

MAE

Mechanical and Aerospace Engineering | Missouri S&T | 2020 Newsletter

MISSOURI
S&T

LET'S CELEBRATE 150 YEARS

Missouri S&T was chartered on Feb. 24, 1870, as the Missouri School of Mines and Metallurgy, and classes were called to order on Nov. 6, 1871.

As the first technological institution west of the Mississippi — and one of the first in the nation — the university was a product of the Morrill Act of 1862 and the land-grant movement of the late 19th century. A year of special events starts with Homecoming 2020 as the official kickoff followed by many events on and off campus through 2021. Please join us as we honor the university's past, celebrate its present and envision its future.

To commemorate the university's legacy, Curators' Distinguished Teaching Professor emeritus Larry Gragg has written a limited-edition hardcover book, *Forged in Gold*. The book launches October 2020 and tells the tale of our university's history, from its hardscrabble "country academy" origins in the 1870s to its position today as one of the nation's top STEM-focused research universities covering 150 years of Miner milestones, memories and mischief. Pre-order your copy at forged.thesandtstore.com.

150.mst.edu

150 
MISSOURI S&T

LETTERS FROM THE INTERIM AND INCOMING MAE CHAIRS



Dr. J. Keith Nisbett,
interim department chair



Dr. David J. Bayless,
incoming department chair



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

“Engineers are problem solvers. Everything else they do is just detail.” This is how I usually start a chat with prospective engineering students. Engineering education is full of details – useful knowledge and tools. But what sets us apart as engineers is a mindset that doesn’t cower from unknowns and obstacles, but instead embraces them as an expected part of the process. Well, we are getting plenty of opportunity to put this into practice! There are so many things that we did not see coming. Maybe this year is no different than most years, and I just feel it more because I have a greater sense of responsibility for the MAE department. Regardless, what I observe is that, through it all, this department continues to rise to the challenge. To be sure, this is not just about engineers. In times of great disruptive events, ordinary people step up, leaders arise, society adapts – we succeed by being problem solvers. I have the privilege of serving a department made up of students, staff, and faculty who are robust, committed, creative, and persistent. Another thing I tell prospective students – “Pick a school based on its personality.” We shall continue to educate and inspire.

Great difficulties may be surmounted by patience and perseverance. –Abigail Adams

J. Keith Nisbett

As a graduate of the department (BSME '87), I am honored to be the next Chair of the Mechanical and Aerospace Department, starting on January 1, 2021. I have spent much of the summer getting to know some of the incredibly bright and dedicated faculty and staff. Despite the challenges of COVID-19 and other issues facing us, I am confident in the bright future of the department.

Excellence is not just a buzzword in MAE. It is the culture, built up over the years by outstanding leadership, driven faculty, caring staff, and bright students. That commitment to excellence will guide us to develop future graduates that will continue to be among the best prepared engineers and researchers in the nation. We will continue to be a place where talented people want to come to learn, work, and create. And we will pull together to not only meet the challenges before us, but use them as opportunities to make this department ever better.

I am looking forward to coming home and when we can safely do so, meet you all.

David J. Bayless

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WELCOME

the new chair of MAE

David Bayless, BSME '87, returns to S&T as chair of mechanical and aerospace engineering.

By Andrew Careaga

David Bayless returns to Missouri S&T on Jan. 1, 2021, as the new chair of mechanical and aerospace engineering. A 1987 Missouri S&T mechanical engineering graduate, Bayless is the graduate chair of mechanical engineering and Gerald Loehr Professor of Mechanical Engineering at Ohio University in Athens, Ohio. He is looking forward to returning to Rolla.

"Dr. Bayless is a dynamic leader with strong ties to Rolla," says **Richard Wlezien**, vice provost and dean of Missouri S&T's College of Engineering and Computing. "His research in energy and waste management will benefit not only S&T, but also our world. We are excited to welcome him back to Rolla."

An expert in the connections among energy, water and waste, Bayless' research focuses on carbon recycling and wastewater remediation, enhancing hydrocarbon recovery from hydraulically fractured (fracked) shale formations, and developing photobioreactors to grow algae for commercial use. He has been principal investigator in more than \$17 million in externally funded research. Bayless holds 13 patents.

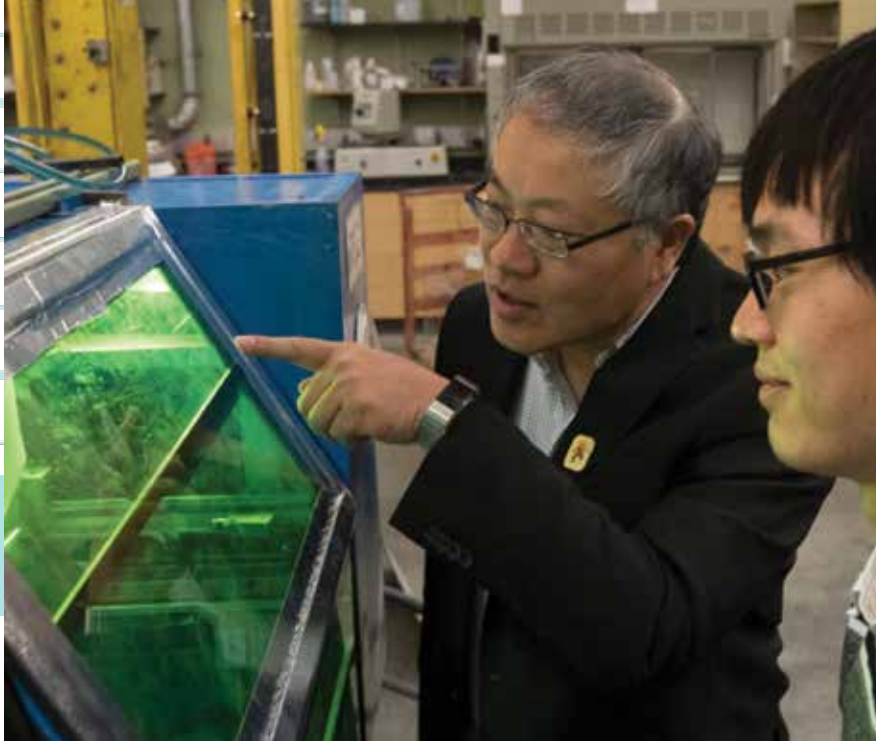
In addition, Bayless is director of the Ohio Coal Research Center and the Robe Leadership Institute. He is a Fellow of the National Academy of Inventors and the American Society of Mechanical Engineers. The Ohio Society of Professional Engineers named him Outstanding Engineering Educator in 2016, and he is a five-time Ohio University Top Faculty Newsmakers awardee. Bayless is a registered professional engineer in both Missouri and Ohio and is a U.S. Navy veteran.

Bayless comes by his engineering and leadership capabilities naturally. His father, the late **Jerry Bayless**, was an associate professor of civil, architectural and environmental engineering and an influential part of Missouri S&T for more than 60 years, from 1955 when he enrolled as a student at what was then Missouri School

"What excites me the most is being able to return home and to my alma mater with a very tangible opportunity to make a difference. How many Rolla kids and S&T alumni get the chance to work among the best faculty in the best department on campus to help shape the future of the department and influence the lives of our students?"

of Mines until his retirement in 2017. Jerry Bayless, known as "Mr. Miner," died in 2019.

David Bayless earned a master's degree in engineering management from the University of Central Florida near Orlando and his doctorate in mechanical engineering from the University of Illinois at Urbana-Champaign.



NEW FACULTY



FRANK LIOU WINS PRESTIGIOUS TAYLOR RESEARCH MEDAL IN MANUFACTURING

Dr. **Frank Liou**, the Michael and Joyce Bytnar Professor and director of manufacturing engineering at Missouri S&T, has won the 2020 Frederick W. Taylor Research Medal from SME (formerly the Society of Manufacturing Engineers). The award honors significant published research leading to a better understanding of materials, facilities, principles and operations and their application to improve manufacturing processes. Liou's research in hybrid additive manufacturing and advanced materials and the industrial impact of the research were the basis for the award, according to SME.

"This recognition for state-of-the-art additive manufacturing research would not have been possible without the top-notch colleagues and facilities I have at Missouri S&T," Liou says. "I am honored to receive this recognition that is due in large part to our government-industry-academic collaborative ecosystem. To a large extent, my accomplishments reflect the feedback I have incorporated from various stakeholders."

Dr. **Robert Landers**, Curators' Distinguished Professor of mechanical and aerospace engineering at S&T, nominated Liou for the award.

"Frank has been the world's leading researcher for the past two decades in the field of metal additive manufacturing, particularly blown metal powder processes, and the integration of metal additive manufacturing with machining," Landers says. "His truly pioneering contributions span the entire range of the field, from fundamental academic discovery to industrial implementation."

Liou joined the Missouri S&T faculty in 1987. In addition to his work as director of the manufacturing engineering program, he is a senior research investigator with the Intelligent Systems Center and a faculty research investigator for both the Graduate Center for Materials Research and the Center for Research in Energy and Environment at S&T.

"Dr. Liou continues to exemplify outstanding leadership among his peers at Missouri S&T," says Dr. **Richard Wlezien**, vice provost and dean of the College of Engineering and Computing. "The Taylor Research Medal recognizes Frank's world-class contributions to our students and to the manufacturing industry. We are thrilled to have seen him grow his career while at S&T and are very fortunate to have him as a member of our team."

Liou's research interests include metal additive manufacturing process design, modeling, integration, monitoring and control, as well as computer aided design (CAD) and computer aided manufacturing (CAM). He is the author of *Rapid Prototyping and Engineering Applications: A Toolbox for Prototype Development*.

WELCOME MICHAEL PUOPOLO

Dr. **Michael Puopolo** joined S&T as an assistant teaching professor in August 2019. He previously taught courses in dynamics and control as an assistant professor of mechanical engineering at Kettering University. At S&T, Dr. Puopolo has been teaching Dynamics and Intro to Engineering Design. He has also been serving as the advisor to ASME.

Dr. Puopolo earned his doctorate in mechanical and aerospace engineering at Oklahoma State University, doing research in flexible robot control and high angle-of-attack aerodynamics. Before earning his doctorate, he worked for 10 years in industry as a research engineer at Space Systems LORAL in Palo Alto, California and as a senior project engineer at ACTA Services Corporation at Vandenberg Air Force Base. In these positions, his primary responsibility was to analyze spacecraft systems to assess failure risks. Michael earned a master's degree in engineering from California Polytechnic State University after receiving a bachelor's degree in physics from the University of California at Riverside. When not on campus with his students, he enjoys reading about classic American sports cars and practicing classical guitar.



JIM DRALLMEIER RECEIVES UM SYSTEM PRESIDENT'S AWARD

Jim Drallmeier, Curators' Distinguished Teaching Professor of mechanical engineering, received the 2020 President's Award for Leadership. The award, which includes a \$4,000 prize, recognizes faculty who have provided exemplary leadership to one of the four UM System campuses through commitment to excellence and integrity in their leadership roles.

While serving

as department chair from 2011 to 2019, Dr. Drallmeier's leadership contributed enormously to the growth and reputation of the largest academic unit of Missouri S&T.

"Jim is a great thinker and an inspirational leader. During his tenure as our department chair, Jim developed a shared vision with the department faculty and then forged an ambitious strategic plan aimed at growing the department's graduate research program while maintaining the high standards of its undergraduate program. The strategic plan was carried out with a methodology founded on the basic principles of excellence, transparency, and fairness," stated **Ming Leu**, Keith and Pat Bailey Missouri Professor of Integrated Product Manufacturing, who nominated Drallmeier for the award.

During his time as department chair, Dr. Drallmeier worked with the faculty to strengthen faculty research productivity resulting in doubling expenditures and tripling the number of doctorate students. A third of the tenure-track faculty he hired received an NSF CAREER award or an ONR/AFOSR Young Faculty award, and most of the new faculty developed careers with metrics rivaling faculty at top research universities. Remarkably, the growth in department research and scholarship occurred while also improving the undergraduate program with the number of undergraduate students increasing by 35% and the number of students on probation and deficiency decreasing from over 5% to less than 2%. These successes were attributed largely to his personal character and integrity.

"Dr. Drallmeier was an exceptional department chair," wrote **Robert Landers**, Curators' Distinguished Professor of mechanical and aerospace engineering. "Dr. Drallmeier led the department by setting clear expectations and working tirelessly to obtain resources and address issues facing the department. He was instrumental in establishing the direction for the MAE department and launching many successful faculty careers. Personally, Jim was an outstanding mentor and friend, helping me to grow as a faculty member and always making the time to listen to my questions and concerns. The example he set and the advice he gave were invaluable as I took on the role of Associate Chair for Graduate Affairs in the MAE department, and as I assumed subsequent leadership positions."

Dr. Drallmeier has also made outstanding leadership contributions to Missouri S&T at large, beyond the MAE department. He served as a co-chair to develop a Missouri S&T strategic plan in 2012-2014, which included developing a plan to hire 100 new faculty and identifying four best-in-class signature areas. Jim's clear vision, methodical planning, collaborative spirit, transparency and inclusiveness are the basis for the respect he has earned among peers.

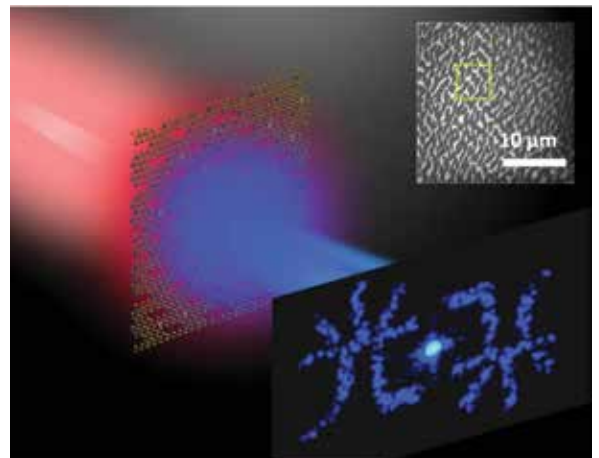
SUB-NANOMETER THICK OPTICAL HOLOGRAM WORK PUBLISHED IN NANO LETTERS

A new concept by Drs. Gao and Yang for making optical holograms with 2D material monolayer has been published in the journal *Nano Letters*, a top journal in nanoscience and nanotechnology research. Their findings hold promise for future technologies such as 3D displays for smart watches, security marking on credit cards, and biomedical imaging.

As described in their article, "Atomically thin nonlinear transition metal dichalcogenide holograms," the hologram is made up of only single nanopatterned tungsten disulfide monolayer punctured by a nanofabrication process known as focused ion beam milling.

"We are able to control the binary amplitude modulation of zero and one by simply etching out or keeping the tungsten disulfide monolayer area," says Dr. Xiaodong Yang, "Our holograms possess significantly higher nonlinear conversion efficiency than the currently existing plasmonic metasurface holograms made of metallic nanostructures."

Dr. Jie Gao also explains, "In addition, our holograms have atomic thickness of less than one nanometer, much thinner than the usual thickness of tens of nanometers for plasmonic metasurfaces and several hundred nanometers for dielectric metasurfaces."





COMMUNITY COLLABORATION PUTS KIDS WITH DISABILITIES IN THE DRIVER'S SEAT

By The Community Partnership

The Community Partnership (TCP) received a small grant to launch a new project called Go Baby Go. Go Baby Go adapts toy ride-on cars for children with disabilities enrolled in TCP's Capable Kids and Families® program.

The Community Partnership requested help from Missouri S&T to adapt the cars. Dr. Kelly Homan, the faculty advisor for the Pi Tau Sigma Mechanical Engineering Honor Society, and Dr. Ashok Midha, professor of Mechanical Engineering Senior Design, agreed to lend their students and their expertise to the project.

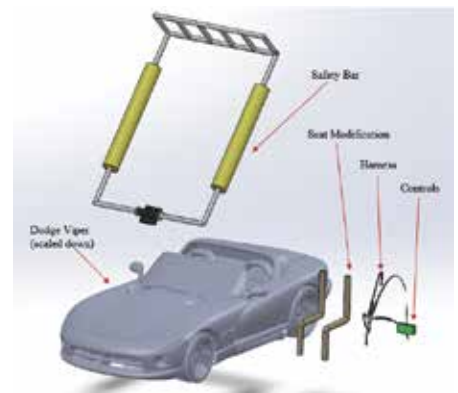
The Community Partnership staff worked with physical and occupational therapists to identify children in the program who would benefit from a car and the specific modifications each child would need. Soon the demand for cars outgrew the funds available through the grant, so TCP turned to the community for help. Hartmann US, Hutchinson Ford, Al West Nissan and a few generous individuals purchased additional cars.

Jessica Haywood, Volunteerism and Greek Life Coordinator, organized a group of Second Saturday Service students to complete the first phase of the project—construction of the basic cars. Dr. Homan then arranged for the cars to be moved to the Mechanical and Aerospace Engineering Lab at Toomey Hall

to await modification. Dr. Midha's students began to design appropriate modifications for each child and plans were made to have a fleet of cars ready to be driven in the St. Pat's Parade.

Although the parade was cancelled and students left campus due to COVID-19 precautions, the project did not stop. The Mechanical Engineering Senior Design class continued to work together remotely. A virtual presentation of the new designs was provided to the children's parents and therapists in May. Each design considers individual children's interests, size, and specific disabilities. Modifications included joystick steering, flexible bumper systems, additional harnesses, padding, roll bar support, and remote-control capability for parents.

The Community Partnership hopes to complete the modifications with the help of Missouri S&T students in the fall. Sponsorship opportunities are still available to provide cars to a second group of Capable Kids children.



ACADEMY OF MECHANICAL AND AEROSPACE ENGINEERS



**SEVEN NEW MEMBERS WERE
INDUCTED INTO THE ACADEMY**

From left to right: James B. Castle, Glenn A. Erutti, Chris W. Maddox, Prof. Walter Eversman, Edward J. Feltrop, Dale A. Spence, and Andy Jeffers.

The Academy of Mechanical and Aerospace Engineers held its 24th Annual Induction Dinner on Thursday, October 3, 2019, in the Missouri S&T Havener Center. The Academy inducted seven new members:

James B. Castle (BSME '99, MSME '01)
Associate Technical Fellow,
Onsite Research Leader - Missouri S&T,
Boeing Research and Technology
Rolla, MO

Glenn A. Erutti (BSME '83) Program
Manager, SLAM ER Cruise Missile Program
The Boeing Company
St. Charles, MO.

Prof. Walter Eversman
Curators' Professor Emeritus
Missouri S&T
Rolla, MO.

Edward J. Feltrop (BSAE '92)
Manager, Aerodynamics Department
Textron Aviation, Inc.
Wichita, KS.

Andy Jeffers (BSMinE '85, BSME '87)
Engineering Group Manager, Global
Powertrain & Electrification Development
General Motors Corporation
Clarkston, MI.

Chris W. Maddox (BSAE '90, MSEM '97)
Senior Program Structural Engineer
Boeing Defense Systems
The Boeing Company
St. Louis, MO.

Dale A. Spence (BSME '97, MSEMGT '05)
Vice President Marketing and Asia Pacific
AFB International
St. Louis, MO.

PASSING OF THE GAVEL...



Past President, Craig Barnes (right), passes the gavel to new president, Russell Flye (left).

Russell Flye is the new president of the academy for 2019-2020, with **Craig Barnes** serving as past president.

Russell E. Flye is the owner and founder of Russell E. Flye, PE, LLC, an engineering consulting office in Pasco, Washington. He is a registered professional engineer in the states of California,

Nevada, and Washington. His career includes working at Bechtel Power Corporation in Los Angeles, California (1972 – 1987), Fluor Federal Services in Irvine, California (1988 – 2006), and Washington River Protection Solutions, LLC (2007 – 2018).

He is an active member of the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) and the American Society of Mechanical Engineers. He is an active member of ASME sub-committees for Common Equipment, Filtration, and Testing.

He received his B.S. in mechanical engineering at the University of Missouri-Rolla in 1971, and an M.S. in management science at West Coast University.

He has been a member of Alpha Phi Alpha Fraternity, Inc. since 1968 and served on the board of directors as the 28th Western Region Vice President from 2013 -2017. He is also an active 4th Degree member of the Knights of Columbus. He is active in several mentoring and service programs in the eastern Washington area.



2019-2020 Scholarship and Graduate Teaching Award Recipients:

From left to right: Xiaowei Yu, Sierra Snedeger, Alyssa Roller, Will Ziehm, Andrew LeBeau, Marcin Glebocki, Usman Bajwa, Andrew Bondor, and Megan Krueger

Not Pictured: Joseph Babcock, Tate Bollweg, Simeon Frank, John Reeves, and Collin Steele.



A TRIP TO FORT LEONARD WOOD FOR THE SPOUSE/GUEST EVENT

Each year as the AMAE members attend the annual business meeting and design team presentations, there is a special trip planned for the AMAE spouses.

In years past, they have had shopping trips, winery and brewery tours, and even visits with local businesses and industrial plants. This year, the spouse trip was a road trip to Fort Leonard Wood, a U. S. Army training installation just 50 miles away. AMAE member Steve Bugg decided to tag along for this special trip. Getting the security clearance necessary to enter the base took some planning. The group took a tour of the military base with a focus on the chemical training building and spent quite some time at the museum.

Afterwards, the group headed out for lunch at the Ozark Tavern. Boasting their burgers, beer and wings, the tavern also offers an array of appetizers, salads, sandwiches, and traditional plated dinners. Leaving with full stomachs and smiles, the group boarded the van to return to campus, joining the AMAE members at the MAE department open house.

CAMPUS RALLIES TO 3D PRINT PROTECTIVE MEDICAL GEAR



By Andrew Careaga

When representatives from Phelps Health, anticipating a shortage of protective masks due to the coronavirus outbreak, needed help, students, faculty and staff at Missouri S&T answered by harnessing the power of technology and ingenuity.

Campus was abnormally quiet Saturday and Sunday, March 21-22, not only because it was the weekend before spring break but also because, due to the coronavirus outbreak, most students had moved out for the semester and a majority of faculty and staff prepared to work remotely. But 3-D printers in a couple of buildings on campus were

humming away, fabricating prototype masks and face shield brackets.

Inside the Kummer Student Design Center, where S&T students usually work on rockets, solar cars, Mars rovers and other projects, a few students, faculty and staff outfitted one room Saturday with a dozen 3-D printers to produce prototypes

for Phelps Health's physicians, nurses and other medical workers.

Across campus, students at Missouri S&T's Makerspace were using their 3-D printers to fabricate prototypes of the face shield brackets. The university enlisted more printers for the cause Sunday.

The S&T prototypes
"are phenomenal,"
says Dr. Casey Burton,
director of medical
research at Phelps Health.

Although there were no confirmed cases of COVID-19 in Rolla at the time, Burton and **Shawn Hodges**, Phelps Health's director of ancillary and surgical services, foresaw the need to obtain more protective gear for the Rolla-based regional health system.

"Shawn had already been experimenting with 3-D printed masks with Rolla High School but realized he needed to drastically scale up production capacity to meet the needs of our community," Burton says. "He reached out to me to rally the university and beyond for their support and to help organize those operations with him on our end."

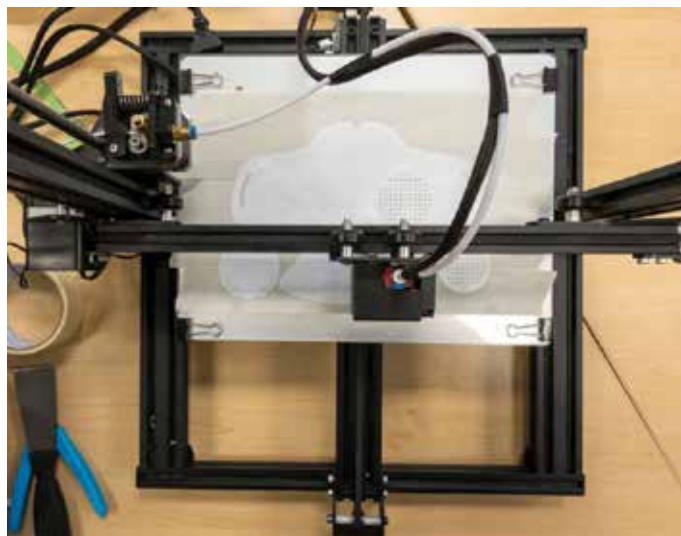
Burton asked Missouri S&T Chancellor **Mohammad Dehghani** if it was possible to harness the university's 3-D printing capabilities to aid in the effort. Dehghani directed others across campus to do what they could to assist.

The Kummer Student Design Center staff and students were among the first to respond. Dr. **Chris Ramsay**, assistant vice provost for student design and director of the center, marshalled the few remaining student members of the center's 19 design teams to set up a 3-D printer farm to run 24 hours a day in the center at 10th Street and Bishop Avenue.

"We started out with five" 3-D printers at the design center, Ramsay says. "I sent a note out to all the design teams, and the students who were still in town brought their printers in and now we're up to 12."

"This has re-energized our design team students," Ramsay says. Hundreds of S&T students had worked since the fall on projects for design competitions that are now canceled due to the coronavirus. "This community need fulfills a hunger that they have to do something positive and meaningful in this crisis."

A prototype medical mask being fabricated on one of a dozen 3-D printers in Missouri S&T's Kummer Student Design Center. Photo by Tom Wagner/Missouri S&T.



Testing prototype medical masks are Missouri S&T student Eric Schneider (left), Phelps Health's Dr. Casey Burton, director of medical research (center), and Shawn Hodges, administrative director of ancillary and surgical services at Phelps Health. Photo by Tom Wagner/Missouri S&T.

"This could certainly be a game changer for us and even the rest of the world, so we appreciate Missouri S&T's efforts," says Dr. **Brian Kriete**, otolaryngologist and medical director of surgical services at Phelps Health.

While the design center produced prototype surgical masks, S&T's Makerspace chief executive officer **Daustin Hoelscher**, a senior computer engineering major from Mascoutah, Illinois, was printing a prototype bracket for the face shields.

"I'm so pleased with how our university community has come together to help in this time of need," says Dehghani. "The rapid response and support for one of our important community partners typifies the true S&T spirit of innovation, ingenuity and community engagement. I am very proud of the way our university has responded to this critical need."

As of June 1, 2020, this project produced a total in excess of 8,500 PPE items. This included 2,000 face masks and 2,000 face shields for Phelps Health, 2,000 face shields and 250 face masks for other healthcare workers and first responders, and 2,500 face shields to be used on campus.



HANDS-ON EXPERIENCE STARTS WITH BALLOONSAT

As a student enters the aerospace engineering program as a sophomore, they waste no time in getting to hands-on experience with their first design course.

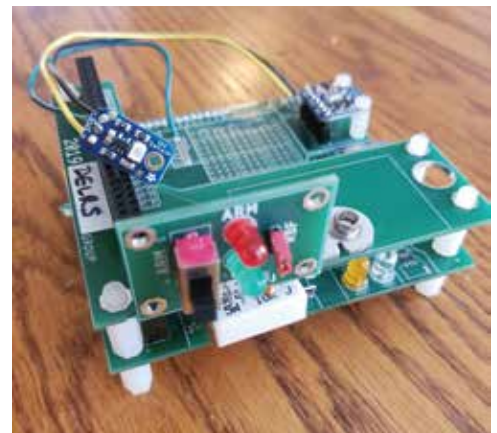
AE 2790 – Introduction to Spacecraft Design is designed to introduce students to the basics of spacecraft design concepts and project timelines. This semester-long project guides students through the design and construction of a “balloonSAT” payload, qualifying it for launch, and demonstrating that it meets given required performance criteria. At the end of the semester, the students launch their payloads on a high-altitude weather balloon to collect data up to an altitude of 100,000 feet!

This course is a new addition to the aerospace engineering curriculum introduced in the Spring 2015 semester as an elective. The course began with only 10

students enrolled and as the enrollment grew each year, the course became required as part of the program. Before being offered as a course, S&T held a high-altitude balloonSAT camp in the Summer of 2014 for high school students. Adding this design course to the curriculum provided students an additional experiential learning opportunity that students were normally not exposed to until their senior year.

This course teaches the students the basics of spacecraft subsystems, environmental testing and the unique challenges associated with designing a spacecraft. Over the course of the

semester, students work in teams of four to five to determine what type of data they are interested in collecting during flight, define a mission statement for their BalloonSAT, and then create their design to achieve their goal. During this process, they learn to solder and construct the BalloonSAT structure, program a flight computer to control their experiment, use CAD tools to create a model of their design, perform ground testing to validate their design, and document their progress.



UP - UP - AND AWAY!

Upon completion of this course, along with the accompanying Introduction to Aircraft Design course taken concurrently, students will have had two discipline-specific design experiences by the end of their sophomore year. Because the student is exposed to both aircraft and spacecraft design early in their academic career, this knowledge and experience will help them make an informed decision about which area of aerospace engineering they want to focus on in senior design and their technical electives. In addition, early exposure to a broader range of engineering design challenges provides students with additional skills and knowledge they could leverage in co-ops, internships, and eventually their careers.

Photos:

Opposite page:

Top - student payloads to be launched

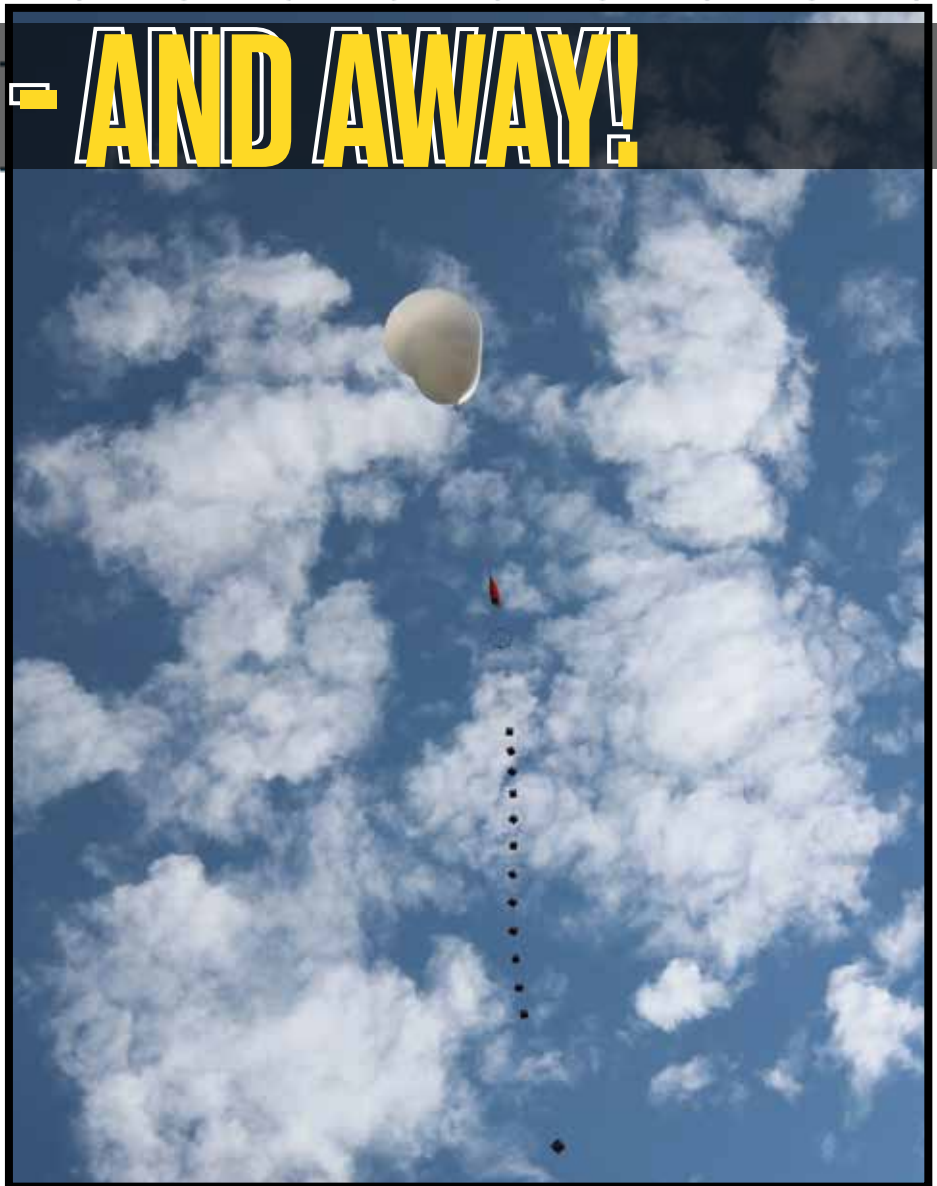
Opposite bottom - flight computer

This page:

Right - Balloon with payloads in flight

Below - Payloads ready to launch

Below and right - BalloonSAT launch





DESIGN TEAM UPDATE

COVID-19 EDITION

FORMULA ELECTRIC

The 2019-2020 competition season began on a low note. The previous season, the team was not able to go to competition because of several team issues. In lieu of going to competition, the team decided to have a "Summer Summit," which consisted of two meetings. One meeting, the team discussed the issues from the previous year, and the next meeting was to propose solutions and adopt changes to the team. The solutions consisted of defining leadership roles, improving team communication, implementing a shop policy, developing a recruiting plan and improving knowledge transfer. The changes were implemented to establish a strong foundation for the team to continue to build off of in the future.

Efforts during the fall and beginning of the spring semester were focused on the construction of the car. The team was able to get 2 test driving sessions in before the COVID-19 pandemic sent campus to a halt. The competition was restructured to an online format with the dynamic events being cancelled. Since there was to be no physical racing of the car, the team spent their time during the campus restrictions preparing for the static events. These events consisted of a cost analysis, a business presentation, and design report/presentation.

Apart from the time spent preparing for competition, considerable effort was put into organizing and structuring the team for consistent performance and growth for the years ahead. To ensure the availability of knowledge and resources for the team in the future, knowledge transfer has become a top priority. A few years ago, one of the members of the team acted upon an idea for a Formula Electric Wiki Site with the goal of documenting all of the design notes, a collection of engineering materials, and various other information. With this tool, future teams will be able to see what was implemented in the past, and understand the pros/cons and the thought process going into that design.

Considering the goals set at the beginning of the year during our "Summer Summit", the team considers the 2019-2020 season to be a successful one. With the foundation laid, Formula Electric is excited for the 2020-2021 season and can't wait to get back in the driver's seat.

MINER AVIATION

As they celebrated their 20th anniversary, Miner Aviation (MAV) competed in the 2020 AIAA Design Build Fly Competition, an annual competition hosted by the American Institute of Aeronautics and Astronautics. Every year they receive a completely different set of rules, meaning they always start from scratch. This year required MAV to build a Banner Towing Bush Plane, which had to tow a banner and carry as many small wooden passengers with luggage as possible. To do well, they knew they had to optimize for a high carrying capacity and a fast top speed.

Miner Aviation accomplished this task by designing a 5 foot wingspan, 40 pound biplane named Atlas. For the first time in over a decade, they constructed a fuselage made completely out of carbon fiber, resulting in a featherlight airframe. Powered by two 8-cell lithium polymer batteries, matching motors produce over 35 pounds of thrust, which, makes Atlas the most powerful aircraft in Miner Aviation's history. The aircraft is capable of flying straight upwards, achieve a top speed of over 75 mph in level flight, and, while never flight-proven,



pull a 45-ft long by 9-ft tall banner. On top of this, Atlas could carry almost 100 wooden passengers with luggage.

Unfortunately, in the midst of flight testing Atlas, the fly-off was cancelled due to COVID-19 concerns. Instead of a fly-off, the competition was judged strictly off of Design Reports, a 60 page technical document outlining a team's design considerations. As this was only Miner Aviation's second year in this competition, they had little guidance in writing the report. In 2019, MAV placed 38th out of 104 teams on the Design Report portion of competition. Using what we learned, Miner Aviation was able to place 7th out of 104 teams, doing significantly better than the previous year.

This past year, Miner Aviation was able to increase the level of innovation and push further than they ever have in celebration of our 20th anniversary. Using this momentum, MAV plans on doing this again in the upcoming year and continuing to improve the design process, manufacturing techniques, and member knowledge to continue to place better at competition. Though this fall semester comes with challenges never before seen by design teams, Miner Aviation will not back down and, as always, will show the world what the Miner's in Flight are capable of.

FORMULA SAE RACING

The Missouri S&T Formula SAE Racing team typically competes alongside 120 teams each year at the Formula SAE Michigan competition near the end of May. Because of the COVID-19 pandemic and the ever-growing social distancing rules sent out by the CDC, this competition had been changed quite drastically to a virtual online competition. The change removed the "dynamic" events such as acceleration, skid-pad, autocross, and endurance from the competition, but allowed for all teams to compete in the "static" events of the competition such as design presentation, business presentation, and cost report.

The 2020 car, named Sydney, was the first car built by our team to implement a drag reduction system (DRS) which adjusts the angle of the elements of the rear wing as it is going around turns and into straights. It also

featured our team's lightest aero package. Though the team seemed to have been on track for one of its best seasons, the shut-down of campus and cancellation of part of the competition made for a very different end to the season – but not one that was wasted. The change in the competition made the team focus on studying designs and preparing presentations for the online format. With the short notice on the cancellation and the large change in the aim of the competition, the SAE organization decided that points and rankings would not be awarded this year for the competition. Despite this, the team received good feedback from judges on their performance with the static events.

ROCKET DESIGN TEAM

For the 2019-2020 school year, the Rocket Design Team saw its first year as a fully integrated team, as the previous school year the team merged with the Liquid Rocket Design Team. Now the team oversees two projects, a liquid propulsion system and a solid propulsion system for the rockets they build. This transition between the projects was smooth, and ultimately benefited both projects in the long run.

For the solid propulsion project, the team was back on campus in July mixing and testing propellants under the advisement of Dr. Catherine Johnson, assistant professor of explosives engineering at S&T. This will allow the team to make better propellant formulations to attempt a 30,000-ft launch at the competition in 2021. Like most things, the 2020 competition was cancelled due to COVID-19. However, the team was still able to launch this summer thanks to the contracts with a large company to launch their payloads for them to conduct testing under launch conditions.

For the liquid propulsion project, the team completely redesigned the engine in the span of the fall 2019 semester, with 800 hours of work being invested by the engine sub team to get this accomplished. The engine, Warlock, was designed for 1000 pounds of thrust and meant to be manufactured by using a copper alloy in a metal 3D printer. Through the fall and beginning of spring, the team worked

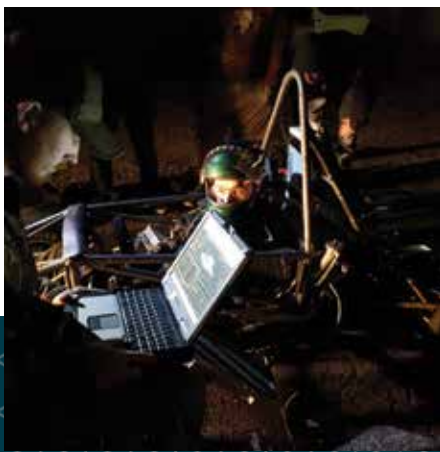
with industry contacts to get advisement on details of the new engine. After team reflection during the transition period to online, they decided that Warlock should be the end goal of the liquid propulsion system project, so efforts are now being made to lay a better foundation (test stands, a simpler engine to test the test stand, and documentation) and have the team eventually manufacture Warlock in a few years. Once the team conducts a successful hot fire on any engine made, the team will be a part of the handful of universities in the nation to achieve this goal.

MINER BAJA SAE

Faced with new challenges created by COVID-19, the Miner Baja SAE team adapted to an online environment while continuing to make progress. In the fall of 2019, work for the team was delayed as a result of the need for reinstatement. The second half of the fall semester was devoted to a redesign of the previous car's drivetrain. In less than one semester the team was able to successfully design, build, and test a replacement torque multiplier. This portion of the drivetrain reduces output speeds and increases torques to more desirable values. The team achieved this accelerated result through teamwork as well as by emphasizing the simplicity and manufacturability of the new torque multiplier. Upon design completion, they moved straight into fabrication and met their goal of a successful test run before the semester's conclusion. Additionally, the overhauled car was an excellent recruitment tool.

In the spring semester, Baja had its first recruitment opportunity of the year. New members joined, and the team embarked on the design of the next car. Major rule changes have been instituted, requiring that the team design a 4x4 car. This will be the first 4x4 car in S&T's history. In an effort to conserve funds, a pre-existing frame was chosen. To permit this, an innovative hydro-mechanical hybrid system is being designed. This will package easily compared to an equivalent shaft-driven system.

The Miner Baja team did suffer some setbacks as a result of COVID-19. The team struggled to communicate with companies





they needed to purchase components from and they overcame this obstacle by filing an extension for use of funds. The team also faced the challenge of keeping team members involved and maintaining interest. The team utilized Zoom and other technologies to overcome this challenge while also becoming more engaged in their social media presence. These tools will continue to help the team be successful as they navigate the new normal set by the COVID-19 pandemic.

HUMAN POWERED VEHICLE

The Missouri S&T Human Powered Vehicle Team (HPVT) spent the past year hard at work. During the fall semester, the team focused on recruiting new, dedicated members and teaching them the basics. After training and honing in their skills, they began manufacturing this year's vehicle, "Greased Lightning," informally known as "Gracie" to the team. HPVT spent long hours at the Student Design and Experiential Learning Center (SDELC) perfecting the vehicle. "Greased Lightning" started as a 3D model in SolidWorks but transformed into one of the team's favorite vehicles.

"Greased Lightning" like several of the previous year's vehicles, is a leaning recumbent tricycle. Unlike the majority of other universities, S&T's team manufactures almost every component in-house at the SDELC. This year's vehicle features custom-made carbon fiber wheels, remote-lockout front suspension, a removable rollbar, an improved adjustable seat, high quality bike components provided by Route 66 Bicycles, and a custom paint job sponsored by Hi-Tech Collision. This year's innovation project presented live rider feedback using a power meter and Garmin-sponsored bike computer.

Although many things were changed due to the spread of COVID-19, the Missouri S&T community and HPVT have continued to connect and make the best of the situation. Both North American ASME events were cancelled, so sadly, the team never made it to Michigan or Georgia to race against schools from across the world. Thankfully, their

hard work did not go unrecognized! To compensate for the cancelled events, the ASME event staff held a Digital E-Fest so that students, industry leaders, and potential employers could still connect. For the Human Powered Vehicle Challenge (HPVC), the competition was based on the extensive design report and presentation. Here, the team described the design, analysis, and testing processes that they followed throughout the year. This year, HPVT focused on expanding by completing extensive testing for the trailer-pull challenge, rollbar verification and drivetrain optimization. Because of resource limitations, most of this testing took place in a living room or in a parking lot, but this did not stop the team from ensuring testing of "Greased Lightning" was completed for competition! They held a "watch party" over Zoom so they could hang out as a team during Digital E-Fest.

The team competed in both the North and South HPVC. Missouri S&T swept the competition and brought home 1st place at both competitions! The team was so proud and happy to be recognized for their hard work.





ANDREW HINKLE RECEIVES NASA SPACE TECHNOLOGY RESEARCH FELLOWSHIP TO WORK ON DUSTY HYPERSONIC ENTRY FLOWS

Andrew Hinkle, a doctoral student in aerospace engineering at Missouri University of Science and Technology, has recently received a prestigious NASA Space Technology Research Fellowship (NSTRF), which is awarded every year to a select group of graduate students in the United States who show significant potential to contribute to NASA's goal of creating innovative new space technologies for our nation's science, exploration and economic future.

Andrew's research under this fellowship will focus on the modeling and simulation of the impact of hypersonic particle-laden flows on planetary entry aerothermodynamics and radiative heat transfer. High velocity flows experienced during planetary reentry pose difficult challenges to both human and robotic spaceflight. The thermal environment experienced in reentry is as dangerous as it is difficult to predict and analyze. Furthermore, analysis challenges such as flows involving particles like dust and spalled thermal protection system (TPS) material lead to further uncertainties in vehicle performance during the entry, descent and landing (EDL) phases of missions, requiring the use of generous design margins in TPS thicknesses. The objective of Andrew's research is to develop and validate a particle flow simulation tool, with two-way coupling with computational fluid dynamics and radiation codes of NASA, and perform

uncertainty quantification (UQ) of the effects of particle-laden flows on deployable hypersonic decelerators including the Hypersonic Inflatable Aerodynamic Decelerator (HIAD) and Adaptable, Deployable Entry Placement Technology (ADEPT) configurations.

"Hypersonic particle-laden flows can be experienced in a number of mission scenarios where spallation of the TPS material can occur, such as entry into Mars during or shortly after a global dust storm or entry into Earth at high velocities experienced in lunar or Mars return trajectories. The accurate modeling of these particle-laden flows will be crucial for the design of TPS for future spacecraft planned for human Mars missions such as the HIAD and the ADEPT concepts," says Dr. **Serhat Hosder**, professor of aerospace engineering at Missouri S&T. Hosder is Andrew's Ph.D. advisor and will serve as the principal investigator for the NSTRF project.

The fellowship, which started in the fall of 2019, is intended for four years with renewal every year. The award includes a stipend, tuition allowance, faculty advisor allowance and on-site NASA Center experience allowance for the student each year. During his fellowship, Andrew will spend his summers at the Aerothermodynamics Branches of NASA Langley and Ames Research Centers and will collaborate with Dr. Chris Johnston, his NASA mentor, and other researchers working on planetary entry aerothermodynamics.



DONNA JENNINGS NAMED INTERNATIONAL AMELIA EARHART FELLOW

Donna Jennings, a doctoral student in aerospace engineering at Missouri S&T, has received a prestigious 2020 Amelia Earhart Fellowship from Zonta International Foundation. She is one of the 35 recipients of this award from all over the world in 2020. The award was established in 1938 in honor of famed pilot and Zontian, Amelia Earhart and the purpose of the award is to empower women through encouragement and financial support pursuing a Ph.D./doctoral degree. The student must demonstrate a superior academic record in the field of aerospace-related sciences or aerospace-related engineering. In the most recent years, Jennings is the third student the aerospace engineering doctoral program at S&T to receive this significant award and they are in great company with other awardees being from notable universities including Massachusetts Institute of Technology, Purdue University, University of Illinois at Urbana-Champaign and Texas A&M University. Jennings' key goal of her research is to develop a method of determining "natural" formations within the nonlinear, and often unstable, dynamics of the system that can be used as a tool in swarm mission planning. The focus of this work is to identify relative formations in the vicinity of the collinear libration points of interest to NASA.

Jennings received her bachelor's degree from S&T in May 2016. Her research interests include small satellites and astrodynamics. She is currently the graduate

student advisor for the GNC subsystem for the Missouri S&T Satellite Research Team. Her future plans are to work in academia where she can fulfill her strong desire to teach and conduct research. Long-term, she wants to secure a faculty position that allows her to serve as a role model to other females in STEM that aspire to become leaders in their fields.



JILL DAVIS WINS SMART SCHOLARSHIP

Jill Davis, a doctoral student in aerospace engineering, has been awarded a prestigious scholarship established by the Department of Defense – the Science, Mathematics and Research for Transportation (SMART) Scholarship. This award is offered to students pursuing any level of degree in science, technology, engineering, and mathematics disciplines. While in school, Jill will receive full tuition and education related fees, a generous stipend, health insurance, paid summer internships, mentoring and guaranteed employment placement with their sponsoring facility upon graduation.

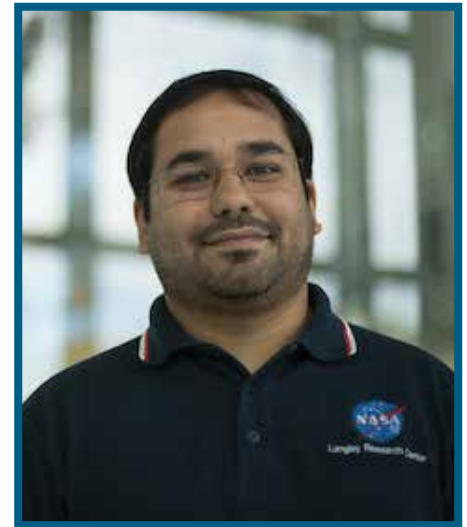
Davis is sponsored by Kirtland Air Force Base and will be collaborating with

them and her advisor, **Hank Pernicka**, on her research project, “Vision-Based Cooperative Navigation for Small Satellites in Deep Space.” This 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 machine 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!

Davis is from Republic, Missouri, and earned her bachelor’s degree in aerospace engineering from Missouri S&T in December 2016. Her interest in aerospace engineering came from her love of reading science fiction and a desire to be on the forefront of human exploration and discovery. As an undergraduate student at Missouri S&T, she was an active member of the Rocket Design Team, as well as a participant in the Chancellor’s Leadership Academy. Throughout her graduate career, she has been engaged with the Missouri S&T Satellite Research Team, with a focus on the MR & MRS SAT proximity operations mission. She is also active in performing K-12 STEM community outreach activities. Following the receipt of her doctorate degree, she will become a civilian employee in the United States Space Force, working with the Air Force Research Lab at Kirtland Air Force Base in Albuquerque, New Mexico. In addition to her studies, Jill enjoys reading, skiing, and hiking.



MARIO SANTOS RECEIVES OUTSTANDING POSTER PRESENTATION AWARD AT THE INTERNATIONAL PLANETARY WORKSHOP

Mario Santos, a Ph.D. student in Aerospace Engineering at Missouri S&T has received the Outstanding Student Poster Presentation award as the 3rd place winner at the 16th International Planetary Probe Workshop (IPPW) held in Oxford University, United Kingdom in July 2019. The IPPW is an annual premiere international event bringing together the top-level researchers and students from all over the world to present their latest research on planetary entry science and technologies.

Mario, who is also a NASA Space Technology Research Fellow, attended the IPPW with a poster presenting his recent Ph.D. research with the title “Multi-Fidelity Modeling for Efficient Aerothermal Prediction of Hypersonic Inflatable Aerodynamic Decelerator (HIAD) Configurations with Surface Scalloping” co-authored by his Ph.D. advisor Dr. **Serhat Hosder**, Professor of Aerospace Engineering and Dr. Thomas West from NASA Langley Research Center. The primary objective of this research is to develop and implement multi-fidelity modeling techniques based on co-kriging for the prediction of aerodynamic heating with surface scalloping inherent to deployable re-entry vehicles, which will be important for efficient and effective design and analysis of HIAD configurations planned for use in future human Mars missions.



MAE GRADUATE STUDENTS SWEEP POSTER COMPETITION

Graduate studies hosted the 11th Graduate Fellows Poster Session from April 28-May 1 in a virtual format, due to Covid-19.

The poster session highlighted the research of 23 students who are either Missouri S&T Chancellor's Fellows or Chancellor's Distinguished Fellows. Both fellowships are highly competitive and require extensive dedication to research and academic excellence.

The winners were:

First Place: **Martin Di Stefano**, a Ph.D. student in aerospace engineering and a Chancellor's Distinguished Fellow, is the first-place winner for his poster titled "Effect of Turbulence Model Uncertainty on Scramjet Strut Injector Flow Field Analysis." Di Stefano's research studies the effect of turbulence model uncertainty.

Martin received his B.A. in physics from Truman State University and his B.S. in aerospace engineering from Missouri S&T. His work experience includes internships at the University of Michigan, Los Alamos National Laboratory, and NASA Langley Research Center, along with full-time positions at the University of Missouri and the US Navy.

Runner-Up: **Donna Jennings**, a Ph.D. student in aerospace engineering and a Chancellor's Distinguished Fellow, is the runner-up winner for her poster, "Numerical Determination of Spacecraft Formations in Deep Space." Jennings' research focus is on determining natural formations in the vicinity of the Earth-Moon L2 point when using the nonlinear equations of motion of the CR3BP.

Donna Jennings is a fourth-year aerospace engineering Ph.D. student at Missouri University of Science & Technology. In May of 2016, she received her bachelors degree in aerospace engineering from Missouri S&T. She is currently the graduate student advisor for the GNC subsystem for the university's satellite research team.

Honorable Mention: **Lauren Tomanek**, a Ph.D. student in mechanical engineering, receives an honorable mention for her poster titled "Temperature Based Identification of Thermal Properties of a One-Dimensional Transient Convection Model of a Slender Cylindrical Fin." Tomanek's research investigates an approach to determine the thermal conductivity of a material from temperature data.

Lauren Tomanek is a 3rd year Ph.D. student working with Dr. **Daniel Stutts**. She graduated with her bachelor's in Mechanical Engineering in December of 2017 from Missouri S&T. Lauren is a graduate research assistant and also a graduate teaching assistant for the Mechanical Engineering Systems Laboratory.

Faculty judges included:

- Dr. **Clair Kueny**, assistant professor of psychological science
- Dr. **Daniel Forciniti**, associate provost for faculty affairs and professor of chemical and biochemical engineering
- Dr. **Daoru Han**, assistant professor of aerospace engineering
- Dr. **V. Prakash Reddy**, professor of chemistry.

MARTIN DI STEFANO



DONNA JENNINGS



LAUREN TOMANEK

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THANK YOU TO EVERYONE WHO MADE CONTRIBUTIONS TO LAST YEAR'S PHONATHON.

The 2020 phonathon will take place the week of September 9th. Thank you for taking the time to speak with one of our student representatives. Every gift helps make a difference and supports MAE's mission of enhancing student learning. Thank you for your help in making this year's fundraising the best yet!