

Fall 2021

re:search

An inside look at innovation and discovery at Missouri University of Science and Technology

\$300 million gift fuels
STEM education vision

MISSOURI
S&T

WE HAVE

BIG PLANS

As we celebrate our milestone 150th anniversary and reflect on our inspiring history, we also look to the future at how Missouri S&T can continue to strive for a better world in the next 150 years.

The newly established **Kummer Institute for Student Success, Research and Economic Development** will **transform STEM research** potential to positively impact our state and region. Created in October 2020 through a \$300 million gift from the late Fred Kummer, a Missouri S&T graduate, and his wife, June, the Kummer Institute also provides greater access to undergraduate and doctoral education for innovation-minded students.

Research facilities like the Center for Aerospace Manufacturing Technologies, the Clayco Advanced Construction and Materials Lab and the Rock Characterization Lab increase our research opportunities. **We have our eyes set on Carnegie R1 research status**, the highest classification for a research university.

Our faculty and students are **fighting climate change and finding breakthroughs in smart medicine and**

artificial intelligence applications in daily life. They're developing new materials for infrastructure, health care and transportation.

S&T's roots are deep in the coal and lead mines of Missouri, but our branches reach for the far corners of our universe. Our researchers are **testing new nanoscale materials that could reduce wear and tear on extraterrestrial vehicles** and examining the role of neutrinos in shaping the universe. We are helping to develop hypersonic flight. Our faculty are preparing students to mine on the moon, other planets — even asteroids.

S&T students are making an impression on space exploration as well, with research into nimble small satellite swarms. NASA recently recognized our students with a BIG Idea Challenge grant to find a way to remove lunar dust from solar cells that power lunar landers, moon explorers and, someday, inhabitants.

Shakespeare wrote, "What's past is prologue," and Missouri S&T is living those words. We have a history of big ideas. And as we look ahead to the next century and beyond, S&T will continue to build on a legacy 150 years in the making.

150.mst.edu

DEAR FRIENDS OF MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY

I am honored to share the following highlights of the outstanding research performed by Missouri S&T faculty, staff and students.

Missouri S&T entered its 150th year with the largest single gift in the history of Missouri higher education: \$300 million from late St. Louis businessman and S&T civil engineering graduate Fred Kummer and his wife, June. Their vision: to transform STEM education and outreach at Missouri S&T. This transformative gift will have a lasting impact on our educational and research activities.

In this issue of *re:search*, we will give you an idea of the breadth of S&T research: from mining on the moon and dealing with lunar dust, to over \$30 million in grant funding to develop the new generation of steel. From music's role in the study of Alzheimer's disease and dementia to curing chronic artery disease at the cellular level. And from researching how to provide broadband access to 17 million Americans, to publishing the Gilder Lehrman Institute of American History's best book of the year on military history.

You will also meet faculty and students who received major accolades, including the NSF CAREER Award and the SMART Fellowship, as well as those elevated to the highest levels of professional, engineering and scientific societies.



These are just a few of the Missouri S&T accomplishments you will find in this issue.

And they, in turn, are a small part of the overall Missouri S&T 2020-21 research performance: Missouri S&T was awarded \$43.9 million in research funds and a total of \$80.7 in external funds, much as a result of the CARES Act. Both totals are records for S&T. In 2020-21 Missouri S&T submitted 25 patent applications and received a record \$720,000 in royalty income from its inventions — a clear sign of the university's impact on the regional and state economies.

I hope that the stories in this magazine offer you a snapshot of Missouri S&T as we continue to excel in our mission to perform research that serves the state and the nation.

Best Regards,

Costas Tsatsoulis
Vice Chancellor of Research

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The Innovation Campus, located adjacent to U.S. Interstate 44 and across from the main campus of Missouri S&T, is shown at full buildout in this conceptual rendering.

\$300 million gift

FUELS STEM EDUCATION VISION

Conceptual rendering (also shown on the cover) courtesy of Mackey Mitchell Architects



N the largest single gift in the history of Missouri higher education, late St. Louis businessman and Missouri S&T civil engineering graduate **Fred Kummer** and his wife, **June**, donated \$300 million to transform STEM education and outreach at Missouri S&T.

The donation established the Kummer Institute Foundation, and the resulting blueprint splits the effort into the Kummer Institute for Entrepreneurship and Economic Development, the Kummer Institute for Education and Research, and various outreach efforts.

"I owe much of my success to the education I received at Rolla," Fred Kummer said in an October 2020 interview. "My Rolla experience taught me how to think, how to work hard and how to manage my own career. June and I believe in the mission of this great university, and that's why we have chosen to invest in S&T's future success. We believe that Missouri S&T's best days are ahead."

Fred Kummer, who died in April 2021 at 92, was founder and chairman of St. Louis-based HBE Corp., which he established in 1960 and built into the world's leading design-build firm for health care. A 1955 civil engineering graduate of Missouri S&T, he and his wife have been major donors to Missouri S&T for decades.

The plan to carry out the Kummers' vision is complex. At its essence, though, the plan is driven by three goals: elevate S&T, broaden STEM outreach and make a positive economic impact.

Four academic research centers of excellence will ensure S&T's work has a spot at the table when it comes to helping build the state and country's economy. Each center builds on S&T's strengths in areas like infrastructure, sustainability, advanced manufacturing, and artificial intelligence and autonomous systems.

Hiring renowned researchers, creating new endowed chairs and professorships, and recruiting a visionary academic leader as dean of the Kummer College of Innovation, Entrepreneurship, and Economic Development will further strengthen S&T's research profile.

Through these actions, the Kummer Institute will have an incredible impact on the region and the state for future generations. A University of Missouri-Columbia economic analysis found that the Kummer investment is predicted to add \$2 billion to Missouri's gross domestic product (GDP) by 2045.

"The future is very bright, and it's very encouraging to be involved in developing the Kummer vision," says Missouri S&T Chancellor **Mo Deghani**. "What we do now will certainly impact S&T and the Rolla region for many generations to come." □

Broadening STEM OUTREACH

Both Kummers benefitted from a strong STEM education — June in architecture, Fred in civil engineering — and both believed that attracting more students into STEM fields is the key to local and global economic success. A significant portion of their gift is devoted to outreach and to programs like the Kummer Vanguard Scholarships for first-year students and the Kummer Innovation and Entrepreneurship (I&E) Doctoral Fellowships for Ph.D. candidates.

This fall, 460 first-year students arrived on campus as Kummer Vanguard Scholars, each aided by an annual \$1,000 to \$3,000 scholarship, which is renewable for four years.

The Kummer I&E Doctoral Fellows Program provides 12-month stipends and tuition remission for up to four years to qualified Ph.D. students. One of the inaugural fellows is **Ashley-Ann Davis**, who earned a bachelor's degree in engineering management from S&T last spring.

"A lifelong goal of mine has always been to become an entrepreneur producing a product that is impactful," says Davis. "This program allows me to not only do research on impactful topics with the professors I've come to love, but also help to develop my entrepreneurial and innovative skills."



Learn more about the Kummer Institute by visiting KummerInstitute.mst.edu

LEADING WITH LANGUAGES

Missouri S&T senior **Jessi Schoolcraft** discussed the benefits of combining engineering education with foreign language skills and cross-cultural experiences in an interview on the national “Lead with Languages” campaign website.

The campaign, sponsored by the American Council on the Teaching of Foreign Languages (ACTFL), aims to create a new generation of Americans who are competent in other languages and cultures and fully equipped to compete and succeed in a global economy.

Schoolcraft is one of the first students to join S&T’s Global Engineering Program. She majors in both environmental engineering and multidisciplinary studies with an emphasis in French and will graduate with a degree in both fields.

A NEW FACE IN ENGINEERING

The American Society of Civil Engineering (ASCE) counted May 2021 Missouri S&T graduate **Erin Bereyso** among its 2021 New Faces of Civil Engineering – Collegiate Edition. Bereyso studied civil engineering with an environmental engineering emphasis in a cooperative engineering program between Missouri S&T and Missouri State University in Springfield, Missouri.

She worked as an environmental engineering intern for Associated Electric Cooperative Inc. in Springfield, served as ASCE student chapter president, and participated in the 2019 Environmental and Water Resources Institute’s World Environmental and Water Resources Congress.

Bereyso received a \$1,000 scholarship from ASCE and is featured on the 2021 New Faces of Civil Engineering – Collegiate Edition website.



Teen blacksmith’s got talent

Before he came to Missouri S&T, metallurgical engineering freshman **Brendan Crotty** earned third place — and a \$150,000 prize — in the 79th Regeneron Science Talent Search, a science and mathematics competition for high school seniors. But long before that, Crotty forged a passion for metalwork ... and blacksmithing.

“My ideal day of just enjoyment and relaxing would be going out and building something,” says Crotty, who learned blacksmithing as a kid at a Civil War reenactment. “That would be fun for me. Just piddling, taking something apart, fixing something, building something.”

Crotty hones his skills in the family garage, which he converted into a machine shop that also houses his welding equipment. There, Crotty designed and built an efficient hybrid gas burner to help reduce the ecological impact of industries like power generation and materials manufacturing. His specialized burner system operates at higher temperatures than current industrial burners, yet emits 19% less polluting nitrogen dioxide gas. The project earned him Regeneron’s third-place title.

Finalists were evaluated on their problem-solving abilities, potential to become scientific leaders and the scientific rigor of their projects.

“Engineering and manufacturing have always been a passion of mine,” he says. “Over the last five years, I studied combustion and burner systems for ultra-high-temperature materials processing. The main goal of my research is the reduction of pollution.”

The Regeneron Science Talent Search is sponsored by Regeneron Pharmaceuticals Inc. and is a Society for Science and the Public program. The competition has been held since 1942 and has produced recipients of 11 National Medals of Science, five Breakthrough Prizes, 21 MacArthur Foundation Fellowships, two Fields Medals and 13 Nobel Prizes.

A swarm of satellites

Two aerospace engineering Ph.D. candidates at Missouri S&T earned high honors in their field. Both study the dynamics of satellite swarms.

Jill Davis is turning a love of science fiction and a desire to be on the forefront of human exploration and discovery into a career in the U.S. Space Force with the help of the Department of Defense's SMART scholarship. It comes with a stipend, full tuition and guaranteed employment with her sponsor, Kirtland Air Force Base in Albuquerque, New Mexico.

Davis and her advisor, Professor **Hank Pernicka**, are developing small satellite navigation techniques to allow formation and swarm missions in deep space and near the moon.

After completing her Ph.D., Davis will become a civilian employee in the U.S. Space Force working with the Air Force Research Laboratory at Kirtland.

Donna Jennings received the 2020 Amelia Earhart Fellowship from the Zonta International Foundation. Recipients must demonstrate a superior academic record in aerospace-related sciences or aerospace-related engineering.

Jennings and her advisor Pernicka study small satellites and astrodynamics and are developing a method to identify natural formations within the nonlinear, and often unstable, dynamics of systems used to plan swarm missions. Her goal is to identify relative formations near the collinear libration points of interest to NASA.

Jennings is an advisor for the S&T Satellite Research Team. She plans to work in academia and to teach, conduct research and serve as a role model for other females in STEM fields.

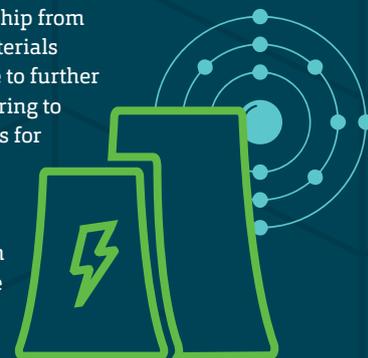


DOE fellowship helps Ph.D. student blend disciplines

An Integrated University Program Fellowship from the U.S. Department of Energy helped materials science Ph.D. student **Joshua Rittenhouse** to further his research on using additive manufacturing to make silicon carbide-based (SiC) materials for nuclear applications.

SiC-based materials are important for components of advanced nuclear systems. Conventional manufacturing can produce high-quality SiC or SiC composite materials, but the process is inefficient and costly, and producing components with complex shapes is difficult. Additive manufacturing is a promising method for efficiently producing components with complex shapes at a lower cost.

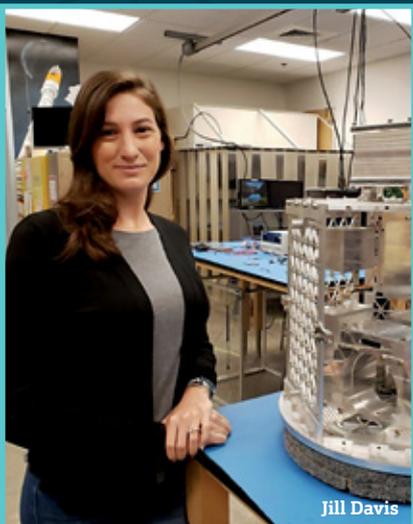
Rittenhouse is working on the project with **Haiming Wen**, assistant professor of materials science and engineering, who has a joint appointment in nuclear engineering.



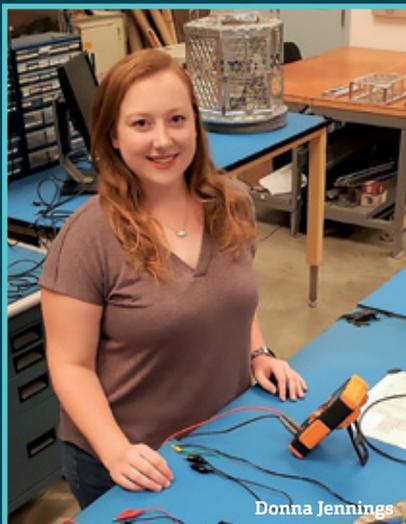
Battery research leads to DOE award

Julian Kosacki, a Ph.D. student in materials science and engineering at Missouri S&T, earned the U.S. Department of Energy's Office of Science Graduate Student Research Award. The award recognizes outstanding academic accomplishments, the merit of the student's research project and the student's potential to advance in their graduate studies.

"Julian's work will impact the next generation of lead batteries that support energy resources transforming into renewables," says Kosacki's advisor **Fatih Dogan**, an S&T materials science and engineering professor. "His research focuses on understanding electrochemical interfaces during battery-cycling, which greatly impacts the electrode design for higher capacity and longer lifetimes."



Jill Davis



Donna Jennings

THE REAL STEEL

As the U.S. Army modernizes weapons systems and combat vehicles, Missouri S&T researchers are developing lightweight and ultra-high-strength steels to improve blast resistance and lower transportation costs.

And with over \$31 million in funding from the U.S. Army Research Laboratory (ARL) and the U.S. Department of Energy, they are making steel production less expensive and more energy efficient than ever before.



Laura Bartlett is developing lightweight steel with strength-to-weight ratios as high as titanium alloys at a much lower cost using a more environmentally sustainable process. She uses a materials-by-design approach to bridge the gap between laboratory-scale and commercial development of these and other ultra-high-strength steels for the military.

Current combat vehicles like the M1 Abrams tank are so heavy that flying them to hard-to-reach areas becomes an expensive ride. So, Bartlett is also helping the Army retrofit current vehicles with lightweight, high-strength steel armor and other components while maintaining or improving their ability to withstand blasts.

A cooperative agreement with ARL brings nearly \$20 million to S&T over five years. First-year funding included a \$2.6 million investment in new equipment that no other university will have, Bartlett says.

Her work will also benefit other branches of the military as well as steel producers, the automotive industry and infrastructure, says Bartlett, the Robert V. Wolf Associate Professor in Metallurgical Engineering and lead researcher.

"All branches of the military need steel," she says. "They also need other advanced materials that we're working on at Missouri S&T as well as artificial intelligence and advanced sensing technology. I see this as perhaps a springboard to develop new partnerships."

FL



Ronald O'Malley, the F. Kenneth Iverson Endowed Chair of Steelmaking Technologies and director of the Kent D. Peaslee Steel Manufacturing Research Center at Missouri S&T, is working with the DOE to create a system that combines a hydrogen-reduction reactor for ironmaking (H2DR) with electric furnace melting for steelmaking. This combination is then integrated into a flexible electrical grid that stores energy and generates hydrogen by balancing hydrogen and natural gas usage in the H2DR process.

O'Malley says this process will help balance the electrical grid and reduce emissions in what is traditionally a carbon-dioxide-intensive process.

"Seventy percent of steel produced in the U.S. is made by melting scrap and virgin iron in an electric arc furnace (EAF)," O'Malley says. "These high-productivity units can produce 170 tons of steel in a half hour, but it requires a high energy input and can damage the furnace."

One protection method uses slag in the furnace to generate foam to cover the electric arc and shield the furnace side walls and roof from arc radiation. O'Malley uses fiber-optic sensors to detect hot spots in the furnace as they develop, then uses the sensor outputs to activate a flexible injection system to direct chemical energy from carbon and oxygen and generate slag foaming as needed. The integrated dynamic control system could also adapt to differences in incoming scrap metal and virgin iron to save energy, reduce costs and increase production yields.

"What's exciting about this work is that these fiber optic systems traditionally have not been used in this kind of environment," he says. "We're actually tailoring several types of fiber optic technologies for specific applications in different parts of the EAF."

Research partners include Big River Steel and Commercial Metals Co.; Arizona State University and Continuous Improvements Experts (CIX), which provide EAF training and optimization services for the steel industry; the Colorado School of Mines and DOE's National Renewable Energy Laboratory; steel supply chain representatives Danieli Corp. and Voestalpine Texas LLC; steelmakers Steel Dynamics Inc., Gerdau and Nucor Steel; and industrial gas and technology providers Linde, Praxair Inc., and Air Liquide.

LESLIE GERTSCH: LUNAR MINER

NASA plans to land on the moon by 2024 and establish sustainable exploration by 2030. Meanwhile, Missouri S&T is preparing engineers for future work in space resources.

Leslie Gertsch, an associate professor of geological engineering at Missouri S&T, says the moon and other planets — even asteroids — hold promise as future sources of water, hydrogen, methane, base and precious metals, and other resources.

Now S&T offers a graduate certificate program for engineers in civil, mining and chemical engineering fields who are interested in space mining. The program is equal parts mining engineering, metallurgy, chemical engineering and economics.

“The potential for mining space resources will require input from several disciplines,” Gertsch says. “S&T can be a leader in this effort because we have those programs plus our aerospace engineering program. That gives us an advantage.”

Space mining itself is sort of a “chicken-or-egg” proposal. Do we populate the moon or other planets first, then start mining? Or do we mine first, then populate? Gertsch says it’s a little of both.

“We’ll need to establish a base to get things started, to see if it’s doable. There might be more efficient ways of doing it that would require fewer people.”



Water is the most important element for the onset of space mining, she says. Most industrial processes, including mining, rely on water to some degree, and it’s used for spacecraft fuels, propellants and life support. Water may be present on other celestial bodies in some form and would require extraction.

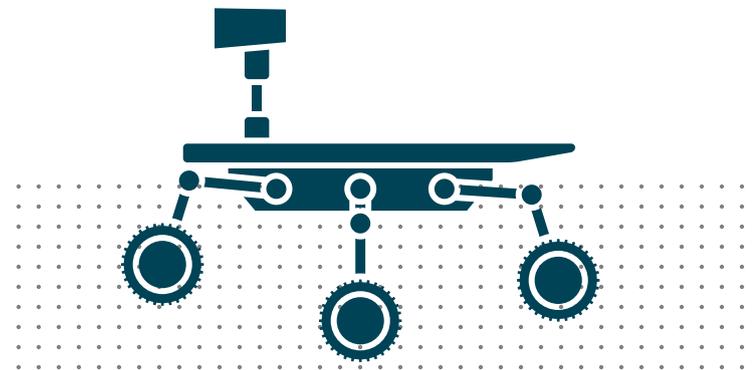
Volatile compounds like oxygen, hydrogen and carbon dioxide would also be among the early needs, along with methane for use as a propellant, Gertsch says.

“People who are not in space exploration think of platinum, gold, all that sort of cool stuff,” she says. “Those sound wonderful, but they’re kind of red herrings in a sense, because it may be a long time before they can be produced in space and sold on Earth for less than we can produce them on Earth itself.”

SPEED LUBE ON MARS?

As NASA’s *Perseverance* Rover explores the surface of Mars, researchers in Missouri S&T’s chemistry department and Argonne National Laboratory’s Center for Nanoscale Materials are learning that a class of two-dimensional nanomaterials known as MXenes could keep future rovers from wear and tear in that environment. These MXenes act as a “superlubricant” and reduce friction. They also should perform better than conventional oil-based lubricants in extreme environments, says **Vadym Mochalin**, S&T associate professor of chemistry, who is leading the research.

Mochalin and his team studied how MXenes perform as solid-state lubricants by conducting ball-on-disk friction tests at the nanometer scale in a dry nitrogen environment to reduce humidity. They deposited a titanium carbide MXene onto a silicon disk coated with a thin layer of silica — the major



ingredient of sand — then tested its ability to withstand wear by sliding it against a diamond-like carbon-coated steel ball.

Mochalin says the MXene interface between the steel ball and silica-coated disk resulted in a friction coefficient in the “superlubric regime” of 0.0067 to 0.0017. Adding graphene to the titanium carbide MXene further improved the results. Friction coefficient refers to the amount of friction between two objects and determined by a value that is usually between 0 and 1. The lower the value, the less friction.

MOON DUST IS A BIG DEAL

The success of NASA's plans to explore and inhabit the moon may depend in part on research conducted by a team of Missouri S&T students.

The team is one of seven university-affiliated groups selected for funding through NASA's Breakthrough, Innovative and Game-changing (BIG) Idea Challenge. This year's challenge: moon dust.

"Lunar dust affects everything we do on the moon, so we need many strategies for reducing or preventing its abrasive effects," says Niki Werkheiser, director of technology maturation in NASA's Space Technology Mission Directorate. "These innovative student concepts could help solve some of NASA's most pressing lunar dust problems."

The S&T team developed a method that takes the piezoelectric electric charge



These innovative student concepts could help solve some of NASA's most pressing lunar dust problems."



Photo courtesy of NASA

that builds up in materials in response to pressure, heat or other stresses and uses a piston-like actuator bonded to the dark side of solar cells to vibrate the cell and shake dust loose.

The project is called CURVES, for "Contaminant Ultrasonic Removal via Vibration Ejection from Solar Cells." The students demonstrated the system on a small scale by using it to remove salt from a fused quartz lens. They will now expand to solar cells and test the design in a simulated lunar environment.

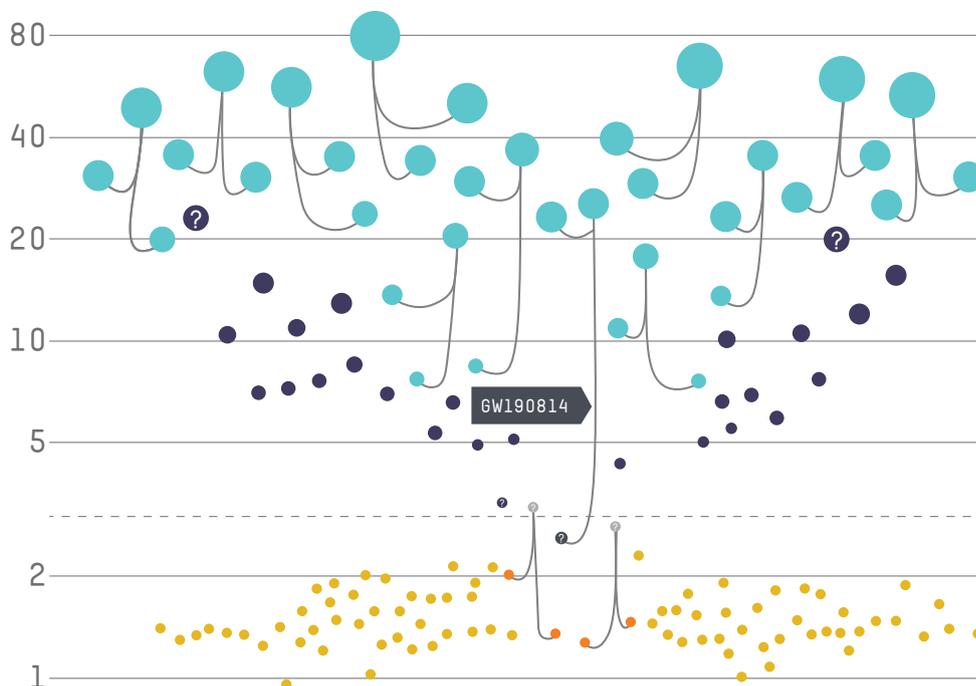
BRIDGING THE (NEUTRON STAR) GAP

For decades, astronomers have been perplexed by a gap in mass that lies between the heaviest neutron stars and the lightest black holes.

A team of physicists led by **Marco Cavaglia**, director of Missouri S&T's Institute for Multi-Messenger Astrophysics and Cosmology, contributed to the discovery of an object that fills that gap — an object 2.6 times the mass of our sun as it merged with a black hole the size of 23 solar masses.

Lying 800 million light-years from Earth, the merger generated a splash of gravitational waves and a new black hole detected in August 2019 with the National Science Foundation's Laser Interferometer Gravitational-wave Observatory (LIGO) and the Virgo detector in Europe.

As Missouri's only institutional member of the LIGO Scientific Collaboration, S&T faculty and students contributed to the discovery, dubbed GW190814, through on-site calibration of LIGO's 2-mile-long laser gravitational wave detector in Hanford, Washington.



Masses in the Stellar Graveyard in Solar Masses

This graphic shows the masses of black holes detected through electromagnetic observations (purple), black holes measured by gravitational-wave observations (blue), neutron stars measured with electromagnetic observations (yellow), and neutron stars detected through gravitational waves (orange). GW190814 is in the middle of the graphic as the merger of a black hole and a mystery object (either neutron star or black hole) around 2.6 times the mass of the sun. [Image credit: LIGO-Virgo/Northwestern U./Frank Elavsky & Aaron Geller]

FACULTY ACCOMPLISHMENTS

➤ Brow nets top ceramic society honor

Richard K. Brow, Curators' Distinguished Professor of ceramic engineering and interim deputy provost for academic excellence, received Distinguished Life Member recognition from The American Ceramic Society (ACerS). This is the organization's highest honor.

Brow's research in the physics and chemistry of inorganic glasses has been used in biomedical implants, fuel cell sealants, high-powered lasers and nuclear waste containment, among other applications. A member of the S&T faculty since 1998 and an ACerS member for over 40 years, Brow is an ACerS fellow.

➤ Jung named NAI senior member

Steven Jung, an adjunct professor of materials science and engineering at Missouri S&T who developed a specialty glass used to speed healing of open wounds, was named a senior member of the National Academy of Inventors in 2020.

Jung, the chief technology officer at specialty glass manufacturer Mo-Sci, holds bachelor's, master's and Ph.D. degrees in ceramic engineering from S&T.

Jung developed and taught a course on biomaterials and has lectured in tissue engineering and introductory ceramic engineering courses. He holds 26 patents. His research as an S&T student resulted in the Mirragen Advanced Wound Matrix, a glass-based, customizable wound care product that has been commercially available since 2017, and a similar product used in veterinary medicine.

➤ Long named IISE fellow

Suzanna Long, chair and professor of engineering management and systems engineering, was named a fellow by the Institute of Industrial and Systems Engineers (IISE). The honor is granted to only 0.1% of the organization's members in any year and is the highest membership classification.

Long has been primary investigator or co-primary investigator in 39 externally funded research projects since joining the faculty in 2008. She studies critical and sustainable infrastructure, supply chain management and transportation, organizational behavior, strategic management and systems management. Her geospatial project through the U.S. Geological Survey was selected for inclusion on GEOPLATFORM, the first time that any project funded by the U.S. Department of the Interior received this honor.

Long earned two bachelor's degrees, a master's degree and a Ph.D. at Missouri S&T.

➤ Reidmeyer named ACerS fellow

Mary Reidmeyer, teaching professor emeritus of materials science and engineering at Missouri S&T, was named a fellow of the American Ceramic Society (ACerS).

Reidmeyer earned bachelor's, master's and Ph.D. degrees in ceramic engineering from Missouri S&T and worked in the refractories industry before joining the S&T faculty.

➤ Corns named ASEM fellow

Steven Corns, associate professor of engineering management and systems engineering at Missouri S&T, was elected to the 2020 class of American Society for Engineering Management (ASEM) fellows.

Corns has served as an author for the engineering management body of knowledge and track chair for several ASEM International conferences. Known for his work with S&T's engineering management and systems engineering graduate program, he has received the ASEM Founders Award multiple times as associate chair of graduate programs.

➤ Luks named AIChE fellow

Christi Patton Luks, teaching professor of chemical and biochemical engineering at S&T, was elected fellow of the American Institute of Chemical Engineers (AIChE) in recognition of her contributions to the chemical engineering field. A fellowship is the highest grade of membership in the organization.

Luks earned a bachelor's degree in chemical engineering from Texas A&M and a master's degree in applied math from the University of Tulsa, where she also earned a doctorate in chemical engineering. She worked briefly in industry and joined the faculty at Missouri S&T in 2014. She serves on the board of the American Society for Engineering Education and is a past national president of Omega Chi Epsilon, the chemical engineering honor society.

➤ Oboh-Ikuenobe named fellow of paleontology society

Francisca Oboh-Ikuenobe was elected fellow of the Paleontological Society in recognition of her contributions to the field of paleontology.

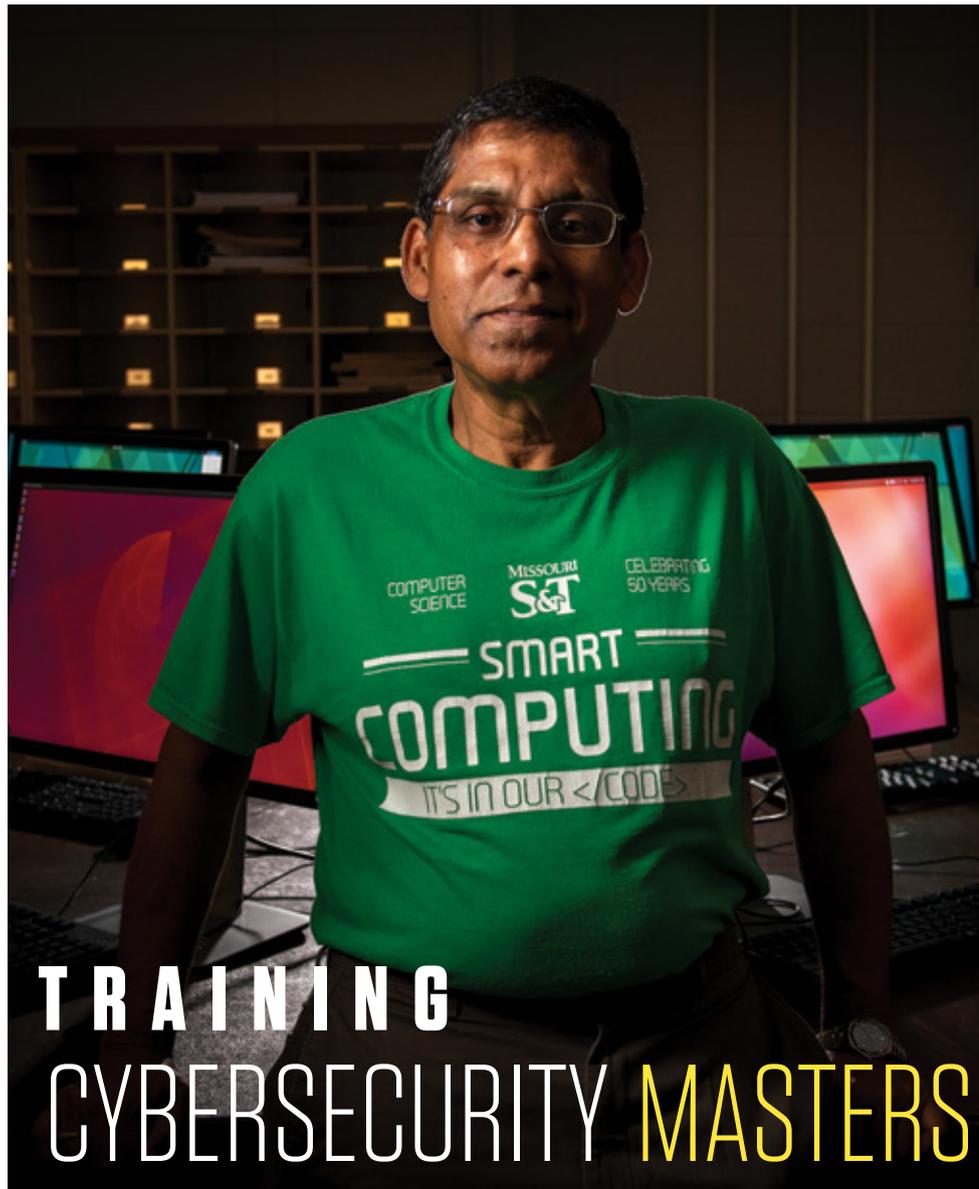
Oboh-Ikuenobe, associate dean for academic affairs in the College of Engineering and Computing at Missouri S&T, as well as professor of geosciences and geological and petroleum engineering, joined the S&T faculty from the University of Cambridge in 1991. She studies palynology, biostratigraphy, sedimentology, sequence stratigraphy and paleoclimatology.

The Paleontological Society is an international nonprofit organization devoted exclusively to the advancement of the science of paleontology: invertebrate and vertebrate paleontology, micropaleontology, and paleobotany.

➤ Hor is six-time highly cited researcher

For the sixth time, **Yew San Hor**, an associate professor of physics at Missouri S&T, was named on the annual Highly Cited Researchers 2020 list from Clarivate.

Hor's focus is experimental condensed matter physics. He explores novel solid-state bulk and nanostructured materials, and his work has implications in topological materials, which hold promise as building blocks for quantum computers, efficient electronics components and catalysts, or magnetic storage media.



TRAINING CYBERSECURITY MASTERS



Missouri S&T continues to combat cybersecurity threats by training the next generation of experts in the field.

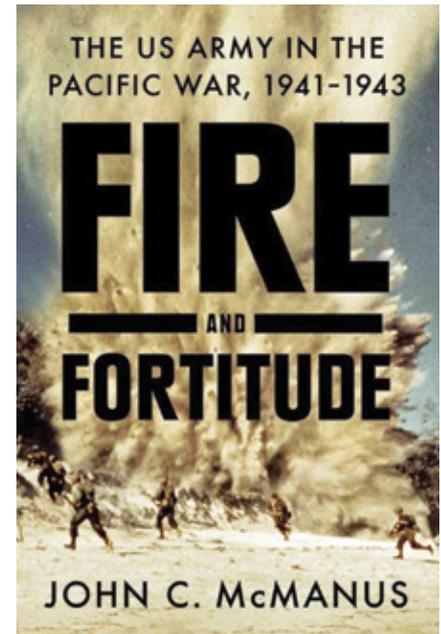
A new \$225,000 grant from the National Science Foundation is funding its "Scholarship for Service" master of science and Ph.D. students, who will specialize in cybersecurity.

After graduating, the scholarship recipients will serve at a federal agency to protect the U.S. government from cyberattacks.

Sajal Das, the Daniel St. Clair Endowed Chair of Computer Science at Missouri S&T, leads the project, titled "MASTER: Missouri Advanced Security Training, Education and Research." This additional grant brings the S&T program's total to over \$3 million in funding.

The program is part of the U.S. government's CyberCorps Scholarship for Service (SFS) through the National Science Foundation in conjunction with the U.S. Department of Homeland Security.

Colleges and universities can earn the grant only if they are certified by the National Security Agency as a National Center of Academic Excellence for Information Assurance Education. Missouri S&T was the first higher education institution in Missouri to achieve that designation and has held the title since 2007.



'BOLDLY REVISIONIST' LOOK AT WWII IN THE PACIFIC EARNS HISTORIAN GILDER LEHRMAN PRIZE

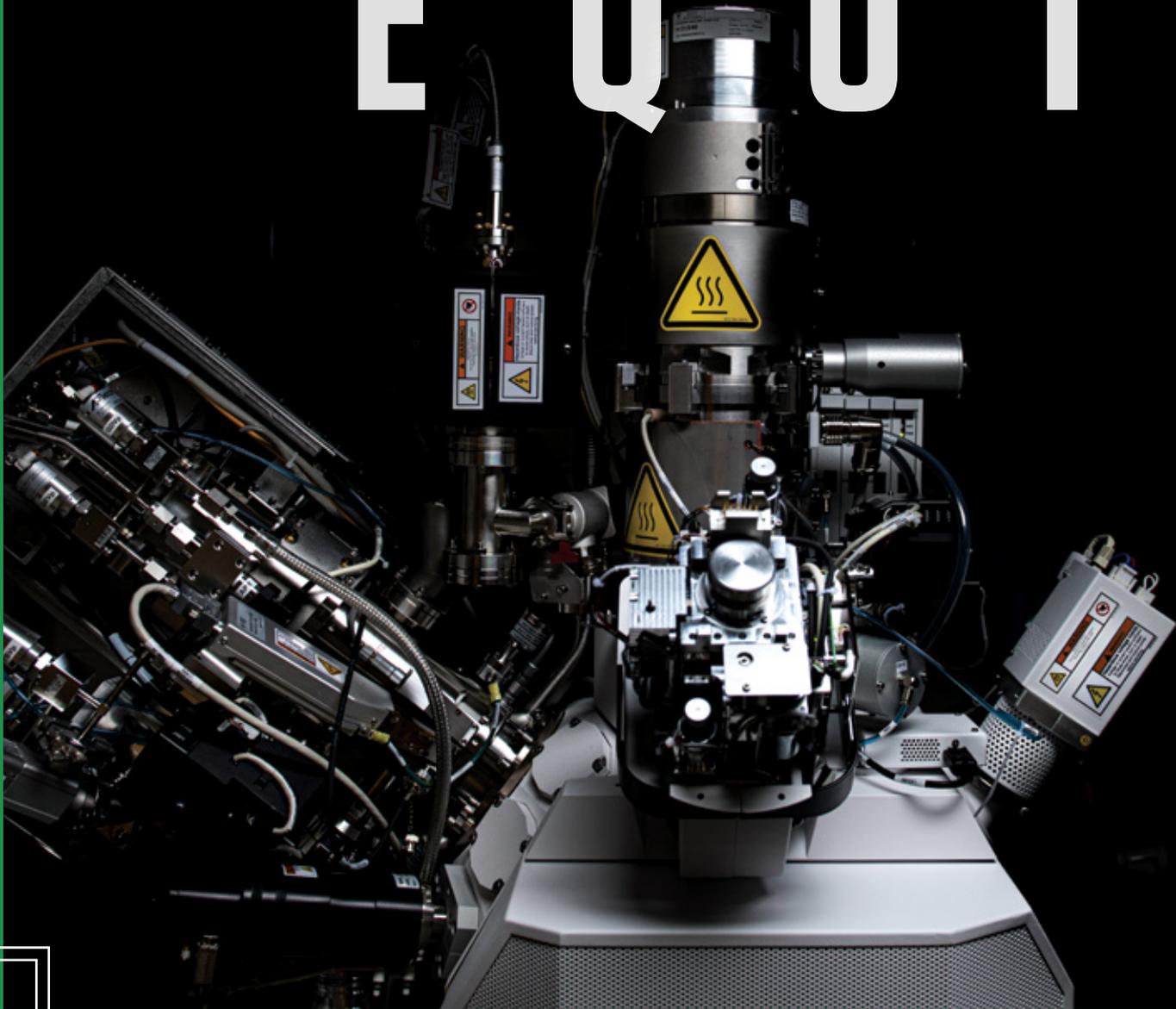
In his 13th book on U.S. military history, **John C. McManus** examined the Army's experience in the Pacific and East Asia during the first half of World War II, from the Japanese attack on Pearl Harbor to the November 1943 Battle of Makin.

Fire and Fortitude: The US Army in the Pacific War: 1941-1943 earned McManus a \$50,000 prize from the Gilder Lehrman Institute of American History for the best book on military history of the year. McManus is a Curators' Distinguished Professor of history at Missouri S&T.

The award is designed to draw public attention to military history as an important staple of education in international relations, diplomacy and conflict studies.

"*Fire and Fortitude* is an epic human story, one that I have wanted to tell for years," McManus says. "I discovered tremendous amounts of new, original source material and came to realize that the Pacific War set the tone for so much subsequent American history."

E Q U I P



FOCUSED ION BEAM/SCANNING ELECTRON MICROSCOPY-HELIOS HYDRA CX

Researchers in materials science, chemistry, physics, biomedicine and other disciplines have expanded capabilities with the addition of \$6 million in the latest equipment at Missouri S&T. The centerpiece is a \$4 million dual-beam instrument that incorporates a scanning electron microscope and a plasma focused ion beam that allows researchers to add or remove materials on the nanoscale level and examine what is below the original surface of a specimen without removing it from the microscope.

"If you see something interesting with the electron microscope, you only see what's on the surface of the material," says **William Fahrenholtz**, Curators' Distinguished Professor of ceramic engineering and director of the Materials Research Center at Missouri S&T. "The focused ion beam

allows you to mill into the material and see if the thing you noticed is just a surface feature or something that extends down into the bulk."

Missouri S&T has also acquired a new scanning electron microscope and an X-ray photo electron spectrometer to characterize the microstructures and compositions of materials.

"These new instruments will expand the quality and quantity of research by enabling us to provide better support for researchers," says Fahrenholtz.

The equipment was acquired with funding through Tier 1 of the University of Missouri System's Research and Creative Works Strategic Investment Program. The acquisition also benefited from a substantial discount as part of the agreement between the UM System and Thermo Fisher Scientific.

M E N T

E X P A N S I O N



HIGH-RESOLUTION, 4D X-RAY COMPUTED TOMOGRAPHY (XCT) SYSTEM

Hospital personnel use CT scanners to examine internal organs, but Missouri S&T's advanced high-resolution, 4D X-ray computed tomography (XCT) system produces higher-resolution images that give researchers new insight into material properties.

Funded with a \$918,397 National Science Foundation Major Research Instrumentation (MRI) award, the device will allow S&T researchers and partners to conduct fundamental materials research.

"The XCT can be used to characterize a broad range of materials, from soft biological materials to engineering materials, which are much harder than human organs," says **Hongyan Ma**, assistant professor of civil, architectural and environmental engineering. Customized

characterization modules allow researchers to study materials under stresses, changes to temperature and humidity, and specific atmospheric changes. The high-speed scanning rate of this XCT will enable so-called 4D scanning — tracing relatively fast evolutions of 3D microstructure following the fourth dimension, time.

"With this instrument, Missouri S&T will potentially be a leader in science and technology research in the region," says **Monday Okoronkwo**, principal investigator on the grant and assistant professor of chemical and biochemical engineering. "We're hoping S&T's new capabilities will make our researchers more competitive and strengthen our education."



ROTATIONAL MICROWAVE SPECTROMETER

Several universities will benefit from a new rotational microwave spectrometer at Missouri S&T, thanks to a \$1.5 million award from the National Science Foundation. The spectrometer will allow researchers to collect some of the most detailed information available about the structure of gas phase molecules, says **Garry Grubbs**, associate professor of chemistry at Missouri S&T and principal investigator on the project.

The uniqueness of the instrument is its multiple detection points, or antennae, which are designed to increase sensitivity compared to other microwave spectrometers in use today. The spectrometer can also be used to promote scientific discovery in the areas of laboratory measurements of interstellar detection, experimental benchmarking for newly synthesized materials, gas phase molecular interactions, and absolute molecular structure determinations including chirality.



BIOWASTE RESEARCH THAT'S DOUBLY CLEAN

■ **Fateme Rezaei**, associate professor of biochemical engineering at Missouri S&T, is developing a fuel tank that can separate carbon dioxide from methane in biogas, making the methane available to power the vehicle. The research could let drivers pump gas from decomposing plants and animal waste directly into their car's fuel tank.

Above: Missouri S&T graduate student Shane Lawson (right) works with Fateme Rezaei, an associate professor of biochemical engineering, in the Adsorption and Separation Lab at S&T.

As biomass decomposes, it releases methane and carbon dioxide. The methane can be burned as fuel, but first the carbon dioxide has to be removed.

"We are able to store biogas in our tank, and we are able to separate CO₂ and methane on board," Rezaei says. "The fuel would be doubly green in terms of environmental impact because it is produced using green energy technologies. Plus it requires no transportation."

With funding from a \$550,000 National Science Foundation grant, Rezaei is designing a fuel tank that contains a porous material that separates CO₂ from methane and sequesters it so it can be returned to the fueling station and used in industrial applications or sequestered to keep it out of the atmosphere.

Because the fuel tank would be on board a vehicle, no pipelines or transportation are necessary. Rezaei says the cost to build natural gas pipelines is around \$1 million per mile.

"It costs too much for smaller operators to clean biogas to pipeline standards, including separation of CO₂," says Rezaei. "They offer lower-grade renewable natural gas (RNG) for heating and electricity production, but conventional natural gas vehicles run on pipeline-grade natural gas or compressed natural gas. Compressing RNG to fueling station pressure is too expensive for small biogas operators."

Rezaei says her research could benefit farmers and others in rural areas. "Biowaste is plentiful in rural areas, and this technology would reduce the barriers to fueling tractors or other vehicles with natural gas."

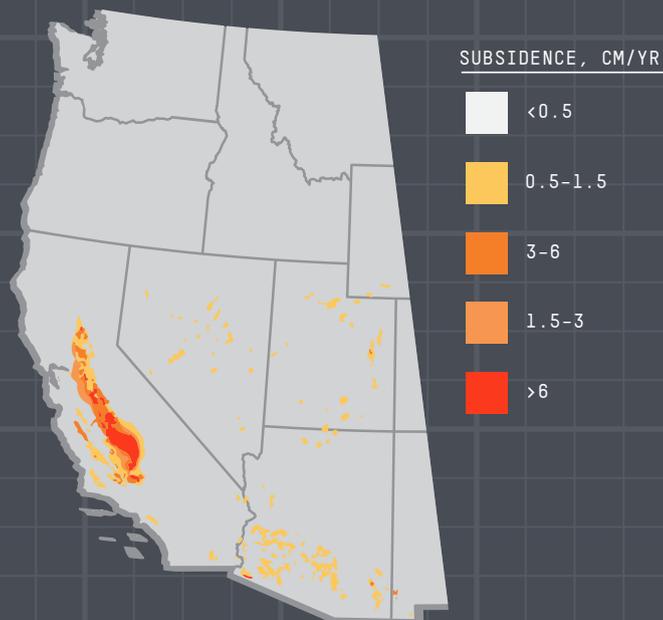


Image indicates the estimated rate of land subsidence in areas with high groundwater use in the western U.S.

THAT SINKING FEELING ... LAND SUBSIDENCE

Too much pumping from underground aquifers is causing the surrounding land to sink, and damage to streets, bridges and other infrastructure, reduced groundwater storage, and contaminated drinking water will soon follow.

Missouri S&T researchers are using machine learning to map the sinking — called land subsidence — to help water policy officials make informed decisions.

Ryan Smith, an assistant professor of hydrology in the geosciences and geological and petroleum engineering department at S&T, says rising temperatures, changing precipitation patterns and increasing demand for fresh water are putting additional strain on aquifers. More frequent and extreme droughts as well as floods reduce the ability to capture and store water.

Traditional methods of measuring land subsidence in areas of groundwater extraction are time consuming, expensive, and could result in errors or gaps, Smith says. Conversely, machine learning quantifies the relationship between widely available groundwater data and land subsidence to predict future subsidence. The data include rates of evaporation from land surface and plants, land use, and sediment thickness.

To carry out their research, Smith and his Ph.D. student, **Sayantana Majumdar**, compiled hydrologic and subsidence data from satellites and ground-based GPS stations across the western U.S., including California, Arizona and Nevada.

Smith and Majumdar are extending their method to estimate other hydrologic conditions, such as groundwater demand in high-use aquifers, including the High Plains Aquifer in Kansas, the Basin and Range Aquifers in Arizona, and the Mississippi River Alluvial Aquifer in the southern U.S. The results could affect groundwater management around the world and in Missouri.

"The wet region of southeast Missouri has high groundwater demand for crops," Smith says. "Officials in the Mississippi alluvial plain could use what we've learned to plan ahead for groundwater needs. We want to work with the agriculture community for a win-win."

TRUSTING THE POWER OF THE SUN

With a \$250,000 grant from the National Science Foundation, Missouri S&T researchers are examining how utility customers use electricity, how utility companies distribute power, and how consumer acceptance levels and economic factors affect the adoption of renewable energy, specifically solar power.

"We want to understand the factors that affect electricity use and adoption of solar energy," says **Islam El-adaway**, the Hurst-McCarthy Professor of Civil Engineering at Missouri S&T, who is conducting the research with Ph.D. student **Gasser Ali**.

El-adaway says solar power can lower costs and increase reliability and power quality as traditional power plants age and are taken offline.

In collaboration with the University of Tennessee in Knoxville, El-adaway and Ali work with the southeastern electric grid of the Tennessee Valley Authority to gather information about its transmission lines, the AC transmission grid and generating units.

By surveying residential electric consumers, El-Adaway can determine how they use power and how motivated they are to participate in programs that allow them to reduce consumption during periods of higher prices. He will also gather information from commercial power users about their experience and concerns with solar power.

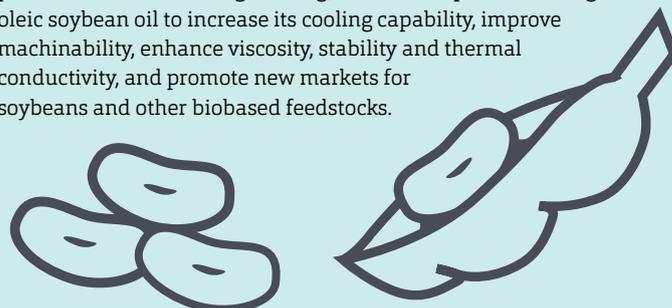


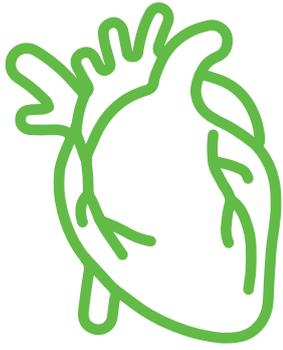
SAVINGS FROM SOYBEANS

Replacing a petroleum and water mixture with soybean oil as a lubricant and cooling agent used in cutting metal would save money, reduce environmental impact, be safer for workers, and potentially help soybean farmers across the United States, say Missouri S&T researchers who are developing the method.

"Conventional metal-cutting cooling methods use a petroleum-based oil combined with water to flood the cutting tool, but the metal at the cutting zone can cause health issues for workers and disposal poses environmental risks," says **Anthony Okafor**, professor of mechanical and aerospace engineering at S&T. "Soybean oil is safe and biodegradable, and our method saves materials costs because only drops of soybean oil are used."

Okafor is working with **Monday Okoronkwo**, an S&T assistant professor of chemical engineering, to add nanoparticles to high oleic soybean oil to increase its cooling capability, improve machinability, enhance viscosity, stability and thermal conductivity, and promote new markets for soybeans and other biobased feedstocks.





HEART HEALTH: CURING CHRONIC ARTERY DISEASE AT THE CELLULAR LEVEL

Fats, cholesterol, calcium and other substances that make up arterial plaque in the blood can restrict blood flow to organs and other parts of the body. When bits of this plaque break loose, heart attack or stroke can result. While there is currently no cure for atherosclerosis, it can be slowed with statin drugs and dietary changes.

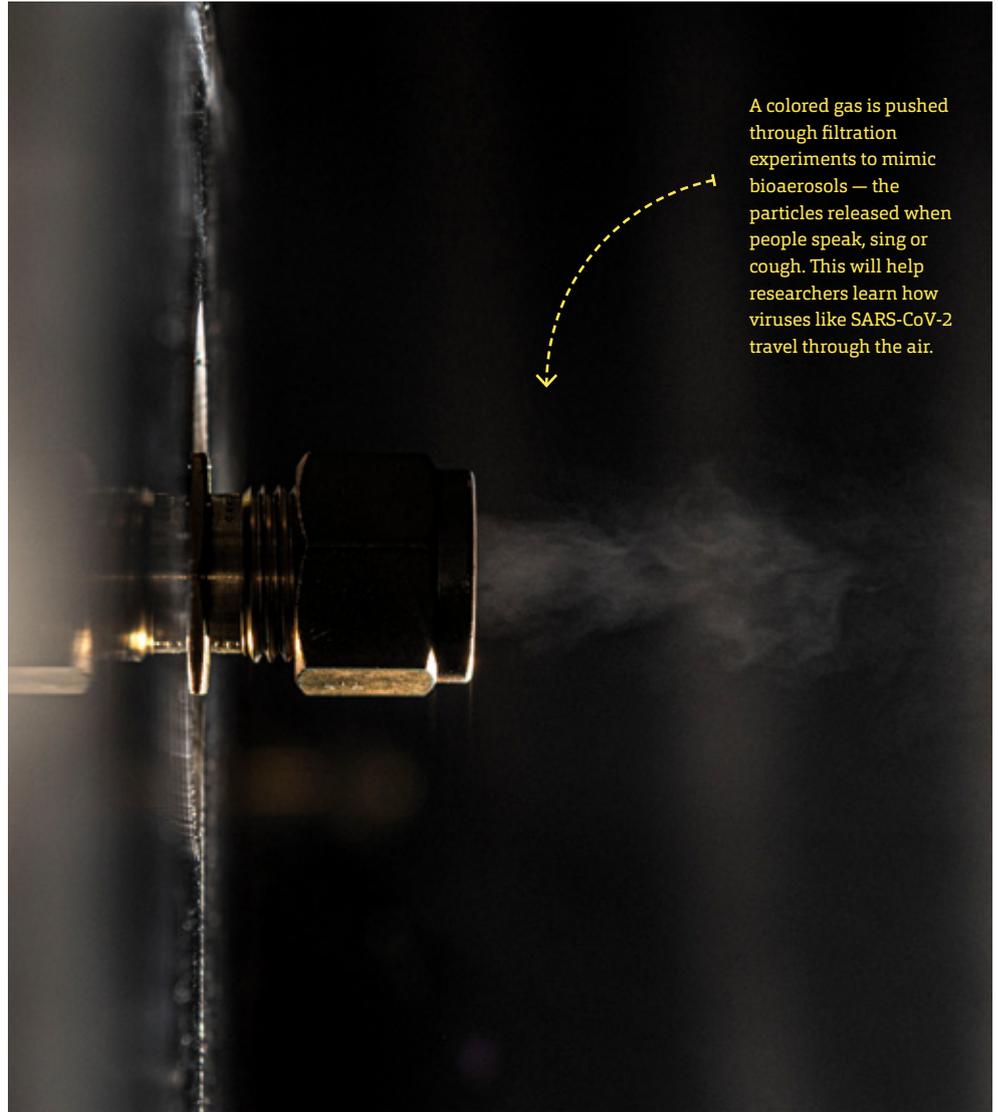
A new method being developed by S&T researchers takes a different approach.

Missouri S&T is partnering in National Institutes of Health-supported research that uses nanoparticles 1/500th the diameter of a human hair to deliver plaque-busting drugs to specific cells in arteries. The approach could lead to a cure for chronic atherosclerosis.

"Our nano formulation directly targets plaque cells and shuts down the intake pathway," says **Hu Yang**, endowed chair of the Doshi Department of Chemical and Biochemical Engineering at Missouri S&T. "We essentially retrain the cells to move cholesterol and lipids through the arteries without accumulating. The drug can also remove cholesterol that is already in the plaque cells, something current medications cannot do. We have observed a significant reduction in plaque in just a few months of experiments."

Yang says the next step is to understand how the body flushes cholesterol from the system after it clears the arteries and then to design the drug's dose strength.

Building evidence of the treatment's efficacy will help attract interest from pharmaceutical companies. Another goal is establishing human clinical trials to ensure effectiveness and safety.



A colored gas is pushed through filtration experiments to mimic bioaerosols — the particles released when people speak, sing or cough. This will help researchers learn how viruses like SARS-CoV-2 travel through the air.

Want to avoid COVID-19? Replace your furnace filter

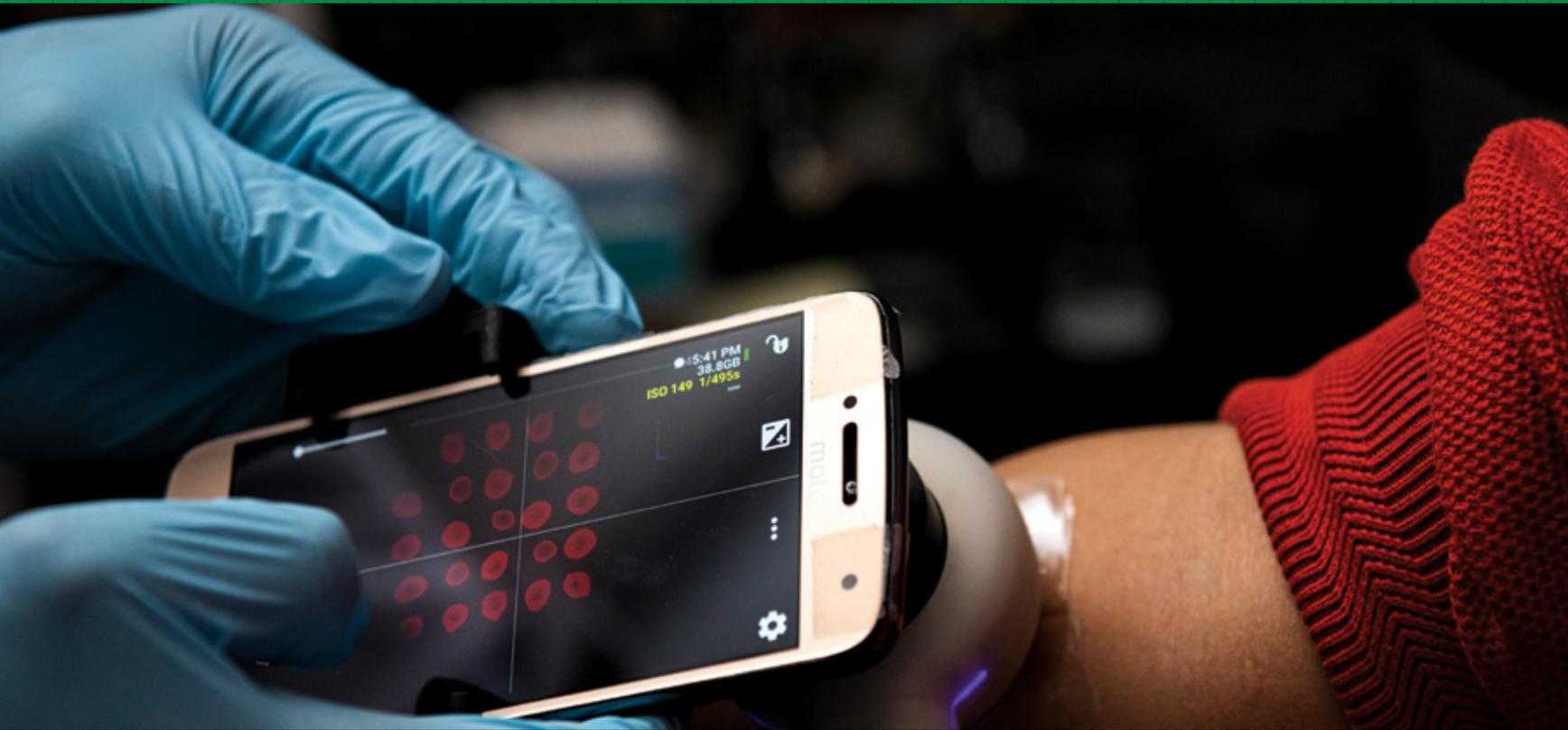
Yue-Wern Huang, director of S&T's Laboratory of Environmental Toxicology and a professor of biological sciences, is studying bioaerosols — the particles people release when they speak, sing or cough — to see how viruses like SARS-CoV-2 travel through the air, how time and environmental conditions affect their viability, and how proper ventilation can help control viral spread.

He and fellow researchers **Yang Wang**, an assistant professor of civil, architectural and environmental engineering, and **Guang Xu**, an associate professor of mining engineering, use a portal chamber and a walk-in chamber to simulate and then study the behavior of bioaerosols by collecting and analyzing pathogens on various filters.

"As particles travel in time and distance, their physical properties such as size continue to change due to environmental factors like humidity and temperature," says Huang. "The viability of pathogens contained within these bioaerosols is largely unknown right now."

The project is funded by a \$330,000 grant from the National Science Foundation.

So far, the team's findings call for air filters with the highest MERV (Minimum Efficiency Reporting Values) rating possible to be used indoors. Portable air filters could provide additional protection. Even a box fan with air filters taped to the front and back could provide additional air filtration.



Need a bandage?

There's an app for that

Missouri S&T researchers are combining biomedical engineering with best practices in medicine to develop the first smart sensor bandage that can detect ulcer formation and potentially prevent skin decomposition.

The researchers are printing an oxygen-sensing patch on a flexible, disposable bandage that can interact with a smartphone. This smart bandage could enable remote monitoring for the early detection of illness, allowing for immediate treatment or intervention.

"Our current work focuses on designing and optimizing a tissue oxygen sensor by using inexpensive inkjet printing techniques," says **Chang-Soo Kim**, professor of electrical and computer engineering at Missouri S&T. "Concurrently, we are developing a smartphone app that can interpret sensor images. This prototype will be evaluated using phantom tissue that mimics a pressure ulcer site."

Kim is working with Rolla dermatologist **William Stoecker**, an adjunct assistant professor of medicine at S&T, and **Paul Nam**, an associate professor of chemistry at S&T. Together, they hope to create an affordable, user-friendly diagnostic bandage that would provide early intervention for chronic sores.

Chronic wounds like ulcers are increasing due to the growing prevalence of diabetes, obesity, strokes and other vascular diseases found in aging populations, says Stoecker. Prolonged immobility from hospital stays or assisted-living care can also lead to such sores.

Generally, ulcer injuries must be assessed manually and evaluated by medical personnel. But a smart dressing could sense impaired blood circulation and poor oxygenation around the at-risk skin region.

Intervening at the site of an injury like a foot ulcer before it is even visible to the eye, these smart bandages can provide feedback to a patient's care provider and complete a diagnosis, all from the patient's home.

"Our optical sensor bandage functions by detecting a low skin oxygen level caused by compromised circulation," says Kim. "This low oxygen produces a color change called luminescence intensity. The smartphone can then take a photograph of the dressing and transmit it to enable remote monitoring or encourage timely intervention before major skin decomposition occurs."

QUICK FIX

FOR POST-CRASH BRIDGES



Vehicle collisions with bridge supports or girders are the second leading cause of bridge collapse in the United States, with an average of three such crashes per day.

A Missouri S&T project supported by \$755,000 in funding managed by the Missouri Department of Transportation could reduce repair costs and find safer, more efficient repair methods.

“First, we examine the remaining strength in a girder after impact. Then, we investigate how to repair the girders to recover their original strength,” says **Mohamed ElGawady**, Benavides Faculty Scholar and professor of civil, architectural and environmental engineering.

There are two possibilities for repair — splicing together severed strands to repair damaged girders or using advanced materials such as fiber-reinforced polymers. ElGawady says the researchers will use materials that are readily available to avoid delays from researching new materials.



BROADBAND BELIEVER

The current lack of high-speed internet in the U.S. means at least 17 million residents can't access online education, telemedicine and remote work. **Casey Canfield**, assistant professor of engineering management and systems engineering at Missouri S&T, is leading a team of experts working to solve that problem.

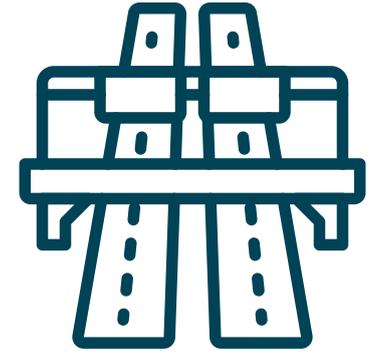
Their project, supported by a \$300,000 grant from U.S. Ignite's Project OVERCOME, is one of seven across the country selected to receive the National Science Foundation funding.

Canfield's team stitches multiple radio frequencies (RF) together to simulate a high-bandwidth device. The method will reduce costs and expand broadband access to underserved communities.

"Our team is deploying a wireless network in Clinton County, in northwestern Missouri, using RF-over-fiber technology to provide high-speed broadband access to residents who are located outside of areas with fiber broadband infrastructure," says Canfield. "We have an amazing team bringing a wealth of experience to the project."

Canfield is working with electrical and computer engineering faculty at Worcester Polytechnic Institute (WPI) in Massachusetts. WPI is providing the underlying technology at the core of this project to make the system a reality. This solution is the result of nearly 14 years of wireless technology research at WPI. As part of their role, WPI researchers will not only program the system to determine when various wireless nodes need to be operational, but also build a replicable architecture for future applications.

Additional partners include United Electric Cooperative, Maximize Missouri, JUPER Communications, University of Missouri Extension and United Fiber.



INFRASTRUCTURE ETHICS

Shane Epting says ethical concerns must be addressed before widespread investment in the transportation network, drinking water systems, renewable energy and other infrastructure projects.

"Often, unintentional consequences can result from improving infrastructure," says Epting, an assistant professor of philosophy at Missouri S&T and co-founder of the global Philosophy of the City Research Group.

He says urban improvements can harm a population's culture in ways most people don't consider.

Epting points to cities like Atlanta, where improvements to the highway system benefit residents in the suburbs, but have left people living in the city's core to deal with increased pollution and adverse health effects such as asthma.

S&T civil engineering professor **John J. Myers**, deputy director of the Missouri Center for Transportation Innovation, says the country needs to invest in infrastructure improvements to keep the business of the nation running efficiently and to create jobs to boost the economy.

But he agrees that infrastructure projects can have negative impacts.

"Sometimes infrastructure can create economic barriers within communities," says Myers. "We need to make sure that people's voices are heard and part of the decision-making process to find common ground."

This fall Epting is teaching a course he created called Creating Future Cities. He says it will show students how transportation, architecture, planning and smart-city infrastructure are all ethical issues that affect most of the world's city dwellers.

"I teach them the canon of moral thought, and then I introduce recent advancements in the philosophy of technology, showing them how to produce better outcomes that can increase safety, manage resources wisely and promote human flourishing," says Epting.

TIMELY STUDY OF LINGUISTICS EQUALITY

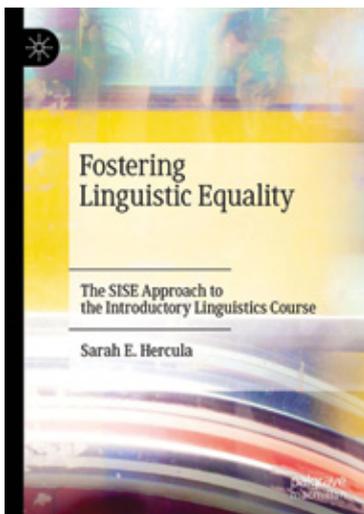
When Missouri S&T linguist **Sarah Hercula** set out three years ago to write her new book, *Fostering Linguistic Equality: The SISE Approach to the Introductory Linguistics Course*, little did she know it would come off the press at one of the most compelling times in the racial history of the United States — fewer than two weeks before the May 25 death of George Floyd at the hands of police.

That defining event, combined with other similar acts, is continuing to stir nationwide conversations about racial injustice.

"The book is a call-to-action for linguists to work to change culturally ingrained attitudes about stigmatized language," says Hercula, an assistant professor of English and technical communication at Missouri S&T who has created a new approach to teaching linguistics. "These attitudes contribute to racial profiling and inequalities throughout our society."

Hercula found that ignorance of the way language variation occurs leads to linguistic discrimination, an erroneous belief that people who speak in certain dialects are less intelligent or inferior to speakers of the preferred or standardized language. These language prejudices and profiling can manifest themselves in a lack of opportunity in employment, housing and education, as well as in the legal system, she says.

Hercula's Structural Inquiry of Stigmatized Englishes (SISE) pedagogy gives teachers, students and researchers tools to counteract prejudicial attitudes and disinformation about language, both in and outside the classroom. The methodology analyzes socially stigmatized dialects, including African American, Chicano and Appalachian Englishes, but it can be used with any number of dialects.



CAUSING A STIR

With funding from a five-year, \$7.5 million grant through the U.S. Department of Defense's Multidisciplinary University Research Initiative competition, three Missouri S&T researchers joined a nationwide effort to create inexpensive materials hard enough to literally stir two pieces of steel together.

Near the top of the Department of Defense's priority list is friction stir welding, which uses a rotating drill-like tool to join two pieces of metal without melting them.

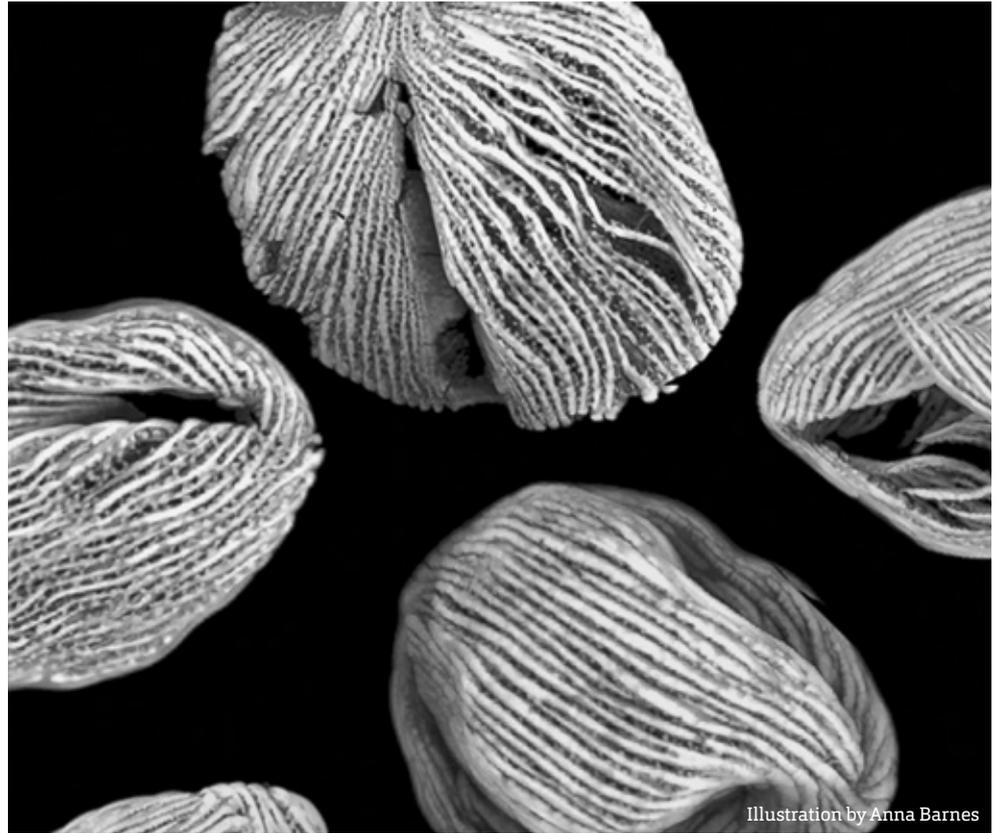
As the tool rotates, it heats and softens the metals, which swirl and mix as the machine moves along a line. Neither metal is heated to its melting point. The result is an extremely strong and durable joint with few defects.

But the technique struggles with steel.

The researchers say a material that combines carbon, boron, nitrogen and five other inexpensive metallic elements could make friction stir welding a viable option.

Enter the Missouri S&T team of **William Fahrenholtz**, Curators' Distinguished Professor of ceramic engineering, **Greg Hilmas**, Curators' Distinguished Professor of ceramic engineering, and **David Lipke**, assistant professor of ceramic engineering. The three are experts in developing materials that can withstand extreme environments — like the ultra-high temperatures hypersonic vehicles experience during flight.

They will use specialized equipment to heat elemental powders to several thousand degrees under high pressures (without melting them) for days, then slowly let them cool. The result, hopefully, is a super-hard high-entropy carbide-boride capable of friction stir welding steel.



New technology gives a closer look at old pollen

Combining high-resolution imaging with machine learning, Missouri S&T geology and geophysics professor **Francisca Oboh-Ikuenobe** is improving the accuracy of fossil pollen identification and discovering links to modern plants. The process is called Airyscanning.

Pollen grains preserved in sediments and sedimentary rocks provide a record of how different groups of plants have evolved and the environmental factors that played a role in their evolution.

Plant scientists and palynologists like Oboh-Ikuenobe identify ancient pollens using observations made under a microscope. But correctly measuring and identifying a pollen grain's shape and structure is difficult because no identification record exists for many ancient pollens. Plus, current methods destroy the sample and are very labor- and time-intensive.

Airyscanning collects cross-sectional images of the pollen without destroying the grain. Scientists train machine classification models using pollen from living plants to confirm their fossil relatives, and with each identification, the models learn to differentiate among specimens that closely resemble one another.

This allowed the team to recognize new genera within a larger morphological grouping of fossil legume pollen and classify specimens from western Africa and northern South America dating back to the Paleocene (66 million–56 million years ago), Eocene (56 million–34 million years ago) and Miocene (23 million–5.3 million years ago) with 90.3% accuracy.

AFTER THE QUAKE



Jonathan Obrist-Farner, assistant professor of geosciences and geological and petroleum engineering (GGPE) at Missouri S&T, studies a particular type of sediment formed during earthquakes to dig into the history of quakes along the North American-Caribbean tectonic plate boundary. His work will help scientists better understand how and when earthquakes occur in the region and will provide new insights for elementary and middle school students.

His five-year \$720,000 Faculty Early Career Development (CAREER) Award will support his study of sediment cores from Guatemalan lakes. The project will help him identify earthquake-related sedimentary features and determine their age using radiocarbon dating. He will use the information to determine how frequently earthquakes have happened along the plate boundary, which may offer clues about future temblors.

Obrist-Farner grew up in Guatemala, where earthquakes are fairly common. He says a major earthquake there now could be even more devastating than the 7.5 magnitude 1976 quake that killed over 22,000 people, left over a million homeless and resulted in \$1.1 billion in damages — equivalent to \$5.1 billion today. At that time, he says, the country's population was about 5 million. Now, the population is 18 million, and about 70% of the country's residents live along the fault.

It's the motivation to understand something better for the benefit of humanity."

"That fascinates me as an earth scientist," says Obrist-Farner. "It's the motivation to understand something better for the benefit of humanity. So many fundamental questions are still unanswered."

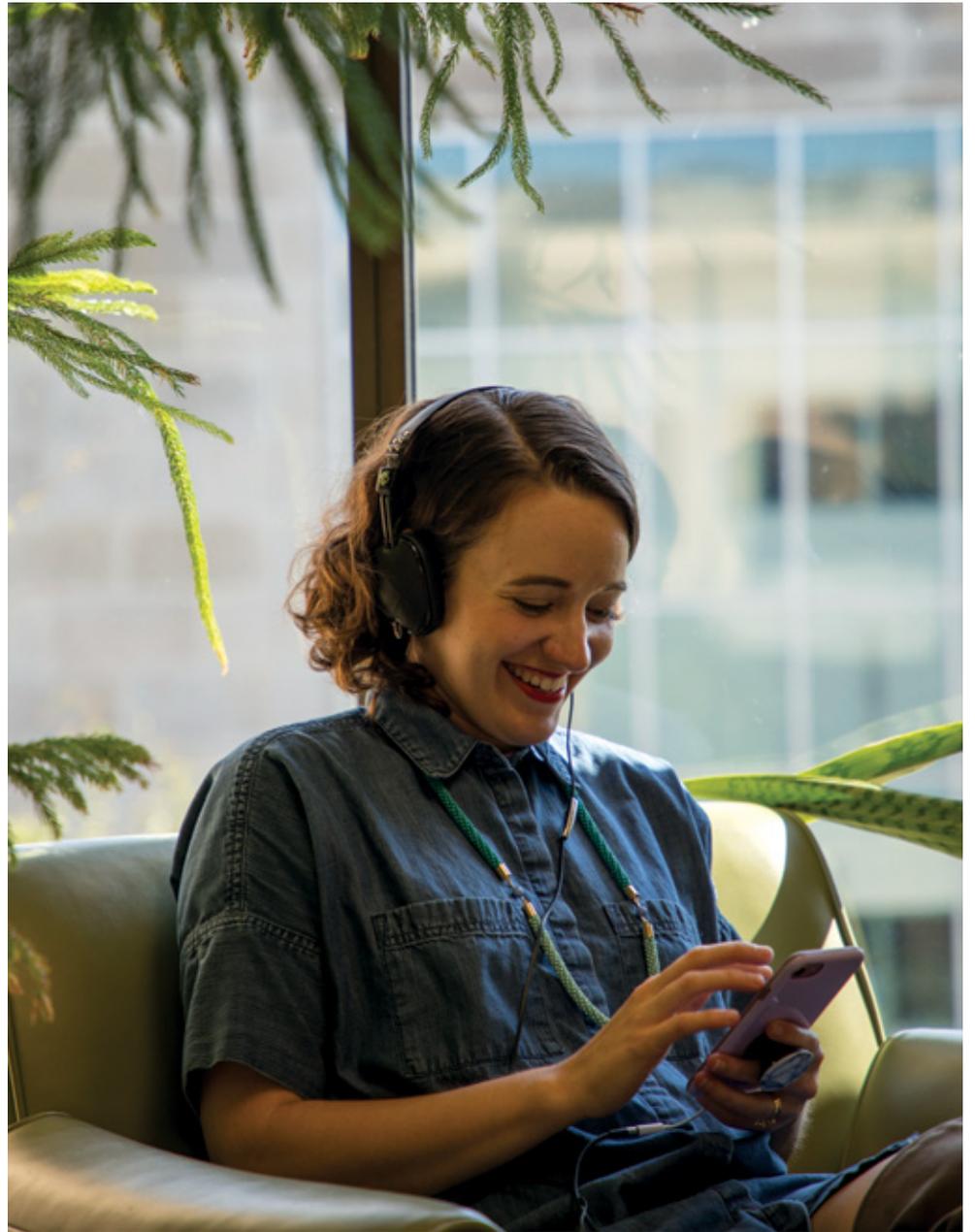


GEORGIA TECH LEADER COLIN POTTS BECOMES S&T PROVOST

Colin Potts, former vice provost for undergraduate education and professor of interactive computing at Georgia Institute of Technology, joined Missouri S&T as provost and executive vice chancellor for academic affairs on June 1.

Potts oversees S&T's academic programs as well as academic support, enrollment management and global learning operations. He succeeded **Stephen Roberts**, who had served as interim since July 2019. Roberts is now vice chancellor of strategic initiatives and chief operating officer of the Kummer Institute at S&T.

At Georgia Tech, Potts oversaw the offices and programs that govern the entire undergraduate education experience. During his tenure, first-year retention reached 96% and the six-year graduation rate hit 90%.



Amy Belfi's infinite playlist

Psychologists and medical researchers for years have used familiar tunes to study brain disorders like Alzheimer's disease and dementia, but they've never had a common set of songs to draw from. A new study by a Missouri S&T neuroscientist could offer a list of "greatest hits" to aid in future studies.

Amy Belfi, assistant professor of psychological science at Missouri S&T, developed a list of 107 well-known tunes she calls the "famous melodies stimulus set" and tested the tunes to see how well people may recall or name a song, as well as how it makes them feel. Working with Belfi was **Kaelyn Kacirek**, who earned a bachelor's degree in engineering management from S&T in December 2020.

Belfi and Kacirek evaluated how study participants responded to familiar melodies from a wide array of genres, including children's songs like "Row, Row, Row Your Boat," holiday tunes like "Rudolf the Red-Nosed Reindeer," religious hymns like "Amazing Grace," and pop and rock classics like "Sweet Caroline."

Participants rated each song on five variables: the emotional categories of valence (from positive to negative) and arousal (from relaxing to stimulating), as well as familiarity, age of acquisition (when subjects recalled first hearing the melody) and their ability to name the tunes.



CHANGING THE LANDSCAPE

As a teen driving his grandfather's riding lawn mower, **George Leno Holmes Jr.** would imagine an army of robotic machines working faster and more efficiently than he ever could.

Now, Holmes and business partner **Keiry "Katie" Moreno Bonnett** are amassing that army.

Their startup, Hire Henry, aims to automate landscaping by equipping heavy-duty yet compact mowers with robotics and artificial intelligence.

"Our goal was to take a job that previously required one person to sit on one riding lawn

mower in the hot sun for 10 hours a day, and transform it into a job where one person can manage 10, 15, 20 different mowers from a laptop or phone screen," Holmes says.

He earned a bachelor's degree in mechanical engineering from S&T in 2016 and a Ph.D. in 2020. He says S&T's undergraduate experience

fueled his interest in entrepreneurship, and his Ph.D. journey led to a partnership with Bonnett.

A native of Bogota, Colombia, Bonnett came to the U.S. at 16 to play basketball and transferred to S&T in 2017, playing two seasons for the Miners before earning a B.S. in mechanical engineering in 2020.

Now Hire Henry cofounders, Holmes is chief executive officer, and Bonnett is chief operating officer.

"I never thought I could start a business right out of school," Bonnett says. "Playing basketball, I learned a lot about teamwork, and that's important for a new company. I think George and I make a great team."

Both believe Hire Henry will transform the landscaping business just as AirBnB has the hospitality industry.

"We're developing the future of the lawn care industry," Holmes says.

Reading

RO

YUN SEONG SONG

ASSISTANT PROFESSOR OF MECHANICAL
AND AEROSPACE ENGINEERING

1

1. NSF CAREER Award recipient Yun Seong Song is teaching robots to interact with people by studying the way people purposefully stiffen or relax their arms – known as impedance modulation – to find the mechanism humans use to constantly process information and make decisions while interacting with others.
2. The computer screen displays the way robot cameras capture the motions of the human it interacts with.

BOT

BODY LANGUAGE



IS YOUR SMART WATCH SHARING YOUR DATA?

You may not realize it, but internet-connected devices like your Ring doorbell, Peloton exercise bike and Nest thermostat all exchange data with other devices and systems over the network.

Internet of Things (IoT) objects like these come with sensors and software, and they often use cloud computing. Most people consider the information they contain — like your height and weight or the times you're away from home — to be highly private.

Device manufacturers need the data to improve their products, but customers want assurance their private information is secure.

S&T researchers say beefing up cybersecurity by improving a machine-learning technique called federated learning could let companies develop new ways to collect anonymous but accurate data.

Federated learning trains algorithms to access multiple individual devices that hold local data. It doesn't exchange data, so no central dataset or server stores all your information.

Sajal Das, the Daniel C. St. Clair Chair of Computer Science at S&T, warns that IoT devices are vulnerable to dynamic environments and attacks from outside sources with erroneous data. He and his co-investigator **Tony Luo**, an associate professor of computer science, are designing new federated learning algorithms with the National Science Foundation, putting data safety and accuracy above all else.

They hope users will contribute data to machine learning with confidence their data is unidentifiable.

Research to understand how humans and robots communicate and interpret each other's intentions garnered a Faculty Early Career Development (CAREER) Award for **Yun Seong Song**, assistant professor of mechanical and aerospace engineering at Missouri S&T. The five-year, \$538,876 award from the National Science Foundation (NSF) will support Song's research to advance physical human-robot interaction.

As robotic systems become more prevalent in everyday life, from handling materials in the manufacturing industry to patient care in clinical settings, humans and robots will need to interact intuitively and effectively while touching or holding each other by the hands.

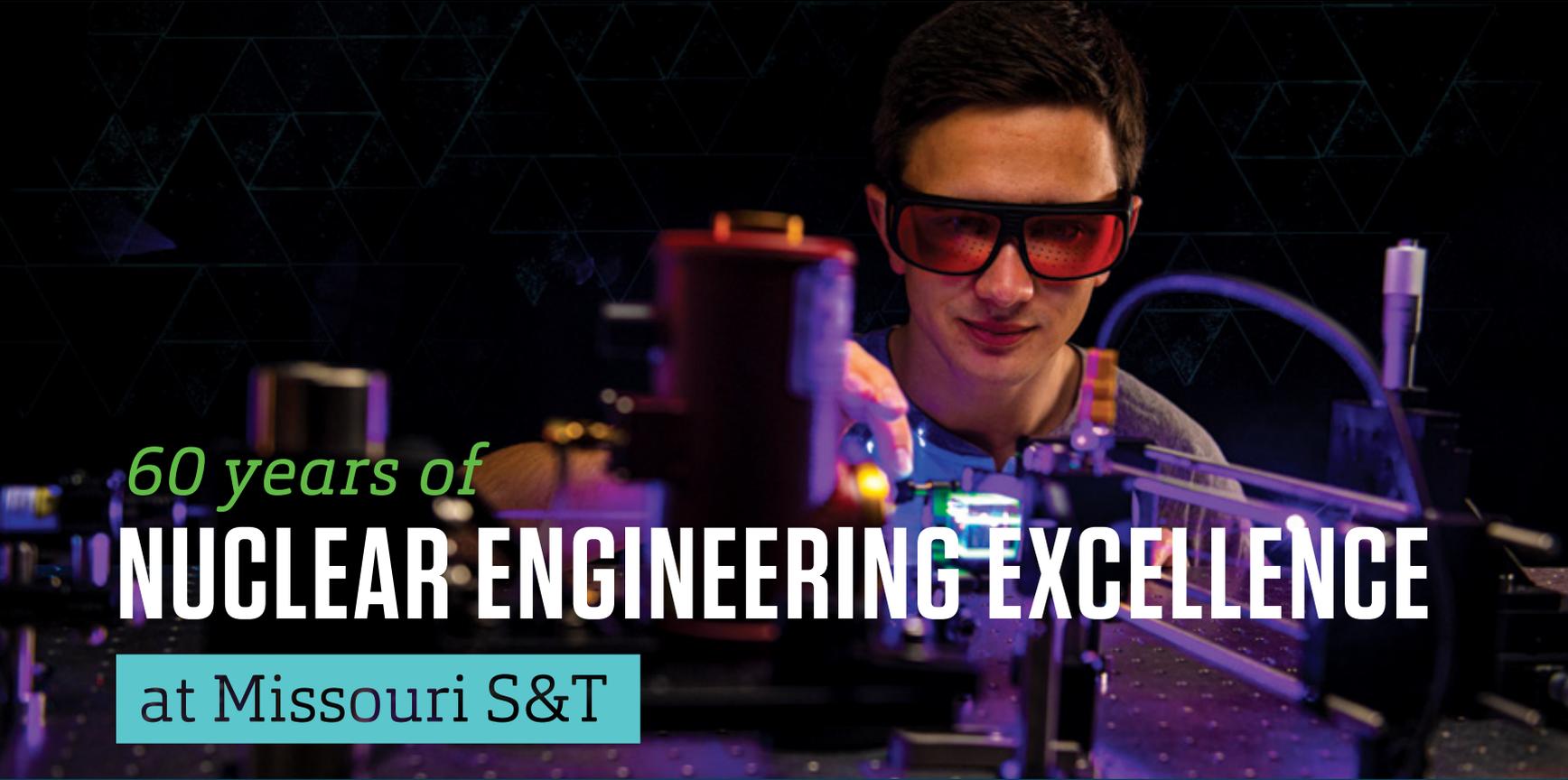
Song wants to understand how a human and a robot can convey intent using interaction forces the way people purposefully stiffen or relax their arms — known as impedance modulation — at a single point of physical contact.

"At first glance, physical interaction is a dynamic task with power exchanges dictated by the passive properties of the interacting beings," explains Song, the director of S&T's physical Human-Robot Interaction Laboratory (pHRI Lab). "But if you examine how humans handle physical interaction, you realize that there has to be constant processing of information and decision making to infer each other's intent. Uncovering the mechanism through which this happens will help us design future robots that can seamlessly interact with their human partners."



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As the U.S. moves toward greater use of renewable energy, nuclear industry experts gathered to discuss America's nuclear future during a virtual symposium hosted by S&T in April 2021. Although not often included in discussions about alternative energy sources, nuclear power accounted for more than half of the nation's carbon-free electricity in 2020 and a fifth of overall power generated in the United States in the past 20 years, says **Rich Wlezien**, vice provost and dean of the S&T College of Engineering and Computing.

In 2021, Missouri S&T begins its 61st year of nuclear engineering education. S&T is one of the first institutions in the nation to offer a nuclear engineering degree and is home to the first nuclear reactor in Missouri, a "swimming pool" reactor used for student and faculty training and research since 1961.

The U.S. Department of Energy recently recognized the program with a \$168,500 award for one scholarship and a three-year fellowship to strengthen the ties between S&T faculty and students and DOE's energy research programs.

"Our students will create tomorrow's cutting-edge solutions in nuclear energy," says **Ayodeji Alajo**, associate professor and interim chair of nuclear engineering and radiation science. "The DOE award and the symposium are high points in the celebration of our students and our department."