Laboratory. She served as an Ambassador for the Honors College and president of Eta Kappa Nu, the electrical engineering honor society. And she served in various chair positions for the Mortar Board Society, Alpha Omega Epsilon and Society of Women Engineers.

Lee
Max Planck Institute for Plasma Physics

Brandon Lee received a prestigious Fulbright Scholarship to work at the Max Planck Institute for Plasma Physics (IPP), one of Europe's leading fusion research centers.

Lee earned bachelor's degrees in chemical engineering and physics. At the IPP, he will study ways that stellarators can expel impurities under experimental conditions in hopes of improving current technologies and making nuclear fusion a viable, clean and safe energy source.

His Fulbright will end in July 2023, after which time, he plans to return to the U.S. to pursue a PhD in plasma physics. Ultimately, Lee wants to work for a national lab.

In addition to the Fulbright Scholarship, Lee was also recently named a Tau Beta Pi Fellow.

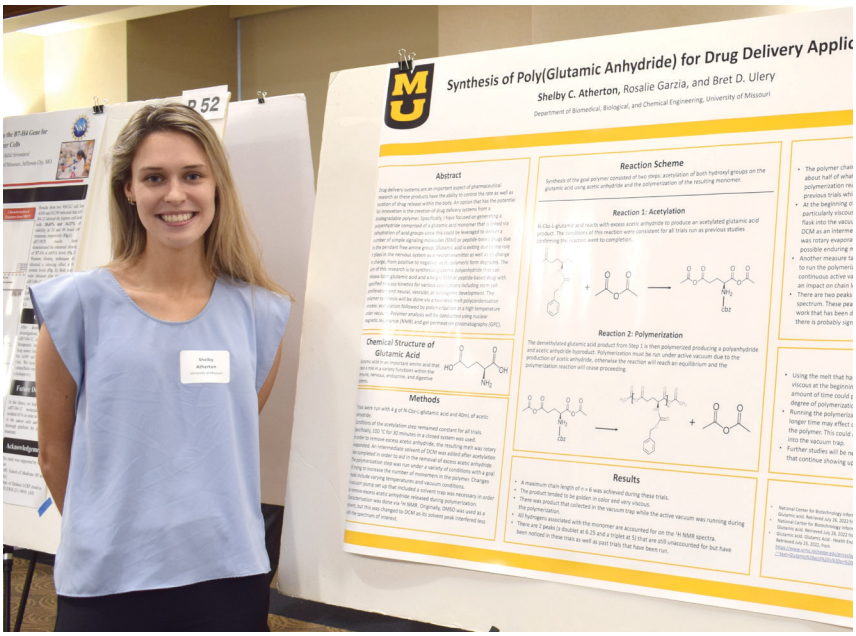
After graduating in May with a degree in mechanical engineering, Anna Merkel landed a job at SpaceX where she hopes to help further space exploration. Merkel has always had her head in the clouds with a natural interest in stargazing and rockets. At Mizzou, numerous opportunities to pair a mechanical engineering education with hands-on experiences propelled her skills and abilities. During her freshman year, Merkel conducted undergraduate research around drones, helped start the MU Student Astronomical Society and was a Stamps Scholar in the Honors College. She also got involved in the Society of Women Engineers, Mizzou Space Program and Alpha Omega Epsilon, the engineering sorority. Among her most impactful experiences were an internship at NASA's Jet Propulsion Lab and an eight-month co-op at Sierra Nevada Corporation.

"There are so many great opportunities at Mizzou to do basically whatever you want to do, whether you want to explore different subjects or join a bunch of clubs," Merkel said. "There's no end to the stuff you can do on this campus."

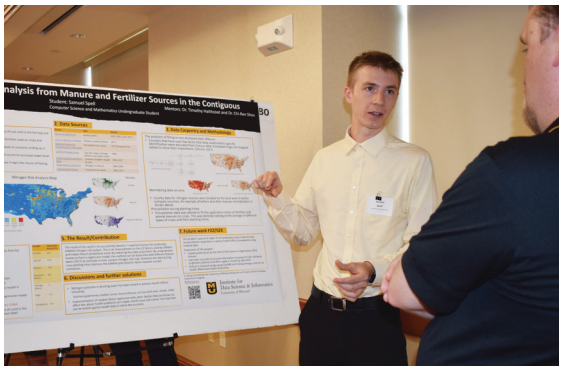
Merkel
SpaceX

Summer Undergraduate Research Forum

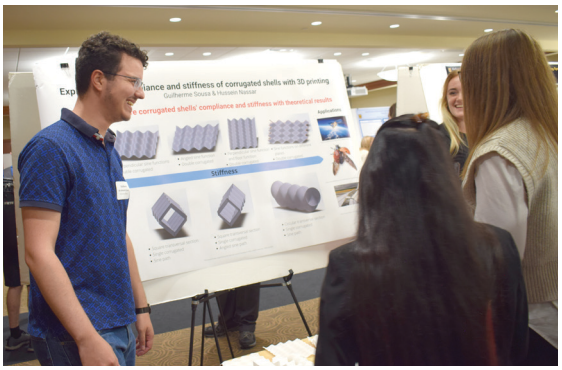
Mizzou Engineers and students participating in Engineering REUs (Research Experiences for Undergraduates) were among nearly 130 student researchers across the University of Missouri campus who had the opportunity to showcase their work this past summer. During the Mizzou Summer Undergraduate Research Forum, teams presented projects ranging from material structural stability to tracking nitrogen risk in soil.



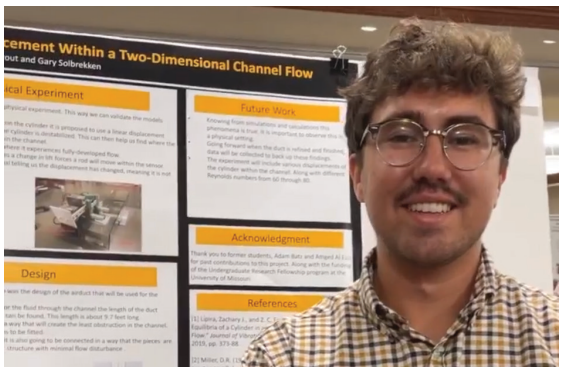
Shelby Atherton, a senior studying chemical engineering and chemistry, helped develop a polymer that can be used in drug delivery systems.



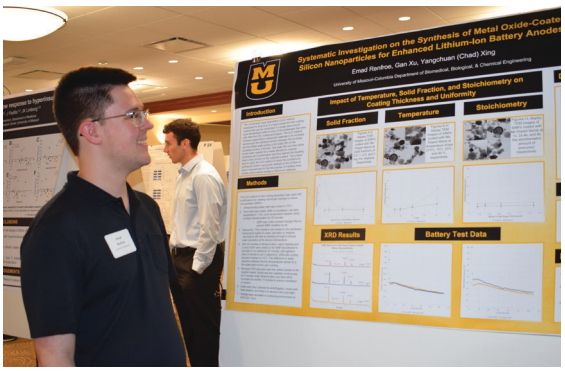
Samuel Spell, a junior majoring in computer science and math, worked on creating a nitrogen risk map for the US using public data and big data analytics techniques.



Guilherme De Amorim Sousa, a senior working on a mechanical engineering degree and business minor, spent the summer 3D printing and examining objects' stiffness and pliability.



Alex Trout, a senior in mechanical engineering, spent the summer researching the displacement of a cylinder in a two-dimensional flow. The theoretical phenomenon is widely accepted, but Trout worked to physically demonstrate the concept.



Emad Renfroe, a senior in chemical engineering, studied the synthesis of thin metal-oxide coatings on silicon nanoparticles to build enhanced lithium batteries. These coatings would prevent the expansion of silicon from destroying anodes within lithium batteries and facilitate higher capacity batteries.

NSBE Takes Top Award

The Mizzou chapter of the National Society of Black Engineers (NSBE) won Region V Chapter of the Year at the organization's 48th annual national convention, capping off a memorable four-day trip to Anaheim, California, in April.

"This was the first (NSBE) hybrid convention, with over 11,000 participants, and the first time we have been in person in over two years," Janell Mason, Mizzou NSBE president and biomedical engineering major, said. "Our group had 25 members in attendance for the convention, and I enjoyed sharing this experience with them."

In addition to the group winning the chapter award, three Mizzou NSBE members received individual honors. Maya Townsend and Hirut Suraphel were selected as executive board members for Region V, and Trenton Foster won two NSBE scholarships. He was awarded an NSBE Honeywell Integrated Pipeline Program Scholarship and an NSBE BCA/Affiliate/Fellows Scholarship. This is the second year in a row Foster has been awarded an NSBE scholarship at their national convention.

The convention featured a mix of in-person, hybrid and virtual workshops, sessions and a career fair. Mason, a Chicago native, had a special family connection for one of the workshops she attended.

"I had the opportunity to hear my uncle speak on his third book during one of my favorite workshops, 'Black Faces in High Places'," Mason said. "It was exciting to see the NSBE family come full circle."

Mizzou NSBE is already excited for the next national convention planned to be held in Kansas City, allowing more members to attend in person. In addition, current Mizzou NSBE Programs Chair Chanel Wheeler will be the 49th national convention's Planning Committee Chair.

Reaching for the Stars

The Mizzou Space Program's performance has been out of this world, and the team is aiming even higher this academic year.

MSP recently attended two competitions, including the Argonia Cup in April, where they placed 6th. The result was an improvement from last year, when they could not recover their rocket during the competition, said Abigail Penfield, MSP president.

In June, there were more than 150 teams selected to compete at the Spaceport America Cup, the world's largest intercollegiate rocketry competition, with 93 teams meeting the requirements to compete. MSP placed 14th in their category of 47 teams and 24th overall.

This fall, the team is celebrating its success with an eye on the future.

"I think everyone had a great time throughout the year, and we all learned a lot," Penfield said. "There's room for growth, but we're aware of the areas we can improve in and have already begun brainstorming for this upcoming year."

MSP is a student-led organization that focuses on furthering aerospace interest by developing space balloons, conducting propulsion research and competing in national and international collegiate rocketry competitions. Students take on specialized roles in the development of two rockets.

Speeding Ahead

Mizzou Engineering's formula car team has been speeding ahead of the competition, placing within the top 20 teams at two recent events, including at the Michigan International Speedway.

Mizzou's formula team competes as a part of Formula SAE (FSAE), organized by SAE International. The car is quarter scale, meaning it's about ¼ the size of a standard formula one vehicle. Students build on work from the previous year to build a more competitive vehicle.

The FSAE team first competed in May at the Michigan International Speedway, placing 19th out of roughly 100 teams. In June, they placed 14th out of 50 teams. They also placed within the top 6 in two distinct events in June.

"The season ended on a very high note," said Spencer Goldstein, a member of the FSAE team. "We get a full year to tune the car that we took to the June competition to make it even better. Placing as highly we did means that next year with this car looks very promising."

Engineers' Week 2022

From the kickoff outside Overholser Atrium to the naming of the E-Week King and Queen — seniors Joseph Thornhill and Riley Jackson — the 119th anniversary of Engineers' Week brought students, faculty, staff and alumni together to celebrate all things engineering at Mizzou. Activities included the annual Dome Lighting Ceremony, a tradition that began as an E-Week stunt in 1988. Prior to the ceremony, roughly 65 alumni met at The Heidelberg to network and reminisce.

Other E-Week events included Professor-for-a-Day series, which brings engineering alumni to campus to serve as guest lecturers; Lab Exhibits, which allow students to showcase research; and the Grand Kowtow, where St. Patrick bestows knighthood on seniors and honorees. Linda Wibbenmeyer, BS ChE '95, customer satisfaction and quality lead for DuPont and president of Mizzou's Chemical Engineering Industrial Advisory Board, gave the Ada Wilson Green Tea Lecture. Throughout the week, students also enjoyed a 5K run/walk, skits, a hot dog banquet and the annual St. Patrick's ball.

The History of E-Week

On March 17, 1903, a mysterious announcement posted to the bulletin board in the Engineering Building proclaimed, "St. Patrick was an engineer. Holiday today." Engineering students, who at that time were in classes six days a week, happily heeded the note and skipped classes that day. The following year, both juniors and seniors skipped classes on March 17.

In 1906, the Blarney Stone was discovered during excavations of the Engineering Annex Building. The stone, which was unearthed during the excavation, was etched with a message in an ancient language. The message was translated to read "Erin Go Bragh," an anglicized version of an Irish language phrase meaning, "Ireland forever." However, the engineers translated the phrase as "St. Patrick was an engineer."

With the discovery of the Blarney Stone came more elaborate celebrations. All of the engineering students gathered on the quadrangle to kowtow before St. Pat, and seniors came forward to kiss the Blarney Stone and receive their knighthood of St. Patrick. Throughout the years, St. Patrick has conferred honorary knighthood to professors, alumni and other prominent figures. In 1934, 11 years before he would serve as president, Harry Truman was given honorary knighthood at the College of Engineering. Edwin "Buzz" Aldrin, the second man to walk on the moon, was knighted in 1971.

Jost Establishes Endowed Chair in Chemical Engineering

The funding will allow the College to recruit top faculty who will prepare countless students to fill the jobs that Jost Chemical and other manufacturing companies create.

Jerry Jost, BS ChE '70, this past year donated a $2 million gift to create the Jerry L. Jost Endowed Chair in Chemical Engineering. The funding will allow the College to recruit top faculty who will prepare countless students to fill the jobs that Jost Chemical and other manufacturing companies create.

"The College of Engineering is crucial to manufacturing, so whatever we can do to impact and improve the educational experience is going to help get more highly skilled engineers out there in the workforce," Jost said. "My hope with the endowed position is that the faculty member hired will bring something renowned to the department to give students the opportunity to explore new areas."

Jost Chemical is an FDA-registered manufacturer of specialty chemicals. It's also a technology company that employs chemical, mechanical and electrical engineers, as well as scientists, to fill a number of highly technical roles.

"Our engineering capabilities are phenomenal for a company of our size, and from an analytical perspective, our instrumental analysis capabilities are rather phenomenal, too," Jost said. "We've had large companies come in and say they wish they had the capabilities we have. We put a lot of money and time into making ourselves top notch and a leader."

Jost started the business in 1985 after several years in industry. He credits his experience at Mizzou and the College of Engineering for equipping him with problem solving skills and providing opportunities to grow as an individual and a leader.

"If it's one thing the College of Engineering does well is teach you the methodology and appropriate way to approach problems," he said. "Just learning to interact and work with people from different backgrounds and the totality of my experience at Mizzou played a role in helping me start a business and in my career as a whole."

That's why Jost has been a strong supporter of Mizzou Engineering over the years. He's also donated more than $300,000 in equipment for a chemical operations laboratory, now the Jost Chemical Lab, and has served more than a decade on the Chemical Engineering Industrial Advisory Board.

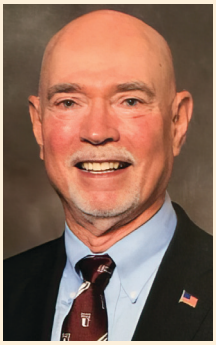
2021 Faculty Alumni Awards

William Baker

William Baker, BS CiE ‘75, was honored with a Mizzou Alumni Association’s annual Faculty Alumni Award. Baker designed the world’s tallest building — the Burj Khalifa — which stands apart for more than its height. For decades, engineering limits restricted the skyscraper to a 600-meter cap. With its “buttressed core,” the Burj Khalifa is nearly double the height of the tallest high-rise before it.

Baker’s innovative “buttressed core” design is but one of the many professional accomplishments that has brought him international recognition. With accolades from the American Society of Civil Engineers, the Institution of Structural Engineers (UK) and the Royal Academy of Engineering, his work has also earned him honorary doctorates from the University of Stuttgart, the Illinois Institute of Technology (IIT), Heriot-Watt University and an Honorary Doctorate in Engineering from Mizzou.

A member of the Columns Society, Shamrock Society and the Engineering Dean’s Leadership Circle, Baker returned to Mizzou as the College of Engineering’s commencement speaker in 2018. He has guest lectured at universities around the world and is cited in countless media sources as an enthusiastic expert on architecture, engineering and design — encouraging a new generation to build on his achievements.



John Clark

John Clark, BS ME ’62, MBA ’75, was honored with a Mizzou Alumni annual Faculty Alumni Award. While flying a reconnaissance mission in 1967, Clark — an Air Force captain at the time — was shot down over North Vietnam, surviving six years as a prisoner of Hòa Lò, later known as the “Hanoi Hilton.” Upon his repatriation, the former ROTC Cadet Corps commander returned to Mizzou for his MBA before returning to flying duty. In 1980 he joined the Missouri Air National Guard, retiring as a colonel in 1992.

He is the recipient of numerous awards, including the Silver Star, two Legions of Merit, the Distinguished Flying Cross and two Purple Hearts, and has readily shared his story — the trauma, subsequent battle with PTSD and the faith that sustained him — with generations of MU students and others. His experiences have granted many with unique, personal insights into the realities of war, and his advocacy on behalf of his fellow veterans continues to this day.

In 1994, he was appointed co-chair of the USS Columbia Submarine Committee, responsible for christening and commissioning events on behalf of the newly built submarine and its crew. Thanks to his efforts, Mizzou’s Naval ROTC unit continues to host annual visits from the crew’s members, with many choosing to become Tigers themselves.

2022 College of Engineering Alumni Award Winners

Bob Thumser

Bob Thumser, BS IE '82, MS IE '90, received the **2022 James E. "Bud" Moulder Distinguished Alumni Award** recognizing his longstanding service to the College of Engineering and the Department of Industrial and Manufacturing Systems Engineering.

"I'm greatly honored to accept this award," he said. "I'm thankful and glad to know I have been an asset to the department over the years."

Thumser's contributions have been vast. He was a founding member of the IMSE Industrial Advisory Board when it was revitalized in 1998, and he has consistently attended meetings every semester over the past 23 years. He's evaluated Capstone Design Team projects, helped ensure curriculum is up-to-date and has been involved in multiple strategic planning initiatives for the department. Thumser has also provided industry insight for ABET accreditation.

In 2011, Thumser was inducted into the IMSE Hall of Fame. He has been on the Hall of Fame Board of Directors since 2015, serving as president in 2020.

"Bob is a true Mizzou Tiger who has generously given back to support the success of the IMSE department and our students," his nominator said.

What's kept him active with Mizzou Engineering for more than two decades? Thumser said it stems from his appreciation for his education.

"I think Mizzou's strong point is that it gives you a strong core engineering foundation," he said. "They give you valuable tools you can use to solve problems."

Over a 37-year career in the aerospace industry, Thumser served in a number of roles at McDonnell Douglass. He later managed groups at The Boeing Company and became an employee of GKN Aerospace following the Boeing sale of their fabrication center.

Lorraine Stipek

Lorraine Stipek, BS EE '86, received the College of Engineering's **2022 Citation of Merit Award** recognizing her significant contributions to the industry and service to MU.

"I'm extremely honored," she said. "There have been so many incredible alumni who have graduated and have done some amazing things for the University. It's so gratifying because it means some of the things I've done have had a positive impact. And that feels great because all we want to do is have a positive impact."

Stipek has served on the Dean's Advisory Council, helped develop undergraduate labs, collaborated on energy projects with MU's research office and has spoken at Commencement and other engineering events.

"Lorraine has also been a strong supporter and advocate for women pursuing a degree in engineering," her nominator wrote.

On that front, she leads by example. Stipek began her career as a test engineer at McDonnell Douglas at a time when not many women were working in engineering. While there, she also earned a Master of Business Administration from Washington University.

Stipek then joined National Instruments, a company comprised of engineers who make test and automation products to sell to other engineers. There, she rose in the ranks from technical sales manager to executive leadership at the company's Texas headquarters.

As Director of Global Business Solutions and Operations, and then Director of Global Operations and Business Effectiveness, Stipek assessed industry needs across five continents, customizing services while saving millions in staffing optimization strategies.

Today, she serves as an Angel Investor for Southwest Angel Network, which supports start-ups that have a social impact on society, mainly in areas of sustainable energy and health.

Michael Melton

Michael Melton, Esquire, BS EE ’81, JD ’84, received the **2022 Missouri Honor Award** recognizing his outstanding contributions to Mizzou Engineering and extraordinary efforts to help support students and young alumni. The award is the highest accolade bestowed on an engineering graduate.

“I’m honored by this,” Melton said. “I am very pleased and happy that the things I do with the University and outside of the University have been recognized.”

Melton is an “extraordinary example illustrating how a great engineering education can lay the foundation for a remarkable professional and business career,” his nominator said.

That career includes working as a registered patent attorney before starting his own company. Today, Melton is Founder, President and CEO of MEM Enterprises Group, which owns, operates and manages Taco Bell and Five Guys Burgers restaurants and commercial real estate.

Melton has also held the positions of Vice President and Director of Worldwide Semiconductor Licensing with Motorola, Deputy General Counsel with Texas Instruments and European Legal Counsel and Corporate Secretary of Texas Instruments Information Engineering International.

After earning a bachelor’s from Mizzou Engineering, he completed a JD, passing both the bar and obtaining registration to practice before the U.S. Patent and Trademark Office. The combination of a technical education and law school proved invaluable.

“At Mizzou, they taught you how to learn about engineering, technology, research and development and how to work with that,” he said. “That was really important in being a patent attorney. You have to be able to converse with inventors and talk with them about their invention in order to document it legally in the form of a patent. That really became the secret of my success in corporate America.”

Doug DeMaire

Doug DeMaire, BS IE ’68, MS IE ’69, received the **2022 Missouri Honor Award** recognizing his outstanding contributions to the College of Engineering and the engineering profession. The award is the highest accolade bestowed on an engineering graduate.

DeMaire said he was “very pleased” to have received the recognition. “It’s a distinct honor,” he said.

DeMaire has supported the Department of Industrial and Manufacturing Systems Engineering over the years, earning him a spot in the IMSE Hall of Fame in 2014. Specifically, he has sought opportunities to enable Missouri students to attend Mizzou and pursue an engineering degree, such as the one that provided the foundation for his career success, his nominator wrote.

The DeMaires established the J. Douglas and Barbara N. DeMaire Scholarship, which supports IMSE students from Missouri, with preference given to those from Barton County, where DeMaire grew up.

“Mizzou provided a solid engineering education,” he said. “We find great satisfaction in knowing this scholarship is helping the College of Engineering continue to produce excellent engineers and leaders for tomorrow.”

After earning his master’s degree, DeMaire went to work for Olin Brass in the St. Louis area. Over the next 26 years, he rose in the ranks, including serving as Vice President of Strategic Planning and Business Development for Olin Corporation. One result of his work was the spinoff of Olin’s Defense Business into a new public company, Primex Technologies, Inc. DeMaire joined the new company, serving as Executive Vice President and then President. He successfully ran the company until it was acquired by General Dynamics, at which time he retired. He then established his own management consulting practice and worked with a variety of clients over the next 15 years.

150 Years of Leadership

Mizzou Engineering has a long legacy of educating engineering leaders. In honor of our 150th anniversary, we featured some of the men and women who stand out among the ranks for their contributions to industry and society. Use your smart phone and hover over the QR codes to read more in-depth profiles.

Jim Fitterling

How do you run a $55 billion company, find innovative ways to reduce carbon emissions worldwide, advocate for LGBTQ rights, combat racial injustice and help Ukraine — all while helping ensure the next generation of engineers are prepared for the workforce? We don't know, but Jim Fitterling is doing it.

Fitterling, BS ME '83, is Chairman and CEO of Dow, Inc. He's Chairman of the Board of Directors of the National Association of Manufacturers, a member of the U.S.-China Business Council Board of Directors, the 3M Board of Directors and dozens of other boards.

"Without my education, I wouldn't have gotten the job at Dow that's led me to this position today," Fitterling said. "A lot of what happens in society today is driven by what's happening in major cities and along the coast, and sometimes we overlook real gems. Mizzou is a real gem, and that story needs to be told."

Jeanie Knuth

Over the past decade, there's been a shift in the collective mindset around the phrase "like a girl." It used to be an insult. Then, in 2014, the Always brand launched a video showing that young girls hadn't yet bought into that stereotype. Asked to run, throw or fight "like a girl," these small children gave it their all.

The campaign was an overnight success with nearly 70% of women and 60% of men said the video made them rethink the phrase "like a girl."

Jeanie Knuth, BS ChE '98, worked on the campaign, now used as a case study for how a brand can change the world. Knuth is Vice President of Research & Development at Procter & Gamble and leads the global production development of feminine care products. She's used what she learned at Mizzou Engineering to effect that change.

"I can't believe how fortunate and blessed I am, and there's no way I'd be where I am today if it weren't for Mizzou Engineering."

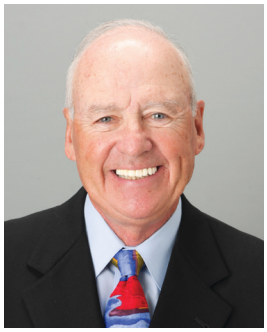
Michael Melton

Michael Melton, Esquire, is often asked whether he ever uses his bachelor's degree in engineering. After all, he's had an extraordinary career as a businessman, having started his own company after working for years as a patent attorney.

Melton, BS EE '81, JD '84, is Founder, President and CEO of MEM Enterprises Group which owns, operates and manages Taco Bell and Five Guys Burgers restaurants and commercial real estate.

And about that engineering education? It started it all, Melton says.

"Engineering is the foundation of why I'm successful," he said. "It was the most difficult achievement I ever had to go through, coming from my background in Kansas City and being ill-prepared to study engineering, but fighting through it with brute force. It taught me problem solving — to keep searching for solutions and being detailed about the possibilities. That inquisitiveness has been a big part of my success."



Tom Kline

Tom Kline knows about leadership. During his 34-year career at Pfizer, Kline served as Plant Manager before rising to the rank of Vice President. He was a platoon leader during the Vietnam War, earning several medals including the Bronze Star. He's been a White House Fellow and a special assistant to the U.S. Secretary of Agriculture. He's a published author. He's raised awareness for diseases such as malaria and COVID-19. He's principal of Kline Health Group. And he's a nationally known racewalker. His reflections were published in his latest book "Walking 85,000 Miles to Aide Humanity and Have Fun."

Kline's path to personal and professional success started with the values his parents taught him, continued as he gained self-confidence during his undergraduate years and solidified with the graduate education he received at Mizzou Engineering.

Wade Foster

Starting is one of the hardest steps to becoming a self-made leader, Wade Foster says.

And he should know. In 2011, at the age of 24, Foster and Bryan Helming (BS Finance '11) began working on an idea that's since become Zapier, an automation system connecting thousands of applications such as Google Apps and Microsoft 365.

"When I first started Zapier, it was a part-time project," Foster said. "So many people delay trying something because they don't think they are good enough yet. The path to getting good at something starts with being bad at something."

Today, Zapier employs more than 600 people across the globe and has a $5 billion valuation.

Foster earned a bachelor's in industrial engineering in 2009 and an MBA the following year through a dual industrial engineering and business program.

"I truly learned what it meant to build expertise in a topic," Foster said. "I spent countless nights in the library trying to understand these topics."

See more profiles here:
https://tinyurl.com/3zrj5t6z

Dean's Advisory Council

The Dean's Advisory Council (DAC) is a group that serves as champions for the University of Missouri College of Engineering. It is comprised of several of the College of Engineering's most prominent alumni.

Co-Chair
Jim Fitterling
Dow Inc., Chairman & CEO
BS ME '83

Co-Chair
Chih-Hsiang (Thompson) Lin
Applied Optoelectronics Inc. (AOI), Founder, Chairman & CEO
BS ME '83, MS EE '90, PhD EE '93 (BS from National Tsing Hua University – Taiwan)

Mike Brown
Euronet Worldwide, Chairman, President & CEO
BS EE '79 (MS from UMKC '97)

Steve Edwards
Black & Veatch, CEO (retired)
BS EE '78

Brian Howard
North Fulton Plastic Surgery, President, Owner (Ret.) MD
BA Bio Sci '86 (MD from University of Rochester, MBA from Emory University)

Kelly King
AT&T, Executive Vice President
BS ME '90 (MBA from SLU)

Ray Kowalik
Burns & McDonnell, CEO
BS Civil '85
MS Civil '99

Sharon Langenbeck
NASA Jet Propulsion Lab, Project Element Manager (Ret.)
BS ME '74, MS ME '76, PhD ME '79

Michael Melton
MEM Enterprises Group Founder and President and CEO
BS EE '81, JD '84

Jim O'Neill
Boeing, President, Boeing Defense Space & Security Development & St. Louis Sr. Executive (Ret.)
BS Civil '81, MS Civil '82

David Payne
PayneCrest Electric and Communications, CEO,
BS EE '83

Christine Pierson
Tresl President & CEO
BS IE '85 (MBA from Rockhurst University)

Ron Wood
Black & Veatch, President & CEO (Ret.)
B&V Energy
BS EE '64

MIZZOU ENGINEERING PRIDE POINTS

FIRST BIOMEDICAL ENGINEERING PROGRAM at a public institution in Missouri

1 of 7 U.S. public universities with engineering, veterinary medicine, medicine and law on a single campus

95.2% of graduates report a successful career outcome six months after graduation

DEGREE PROGRAMS

10	9	7
undergraduate	master's	doctoral

OVER $30M in research expenditures per year

BEST GRAD SCHOOLS U.S.News & WORLD REPORT ENGINEERING 2023

$9M awarded in scholarships and financial aid by Mizzou Engineering for 2022-2023

More than **200** companies recruit Mizzou Engineering students annually

Oldest collegiate Engineers' Week celebration in the nation

ENGINEERING STUDENTS

2,750+ undergraduates

170+ master's

270+ doctoral

More than **50** student orgs

$65,854 average starting salary for 2020 graduates

More than **28,000** living alumni

College of Engineering
University of Missouri

College of Engineering
University of Missouri

416 South 6th Street
Columbia, MO 65211

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