MAE

Mechanical and Aerospace Engineering | 2021 Newsletter

CAMT GETS PRODUCTION READY

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MISSOURI S&T

MESSAGE FROM THE CHAIR

Dr. David J. Bayless, MAE department chair

MAE ALUMNI, FACULTY, STAFF, STUDENTS, AND FRIENDS,

It may be because I am relatively new on the job, or the excitement of returning to Rolla after receiving my B.S. in mechanical engineering at S&T (then UMR) 34 years ago, but I can't help being optimistic about the future of the mechanical and aerospace engineering department. We can reflect on several significant milestones throughout the past year. The campus received a transformative $300,000,000 gift from alumnus Fred Kummer and his wife, June. MAE moved up in the U.S. News & World Report rankings for mechanical engineering (#63 from #65) and aerospace engineering (#38 from #47) in 2021. Our students are launching advisory councils to help the department improve the student experience. And even though the pandemic is on-going, MAE at S&T continues to provide excellence in educational opportunities for our students and research innovation for our stakeholders.

Our talented students, alumni, and faculty continue to impress with their achievements. S&T Racing's Formula SAE Design team placed 3rd at the Formula SAE Michigan competition in July. David Lund, a Ph.D. student in aerospace engineering, received a NASA Space Technology Graduate Research Opportunity award to support research that will help understand the ways plasma and lunar surface dust interact in preparation for the next mission to the moon, the Artemis Exploration Program. Dr. Serhat Hosder, professor of aerospace engineering, was named Royal Aeronautical Society Fellow. Dr. Yun Seong Song joined the sizable list of MAE faculty receiving an NSF CAREER award for early faculty development. His research focuses on the understanding how a human and a robot can communicate each other's intent through impedance modulation at a single point of physical contact. Dr. Dan Stutt's team of graduate and undergraduate students is one of seven teams who won a NASA Breakthrough, Innovative and Game-changing (BIG) Idea Challenge. Their research will focus on removing lunar dust from power-producing solar cells. Hire Henry, a tech startup founded George Leno Holmes Jr., a 2020 mechanical engineering Ph.D. graduate, and Keyri Moreno Bonnett, a 2020 bachelor of science graduate in mechanical engineering, won Alpha Labs Great Hardware Pitch competition for their robotic technology that could transform commercial lawn care. Our alumni in the Academy of Mechanical and Aerospace Engineers have not only provided mentoring for our mechanical engineering senior design teams, but they have also instituted one-on-one mentoring with students for professional development that is a model for other alumni mentoring programs. And these are just a few of the many achievements of MAE.

Finally, I would like to thank all our alumni and friends whose many contributions enhance the quality of our programs and contribute to the education of future Miner engineers. From the new Ed and Carol Haug Freshman and Pathways Scholarships to the numerous phonathan contributions that made the new manufacturing hardware possible to revamp ME 2653 - Introduction to Manufacturing, your support matters! Now, more than ever, our ability to deliver the excellence that has long distinguished our programs depends on you. We look forward to hearing from you and getting you involved in helping future Miners.

With sincerest thanks,

David J Bayless

Chair, Mechanical and Aerospace Engineering

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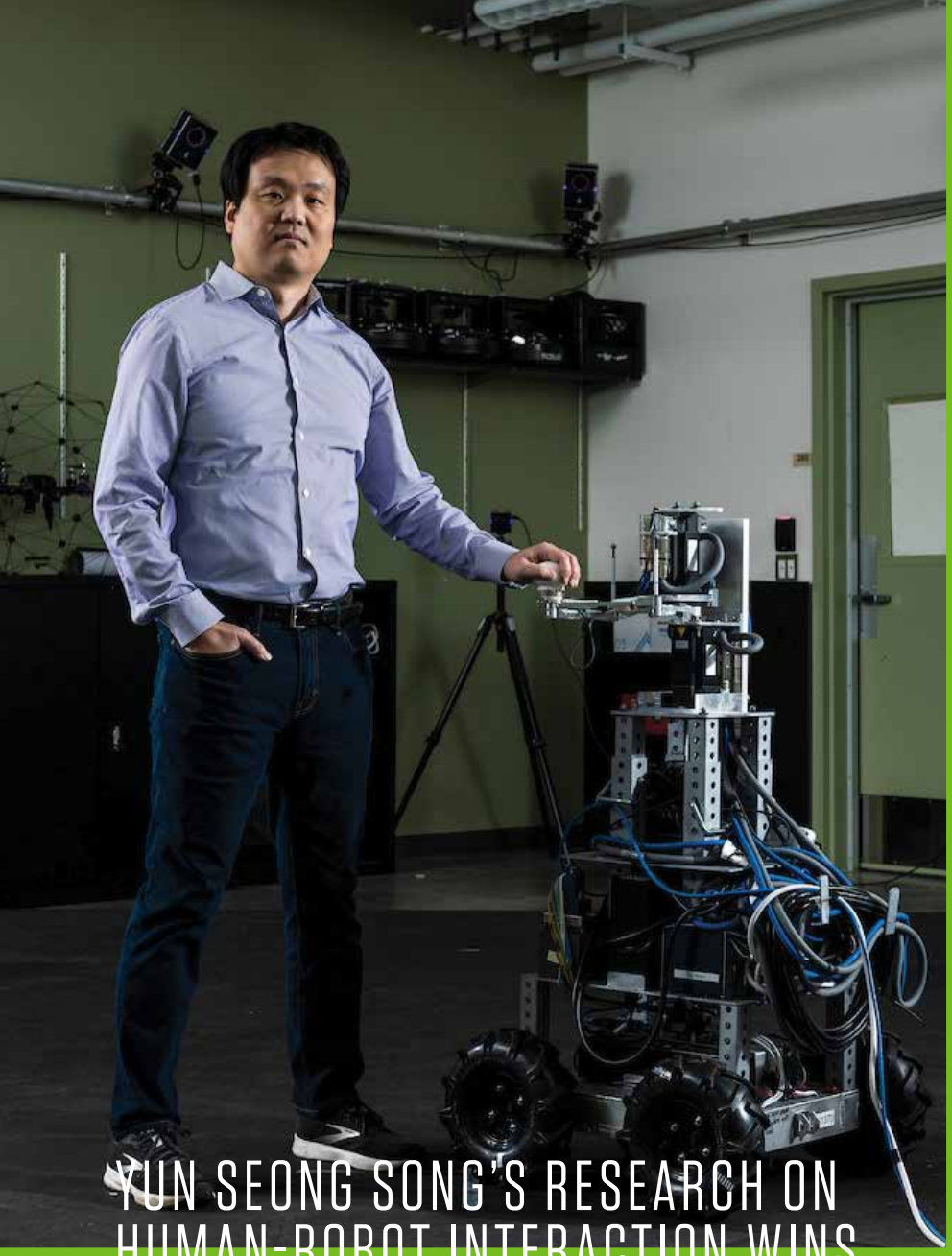


YUN SEONG SONG'S RESEARCH ON HUMAN-ROBOT INTERACTION WINS NSF CAREER AWARD

Research to understand how humans and robots communicate and interpret each other's intentions has resulted in a Faculty Early Career Development (CAREER) award for Dr. 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 materials handling 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. According to Song, this project focuses on understanding how a human and a robot can convey their intent using interaction forces through 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."

The project will employ a robotic system built in the pHRI Lab that interacts with a human as they walk "hand-in-hand" while analyzing the forces at the hands and movements of the arms throughout different scenarios, such as helping someone to walk. The work behind this project will create the groundwork for implementing intuitive physical communication between humans and robots.

The NSF CAREER award supports junior faculty who exemplify the role of teacher-scholars through their outstanding research and education contributions. This recognition ranks Song among the best early career researchers across the U.S.

"Dr. Song is a valued faculty member and researcher at Missouri S&T," says Dr. Costas Tsatsoulis, vice chancellor of research and graduate studies at S&T. "We are pleased with this recognition of his contributions and are proud to have him join the ranks of S&T's CAREER Award winners."

Song joined S&T in 2016 after working as a postdoctoral fellow at Georgia Institute of Technology and Emory University. His research expertise is in physical human-robot interaction, physical human-human interaction, human movement assistance, rehabilitation robotics, wearable devices, energy-harvesting from human movement, and design and instrumentation of medical devices. Song received a master's degree in mechanical engineering from Carnegie Mellon University and a Ph.D. degree in mechanical engineering from Massachusetts Institute of Technology.

JUNE AND FRED KUMMER'S TRANSFORMATIVE GIFT

In the Fall of 2020, the university announced that Fred Kummer and his wife June donated $300 million to a foundation that will support Missouri S&T.

This new gift enables the university to establish the Kummer Institute, and the resulting blueprint splits the effort into three distinct but complementary sections, each corresponding to one part of the Kummers' three-fold vision: the Kummer Institute for Entrepreneurship and Economic Development, the Kummer Institute for Education and Research, and various outreach efforts.

"This gift is transformative for S&T, the Rolla region and our state," said Dr. Mo Dehghani, Missouri S&T chancellor. "For nearly 150 years, Missouri S&T has been known as the state's premier technological university. Now, thanks to June and Fred, S&T will have the opportunity to become one of the nation's leading universities for innovation. At the same time, this gift will make our school a center for entrepreneurship, thereby energizing the economy of the Rolla area and the entire state of Missouri.

"With this gift, we expect to be able to dramatically increase the size of our student body, recruit outstanding new faculty, establish powerful new centers of research, and engage with the community in new and exciting ways," Dehghani said.

The Kummer Institute plan is driven by three goals: elevate S&T, broaden STEM outreach, and make a positive economic impact.

Elevate S&T: Hiring renowned researchers for the institute's four research centers of excellence, attracting new endowed chairs and professorships, and recruiting a transformative academic leader as dean of the Kummer College of Innovation, Entrepreneurship and Economic Development will bring more research funding and greater visibility for the institute and the university as a whole.

Broaden STEM outreach: Science, technology, engineering and mathematics (STEM) fields are important to June and Fred Kummer. That is why a significant portion of their girft is devoted to outreach programs like the Kummer Vanguard Scholarships for first-year students and Kummer Innovation and Entrepreneurship Doctoral Fellowships for Ph.D. candidates.

Make a positive economic impact: The Kummer Institute's four new research centers are expected to stimulate greater innovation in areas critical to the economic development of the state and nation.

"I owe much of my success to the education I received at Rolla," Fred Kummer said. "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, 91, was the 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. He was a 1955 civil engineering graduate of Missouri S&T. Kummer passed away April 30, 2021.

CENTER FOR AEROSPACE MANUFACTURING TECHNOLOGIES GETS PRODUCTION READY

A premier national center for manufacturing research, the Center for Aerospace Manufacturing Technologies (CAMT) at Missouri S&T has seen significant changes and growth over the past few years.

Shifting focus from impact through published research to an industrial impact by directly inserting applied research and technologies into manufacturing production in partnership with companies, CAMT is transforming to be a top value-producing resource for all members. A 6,000-square-foot space and $1.4 million was allocated by the College of Engineering and Computing to begin renovation to house CAMT's pre-production research on industrial manufacturing equipment. This space now houses $5 million in manufacturing equipment assets, including state-of-the-art machines such as the DMG-Mori Lasertec 4300, Renishaw AM250, Stratasys Fortus 400, Optomec LENS LPE), supporting equipment for additive manufacturing pre- and post-processing and characterization, its incremental sheet forming robot, and additional machines arriving from industry partners. This facility and growth give industry researchers and engineers the space to work side-by-side with S&T students on industrial equipment.

CAMT was founded in May 2004 in partnership with the Air Force Research Laboratory and Boeing Research and Technology to serve as a U.S. center of excellence for the development and transition of innovative advanced technologies for the aerospace manufacturing supply chain. This effort was made possible through a federal appropriation of $8.8 million and was one of the nation's largest initiatives to develop new manufacturing methods for the aerospace industry.

CAMT has an array of technologies devoted to advancing manufacturing technologies and supports the research and development efforts of creating knowledge, methodologies, and tools that reduce production cost and lead time while improving quality, reliability, and safety in aerospace manufacturing. CAMT operates on a membership funding model, where each company pays for membership and the membership funds are pooled together to fund research of mutual benefit to the consortium.

Founded by Dr. Ming Leu, Keith and Pat Bailey Distinguished Professor of Mechanical Engineering , CAMT today has grown to become the center point of manufacturing research on campus. Led today by Dr. Doug Bristow, professor of mechanical engineering, CAMT's industry partners and faculty worked together to chart a course for growth. This growth path started with the mission - ...to serve as a national center of excellence to research, develop, evaluate and demonstrate methodologies and tools for rapid and cost-effective manufacturing of aerospace products and to educate the evolving aerospace manufacturing workforce, resulting in significant technological advancement and economic impact.

The team outlined clear objectives to achieve these goals:

• Research, develop, evaluate, demonstrate, and transfer advanced technologies of critical importance to the aerospace defense and commercial manufacturing industries in the United States.

• Create knowledge, methodologies, and tools that can improve affordability, rapidity, quality, productivity, reliability, and safety in aerospace manufacturing.

• Disseminate the knowledge, methodologies, and tools developed by the Center to the aerospace manufacturing industry through direct technology transfer as well as the development of education, training, and outreach activities.

• Serve as a role model of university-industry-government collaborative partnership.

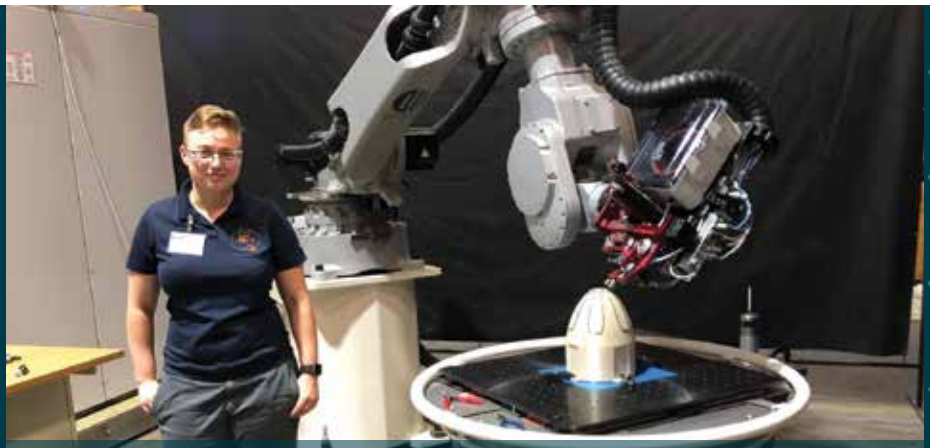
Pictured above: Early stages in the development of a robotic machining research cell. The monitor shows a virtual machining process in-the-loop with the physical robot. Pictured in the right top corner: A robotic sheet forming cell uses digital image correlation measurements in-the-loop to create high accuracy freeform sheet metal parts.

Central to this mission and objectives is the expected result of having direct economic impact to the partner companies investing in CAMT. Traditionally, in universities, this impact has been research papers that companies reference when making technology investment decisions and considering students for employment. CAMT, however, saw the opportunity to take this further and dedicates the largest portion of its research portfolio to applied research in partnership with a member company, thereby enabling the research to be directly inserted into manufacturing production. This paradigm shift allows CAMT to directly impact the success of its partners and produces research that is industrially relevant and students that are industrially ready.

Richard Wlezien, vice provost and dean of the College of Engineering and Computing at Missouri S&T, recognized this shift and saw an opportunity for CAMT to grow the impact across a wider network of industry partners by creating a vehicle for preproduction research. Preproduction research uses production-grade equipment, develops a working solution, and transitions that complete production solution to the member company for implementation. While CAMT had demonstrated the capacity to do this type of work, CAMT lacked a facility and the production level equipment necessary to deliver that vision. In 2019-2020, led by the Dean's Office, Missouri S&T invested in the creation of a $1.4 million production-grade high-bay research facility. Industry recognized the opportunity and immediately invested another $3 million in filling the facility. Industrial grade equipment provided by DMG-Mori, Kansas City National Security Campus, Yaskawa Robotics, and Applied Precision Inc. were added to the facility taking the space from 50% capacity during construction planning to 125% capacity when the space opened less than a year later. As Dr. Bristow recounts, "We built our vision for CAMT in collaboration with engineering leaders at our industrial partners, so it is exciting to see commitments match the collaborative effort, enabling us to deliver a world class production-ready research facility."

Announced in October 2020, St. Louis businessman and S&T alumnus Fred Kummer and his wife June donated $300 million to launch the Kummer Institute at Missouri S&T. Their gift is the largest single gift ever to any Missouri university, public or private. The Kummer Institute is envisioned to have direct economic impact on the region through technology innovation and entrepreneurship. To achieve these goals, four centers are planned in areas where Missouri S&T is best positioned to impact the economy. Building on the success of CAMT and the MAE manufacturing program, one of these four keystone centers is the Center for Advanced Manufacturing. This transformational opportunity will enable CAMT and MAE to leverage the Kummer family investment and grow the impact exponentially.

CAMT would like to engage your company in manufacturing research. While CAMT was founded on aerospace manufacturing research, the members span multiple industries. Research ranges from additive manufacturing to materials, robotics, and more with a tiered membership structure that allows companies of various sizes to engage. The MAE department is ready to enable your industry-ready manufacturing research either through CAMT or directly with the department. We look forward to showing you CAMT's new facility and introducing you to our research the next time you are on campus. For more information on CAMT, please contact camt@mst.edu or visit the website at https://camt.mst.edu/.

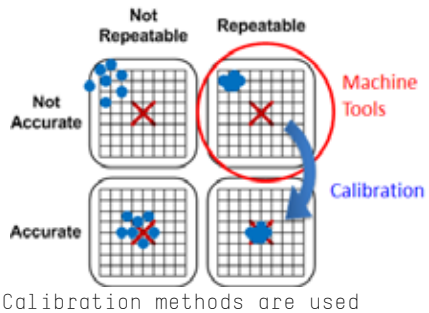


DR. CREAMER GRADUATES CAMT TECHNOLOGY INTO PRODUCTION

For most, it would take years to have your research applied to industry, especially as a student. However, Jennifer Creamer, a Ph.D. graduate who studied under Drs. Doug Bristow and Robert Landers in the Center of Aerospace Manufacturing Technologies (CAMT), conducted research in volumetric error compensation of machine tools which led to a technology that came to realization on the production factory floor at Boeing. Together with the Boeing team, this technology was installed on production machine tools to improve their accuracy, reducing rework and improving part quality. In some cases, this technology enabled machine tools that could not make parts at all to produce tight tolerance parts. This industry relevant research is a hallmark of the Center for Aerospace Manufacturing Technologies, and research team has a strong track record of delivering measurable business impact to the member companies of CAMT.

Volumetric Error Compensation is a powerful family of technologies that utilizes a laser tracker and active laser target to calibrate a repeatable machine tool in different positions inside the potential work space (figure to the right). After a carefully designed set of measurements are taken, Creamer would generate complex numerical models of the motion of the machine tool in its workspace and analyze where the machine is moving to the desired location and when it is in the wrong place. It is common to discover machine tools have significant errors in certain types of motion while being quite accurate in other types of motion. Essentially, it is common for the machine to be precise, but inaccurate. Based on this complex three dimensional data, Creamer would generate a set of motion corrections that move the machine to the desired accurate state.

Through the Boeing/Missouri S&T Master Research Agreement, Dr. James Castle, Boeing's representative to the CAMT Industrial Advisory Board, identified one of the key pillars of this agreement is to provide a direct pathway for students working on projects for Boeing through CAMT to transition into the company as an employee. Dr. Castle shared, "We have had a long track record of success bringing CAMT technology into the company, but the pathway for the graduate student with the expertise to advance that technology inside the company was less clear than the typical way Boeing hires undergraduates via the intern program." Dr. Castle sought to close this gap and piloted a program to hire graduate interns. As one of the first interns, Dr. Creamer sat in the Boeing office and worked part-time on a Boeing team as a regular employee while remaining on campus to finish her PhD. Creamer stated, "This graduate intern position allowed me to interface directly with industry and shape my research so that it impacted production systems. Having access to the experienced team at Boeing and industrial machines for experiments was invaluable."



Calibration methods are used to correct for precise, but inaccurate processes.

Since joining Boeing, Dr. Creamer has continued to support her technology throughout the company. Together with Drs. Bristow and Landers, she has transferred the technology to robotics creating further impact beyond machine tools. Drs. Bristow and Landers have generated a portfolio of research development based on volumetric error compensation bringing in significant research funding which directly impacts CAMT member companies today. This combination of industry relevant research, results focused faculty, and high potential graduate students continues to draw new members to CAMT with LMI Aerospace and MotoMan robots joining due to this technology.

"At its best CAMT succeeds because of the ecosystem of collaboration that enables the best of industry, academia, students, and capital equipment to come together and deliver results," says Dr. Doug Bristow, Director of the Center of Aerospace Manufacturing Technologies. "Volumetric Error Compensation and Jennifer's story are an excellent example of the value CAMT seeks to deliver to all our partners."

MISSOURI S&T RESEARCH SYMPOSIUM HIGHLIGHTS STATE'S MANUFACTURING CAPABILITIES

Missouri S&T brought together university researchers, industry experts and government leaders Thursday, Sept. 3, for a research symposium that highlighted the state's manufacturing capabilities.

Missouri S&T's College of Engineering and Computing hosted the "Integrative Manufacturing and Remanufacturing Technologies to Spur Rural Development" and featured speakers such as Missouri Gov. Mike Parson and U.S. Sen. Roy Blunt. The symposium featured in-person speakers and panelists addressing participants who tuned in virtually via Zoom.

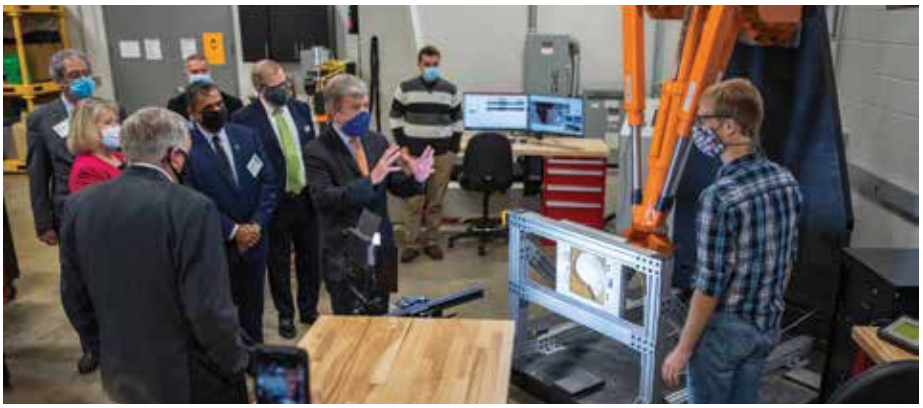
Missouri S&T's advanced manufacturing expertise is instrumental to making Missouri a leader in manufacturing and economic development.
"Today's symposium is focused on the very bright future of manufacturing and re-manufacturing in our state – and Missouri S&T has an important role to play in this arena," said Missouri S&T Chancellor Mo Dehghani during opening remarks at the event. "The university stands ready and able to work with our federal and state government partners, as well as our partners in education and industry, to further develop Missouri's workforce and economy."

Following Dehghani's opening remarks, Parson discussed the need to overcome the challenges of the COVID-19 pandemic, continue the push for rural broadband access, and ensure the state meets education and training needs.

"We've got to beat the challenges like S&T does every day," said Parson. "But if they (industries) don't have the foundation of the education communities of our state, we're kidding ourselves if we're going to be a leader. We will not be a leader if we don't support K-12, our training centers, community colleges and our universities."

Blunt also spoke about the desire to bring back manufacturing capabilities to the U.S. and Missouri to boost the state's workforce.

Governor Parson speaking to attendees at the Missouri S&T Advanced Technology Research Symposium.



U.S. Senator Roy Blunt speaks with a research student about the new technologies being developed by the Center for Aerospace Manufacturing Technologies.

"In that advanced manufacturing concept, you take at least two different businesses with a university or college partner and you get some benefits," said Blunt. "But the chancellor's understanding already of the institution is so important. When you've got this kind of expertise, this research, this partnership, why wouldn't this be a hub for rural manufacturing? Once you check those first three boxes, you get to that workforce box and we win when we check that box."

Dr. Steven Jung, chief technology officer at Mo-Sci Corp. and an adjunct professor of materials science and engineering at S&T, spoke about Mo-Sci's state-of-the-art technologies using bioactive glass. Dr. Frank Liou, director of the manufacturing engineering program and the Michael and Joyce Bytnar Professor of mechanical engineering at S&T, led a presentation titled "Integrative Manufacturing and Remanufacturing Technologies to Spur Rural Development." In addition, two separate panel discussions were held on strategies for a thriving industrial ecosystem and the evolving workforce development needs for the manufacturing industry.

Following their remarks, Parson and Blunt toured Missouri S&T's new Center for Aerospace Manufacturing Technologies (CAMT) location. The center specializes in fabrication and assembly technologies for aerospace and other manufacturing industries. Dr. Douglas A. Bristow, CAMT director and professor of mechanical engineering, led the tour.

Some of the center's main research areas include additive manufacturing, rapid prototyping and manufacturing, laser-based materials processing, composites fabrication and evaluation, machining and machine tools, metrology, assembly modeling and simulation, and manufacturing ergonomics.

Dr. Doug Bristow, director of CAMT (right) leads a tour of the new CAMT facilty to Chancellor Mohammad Dehghani, Governor Mike Parson, First Lady Teresa Parson, and Senator Roy Blunt (from left to right).

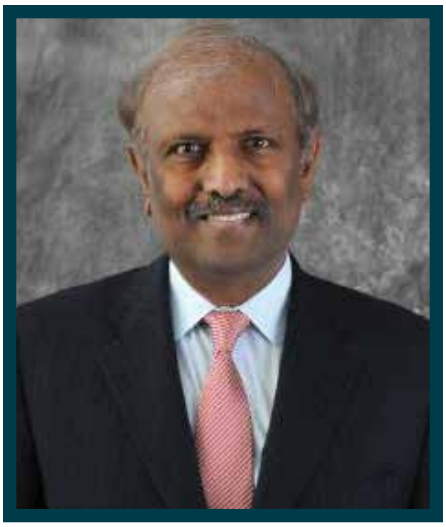
CAMT & BOEING PARTNERSHIP: A WINNING COMBINATION

Missouri S&T's Technology Development Center, home of S&T's Boeing office.

Boeing has been an active participant in the Center for Aerospace Manufacturing Technologies from its founding by the Air Force Research Lab in 2004. After CAMT's initial success, Boeing worked with Missouri S&T to form the Industrial Advisory Board in 2007, which has been chaired by Boeing to this day. Recognizing the value of the engagement, leadership in Boeing Research and Technology made the decision to open an office on campus in 2014 in conjunction with the signing of the Boeing / Missouri S&T Master Research Agreement. Dr. James Castle, a member of the Boeing Technical Fellowship, has been an active part of the on-site collaboration ever since.

Since the opening of the Boeing office in 2014, Boeing has hosted ~30 students including three graduate student interns. Boeing's footprint has grown with the addition of the Boeing IT organization and new partnership models for students to work on Boeing projects from the local office.

Dr. James Castle, technical fellow and on-site research lead for Boeing at Missouri S&T



DR. S. N. BALAKRISHNAN REMEMBERED

The Missouri S&T community is saddened to learn of the death of Dr. S.N. Balakrishnan, Curators' Distinguished Professor of aerospace engineering. He died Sunday, Jan. 24.

Dr. Balakrishnan, who joined S&T's faculty in 1985, was internationally known for his work in developing missile guidance algorithms and intelligent control. His research was supported by grants from the Army Space and Missile Defense Command, Naval Surface Warfare Center, the Air Force, and the Missile Defense Agency. He delivered keynote addresses and invited lectures in several countries. He published numerous journal articles with his students, and many of his students won top awards at national and international conferences. He was affiliated with several professional organizations, including the American Institute of Aeronautics and Astronautics.

Dr. Balakrishnan served on Missouri S&T's Faculty Senate and led the senate as president from 2012-13.

SERHAT HOSDER ELECTED AS FELLOW OF ROYAL AERONAUTICAL SOCIETY

The Royal Aeronautical Society (RAeS) has elected Dr. Serhat Hosder, a professor of aerospace engineering at Missouri S&T, as a fellow in the oldest international professional institution devoted to the aerospace community.

"I am honored to be a fellow of the Royal Aeronautical Society and by this acknowledgement of my contributions to the field," says Hosder. "I look forward to actively contributing to RAeS as a fellow."

Hosder, who joined Missouri S&T in 2007 and serves as director of the Aerospace Simulations Laboratory, is also an associate fellow of the American Institute of Aeronautics and Astronautics (AIAA) and a member of the AIAA Hypersonic Technologies and Aerospace Planes (HyTASP) Technical Committee (TC). He was the most recent chair of HyTASP TC and currently serves on the steering committee.

Hosder's research activities focus on hypersonic flight and vehicle performance in extreme and uncertain environments characterized by intensely high temperature flows, which may also include dust, ice and rain particles. Hosder and his students work with computer modeling and predictions for hypersonic flight – five times the speed of sound or faster. Examples include spacecraft entering the atmosphere of Earth or Mars and aircraft that are designed to fly at hypersonic speeds.

A fellowship in the Royal Aeronautical Society is the highest honor achievable in the organization and is given only to those in the profession of aeronautics or aerospace who have made an outstanding contribution to the profession, attained a position of high responsibility or have had long experience of high quality in the profession.

The Royal Aeronautical Society is a British multidisciplinary professional society dedicated to the global aerospace community. It exists to further advance aeronautical art, science and engineering around the world. Established in 1866, the RAeS has been at the forefront of developments in aerospace, seeking to promote the highest professional standards and provide a central forum for sharing knowledge.

RESEARCH ON SOYBEAN OIL MAY BENEFIT MANUFACTURERS, FARMERS AND ENVIRONMENT

Replacing a petroleum and water mixture with soybean oil as a lubricant and cooling agent for 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 and the metal at the cutting zone. That can cause health issues for workers, and disposal poses environmental risks," says Dr. Anthony Okafor, professor of mechanical and aerospace engineering at Missouri S&T and primary investigator for the project.

"Soybean oil is safe and biodegradable, and our method saves materials costs because only drops of soybean oil are used."

Cutting fluid plays a vital role in metal cutting by cooling and lubricating the cutting zone, the researchers say. Friction and the resulting high heat from cutting metal cause rapid tool wear, especially with hard-to-cut metals such as Inconel-718. That material is commonly used in oil and gas drilling tools, aerospace manufacturing of components used in the hottest compartment of jet and rocket engines, and in cryogenic tankage. A technique called minimum quantity lubrication (MQL) uses a small amount of lubricant and compressed air to form an aerosol spray to cool and lubricate the cutting area.

Okafor is working with Dr. Monday Okoronkwo, an assistant professor of chemical engineering at S&T, to add nanoparticles to the high oleic soybean oil to increase cooling capability, improve machinability of Inconel-718, enhance viscosity, stability, and thermal conductivity of the soybean oil, and promote new markets for soybeans and other biobased feedstocks.

The research project came about through coincidence. Okafor, whose background is in manufacturing machining, needed a rheometer to measure how fluids and nanofluids behave under varying pressure and temperature. Okoronkwo's background in chemistry includes work with soft materials such as liquids, gels and granular materials. He had just acquired a rheometer for use in his own lab. Okafor asked to use the equipment, and a partnership was born.

NEW FACULTY
WELCOME RAN SUI

Dr. Ran Sui joined MAE Department of S&T as an assistant professor of mechanical engineering in January 2021. Prior to Missouri S&T, he received a B.Eng. in Mechanical Engineering (2010) from Shanghai Jiao Tong University, China, a M.Sc. in Computer Science (2013) from Technical University of Munich, Germany, and a Ph.D. in Mechanical Engineering (2017) from ETH Zurich, Switzerland. In 2018, Dr. Sui joined Princeton University as a Postdoctoral Fellow and was promoted to the rank of Associate Research Scholar (professional research staff) in 2020.

Aiming at the utilization of environment-friendly and alternative fuels in future power generation, fuel processing and emission control, Dr. Sui's major research activities include catalytic combustion, coupling of hetero-/homogeneous thermochemical processes, and the related computational methods and experimental diagnostics. His research has been honored by several awards, including a Distinguished Paper Award from the International Combustion Institute, a postdoctoral fellowship from the Swiss National Science Foundation, an Outstanding Abroad PhD Award from the China Scholarship Council, and an European Erasmus Scholarship.

S&T STUDENT, PH.D. GRADUATE EARN
$50,000 FOR ENTREPRENEURIAL STARTUP IDEA

A MISSOURI S&T STUDENT AND RECENT PH.D. GRADUATE WERE RECENTLY AWARDED $50,000 TO BUILD THEIR ENTREPRENEURIAL START-UP COMPANY AND ACHIEVE NEW BUSINESS GOALS.

The Missouri S&T duo who earned funding are George Holmes Jr., a 2020 mechanical engineering Ph.D. graduate from Missouri S&T, and Keyri Moreno Bonnett, a graduating senior in mechanical engineering from Bogota, Colombia. Together the two have created "Hire Henry," a company that provides autonomous heavy duty robotic lawn mowers to commercial landscapers.

Hire Henry is one of six companies selected out of over 430 applicants to earn the $50,000 cash award. The six selected startups will participate in an eight-week business development program, which begins in January 2021. The selected founders will also have access to nearly $200,000 of in-kind resources such as education, mentorship and other forms of support.

The funding for the six teams comes from the Diversity, Equity and Inclusion (DEI) Accelerator program of UMSL Accelerate at the University of Missouri-St. Louis. The program aims to put underrepresented entrepreneurs at the center of a purpose-driven, university-led accelerator that begins with a non-dilutive $50,000 capital injection. The accelerator is supported by private support and the public commitment of Ameren Corp., Edward Jones and Express Scripts. It encourages entrepreneurs of all backgrounds to apply for funding.

MISSOURI S&T PH.D. STUDENT RECEIVES

NASA GRADUATE RESEARCH AWARD

When NASA sends humans to the moon for the first time in nearly 50 years as part of its Artemis Exploration Program, research conducted by a Missouri S&T Ph.D. student will help crew members understand the ways plasma and lunar surface dust interact.

David Lund, a third-year Ph.D. student in aerospace engineering at Missouri S&T, has received a NASA Space Technology Graduate Research Opportunity (NSTGRO) award to support his research.

"I am looking at the effect of lunar surface and dust grains that are electrically charged by solar wind particles and photoemissions and how this surface charge affects the safety of astronauts and equipment on the lunar surface," Lund says. "This award from NASA will further my research."

Lund says solar winds and photoemissions positively charge sunlit surfaces and negatively charge shadowed regions. This electrostatic environment creates a plasma region that charges dust grains and sends them aloft if the uplifting electric force on the dust grain is stronger than the downward gravitational force. Once aloft, charged dust grains may accumulate on astronauts' spacesuits and equipment. Strong electrical fields may discharge and arc, seriously affecting activities on the lunar surface.

"David has made significant progress on this project," says Dr. Daoru Han, assistant professor of mechanical and aerospace engineering and Lund's Ph.D. advisor at Missouri S&T. "We just published an article about our high-fidelity numerical simulation tool, and we are truly excited to expand this research front in collaboration with NASA."

In collaboration with the Electrostatics and Surface Physics Laboratory at NASA's Kennedy Space Center, Lund will work to develop accurate and efficient computational models of the interactions between plasma and surface dust. The multiscale model ranges from microscopic charging to macroscopic transport of dust grains. Lund says previous efforts have focused on one scale or the other, but no current known model links the two scales together. Varying space and time scales of physics – from micrometer scale dust charging to meter scale dust transport – and sources of uncertainty like dust size and ambient plasma environment present challenges. Lund's proposed research will address the challenges.

Lund will spend summers at Kennedy Space Center working with James R. Phillips III, his NASA mentor. The NSTGRO award includes a stipend, tuition allowance, faculty advisor allowance and on-site NASA Center experience allowance for the student. The award will also help Lund fulfill his career aspiration to work at NASA.

S&T'S FORMULA SAE TEAM FINISHES THIRD OVERALL IN INTERNATIONAL COMPETITION

The 2020-2021 school year has been a difficult and different year due to the continuing pandemic.

However, Missouri S&T Formula SAE Racing has been able to find major successes and make large strides in development for the future of the team. The team was able to continue to develop the 2020 car for 2021 competition and focus some of the design and budgeting towards the start of a two-year development of a carbon-fiber monocoque chassis.

This summer the team headed to Brooklyn, Michigan to compete in the Formula SAE Michigan event at the Michigan International Super Speedway. Competing against 51 other teams from all over the world, S&T earned third place overall. In competition, the team took first place in skidpad, an event designed to test the car's cornering ability on a figure-8 course, and in autocross, a one-lap race that tests the car's performance on a tight course. Each team's fastest lap of four attempts determines the winner, as well as the starting order for the final endurance race.

The team took fourth place in acceleration and third in autocross. An acceleration test measures the car's straight-line speed over a short distance, and the autocross race proves the car's maneuverability on a tight course and determines the starting order for the final event – an endurance race designed to test the car's durability. Teams are ranked by time; cars don't race head-to-head.

The Formula SAE Design Team is one of 19 student design teams associated with S&T's Student Design and Experiential Learning Center. The team designs, builds, tests and races an open-wheeled, formula-style race car every year. The team was founded in 1989 and is one of S&T's longest running design teams. For the 2022 season, the team plans to continue the development of the team's first ever carbon-fiber monocoque chassis and to return to competition and improve their results once again.

MINER BAJA SAE REVIVAL BRINGS IN A POSITIVE SEASON

The 2020-2021 season revitalized Miner Baja SAE, the team worked to lay the foundation for long-term success and learning.

While the senior members stood by to help, new members were trained in design and manufacturing and were also given projects early on, gaining knowledge and experience. The team tripled the number of members certified to be able to operate mills and lathes while skilled designers, welders and mechanics within the team also increased. Due to organizational and manufacturing constraints related to COVID-19, there was uncertainty as to completing the car on time. Focusing on creating a more simple, reliable car helped the team to finish rapidly allowing for member development, testing and driver training.

To be more competitive, the frame was designed with a cockpit that was eight inches shorter and over ten pounds lighter. The team decided to utilize an off-the-shelf gearbox to enhance reliability compared to the previous model, simultaneously conserving valuable design time. The entire drivetrain assembly is a modular unit, enhancing serviceability. The biggest design change was the new rear suspension. The team now uses a three-link system that offers adjustments and is lighter, yet stronger than our previous system. Neither the drivetrain or suspension had a single failure on any of the custom components. Once the subsystems were complete, the team worked tirelessly to achieve the finished product - dubbed "Leo". The name comes from Leonardo Da Vinci, a renaissance man. The renaissance was a period of revival in history and this season was the same for the Baja team. In the weeks leading up to competition, members rallied together with all-hands-on-deck, resulting in finishing the car early with time to spare for testing.

In May, the team traveled to Louisville, Kentucky to attend SAE's international competition where the car shined during the dynamic events. During the suspension run, Leo was one of the first ten cars to try the track making it almost to the end on our first run. Miner Baja placed 16th in suspension, and placed above average in all the events. For the endurance race, Leo made great lap times and worked to the head of the pack. Unfortunately, an issue with the shock absorber took the car out for a quarter of the race. Team members were able to fix the problem and get back onto the track. However, later on, the car experienced a frame failure which ended Miner Baja's race.

This season was an all-around great experience. Despite numerous obstacles, the team managed to get the car built with time to spare after many long, hard days and nights. Team members were able to experience a competition - gaining insight for the next car on potential improvements. This year was one of the team's best performances in many years and the team is already working to make the next car even better. The frame and suspension for our 2022 competition were already under design this summer, and with more experienced and active members, the future looks bright.

Multirotor Design Team Update

Much like other design teams, the Multirotor Design Team faced plenty of challenges throughout the 2020-2021 year, as opportunities to collaborate were very limited. Despite that, the team has made good progress for the International Aerial Robotics Challenge (IARC), opened up a quadcopter racing division, and even partnered with the Rocket Design Team to create a collaborative project for the Argonia Cup Collegiate Rocketry Competition.

Since IARC was postponed for the summer of 2020, Multirotor had another year to make some necessary refinements to the project, which is an octocopter measuring approximately 4 feet by 6 feet and weights anywhere from 42 to 52 pound depending on the battery configuration. The primary reason for such a size and weight was due to some of the competition requirements, which included flying a total distance of 3 kilometers, carrying a 2-pound payload, and performing module interaction tasks within 9 minutes under full autonomous guidance (no human intervention.

Aside from IARC, the SDELC has had one of the first major collaborations between two design teams in the form of a project by both the Multirotor and Rocket Design Team for the Argonia Cup competition. The Argonia Cup requires a rocket to be at apogee of over 8000 feet, and then the rocket must eject a golf ball payload as close as it can to a designated target. Instead of just using a rocket, the two teams decided to create a rocket that could hold a small quadcopter as the primary payload. Once the quadcopter gets ejected, the quadcopter can fly the golf ball to the designated target through various methods, including GPS-guided autonomous flight or manual flight through digital first-person view goggles and an experienced racing pilot. While the collaboration ultimately ended up with the team placing 7th out of 16 teams, this year was an exciting start for a long future of collaborative projects between the Multirotor and Rocket.

ACADEMY OF MECHANICAL AND AEROSPACE ENGINEERS

Welcome the 2020 Inductees to the Academy of Mechanical and Aerospace Engineers

Pictured (top from left to right): John T. DeRuntz, Mark E. Eck, and Eric M. Kozak. (bottom from left to right) Susan (Sue) Kramp, Greg Krekeler, and John A. Yates.

The Academy of Mechanical and Aerospace Engineers held its 25th Annual Induction and Awards Ceremony on Thursday, October 15, 2020 on Zoom due to the COVID-19 pandemic. The Academy inducted six new members:

John T. DeRuntz (BSME '84)
Operations Executive and Consultant
Colleyville, TX

Mark E. Eck (BSME '80)
Chief Operating Officer (Retired)
MidStates Petroleum
Tulsa, OK

Eric M. Kozak (BSME '89)
Vice President of Gas Operations
Ameren Illinois
Collinsville, IL

Susan (Sue) Kramp (BSME ' 84)
Structural Design Engineer
Boeing Company
Associate Technical
Fellow and Technical Focal
Boeing Defense, Space and Security
St. Louis, MO

Greg Krekeler (MSAE '92)
Senior Director
Government
Training Systems & Services
Boeing Global Services Engineering
St. Louis, MO

John A. Yates (BSME '87)
Director of Engineering
Assembly and New Technology
LMI Aerospace, Inc.
St. Charles, MO

2020-2021 SCHOLARSHIP AND GRADUATE TEACHING AWARD RECIPIENTS:

Each year, AMAE honors select students with scholarship awards and graduate teaching awards. Here are the winners for 2020-2021.

Scholarship recipients:

Tate Bollweg
BSME - December 2020
Butler, MO

Ean Buffington
BSAE - May 2023
Jackson, MO

Alivia Dean
BSME - May 2021
Clyde, OH

Jon Mataya
BSME - May 2022
St. Louis, MO

Garrek McCune
BSAE - May 2023
Carthage, MO

Madison Meier
BSME - May 2021
Lake St. Louis, MO

John Reeves
BSME - December 2021
Miller, MO

Caleb Skinner
BSME - May 2021
St. Peters, MO

John Whitelock
BSAE - May 2021
Pacific, MO

AMAE Past Presidents' Scholarship:
Lucas Breckenridge
BSME - December 2020
Rich Hill, MO

AMAE McGovern Award:
Aaron Chang
BSME - December 2021
Chesterfield, MO

Steve and Julie Moss Promise and Opportunity Scholarships:
Jackson Barry
BSME - December 2021
Canton, MO

Davis Perry
BSME - May 2021
Kansas City, MO

Matthew John Russell

Dual BS: AE & ME - December 2020
Warrenton, MO

Graduate Teaching Award Recipients:

Austin Sutton
ME PhD
Liberty, MO

Lauren Bryce Tomanek
ME PhD
Springfield, MO

UPCOMING EVENTS

26TH ANNUAL INDUCTION AND AWARDS CEREMONY

Thursday, October 7, 2021
Signature Events Center - Rolla, Missouri
Virtual Option Available

ANNUAL MEMBERSHIP MEETING AND SPOUSE/ GUEST EVENT

Friday, October 8, 2021
Student Design and Experiential Learning Center - Rolla, Missouri
Virtual Option Available

MECHANICAL & AEROSPACE ENGINEERING
400 W. 13th St.
194 Toomey Hall
Rolla, MO 65409-0050

THANK YOU!

For many students in our department, learning in undergraduate labs is the hands-on experience employers value most. They are the places where theory and practice converge into real world application.

Your annual support of MAE programs makes a difference in many ways. Donations help fund student scholarship and fellowship programs as well as improving our instructional labs.

So when you get a phone call from a student eager to share what is happening on cmapus and in the department, we hope you'll take time to connect and catch up. We also hope you'll help us build the next generation of engineering leaders by giving back.

mae.mst.edu/giving/