MAE

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MESSAGE FROM THE CHAIR

Dear Friends,

It is with great pleasure that I provide you with our 2019 Mechanical and Aerospace Engineering newsletter. Inside this edition of our newsletter, you will find a few of the many accomplishments of our talented students and faculty from the 2018-19 academic year. I am sure you'll agree the student design teams continue to impress, including S&T Racing placing 4th at the Formula SAE Lincoln competition and Miner Aviation placing in the top 20 for their first AIAA competition. You will read about many of our graduate student honors, including Jill Davis's Amelia Earhart Fellowship. Our faculty continue with groundbreaking research, including Dr. Chen teaming up with Argonne National Laboratory to improve additive manufacturing. Once again the National Science Foundation's most prestigious award in support of early-career faculty, the CAREER Award, was given to one of our faculty. This year's honors go to Dr. Heng Pan. The Award recognizes those who have the potential to serve as academic role models in research and education. Dr. Pan's five-year, $500,000 NSF CAREER award provides support to his research to develop a new approach for direct fabrication of functional nanostructures from multiple materials. The research could lead to advances in solar cell and battery technology, nanophotonics (the study of how light behaves on the nanometer scale), and the development of metamaterials, which are materials engineered to exhibit properties not found in naturally occurring materials. Several other faculty and student achievements and awards are highlighted in the newsletter along with honors of our alumni.

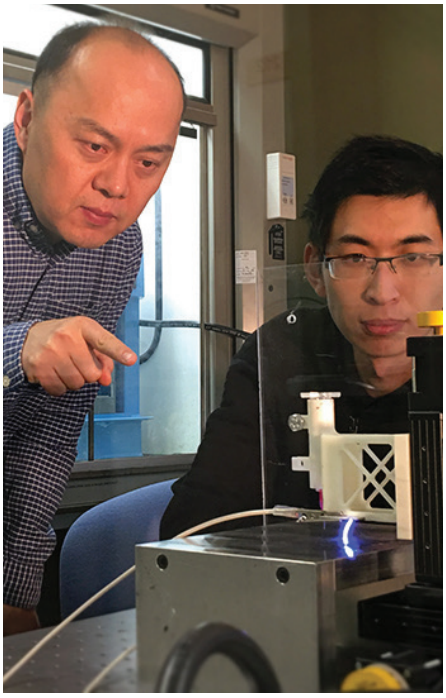
On a personal note, this will be my last letter to you as I have officially stepped down as chair of Mechanical and Aerospace Engineering department on June 30, 2019. I leave the chair position with the department in a position of strength from nine years of deliberate implementation of its ambitious strategic plan. During the past years, research expenditures of the MAE Department have doubled, with broad support across federal and industrial sponsors, PhD enrollment has doubled, and five faculty have received prestigious NSF CAREER and AFOSR or ONR Young Investigator awards. The mechanical and aerospace program has seen a 30% growth in undergraduate enrollment continuing to make us the largest academic department on the Missouri S&T campus. Truly much to be proud of and it has been my pleasure to chair such a remarkable and ambitious department.

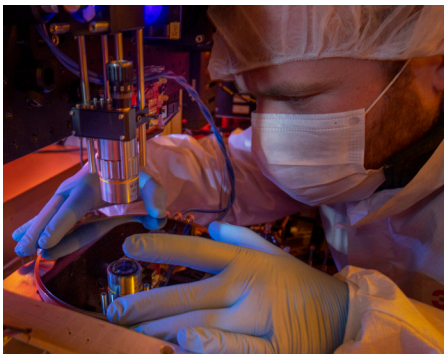
I would also like to extend my sincere thanks to the many alumni and friends whose many contributions continue to enhance the activities of the department and contribute to the education of future Miner engineers. It has been a pleasure to meet with many of you over the past nine years that I have served as department chair and ask that you continue to support our department as alumni and friends.

Warm Regards

Jim Drallmeier

Chair, Mechanical and Aerospace Engineering





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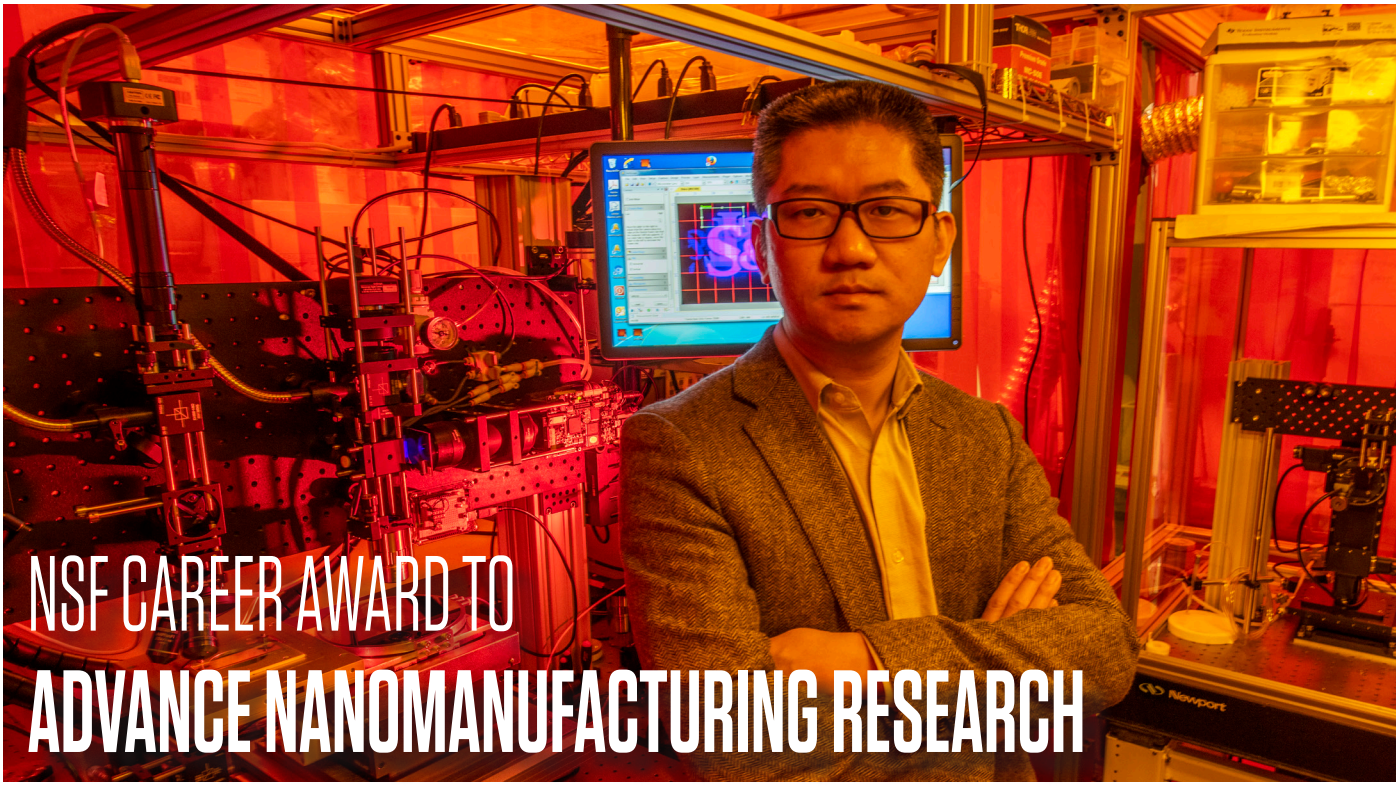


NSF CAREER AWARD TO ADVANCE NANOMANUFACTURING RESEARCH

Dr. Heng Pan, assistant professor of mechanical and aerospace engineering at Missouri S&T, has received a big boost from the National Science Foundation (NSF) to support his efforts to create large-scale nanostructures from very small nanocrystals.

Pan received the NSF Faculty Early Career Development (CAREER) Award for his project, "Laser Direct Writing of Three-Dimensional Functional Nanostructures." The five-year, $500,000 award will support his research to develop a new approach for direct fabrication of functional nanostructures from multiple materials. The research could lead to advances in solar cell and battery technology, nanophotonics (the study of how light behaves on the nanometer scale), and the development of metamaterials, which are materials engineered to exhibit properties not found in naturally occurring materials.

> "We are enabling a new process to fabricate very large-scale, three-dimensional nanostructures with multiple materials integrated into the process," says Pan.

This differs from the conventional approach of creating nanostructures from single elements, such as silicon, which is used to make semiconductors. Pan's approach involves using multiple materials that can be written onto a surface through the use of laser "beamlets." So instead of producing a nanostructure from a single element, researchers can produce nanostructures containing many elements.

The process is similar to the way a laser printer in an office might work. Instead of printing a single color – black ink on white paper – modern printers can produce documents in a variety of colors and gradients. Likewise, beamlets can "write" patterns with different materials and create new types of 3-D nanostructures at a large scale.

But first, Pan wants to better understand how the building blocks, known as nanocrystals, behave under certain conditions. Materials designed at this very small scale – a nanometer is one billionth of a meter –contain unusual properties, Pan says. They may have different mechanical, thermodynamic or optical properties compared with their bulk material counterparts. How nanomaterials interact with laser beamlets may also differ depending on different wavelengths of the beamlets. A shorter wavelength may affect an element differently than a longer one.

Pan's research could also lead to advances in a variety of nano-devices, including nanostructured solar cells, batteries and nanostructures that could be used to split water to free up hydrogen for use as a fuel source.

Pan's CAREER Award will support his efforts to better understand the "laser-nano interactions" that are the key to the success of the new fabrication process.

Pan joined Missouri S&T in 2013. He earned a Ph.D. in mechanical engineering from the University of California-Berkeley in 2009. He earned a master of science degree in manufacturing engineering from Missouri S&T in 2004 and earned a bachelor of science degree in mechanical engineering from Zhejiang University in China in 2002.

In 2015, Pan received a grant through the Oak Ridge Associated Universities Ralph E. Powe Junior Faculty Enhancement Program to support his research.

BY ANDREW CAREAGA

DR. CHEN TEAMS UP WITH ARGONNE TO IMPROVE 3D PRINTING

Dr. Lianyi Chen's team at Missouri University of Science and Technology, just completed a study with Dr. Tao Sun's team from the U.S. Department of Energy's Argonne National Laboratory to understand the physics behind additive manufacturing and help eliminate structural defects in 3-D printed materials.

Additive manufacturing, often referred to as 3-D printing, has the potential to transform manufacturing as engineers use titanium and other metal alloys to tap raw materials more efficiently, which in turn will reduce product costs and weight and shorten supply chains. With this technology, possibilities seem to be endless as scientists create things such as medical prosthetics, jet engines, and even vehicles.

Yet metal additive manufacturing faces roadblocks. Printed materials often contain structural defects and vary from their designs, forcing engineers to repair their finished pieces or start over from scratch. And not all physics behind the process are well understood.

To address these problems, scientists at Missouri S&T and Argonne National Laboratory investigated the entire 3-D printing process, including the properties of the powders, how the powders are spread to form a powder bed, and how the laser fuses those powders into the desired components, to discover both how defects form and methods to avoid them.

The team showed they can observe and quantify many metal 3-D printing characteristics — including dynamics of powder spreading, melt pool size and shape, powder ejection, solidification, porosity formation and phase transformations. Ultimately, these efforts will achieve the best of both worlds: Scientists will uncover the dynamic mysteries of metal additive manufacturing, while industries will thrive with blueprints to rapidly print cost-effective and reliable products.

Chen's research was reported in Acta Materialia, "Transient dynamics of powder spattering in laser powder bed fusion additive manufacturing process revealed by in-situ high-speed high-energy x-ray imaging", Qilin Guo of Missouri S & T and Cang Zhao of Argonne National Laboratory as the leading authors; and in the Scientific Reports, "Revealing particle-scale powder spreading dynamics in powder-bed- based additive manufacturing process by high-speed x-ray imaging", Luis I Escano of Missouri S&T as the leading author. The work published in Acta Materialia is also a feature story published on the Argonne National Laboratory website. Other publications related to this research include an article in the Scientific Reports, "Real-time monitoring of laser powder bed fusion process using high-speed x-ray imaging and diffraction."

DR. KEITH NISBETT NAMED DEAN'S EDUCATOR

To honor excellence in the classroom and contributions toward student service, Dr. Keith Nisbett, associate professor and associate chair of mechanical engineering, was recognized by the College of Engineering and Computing with the title of Dean's Educator. The two-year title includes a $5,000 stipend. Nominations are extended by the department chair and selected by a five-person committee of senior CEC faculty. Dr. Nisbett was one of three faculty recognized at the annual CEC meeting on October 25, 2018.

Co-author of a popular undergraduate textbook on machine design, Dr. Nisbett is a sought-after teacher, mentor and unofficial consultant to members of the school's many student design teams. He served for many years as the faculty advisor of the Human Powered Vehicle Team. For 15 years, Dr. Nisbett has mentored middle-school and high-school robotics competition teams, and hosted S&T's robotics summer camp. He estimates that he has instructed and mentored over 3,000 middle school and high school students in hands-on activities that develop interest in STEM fields.

Over the past 30 years of teaching at Missouri S&T, Dr. Nisbett has been honored with numerous Outstanding Teaching and Faculty Excellence awards, including the Governor's Award for Teaching Excellence. His areas of expertise include kinematics, mechanical design and mechanism synthesis. In 2002, Dr. Nisbett was a gubernatorial appointee to the newly formed Missouri Amusement Ride Safety Board. He served as chair of the board for its first 12 years.

DR. HOSDER AWARDED **NASA LANGLEY'S H. J. E. REID AWARD**

The journal paper entitled, "Uncertainty and Sensitivity Analysis of Afterbody Radiative Heating Predictions for Earth Entry" co-authored by Thomas West, Chris Johnston, and Serhat Hosder, associate professor of Aerospace Engineering, was selected as the second-place winner of NASA Langley Research Center's prestigious Henry J. E. Reid Award in 2018. The Reid Award is NASA Langley's top award recognizing technical excellence in research publications. The competition for the award is rigorous. The recommendations for awards are made from a field of high quality research publications by a panel of Agency Senior Technologists who, by virtue of their positions, are designated the Agency's technical leads in their disciplines.

"The research described in the paper successfully identifies the most significant uncertainty sources and their impact on the afterbody radiative heating predictions of spacecraft during hypersonic entry, which will play a significant role in the design of thermal protection systems for future NASA spacecraft" says Prof. Hosder. The first author of the paper, Dr. Thomas West, who currently works at the Vehicle Analysis Branch of NASA Langley, received his PhD in Aerospace Engineering from Missouri S&T and was a graduate student of Dr. Hosder. The paper is published in AIAA Journal of Thermophysics and Heat Transfer and is available to download at https://doi.org/10.2514/1.T4948.

MAE RECEIVES FEDERAL GRANT TO SUPPORT GRADUATE STUDENTS IN **ADVANCED MANUFACTURING**

Manufacturing continues to be a mainstay of the American economy, accounting for over 18% of the real gross output in 2017. However, manufacturing industries in the United States are facing an increased demand for products that are on the one hand more customized and of higher quality, and on the other hand are less expensive. In addition, US industries are seeing increased global competition. To remain competitive, US industries must fully utilize the latest advances in manufacturing, including new processes such as additive manufacturing, increase the use of computer automation and data/information, implement monitoring and control systems for real-time quality assurance, etc. To achieve this, future engineers must be trained in advanced manufacturing concepts and technologies to create a workforce capable of driving new initiatives and technologies in advanced manufacturing and transitioning the latest ideas from the laboratory into production.

To build this workforce, the U.S. Department of Education has awarded the Department of Mechanical and Aerospace Engineering at Missouri S&T $1,194,000 through its Graduate Assistance in Areas of National Need (GAANN) project to create a fellowship program. This program, directed by Dr. Robert G. Landers, Curators' Distinguished Professor of mechanical engineering, will support domestic PhD students conducting research in the area of advanced manufacturing. These students will advance the theories and applications of feedback control, physics–based modeling, simulation–based analysis, engineered materials, etc., as well as advanced manufacturing technologies like metal additive processing, incremental sheet forming, battery manufacturing, etc., to better position the US in the new global economy.

The fellowship offers a yearly stipend of up to $34,000 (based on financial need), a full tuition waiver, resources to conduct research, and an opportunity to work with world-renowned faculty and leading manufacturing industries in state-of-the-art manufacturing facilities. This is the third GAANN program directed by faculty in the MAE department over the past six years. The previous two GAANN programs were Direct Digital Manufacturing, directed by Dr. Landers, and Mechatronics, directed by Dr. Douglas Bristow, director of the Center for Aerospace Manufacturing Technologies.

CAMT INTRODUCES INDUSTRY PARTNERS TO **NEW DEMONSTRATION FACILITY**

The Center for Aerospace Manufacturing Technologies (CAMT) held its Fall Industry Advisory Board Meeting at Missouri S&T on November 27-28, 2018. Welcoming representatives from consortium member companies, including Boeing, GKN Aerospace, Spirit Aerosystems, DMG Mori, Toyota, LMI Aerospace, Automated Precision, Steelville Manufacturing, and Product Innovation, who were in store for two days of announcements, presentations, tours, and networking.

The meeting was opened with welcoming remarks by Dr. Richard Wlezien, Dean of the College of Engineering and Computing, who announced that the college had located a 6,000 sq. ft. high bay space and $1.4M to begin renovation for CAMT to house its Manufacturing Demonstration and Research Facility. The facility will house industrial-grade manufacturing equipment including several additive manufacturing (3D printing) machines (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. The Industry Advisory Board reviewed project presentations by faculty and students from its 2018 project portfolio and project proposals for its 2019 portfolio. Industry members also had a chance to tour the pre-renovation facility and explore projects in more detail during a graduate student poster session held in the new space.

Founded in 2004, the Center for Aerospace Manufacturing Technologies (CAMT), led by director Dr. Douglas Bristow, is a premier center for aerospace manufacturing research that operates through university-industry partnership. Its mission is 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.

FACULTY RETIREMENTS

Dr. Victor Birman, professor of mechanical engineering and Director Missouri S&T Global-St. Louis (1989 - 2019)

Dr. Alfred Crosbie, Curators' Distinguished Professor of Mechanical Engineering (1968 - 2019)

Dr. Xiaoping Du, Curators' Distinguished Teaching Professor of Mechanical Engineering (2002 - 2018)

ACADEMY OF MECHANICAL AND AEROSPACE ENGINEERS

EIGHT NEW MEMBERS WERE INDUCTED INTO THE ACADEMY

Above from left: Robert Wagner, Michael "Boots" Miller, John Hampton, John Adams Jr., David Baer, Kent Koederitz, and Robert Lankston.
Pictured right: Scott White - who was inducted posthumously.

The Academy of Mechanical and Aerospace Engineers held its 23rd Annual Induction Dinner on Thursday, October 11, 2018 in the Missouri S&T Havener Center.

Eight new members were inducted into the Academy of Mechanical and Aerospace Engineers at the academy dinner held in October. The evening was filled with fun and festivity as the academy, staff and students celebrated many accomplishments and honors.

John L. Adams Jr. (MSME '85) - Sr. Manager F15 Airframe Structures, The Boeing Company, St. Louis, MO

David M. Baer (BSME '84) - Sr. Manager MQ-25 Air Vehicle, The Boeing Company, St. Louis, MO

John L. Hampton (BSME '85, MSME '91) - Sr. Manager Military Seating Engineering and Testing, United Technologies Aerospace Systems, Colorado Springs, CO

Kent E. Koederitz (BSME '84) - Deputy Fire Chief, West Point, Merck & Co. Inc., West Point, PA

Robert R. Lankston (BSAE '85) - Managing Director Aircraft Engineering and Technical Planning, FedEx Express, Memphis, TN

Michael J. "Boots" Miller (BSAE '74) - Executive Director USAF Security Assistance Training Group, Colonel (ret), USAF, San Antonio, TX

Robert M. Wagner (BSME '93, MSME '95, PhDME '99) - Directory National Transportation Research Center, Oak Ridge National Laboratory

Scott R. White (BSME '85) - Donald B. Willett Professor of Aerospace Engineering, University of Illinois Urbana - Champaign

PASSING OF THE GAVEL...

Past President, Dale Pitt, passes the gavel to new president, Craig Barnes.

Craig Barnes is the new president of the Academy for 2018-2019, with Dale Pitt serving the Academy as past president.

Craig began his engineering career as a co-op student with John Deere in 1975 and continued there upon receiving his BSME in 1978 where he focused on diesel engines and related technologies. In 1988, Craig joined Cummins Inc where he has held a number of engineering leadership roles. Some of his most recent roles include: Executive Director, Research and Engineering, Cummins Emissions Solutions (2005-2008); Chief Technical Officer for Cummins India (2008-2011); and Executive Director, Research and Engineering, Cummins Components Businesses (2011-2013); and Executive Director, Technology Planning until his retirement at the end of 2015. Since then, Craig has been working as an independent consultant through his company, CAB Consulting LLC.

Craig is a life-time member the Society of Automotive Engineers International and has held a number of leadership roles. He is also active with the Society of Women Engineers and in October 2009, he was honored with Rodney D Chipp Memorial Award for his work in establishing a culture of inclusion in the workplace and creating opportunities for women engineers in the United States and abroad. Craig was presented with the Award of Professional Distinction at the May 2015 Missouri S&T commencement ceremony and also received the Distinguished Alumni Award at the 2016 Missouri S&T Homecoming activities.

2017-2018 Scholarship and Graduate Teaching Award Recipients:

Front Row (from left to right): Katherine Allen, Sarene Allen, Alyssa Roller, Brandon Queri, Megan Krueger, and Eric Dahl.
Back Row (from left to right): Abdulaziz Abutunis, Bret Curtis, Collin Steele, Andrew Treas, and Ty Bollweg.
Not Pictured: Patrick Corcoran, Nathan Lutes, Anthony Schmitt, and Christopher Smith

GOOD FOR WHAT ALE'S YA!
THE SPOUSE/GUEST EVENT

While the members of AMAE attended their annual business meeting on October 12, 2018, the spouses and guests had a fun time learning all about Public House and St. James Winery. The first stop was the Public House in Rolla, MO, where Josh Stacy, one of the founders, gave the group a history talk about how he began in brewing beer and how Public House was started.

As Public House in Rolla became very popular, they needed more space to brew their beer, so they partnered with St. james Winery and created a destination by adding the St. James Tap Room. This space gave them the area to produce more beer. The group then traveled twelve miles to St. James to continue their tour of the St. James taproom where they sampled beers and ales. The guests also enjoyed lunch at the St. James Taproom. They offer a menu of an array of appetizers, salads, pasta, steak, burgers, and their brick oven pizzas.

After dessert, the spouses and guests took a trip across the parking lot to visit the St. James Winery. After a brief tour of their wine production area, they were able to sample and buy their award winning wines.

The day was filled with great conversation, craft beer and Missouri wines. They loaded up and headed back to S&T's campus jsut in time to enjoy the Toomey Hall Open House.

S&T MINERS HEAD TO SPACE

The Missouri S&T Satellite Research Team (M-SAT) endeavors to develop new small satellite technologies that are tested in low Earth orbit (LEO) with smallsats designed, fabricated, and tested by Missouri S&T students, faculty, and staff.

The design/build/fly process is complex, bringing concepts and ideas to reality for completion of flight-worthy satellites. Team members of M-SAT come from varying majors and academic levels. The team mimics industry practices in an academic interdisciplinary environment with assistance from faculty and staff. This past year was a busy one with three flight projects ongoing in addition to the high-altitude balloon program the team conducts.

The first mission, MR & MRS SAT, is nearing completion. The purpose of this satellite project is to circumnavigate about a non-cooperative (or unfamiliar) resident space object (RSO) in order to capture images of the RSO. Once pictures have been taken, the images will be downlinked to the M-SAT ground station, located on campus, so that a 3-D model may be constructed to determine what the RSO's purpose and capabilities may be. For this mission M-SAT will assemble a single microsatellite (~50 kg mass) composed of the two smaller spacecraft MR SAT (Missouri-Rolla Satellite) and MRS SAT (Missouri-Rolla Second Satellite). MR SAT is the active imaging satellite while MRS SAT represents the non-cooperative RSO. Using "his" cold-gas propulsion system, MR SAT will perform maneuvers about MRS SAT, taking multiple images of "her" with his imaging system at various angles. After the images are downlinked to the M-SAT ground station, the team can then infer the capabilities and purpose of the RSO. Because most of the mission's funding is provided by the Air Force, this mission profile was developed in collaboration with personnel at Kirtland AFB and addresses several areas of technical interest that they have identified.

M-SAT is currently focused on achieving a critical milestone in the Fall 2019 semester that requires the team to perform four

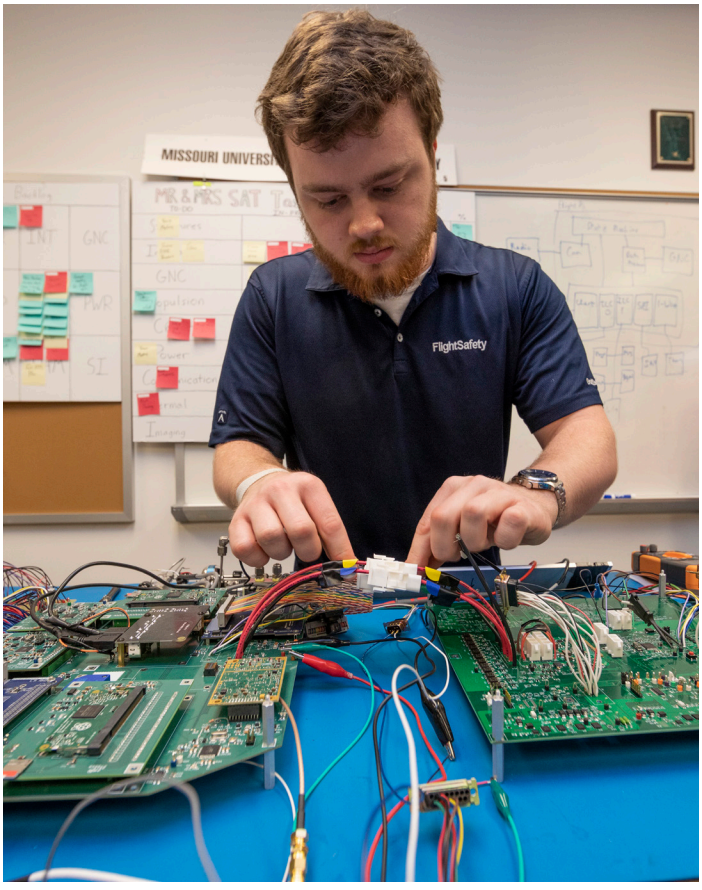
major tests to demonstrate the capabilities of the prototype MR & MRS SAT satellite pair as its Pre-Integration Review (PIR) with the Air Force. After successful completion of PIR, M-SAT will build the final space-grade satellites that will then be shipped to Kirtland AFB for final testing before hopefully being launched to the International Space Station for deployment. As such, M-SAT is currently purchasing space-rated components and equipment for its lab to facilitate the detailed integration procedures required for satellite assembly. In parallel to spacecraft integration, the Department of Defense and the Air Force are responsible for assigning priority for providing launch opportunities to government-sponsored satellites requiring M-SAT students to present to the DoD Space Experiments Review Board (SERB). The team has consistently ranked higher compared to other universities, and senior Matt Russell has already made the first in a series of three required presentations for this upcoming review cycle that culminates in November.

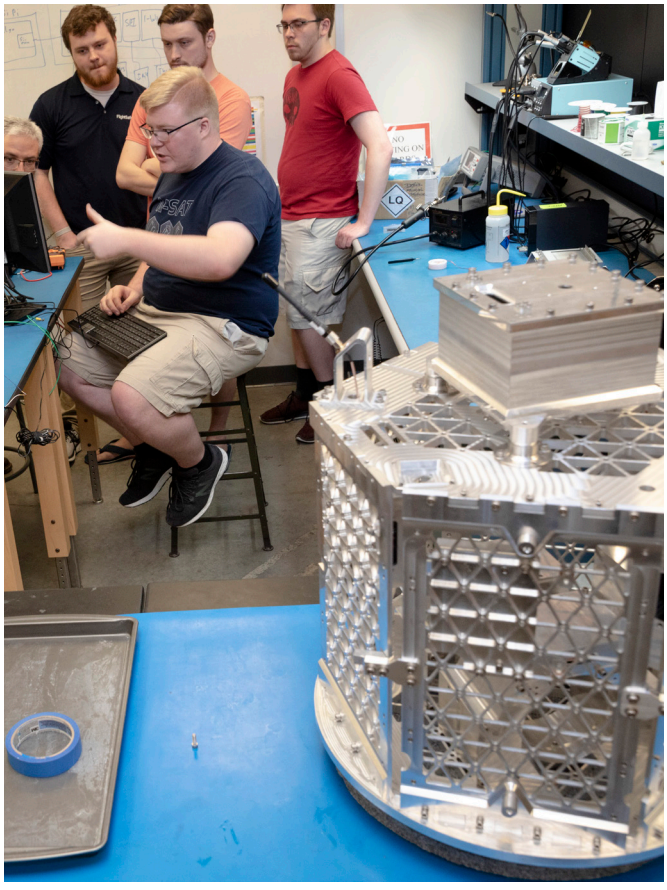
The M-SAT team's Advanced Propulsion Experiment (APEX) is a current participant in the Air Force Research Laboratory's University Nanosatellite-10 program, with the competition officially having kicked off this past January 2019. The APEX mission will serve as a Technology Demonstration Mission for a single, successfully integrated multi-mode propulsion system that can operate in either chemical mode or electric mode. This integrated propulsion system will use the same ionic liquid monopropellant for both modes. The benefit of this innovation is that it allows for wide flexibility in the mission by allowing a variable amount of propellant to be budgeted toward either mode as mission needs arise. Conventional satellites typically use a single mode thruster, limiting maneuvers to either high-thrust/low-Isp or high-Isp/low-thrust. Two separate propulsion systems, chemical and electric, could be used to bridge the gap between these types of maneuvers, but at increased hardware cost (i.e. mass and volume), which is challenging for small satellites. The multi-mode thruster payload in this mission is a single thruster capable of operating in two modes, and thus has a hardware footprint similar to existing single-mode propulsion systems. Currently the team is preparing for a design review in August at the 33rd annual Conference on Small Satellites with Air Force and industry reviewers.

The M-SAT team is also developing a CubeSat as part of NASA's Undergraduate Student Instrumentation Project (USIP), which provides undergraduate students the opportunity to design, test, build and launch a small satellite. Referred to as the "Multi-Mode Mission" (M3), the spacecraft is a 3U CubeSat that complements the larger 6U APEX CubeSat mission. This simplified version of APEX is designed to identify and address high risk aspects of the multi-mode thruster. The M3 mission integrates a single-strand multi-mode thruster with the primary focus to obtain pressure, voltage and temperature values of the thruster and its custom propellant in the unique testing environment of space.

Currently, both prototype and flight versions of M3 are being fabricated/integrated. Plans are underway to conduct environmental testing of the flight version this summer and fall semesters. Manifesting a launch has been approved by NASA, and NASA/ Kennedy Space Center personnel are actively seeking a launch opportunity for M3 (possibly using an Antares launch vehicle).

Finally, the team actively provides high-altitude balloon flights to approximately 100,000 feet with student-built "smallsat" payloads that are used to teach aerospace engineering sophomores and high school students interested in STEM fields the basics of spacecraft design. Two successful flights were conducted during the spring semester, and at least one more will be flown over the summer.





DESIGN TEAM UPDATE

AN UPDATE FROM THE TEAMS ON THEIR 2018-2019 SEASON.

MINER AVIATION

Miner Aviation competed in the AIAA Design/Build/Fly Competition in Tucson, Arizona on April 11th-14th. This was the team's first time competing in this particular competition and they are proud of their results. The aircraft performed to the best of its ability, which it received many compliments for its design by both fellow competitors and judges. There were still some challenges, but that was to be expected with the new competition.

With this being a new competition for Miner Aviation, the team wasn't sure what to expect. They decided to use their prior experience and play it safe with the design and performance of the plane. AIAA's structure to their competitions essentially involve a "theme" to them for three missions the aircraft must complete. This year, the missions focused on a military focused aircraft carrier utility. One of the missions involved carrying as many bombs (nerf missiles) as possible that a team's plane could carry and drop each bomb individually per lap around the flight path. Miner Aviation decided based on their design and propulsion system the amount the plane could carry successfully was six bombs. Upon going to competition, seeing how the other teams performed and the ability of the plane, the team realized they could have carried more bombs than expected if they would have adjusted the propulsion system. In the end, the team successfully dropped the bombs individually per lap and the other missions were successful as well. Miner Aviation placed 15th out of 104 teams, with 21 international teams included. The team was extremely proud of placing within the top 20 teams with this being their first time at the AIAA competition.

As for next year's season, the competition will take place in Wichita, Kansas. The themes for the competition at this location are commercial-based for aircraft, which Miner Aviation is anxiously awaiting the release of the competition's missions and rules. The team is preparing to push the envelope on the next aircraft's design and performance. They hope to place even higher than this year's results now that they know what to expect, and they are ready to push the limits for an exceptional aircraft.

MISSOURI S&T ROCKET DESIGN TEAM

The Missouri S&T Rocket Design Team is a group of students that come together to reach for greater heights through their love of rocketry. The team's main objective is to design and manufacture high-powered rockets for competition each year, further expanding their knowledge and capabilities from the year before. In addition to hands on experience with the team projects, individual members also have opportunities to build their own rockets and become Tripoli certified rocket scientist through the team organized Level 1 High-Powered Rocketry Workshop. At the end of this year, the team decided that it will fully support both solid and liquid propulsion types in the years to come.

This past year, the team made significant strides. For the first time, two rockets were built within a school year and performed very well in flight. Having two rockets aided in members being able to gain more experience, allowed an additional rocket for future payload testing, and provided practice to perfect the second rocket for competition. Both Nova rockets were approximately 15' tall, 6.6' in diameter, and constructed with competition in mind. For competition the team attended the 2019 Spaceport America Cup in New Mexico, where the newest Nova was launched in the 10,000 ft. Student Researched and Designed Solid Motor category. Launch went smoothly, and Nova soared to 8,000 feet. Afterward, the rocket was recovered safely a mile away. The payload featured on Nova's flight, which was also an aspect of competition, was a 3U CubeSat that has a chamber inside that tested a counter roll system. Unfortunately, the payload did not perform as expected due to an error within the code, but the team feels that they can fix this problem and prove the system in later testing.

For the team's solid project in the upcoming year, the group is attempting their most ambitious rocket yet. It will feature a completely student designed and manufactured motor that will propel the rocket to 30,000 feet. Onboard will be a payload in CubeSat form that alumni will be able to contribute to as far as experimentation subject and design. The team will also be diving head first into new telemetry systems and flight computers that will be designed in flight. This project will be used to compete at the end of the upcoming year. As for the liquid project, the team hopes to expand upon what they did this past year and work towards having their first full liquid rocket propulsion system. Members of this project have completing research as well as various analyses on proposed combustion chamber geometries, system heat transfer elements, injectors, and main valves for their plumbing system. Project goals for the upcoming semester include having a test stand design finalized, as well as the engine design and other supporting component designs. From there, manufacturing and testing will take place. The long-term project goal is to have a rocket reach the Karman line on the propulsion system while competing in the 3-year long Base 11 competition.

The Missouri S&T Rocket Design Team would love to hear from alumni. Feel free to contact the team with suggestions, advice, or what you would like to see from them. Contact can be made at rocket.mst.edu or in-person at weekly meetings. Meetings are held on Wednesday nights at 7:30 PM in Toomey Hall.

FORMULA SAE

The S&T Racing team faced a lot of challenges throughout the 2018-2019 year, the team overcame those challenges through team work and effort. Through changes in team members and team roles, the team dynamic was different this year. However the team was still able to produce a high performing vehicle has been seen in the past.

The biggest obstacle the team had to face in terms of design was working out how to update the aerodynamics package to help cool the car. Last year, the team faced a challenge at Lincoln with the heat and the car was overheating during the endurance race. This year, however, the team dedicated resources to solve this problem. With the new curved elements on the front wing, the car saw some improvement. The team designed the new front wing specifically to help direct air into the sidepods (the big tunnels on the side of the car that direct air into the radiators).

S&T Racing attended two competitions this year, FSAE Michigan and FSAE Lincoln. At both competitions the team scored high in the design portion and had major improvements from last year. At Michigan, the team placed 23rd overall out of 108 cars. Michigan always has a tough competition with the best of the best cars in attendance. To be in the top 25, especially after having some failures on the day of the event, is great for the team. At Lincoln, S&T placed 4th overall out of 77 teams, 2nd in the business presentation portion, and 2nd in the skidpad portion.

S&T's Racing's performance in the previous year set the world ranking back some, but after a successful year in 2019, the team is excited to see where they will rank now. Next year's team will use the achievements as well as the lessons learned to build an even better car.

We cannot thank the MAE department, the SDELC staff, the MAE Academy, S&T FSAE Alums, our families, friends, professors, and team sponsors enough for all they do for us during the racing season. We could not do it without all the support and encouragement we receive from all of them. Thank you from all of us at S&T Racing and we'll see you in August!

HPV

The 2018-2019 Human Powered Vehicle competition season has officially ended. Throughout the past year, the team focused on continued development in the recruitment of new members and the procurement of new knowledge and experience.

The team continued to build upon their experience with the leaning tricycle in this year's design. Cycleangelo features an innovative disc brake leaning mechanism, a newly designed adjustable seat, and custom-made carbon fiber wheels.

HPVT started the competition season in March, traveling once again to Pomona, California where the team competed against 19 other teams from around the world. In sharing both tools and riders, HPVT was able to network and build relationships with international students from both Tec de Monterrey, Mexico and Cairo, Egypt. Out of 20 teams, the team placed 8th in Design, 3rd in Women's Speed, 2nd in Men's Speed, 7th in Endurance and 5th overall.

In the two weeks in between West and North competitions, the team utilized this time to make small design changes to improve overall performance including a refined wheel alignment and larger parcel carry system. After many long hours of preparation and upgrades, the team was geared up and ready to compete with 50 teams at Michigan State in East Lansing, Michigan.

HPVT's speed was put to the test both on and off the course. Recurring flat tires at West Competition forced our pit crew to move quickly and efficiently to keep the vehicle racing. A catastrophic tube failure during the Men's drag race at North Competition led to an afternoon of grinding, welding, and engineering to ensure the bike would be mobile for the endurance race. Sure enough, the team was ready to compete from start to finish the next day. When the results came in, S&T placed 16th in Design, 5th in Women's Speed, 9th in Men's Speed, 12th in Endurance and 10th overall.

HPVT is already planning and excited to compete in both E-Fest US competitions again in 2020. The year will begin with SolidWorks designs, new member recruitment, and prototyping components. Before starting the build cycle, a preliminary design review will be held in the beginning of September. Then, the final build will begin before the end of the fall semester. HPVT strives to enable students to gain real world experience in design, fabrication, teamwork, and leadership all of which would not be possible without the support from our generous sponsors.

Visit humanpowered.mst.edu or contact humanpowered@mst.edu

ALEX REYNOLDS PLACES 1ST

AT AMERICAN ASTRONAUTICAL SOCIETY GUIDANCE AND CONTROL CONFERENCE

Aerospace engineering senior, Alex Reynolds, received first place and a $1000 prize for his student paper at the 42nd Annual American Astronautical Society Guidance & Control Conference earlier this year. His paper, "Design and Verification of a Stereoscopic Imager for Use in Spacecraft Close Proximity Operations," focused on research that he conducted as part of the Missouri S&T Satellite Research Team (M-SAT). This research included the design and testing of the stereoscopic imaging algorithm that "MR SAT" will use in space to track "MRS SAT". Specifically, it addresses how MR SAT processes images to find MRS SAT in space so MR SAT can navigate around MRS SAT.

As the space environment becomes more crowded, having spacecraft that can detect and maneuver around other objects in space will be very helpful. The problem is that many of the methods for detecting other objects (like radar and lidar) are too large and use an excessive amount of power for use onboard a microsatellite. As a method for enabling such "proximity operations" by a small satellite, stereoscopic imaging is ideal because of the low volume and power requirements. The research presented in Alex's paper focuses on the imaging computer on MR SAT - which isn't very powerful - so more traditional image processing methods don't work well. Instead, Alex developed an algorithm that uses OpenCV (an open-source image processing library) to perform initial image processing, then applies a special filter designed specifically for the space environment to determine where objects are located. His paper focuses primarily on the algorithm's development, but also includes some extensive testing results.

YOU'RE INVITED!

MAE ORGANIZATIONS ARE LOOKING FOR SPEAKERS

At S&T, the mechanical and aerospace engineering department is home to four professional and honor societies. These include AIAA, ASME, Pi Tau Sigma, and Sigma Gamma Tau. The groups are scheduling presentations for upcoming meetings and welcomes all employers, business professionals, and alumni to share their expertise.

The groups strive toward bettering its members' networking opportunities and awareness of the real world by endorsing new topics, unique industry experience, career path preparation, and exposure to daily problems faced by engineers.

Below are topic suggestions, but please be encouraged to share your original ideas:

- Project management
- Science news & innovation
- Research & development
- International relations
- Emphases & minors
- Certifications and becoming a PE
- ASME after college
- Industries:
    - Aerospace
    - Agriculture
    - Automotiwve
    - Construction
    - Controls
    - Defense
    - HVAC
    - Manufacturing

Meetings are held on campus, bi-weekly, and open to all students. With questions or presentation reservations, please reach out to mae@mst.edu.

JILL DAVIS RECEIVES PRESTIGIOUS **AMELIA EARHART FELLOWSHIP**

Jill Davis, a PhD student in Aerospace Engineering, has received a prestigious 2019 Amelia Earhart Fellowship from Zonta International Foundation. Jill, who is advised by Dr. Hank Pernicka, is one of the 30 recipients of this award from all over the world in 2019, which is given to women of any nationality pursuing a Ph.D./doctoral degree who demonstrate a superior academic record in the field of aerospace-related sciences or aerospace-related engineering.

Ms. Davis's PhD research focuses on the development of novel small satellite navigation techniques to enable deep space and cislunar (near the Moon) formation and swarm missions. As humanity again pursues the exploration of space beyond low Earth orbit, there is a need for advanced manned mission support systems. Small satellites have shown great promise in accelerating the development of space systems while decreasing the overall associated costs, and as technologies mature, SmallSat mission portfolios can expand to operate with increased functionality beyond Earth orbit. Groups of rapidly developed spacecraft with lowered launch costs operating in a swarm can reduce the need for the typical monolithic spacecraft that take years to develop and launch.

Currently, Ms. Davis' research seeks to develop vision-based sensor suites that enable relative position and orientation estimation between cooperative members of a spacecraft swarm. This work will explore the use of advanced cooperation mechanisms, such as LEDs or QR codes attached to the spacecraft that enhance the accuracy of the sensor suites. The project will also incorporate learning algorithms to facilitate spacecraft identification and tracking, as well as investigate a variety of swarm/sensor configurations and architectures that will be analyzed using a design optimization approach.

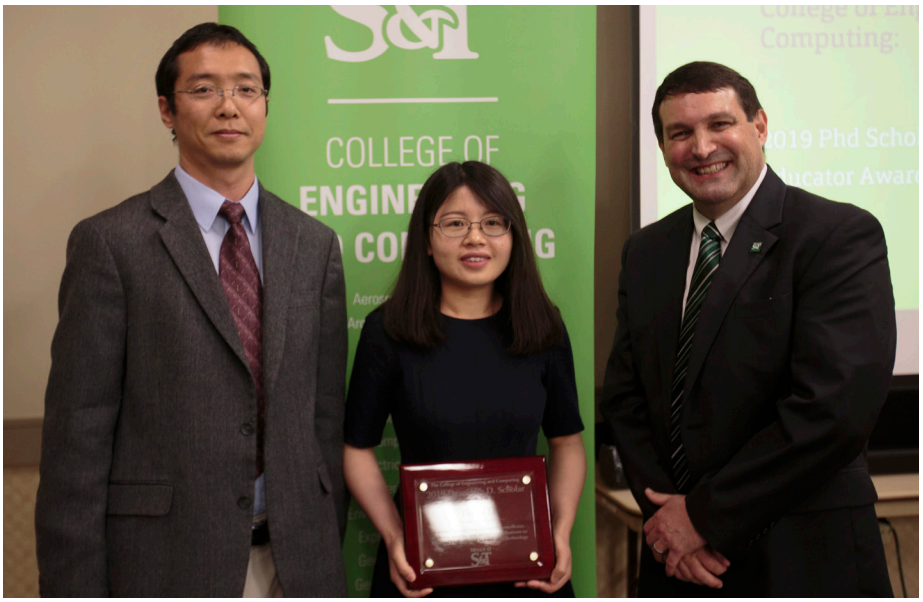
After analyzing candidate designs, prototypes will be tested in Missouri S&T's Space Systems Engineering lab. Further tests of the system will likely include campus high-altitude balloon flights to assess system performance in a dynamic near-space environment. The solution set provided by this research will help expand the ever increasing SmallSat mission capabilities and potentially help propel humans to the Moon, Mars, and beyond!

More information on the Amelia Earhart fellowship can be found on the fellowship website https://foundation.zonta.org/Our-Programs/Educational-Programs/Amelia-Earhart-Fellowship. According to this website, the Amelia Earhart Fellowship was established in 1938 in honor of famed pilot and Zontian, Amelia Earhart. The US $10,000 Fellowship is awarded annually to 30 women pursuing Ph.D./doctoral degrees in aerospace-related sciences or aerospace-related engineering. Previous recipients of this award include fellows, who have gone on to become astronauts, aerospace engineers, astronomers, professors, geologists, business owners, heads of companies, even Secretary of the US Air Force in their careers.

JASON JOHNSON RECOGNIZED FOR **ADDITIVE MANUFACTURING OF GLASS RESEARCH**

Jason Johnson, a junior majoring in mechanical engineering, has been working hard on his undergraduate research and has received recognition through presenting a paper at the Photonics West conference and receiving a prominent internship offer. Mr. Johnson's internship offer is with Lawrence Livermore National Laboratory (LLNL) through the Department of Energy Science Undergraduate Laboratory Internship (DOE SULI) program. At LLNL, he will be working in the Materials Engineering Division on the additive manufacturing of glass optics using a direct ink writing process.

In his paper, his work researching the printing of optical fiber has focused on printing fiber optic components for light routing including sensing applications. The ability of glass fiber to guide light down the length of the material is the basis of many communication and sensing technologies. The goal of the research is to combine this ability of fiber optics with the manufacturing capabilities offered through the AM of glass process in order to create unique designs for new types of integrated sensors for photonic applications. The Photonics West paper specifically focused on the development and optimization of the AM of glass process and parameter space for the printing of single-mode fiber to test the effects of the printing process on the fiber's light-guiding abilities.



CONGRATULATIONS TO THE CEC PH.D. SCHOLARS AND GRADUATE EDUCATORS

Fifteen doctoral students in the College of Engineering and Computing at S&T have been honored for their scholarly productivity and teaching excellence. Nine students were named CEC Dean's Ph.D. Scholars and another six were named Dean's Graduate Educators. Each student was recognized and honored at the end-of-semester reception on May 16, 2019.

Three of the award winners were from MAE. The award winners were nominated by professors in their departments, selected by the department chair for consideration from the college. The winners were selected by Vice Provost and Dean Richard Wlezien.

Dr. Yingqi Li, from China, (pictured in the top photo) received the Dean's Ph.D. Scholar award. Dr. Li graduated in May with her degree in mechanical engineering and was advised by Drs. Ming Leu and Hai-Lung Tsai. She is currently a Material Joining Engineer at Gestamp North America R&D center.

Xinchang Zhang, from China, (pictured center) also received the Dean's Ph.D. Scholar award. Dr. Zhang graduated in May as well with his degree in mechanical engineering. He was advised by Dr. Frank Liou and is now interning at Idaho National Laboratory.

Abdulaziz Abutunis, Ph.D. candidate in mechanical engineering, earned the Dean's Ph.D. Educator award for his teaching in the Control Systems Laboratory for Dr. S. N. Balakrishnan. Abdulaziz is from Libya and plans to graduate in the Fall of 2019 with plans to continue teaching and research as a faculty member in higher education. He is advised by Dr. Chandrashkhara.

STAFF NEWS

WILLY PROMOTED TO OFFICE SUPPORT ASSISTANT IV

After three years as the Academy and undergraduate office support assistant III, Debi Willy accepted the position of office support assistant IV where she handles purchasing functions for instructional needs and class projects. She trains faculty, staff and students on travel and expense reimbursements and provides support to the manufacturing program. Debi has great rapport with everyone with whom she interacts and goes the extra mile to find answers for students, faculty, staff and alumni.

As she transitions to her new position, she will continue to work with the Academy and undergraduate appointments. This includes assisting faculty in student hires, supporting the department scholarship program, and helping the academy with their meetings and events.

With Debi's organizational skills, adept time management and expertise, she continues to serve the department with dedication and professionalism.

INTRODUCING AMOLLIE, MAE'S ACADEMIC ADVISOR

Recently, the department has added a new position to support the MAE advising office. With the ever growing student enrollment, the advising office plays a great role in student support and success. Amollie Stoermer joins the department as an academic advisor.

In her role at S&T, Amollie will advise current MAE students and have an integral role with the inaugural class of students in the Mechanical Engineering cooperative program with Missouri State University. This program is slated to bring in first students in the fall semester of 2020. She will also be assuming many of the duties surrounding student assessment and assisting with ABET audits and updates.

Amollie was born and raised in Cole Camp, Missouri. In May of 2018, she earned a bachelor's of arts degree in communication studies at Truman State University. Upon graduation, she joined Missouri Valley College as an academic advisor and retention specialist.

For fun, Amollie enjoys singing and attending theatre productions. She also enjoys exploring new places, hiking, and crocheting.

SKYLAR JOINS MAE AS NEW SHOP TECH

Skylar Rea joined MAE as the new engineering technician of the machine shop in 2018.

Skylar brings an extensive background of machining through previous work as a CNC milling machinist for Roberson Machine Co., a machinist for Wolfert's Tool and Machine Company, and a welder/fabricator for CZ Engineering. He also has an associates of applied science degree in machine tool technology from State Technical College of Missouri in Linn, Missouri.

Skylar's family has several members who worked in the manufacturing, aerospace and automotive industries. Fabricating and repairing things were typical weekend projects during his childhood and he credits his interest in machining to his Rolla Technical Institute instructor, Ron Woody. During high school, Skylar attended the vo-tech machine tool program to learn about the manufacturing aspect of engineering and design before continuing onto college.

Outside of work, Skylar enjoys raising his two children with his wife and operating his family farm, where they proudly graze cow-calf pairs.

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THANK YOU TO EVERYONE WHO MADE CONTRIBUTIONS TO LAST YEAR'S PHONATHON. THE PHONATHON WILL BEGIN THE WEEK OF SEPTEMBER 9TH. WHEN THE PHONE RINGS, PLEASE TAKE A MOMENT TO SPEAK WITH ONE OF OUR STUDENT REPRESENTATIVES. EVERY GIFT HELPS MAKE A DIFFERENCE AND SUPPORTS MAE'S MISSION OF ENHANCING STUDENT LEARNING. PLEASE HELP MAKE THIS YEAR'S FUNDRAISING THE BEST YET!

WE LOOK FORWARD TO SPEAKING WITH YOU SOON!