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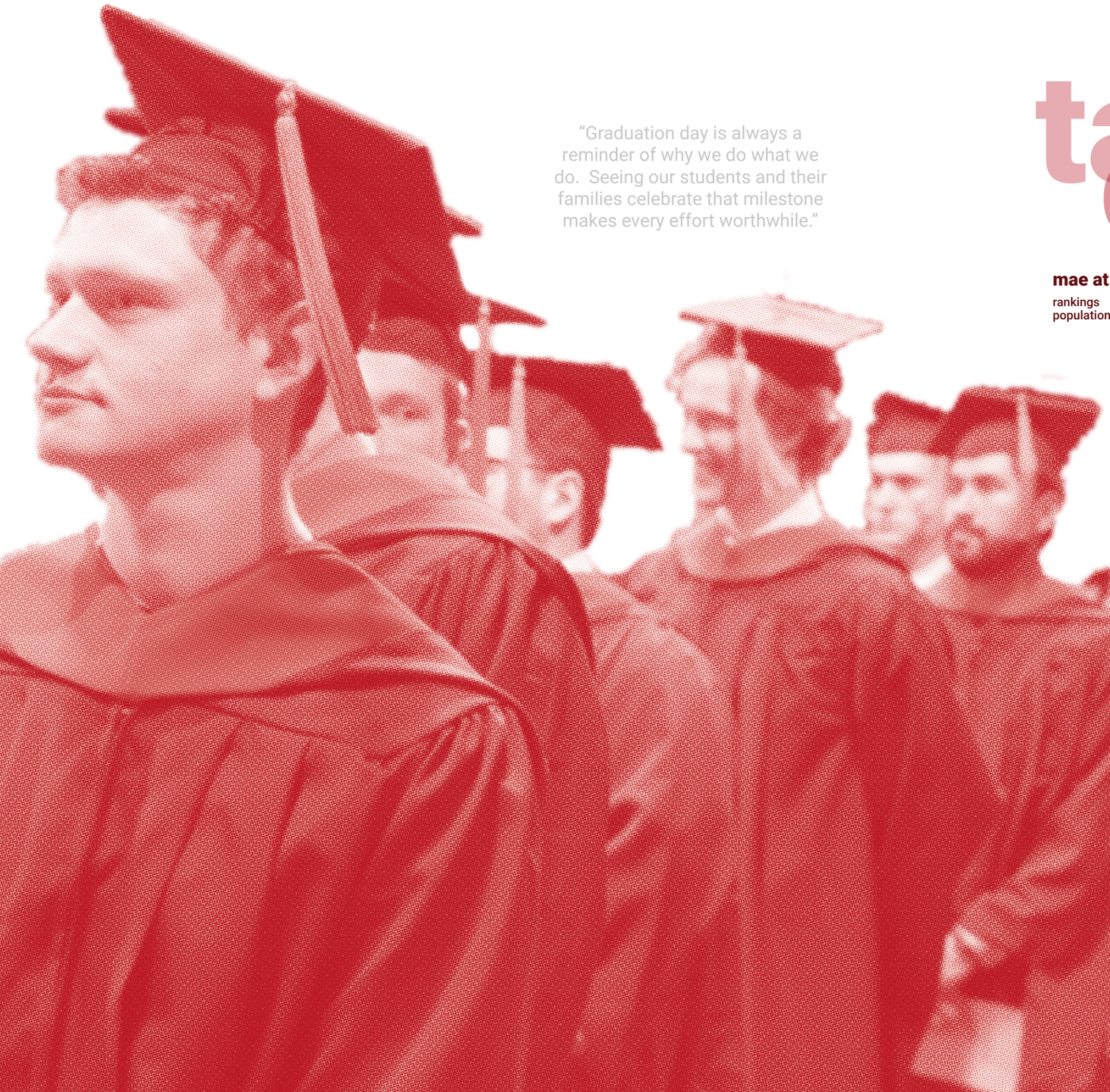
nc state 2024 mechanical and aerospace engineering



"Graduation day is always a reminder of why we do what we do. Seeing our students and their families celebrate that milestone makes every effort worthwhile."

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mae at a glance

rankings

NC State College of Engineering is ranked 25th in Best Engineering Schools for Graduate Students and 30th in Best Undergraduate Engineering Programs

Mechanical Engineering graduate program is ranked 36th

Aerospace Engineering graduate program is ranked 23rd

Mechanical Engineering undergraduate program is ranked 29th

Aerospace Engineering undergraduate program is ranked in the top 25

Online Master's in Mechanical/Aerospace Engineering program is ranked 11th

population statistics

graduate

Total graduate enrollment: 410 students

Aerospace graduate enrollment: 146 students

Mechanical graduate enrollment: 264 students

PhD enrollment: 185 students

Master's enrollment: 225 students

Graduate degrees conferred in Spring 2024: 65

Average graduate student GPA: 3.69

undergraduate

Total undergraduate enrollment: 1,420 students

Aerospace undergraduate enrollment: 390 students

Mechanical undergraduate enrollment: 1,030 students

Average undergraduate GPA: 3.39

First year MAE intended enrollment: 601 students

Undergraduate degrees conferred: 330

Average GPA for undergraduate student CODA admission

- Average AE CODA GPA: 3.63
- Average ME CODA GPA (spring 2023): 3.54

Ekkad helms mae expansion and looks toward the future

"We've achieved so much in the past seven years, but the best is yet to come."

Over the past seven years, NC State University's Department of Mechanical and Aerospace Engineering (MAE) has undergone a remarkable transformation under the leadership of Srinath Ekkad. In this period, MAE has grown substantially in student enrollment, faculty numbers, and research output, positioning itself as one of the top departments in the College of Engineering.

"When I arrived, we had about 1,250 undergraduates and 46 faculty members," said Ekkad, who took over as Department Head in 2017. "Today, we have 1,450 undergraduates and 63 faculty members. It's been a significant expansion, not just in size, but in the breadth of research and the strength of our academic programs."

Faculty Growth and Research Expansion

Ekkad emphasized the importance of hiring top-tier faculty to support the department's rapid growth. "In the last six years, we've hired 31 new faculty members, which means that nearly half of the department is new," he said. This influx of talent has helped propel MAE to new heights in terms of research, with the department doubling its research expenditures from $7.5 million in 2017 to $16 million annually today.

"We've seen a dramatic increase in research output," Ekkad noted. "The new faculty we've brought in are doing phenomenal work in areas like hypersonics, renewable energy, advanced manufacturing, and bio-related fields. Their contributions have been critical to our growth."

Ekkad highlighted hypersonics as a particularly promising area of research. "We're building a strong group in hypersonics that is getting national and international attention. Additionally, we're pushing forward in applied AI, battery technology, and urban air mobility," he said, adding that these emerging areas will be key to maintaining MAE's competitive edge in the coming years.

Student Growth and Selectivity

The department has also become one of the most sought-after programs within NC State's College of Engineering, with the number of applicants growing steadily. "We only accept about 60% of the students who apply to our undergraduate program," said Ekkad. "That means we're a top choice for students interested in mechanical and aerospace engineering, and it speaks to the strength of the program we've built here."

MAE's graduate programs have also seen growth, particularly at the Ph.D. level. "We've increased our Ph.D. student population by about 20% in the last few years," Ekkad said. "It's part of our strategy to continue building a research-driven department that not only educates but also innovates."

Plans for the Future

Looking ahead, Ekkad sees continued growth for MAE, both in terms of student enrollment and faculty hires. "Engineering expansion at NC State is on hold for the next two years, but in 2026, we expect to grow by another 20%. This would put us among the top five mechanical and aerospace programs in the country in terms of undergraduate numbers," he explained. "We're also planning to add 10 more faculty members, which will bring our total to more than 70 by 2028."

The department's growth is not just about numbers. Ekkad has a clear vision for where he wants to take MAE in the future. "Our next steps are to grow our research into new areas like battery technology, applied AI, and bio-related robotics and automation. These are the fields that will define the next generation of engineering challenges, and we want to be at the forefront of solving those problems," he said.

Ekkad also emphasized the importance of staying connected to industry trends. "We have strong relationships with companies and government agencies that are driving innovation, particularly in renewable energy and aerospace. These partnerships are critical to keeping our research relevant and making sure our students are prepared for the workforce."

Strengthening Alumni Engagement

One of the key goals for the department moving forward is to strengthen its engagement with alumni. "We've done a lot better in reaching out to our alumni over the last few years, but we're still only engaging about 10% of our alumni base," said Ekkad. "We need to be more proactive in building those connections, whether through mentoring, senior design projects, or bringing alumni back to campus to see what's happening here."

The department has several initiatives designed to foster alumni involvement, including its Senior Design program, which offers alumni the opportunity to work with students on real-world

engineering projects. “Senior Design is a great way for alumni to get involved and help shape the next generation of engineers,” Ekkad said. “We’ve had alumni work on everything from drone systems to energy-efficient designs, and their contributions have been invaluable.”

Ekkad also pointed to the MAE Hall of Fame as a key way for alumni to stay connected. “The Hall of Fame is a way for us to recognize distinguished alumni and celebrate their contributions to the field,” he said. “But beyond that, it’s an opportunity for alumni to give back and be part of the department’s future.”

A Promising Path Forward

As Ekkad looks ahead, he’s optimistic about the direction of the department. “The future for MAE is incredibly bright,” he said. “The faculty we’ve hired are some of the best in the country, coming from top institutions like Caltech, MIT, and Berkeley. These young researchers are going to drive the future of the department, and I’m excited to see where they take us.”

In addition to expanding faculty and research areas, MAE is also focused on enhancing its infrastructure. “We’re investing in new lab spaces and research facilities that will provide students with the tools they need to be successful,” Ekkad said. “We want to create an environment where students can innovate and explore new ideas, whether they’re undergraduates working on senior design projects or Ph.D. candidates conducting groundbreaking research.”

Ultimately, Ekkad sees MAE playing a critical role in the future of both the state of North Carolina and the nation. “As a land-grant institution, we have a responsibility to serve the people of this state, and we’re doing that by educating the next generation of engineers and solving the challenges that will shape our future,” he said. “Whether it’s through research in renewable energy, advanced manufacturing, or aerospace systems, MAE is poised to make a lasting impact.”

With its strong foundation, commitment to innovation, and ambitious plans for the future, NC State’s Department of Mechanical and Aerospace Engineering is well-positioned for continued success.

“We’ve achieved so much in the past seven years, but the best is yet to come,” Ekkad said.

undergraduate programs thriving amidst growth

The Department of Mechanical and Aerospace Engineering (MAE) at North Carolina State University continues to distinguish itself as one of the premier undergraduate programs in the nation. Drawing students from across North Carolina and beyond, the department’s recent successes highlight its status as a flagship destination for aspiring engineers.

“We are attracting some of the best students in North Carolina,” said Dr. Tarek Echekki, Associate Department Head and Director of Undergraduate Programs for MAE. “We are the flagship program as far as mechanical and aerospace engineering is concerned. In fact, our aerospace program is the only one of its kind in the state, whether you consider private or public institutions.”

As the College of Engineering experiences unprecedented growth, the MAE department has played a pivotal role in sustaining and managing that expansion. Echekki points out that this influx of talent, fueled by the department’s reputation, comes with both opportunities and challenges. “Mechanical engineering has been popular for a long time,” he said, “and the recent growth of interest in space-related fields has only amplified our appeal.”

The department’s ability to adapt to this rapid growth is a key achievement, demonstrating a commitment to excellence in education while ensuring students receive the resources and attention they need. The undergraduate experience has been enhanced by a holistic approach to teaching, hands-on learning opportunities, and strong faculty involvement.

“We’ve managed to keep the student experience intact despite our size,” Echekki explained. “Our students find smaller communities within the program, such as student groups and participation in campus activities, where they can thrive. Many of them are entrepreneurs, engaged citizens, and deeply involved in service. It’s inspiring to see them flourish in so many different ways.”

Balancing Growth and Resources

One of the most significant challenges faced by the MAE department is the strain on resources caused by rapid growth. “The biggest challenge is growth, which puts strain on our facilities, instructors, and staff,” Echekki said. “We want to accommodate as many highly qualified students as possible, but it’s critical that we expand our faculty and staff support accordingly.”

The department has made strategic hires to bolster faculty numbers and diversify its research. “We’ve recruited additional tenure-track faculty, which has allowed us to strengthen specific research areas and offer new courses. These efforts ensure that we continue to provide students with the latest knowledge and tools necessary for success after graduation.”

The strain of teaching larger

classes hasn't gone unnoticed by faculty, but Echekki is quick to commend their adaptability. "Our faculty have been incredible in supporting the growth. Some courses have seen class sizes jump from 85 to over 100, yet our instructors have managed to maintain high levels of teaching and student engagement," he said.

To further support the growing student body, the department is expanding its teaching assistant (TA) program. "We're working on increasing TA support to manage different sections of core courses," Echekki said. "This helps ensure that students receive the additional support they need outside of the classroom."

Focus on Cutting-Edge Education

A significant part of MAE's strategy in handling growth is a commitment to modernizing its curriculum. The goal is to equip students with the analytical and practical skills they need to thrive in the evolving world of engineering.

"We want our curriculum to be as responsive as possible to the demands of the modern workplace," Echekki explained. "One example is the introduction of a course in numerical methods, which teaches students to solve complex problems when they cannot do so analytically. This kind of skill is invaluable to their future careers."

In addition to new courses, the department has reimagined existing ones to create a more integrated learning experience. "We've replaced the traditional thermodynamics course with a unified course in thermal fluid sciences, combining different disciplines under one umbrella," said Echekki. "This approach reinforces common concepts across multiple courses and provides students with a more holistic understanding of the subject matter."

The MAE department is also placing an increased emphasis on hands-on learning and undergraduate research. "Participation in undergraduate research has been growing, with students getting involved as early as their sophomore year," Echekki said. "The quality of their work is impressive, and it reflects the strong mentoring they receive from our faculty." The department supports over 30 students annually through the Research Experience for Undergraduates (REU) program, and many students go on to secure prestigious fellowships, including those from the National Science Foundation (NSF) and the Department of Defense.

Preparing Students for Success

Beyond academics, the department is focused on preparing students for their post-graduate careers through closer engagement with alumni and the broader engineering community. "We're looking to enhance our relationship with alumni, not just for financial support, but for career advice, mentoring, and providing students with more opportunities for internships, co-ops, and eventual employment," Echekki explained.

This alumni engagement, he believes, is vital for expanding students' career paths and providing mentorship from those who have already walked the same path. "It's like having a big brother or big sister in the program. Our alumni are eager to help students succeed and provide them with invaluable guidance."
Looking ahead, Echekki emphasizes the importance of modernizing the department's laboratory facilities to better align with what students are learning in their courses. "We want to ensure our labs reinforce the skills taught in the classroom and provide students with the hands-on experience they need to be successful," he said.

A Bright Future

Despite the challenges posed by rapid growth, the MAE department at NC State remains committed to providing its students with a world-class education. The department's adaptability, combined with its focus on modernizing the curriculum and expanding support for students, positions it as a leader in both mechanical and aerospace engineering education.

"Graduation day is always a reminder of why we do what we do," Echekki said. "Seeing our students and their families celebrate that milestone makes every effort worthwhile."

As the department continues to grow, it remains focused on its core mission: to provide students with the knowledge, skills, and opportunities they need to succeed in a rapidly evolving world. With a dedicated faculty, a commitment to cutting-edge education, and a growing community of engaged alumni, NC State's MAE department is poised to continue leading the way in engineering education for years to come.

saul leads graduate programs into a new era of growth

Katherine Saul, Associate Department Head and Director of Graduate Programs at NC State University's Department of Mechanical and Aerospace Engineering (MAE), has made an immediate impact since taking the helm in January 2024. With a commitment to professional development, community building, and streamlining processes, Saul has ushered the program into an exciting new chapter.

"I'm lucky because I walked into a program that was already doing really well," Saul reflects. "We have terrific staff, and with the ongoing expansion in engineering, we have a unique opportunity to accelerate what we offer students and elevate the visibility of the program."

The groundwork laid by the department's previous leadership provided a robust framework, and Saul has focused on enhancing that solid base to push the program even further. Her initiatives have been aimed at optimizing the student experience, simplifying degree navigation, and attracting top talent, both locally and globally.

Streamlining the Graduate Experience

One of Saul's immediate priorities was to reduce the administrative burden on students, allowing them to focus more on academics and research. "We've been really focused on ensuring students understand their degree timelines," Saul explains. "We've overhauled our operations and communication to make it easier for students to navigate the often complex journey of graduate education."

The new website, along with updated processes, has been a big part of this shift. "We're making it clear what students need to do and when," Saul adds. "This frees them up to concentrate on their work and research instead of worrying about bureaucratic hurdles."

Saul's push for clarity and efficiency extends beyond the students' current academic experience. She's laying the groundwork to support them in their future careers. Saul has implemented a dedicated career services initiative to guide both master's and PhD students in securing the jobs they want after graduation. "We're looking to hire new staff to provide resume advising, career tips, and build relationships with industry directly within the department," she says.

In a recent student survey, the enthusiasm for these new career services was evident. "I sent out the survey, and within an hour, I had over 25 responses," Saul laughs. "Students clearly want this, and we're responding to that demand."

Expanding Recruitment and Global Reach

Saul's vision doesn't stop at improving internal processes; she's also focused on growing the program's reach. Recruitment efforts have become more targeted, especially within the region. "We already have great students," Saul emphasizes, "but we know we can draw even more from our region, and we're making that a priority."

NC State's MAE program is also expanding its global footprint. "We're working with external partners to grow our global reach," Saul notes, mentioning initiatives like digital advertising and strategic blog posts aimed at drawing international students. These efforts are part of a broader goal to meet the enrollment growth targets set by the College of Engineering's expansion plan.

"We're already seeing interest from new regions where we know we can grow," she says. "As our reputation continues to spread, we expect to attract even more top talent from around the world."

Cutting-Edge Research and a Broad Range of Career Paths

The diversity of research being conducted within the department is one of its greatest strengths, according to Saul. "Our students are doing some incredible things," she says. "They're attending clinical conferences for healthcare, working in government labs, and winning national and global awards."

Research at MAE touches on critical areas like healthcare, energy, aerospace, and environmental issues, which opens up a wide range of career options for graduates. "The research here goes beyond what people normally think of mechanical and aerospace engineering," Saul notes. "Our students are solving hard, important problems that matter in a wide range of industries, and they're making an impact."

This diversity in research allows students to pursue careers in a variety of sectors, including academia, industry, government, and consulting. Saul is particularly proud of the department's ability to prepare students for whatever career path they choose. "We're not homogenous," she says. "The wide variety of research we do means our students have different career options, and many are taking advantage of opportunities like co-ops and internships to gain real-world experience while still in school."

Saul also highlights the growing trend of students transitioning from the master's programs into our PhD programs. "It's a testament to the strength of our research culture," she says. "Students are realizing that research is for them, and we're helping them accelerate that path."

Looking Ahead: Building Community and Supporting Students

As Saul looks to the future, she's excited about the continued growth and development of the program. "One of the things I'm most passionate about is building a real sense of community among the students, faculty, and staff," she says. "We want to focus on professional development and career services so that every student feels prepared to get the career they want."

But it's not just about academics or career prep. Saul is equally committed to ensuring that students enjoy their time in the program and feel supported. "The time students spend here is such an important part of their life, both personally and professionally," she says. "We want them to be happy for their own wellbeing and because we know that when people are happy, they do better work. It's better for everyone."

Under Saul's leadership, the MAE graduate program is poised for even greater success. With a focus on community, professional development, and groundbreaking research, there's no doubt that the program will continue to thrive. "At the end of the day, we're here to support our students in every way we can," Saul says. "We want to give them the tools they need to go out and change the world."

"When people are happy, they do better work."

The Bogue Family: A Legacy of Engineers at NC State's Department of Mechanical and Aerospace Engineering

From Classmates to Soulmates: A Love Sparked in HVAC

For the Bogue family, the Department of Mechanical and Aerospace Engineering (MAE) at NC State University is more than just a place of higher learning; it's a place that has defined and shaped their lives, both professionally and personally. Glenn and Sherri Bogue, along with their three children—Austin, Erika, and Jordan—are all proud graduates of the MAE program, and their shared passion for engineering has brought them closer as a family.

"We met in the HVAC and fluids class," Sherri said, reminiscing about her early days at NC State. "We started studying together, and I guess the rest is history."

Their journey began when Glenn and Sherri, both from mechanical engineering backgrounds, met at NC State in the early 1990s. After graduation Glenn ended up working as a facility engineer while Sherri found her passion as a manufacturing engineer. "My family had a machine shop, and that led me toward mechanical engineering," Sherri said. "I grew up on a farm and have always enjoyed working on mechanical equipment," Glenn added.

More Than Just Gears and Grease: Engineering Runs Deep

Even with careers pulling them in different directions—Glenn working for a tobacco company and Sherri eventually opening a bakery—engineering remained at the heart of the family. Sherri, who eventually left her job in manufacturing to raise their children, joked about how much she still uses her engineering skills in her current venture. "You'd be surprised how much I wish I'd paid attention to industrial engineering," she laughed. "We make custom fixtures for wedding cakes and do a lot of process optimization."

Their children grew up surrounded by mechanical systems, machine shops, and a strong work ethic that revolved around problem-solving and precision. "We always heard, 'It doesn't matter what grade you get, as long as you do your best,'" Austin recalled. But the kids rarely strayed far from high expectations. Both Erika and Austin graduated with perfect 4.0 GPAs, while Jordan, the "lame duck" as he joked, graduated with a still-impressive 3.91.

Masters of Multiplication: Three Kids, Three Engineers, One Legacy

Each child found their own path in engineering, but all under the same MAE umbrella. "I grew up with a combination of exposure to farm life and machine shop work, so mechanical engineering seemed like the degree that would allow me to be in any industry I wanted," Austin explained. "I didn't realize how diverse the degree was until I started school."

Austin went on to complete his master's degree at NC State through the five-year program, working for Cummins, a global powertrain solutions company headquartered in Southern Indiana. His work focuses on intake and exhaust system component design, specifically addressing warranty and emissions issues with diesel engines.

Erika took a slightly different route, blending her love for design with engineering. "I liked the calculus and the architecture classes in high school" she said. "I chose mechanical engineering for the variety of things you could do after graduation." Erika has passed the FE and PE exams and is pursuing her Professional engineer PE license. She works for Killian Engineering, designing plumbing, electrical, and mechanical systems.

Jordan, the youngest, was inspired by his siblings' success but also found his own niche. He initially considered aerospace engineering, but after discussions with Austin, he realized the flexibility of a mechanical engineering degree was too hard to argue with. "You can go into almost any industry you want," Jordan said. He now works at Essex Parts Services, helping to design performance braking solutions for track day enthusiasts, as well as testing systems for NASCAR, IndyCar, and endurance racing teams. "At Essex I have the opportunity to learn under a well experienced authority in the performance braking world.," Jordan proudly shared.

Family Feuds, Engineering Style: When Dinner Turns Mechanical

All three siblings were heavily involved in the Pack Motorsports Formula SAE team, a student-led project where engineering students design, build, and race formula-style cars. This involvement became a central part of their engineering education and helped solidify their bond as siblings.

"There's always a mechanical engineering discussion whenever we're together," Austin's wife has noted, humorously acknowledging how easily engineering topics dominate family gatherings. "Whether it's racing, a new process, or even something we see on the road, there's always some kind of analysis going on."

For the Bogue family, NC State wasn't just a stepping stone to their careers. It was a formative experience that allowed them to work together in a way they hadn't before. "We've worked on everything from restoring a '66 Mustang to hosting cookouts for the Formula team," Sherri said with a laugh.

From the Farm to Formula: The Bogue Family Goes Racing

One of their proudest moments came when all three children were involved in Pack Motorsports at the same time. "That 2020-2021 year was the only time we were all at NC State together, all on the Formula team," Austin recalled. "That's a really cool experience, something we'll probably never do again."

Erika, who served as the co-captain of the team, reflected on how the experience shaped her engineering career. “Being on the team teaches you adaptability, problem-solving, and teamwork in ways you don’t get in a classroom. You learn to fill in the gaps and support others to reach a common goal.”

Jordan took over the brakes and steering systems for the team after Erika graduated, further building on the foundation she laid. “I was able to test out new design theories with the brake rotors and make adjustments that helped the team finish stronger during events,” Jordan explained. “It’s thrilling to see the car perform and know that I contributed to that.”

Engineering in the Blood: Passing the Torch to Future Generations

One of the most memorable moments for the family came in 2021 when the Pack Motorsports team finished second at a competition in Las Vegas and fourth in Michigan. “The picture of the three of us with the car we helped build is one of my favorite memories from college,” Austin said. “It’s a testament to how much we grew as engineers and as siblings.”

Even now, years after they’ve all graduated, the Bogues maintain their connection to NC State and the Formula team. “There’s a legacy here,” Glenn said. “Professors we had are still teaching, and some even taught our kids. It’s incredible to see that continuity.”

The Bogue family’s journey through NC State’s MAE program is not just a story of academic and professional success. It’s a story of love—love for engineering, for racing, and most importantly, for each other. Through their shared experiences and diverse careers, they’ve proven that engineers are more than just machinists and scientists; they’re problem-solvers, creators, and dreamers who carry their passion into every aspect of their lives.

As for the future? The Bogues are hopeful that the next generation will follow in their footsteps. “Maybe we’ll have MAE grandkids someday,” Sherri said with a smile. “You never know.”

These four cars were built with the help of all three bogue kids.

Faculty

Sajjad Bigham

Associate Professor

James Braun

Assistant Professor

Matthew Bryant

Associate Professor

Gregory Bucker

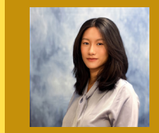
Professor

Darius Carter

Assistant Professor

Mingtai Chen

Assistant Teaching Professor



Chuyi Chen

Assistant Professor

Tarek Echekki

Associate Department Head

Jack Edwards

Director of Aerospace Research

Srinath Ekkad

Department Head

Felix Ewere

Associate Teaching Professor

Tiegang Fang

Professor

Etana Ferede

Assistant Teaching Professor

Scott Ferguson

Associate Professor

Farhan Gandhi

Hassan A. Hassan Distinguished Professor

Ashok Gopalarathnam

Professor

Landon Grace

Associate Professor

Kenneth Grandlund

Associate Professor

Veeraraghava Raju Hasti

Assistant Research Professor

Mohammad Heiranian

Assistant Professor

Tim Horn

Assistant Professor

Anna Howard

Teaching Professor

Jingjie Hu

Assistant Professor

Hsiao-Ying Shadow Huang

Associate Professor

Xiaoning Jiang

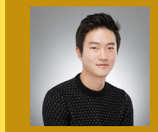
Dean F. Duncan Distinguished Professor

Arun Kumar Kota

Associate Professor

Andrey Kuznetsov

Professor



Donggun Lee

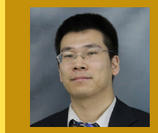
Assistant Professor

Jaemin Lee

Assistant Professor

Andrew Lee

Assistant Professor



Jun Liu

Associate Professor

Hong Luo

Professor

Kevin Lyons

Professor

Andre Mazzoleni

Professor

Nancy Moore

Associate Teaching Professor

Mark Moretto

Assistant Professor

Marie Muller

Associate Professor

Venkat Narayanaswamy

Professor

Gracious Ngaile

Professor

Brendan O'Connor

Professor

Laura Paquin

Assistant Professor

Kara Peters

Distinguished Professor

Afsaneh Rabiei

Professor

Jong Eun Ryu

Assistant Professor

Susmita Sarkar

Assistant Professor

Katherine Saul

Professor

Alexei Saveliev

Associate Professor

Larry Silverberg

Professor

Hao Su

Associate Professor

Hooman Tafreshi

Professor

Chau Tran

Associate Teaching Professor

Cheryl Tran

Director of Undergraduate Advising

Jay Tu

Professor

Henry Ware

Assistant Professor

Greg Watkins

Teaching Professor

Fen Wu

Professor

Liming Xiong

Associate Professor

Cheryl Xu

Professor

Chi-An Yeh

Assistant Professor

Jie Yin

Associate Professor

Fuh-Gwo Yuan

Samuel P. Langley Distinguished Professor

Mary Zadeh

Assistant Teaching Professor

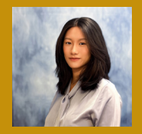
Yong Zhu

Associate Department Head for Research and Faculty Advancement

Mohammed Zikry

Zan Prevost Smith Professor

New Faculty



Chuyi Chen

Assistant Professor

Etana Ferede

Teaching Assistant Professor

Farhan Gandhi

Teaching Assistant Professor

Jaemin Lee

Assistant Professor

Mark Moretto

Assistant Professor

Laura Paquin

Assistant Professor

Susmita Sarkar

Assistant Professor

Greg Watkins

Teaching Full Professor

Faculty Awards

Srinath Ekkad was named Fellow of the The American Institute of Aeronautics and Astronautics (AIAA).

Katherine Saul inducted into the American Institute for Medical and Biological Engineering (AIMBE) College of Fellows.

Katherine Saul was selected as the 2024 recipient of the Founder's Award from the American Society of Biomechanics (ASB).

Katherine Saul was elected President of the American Society of Biomechanics (ASB).

Jingjie Hu received the prestigious National Institutes of Health (NIH) Trailblazer Award.

Cheryl Xu was elected editor-in-chief for npj Advanced Manufacturing, an online, open-access journal in the Nature Portfolio dedicated to progressing the field of advanced manufacturing.

Cheryl Xu was named Fellow of Drexel University's Executive Leadership in Academic Technology, Engineering and Science (ELATES) program.

Yong Zhu was chosen by ASME's Applied Mechanics Division as the inaugural recipient of the Zdeněk P. Bažant Medal.

Fuh-Gwo Yuan received the 2023 Hans-Jurgen Schmidt Award from the International Workshop on Structural Health Monitoring (IWSHM).

Fuh-Gwo Yuan received 2023 R.J. Reynolds Tobacco Company Award for Excellence in Teaching, Research and Extension.

James Braun and Andrew Lee were each individually awarded a three-year $450,000 grant as a part of the AFOSR Young Investigators Program (YIP) awards from the Air Force Office of Scientific Research.

Andrew Lee was awarded the 2023 Initiation Grant from the American Society of Mechanical Engineers (ASME) Applied Mechanics Division (AMD).

Tim Horn was awarded the highly selective Defense Advanced Research Projects Agency (DARPA) Director's Fellowship. One of only two faculty at NC State to do so.

Faculty Promotions

Matt Bryant to Full Professor

Hooman Tafreshi to Full Professor

Sajjad Bigham received tenure at Associate Professor

Tim Horn received tenure and promoted to Associate Professor

Chi-An Yeh, Jingjie Hu, Andrew Lee, Henry Ware all reappointed for second term Assistant Professor

MAE hosts Thermal Management Conference with American Carbon Society

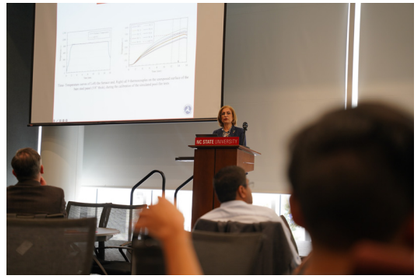
The NC State University Department of Mechanical and Aerospace Engineering hosted a conference with the American Carbon Society on March 18 and 19, inviting some of the brightest minds in their research fields to discuss a variety of topics on Thermal Management.

The Thermal Management Symposium and Workshop was organized by MAE professor Cheryl Xu, along with Collins Aerospace Company Senior Technical Fellow Weiming Lu, who has more than 30 years of experience in advanced composite development and processing.

According to Xu her research focus is on manufacturing of multifunctional ceramic materials, especially on their electrical/ dielectric, mechanical, and thermal properties, and how to manufacture such materials for high temperature applications.

Lu and Xu arranged the conference and coordinated with leading experts in Thermal Management from government, industry and academia to discuss the future of high-temperature materials research. The workshop garnered significant attendance with around 45 individuals joining in person, and about 35 online participants. About 30 graduate students from MAE also actively participated in the conference.
Through keynote speeches, panel discussions, poster sessions and hands-on lab tours, we will enhance the understanding of the challenges and opportunities within thermal management and foster collaborations that bridge the gap between theory and application," the conference program states.

The conference aimed to converge on four central topics in Thermal Management:

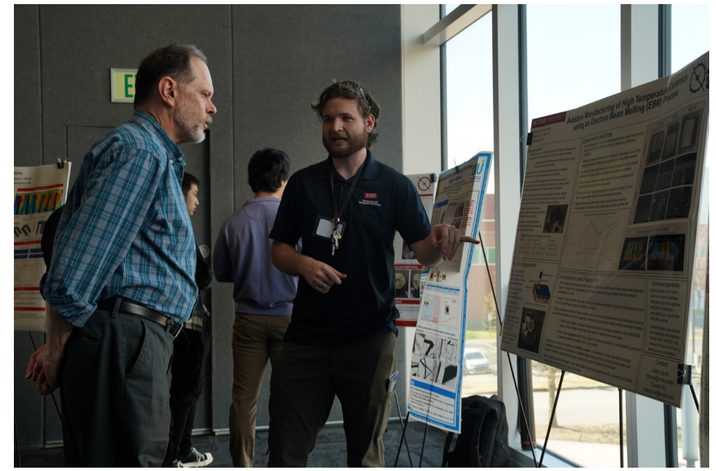


Materials for Thermal Insulation, Materials for High Thermal Conductivity, Materials for Constructing Fire / Heat Barriers & Seals, and Thermal Analysis.

Among the experts invited to speak at the conference, MAE Professors Afsaneh Rabiei and Hooman Tafreshi each presented their own research on Thermal Management related topics to conference attendees. Rabiei spoke on her research concerning her Composite Metal Foam technology, while Tafreshi presented his work on Microscale–Macroscale Modeling of Heat Transfer in Fibrous Insulations.

Following presentations from each of the conference participants, two thermal management discussion panels were held to elaborate further on the topics discussed during the presentations.

The first panel discussion covered the challenges faced by the Thermal Management community, and panelists included Suraj Rawal, Carolyn Grimley, Rob Riegle, Andy Reynolds and Marc Simpson.



The second panel discussion
covered "future visions" to address the current challenges within the community, and the panelists included Dave Shifler, Bob Burton, Michael Mullins, Julian Norley and Emiel DenHartog.

To conclude the conference after the panel discussions, visiting participants and NC State faculty were invited to a student poster session, where many MAE students shared their research in Thermal Management with the experts and were able to discuss possible applications, improvements, and future research on their various fields of study.

MAE Welcomes Gandhi as First Hassan A. Hassan Professor

A reception was held in February to celebrate appointing the newly established Hassan A. Hassan Distinguished Professor at the NC State University Department of Mechanical and Aerospace Engineering.

Farhan Gandhi, world-renowned for his research contributions to the field of eVTOL (electric vertical take-off and landing) aircraft technologies, was selected for the prestigious position only after MAE spent several years searching for someone capable of filling the shoes of the professorship's namesake.

Hassan A. Hassan, late titan of the MAE department and legend in the field of aerospace engineering, helped to establish the professorship shortly before his passing in 2019 alongside his son Basil Hassan (BSAE '88, MSAE '90, and PhD AE '93) and MAE Department Head Srinath Ekkad.

In 1962, Professor Hassan joined North Carolina State University as a full professor and spent 53 years at NC State before beginning his phased retirement in 2015. While at NC State, he was the major adviser to 34 doctoral students, he authored more than 200 publications, and has been recognized with numerous research awards; including the Alcoa Foundation Distinguished Engineering Research Award in 1987, the Alumni Distinguished Graduate Professor in 1991, the NASA Public Service Medal in 1992, the R. J. Reynolds Co. Award for Excellence in Teaching, Research, and Extension in 1993, the AIAA Thermophysics Award in 1999, and the Alexander Holladay Medal For Excellence in 2004 – the highest honor bestowed on a faculty member by the NC State trustees.

Professor Hassan died at the age of 87 in 2019, but through his massive contributions to the field of Aerospace Engineering, and through his establishment of both the Dr. Hassan A. Hassan Distinguished Professorship, the Hassan A. Hassan Distinguished Lecture Series, and many more lasting contributions to the department, his legacy lives on.

Gandhi now plays an important role in carrying out that legacy in the MAE Department and at NC State University as a whole. According to Basil Hassan and Dr. Ekkad, the committee's requirements for filling the professorship were as steep as Profesor Hassan's mounting list of contributions to this institution – one such requirement being that the candidate had to be an AIAA Fellow – which with the addition of Gandhi, makes three faculty members who hold that position at MAE, including Ekkad and Angel Family Professor Jack Edwards.

Gandhi obtained his BTech in Aeronautical Engineering from IIT-Bombay in 1989, and his doctoral degree in Aerospace Engineering from The University of Maryland's Alfred Gessow Rotorcraft Center in 1995. After 17 years on the Penn State Aerospace Faculty, he moved to Rensselaer Polytechnic Institute in 2012 as the Redfern Endowed Chair Professor in Aerospace Engineering.

With an academic career of more than 29 years, Gandhi has published around 360 technical papers in journals and major conference proceedings, and has advised 29 PhD students to graduation. He currently leads a vibrant research group comprising of two research scientists and eight doctoral students. On 12 occasions, Gandhi has been a plenary/keynote speaker at major technical conferences and has delivered prestigious named lectures such as the 2022 Royal Aeronautical Society's Cierva Lecture in vertical lift, and the 2019 AIAA Adaptive Structures Lecture, among others.

In the area of multi-rotor eVTOL aircraft technologies, Gandhi's group has conducted cutting edge research in the areas of multi-rotor/rotor-wing interactional aerodynamics, aeroacoustics, flight controls and eVTOL aircraft flying qualities, fault identification and fault tolerance, vibration reduction, eVTOL aircraft configuration design and analysis, and eVTOL aircraft flight testing.

Gandhi was joined by Ekkad and Basil Hassan; along with the new Dean of The College of Engineering, Jim Pfaendtner, and some of MAE's best and brightest during the reception to welcome his arrival into the department, and to honor Professor Hassan's great legacy in the department and at NC State.

Muller and Team Awarded $2.9 Million NIH Grant

A professor in the Department of Mechanical and Aerospace Engineering at NC State University along with co-investigators from the Departments of Biomedical Engineering and Electrical and Computer Engineering and the University of North Carolina has been awarded a grant of more that $2.9 million from the National Institute of Health (NIH) to research methods for identifying cancer aggressiveness using ultrasound technology.

Associate professor Dr. Marie Muller will serve as principal investigator for the project, titled "Quantitative Assessment of Angiogenesis using Ultrasound Multiple Scattering," and she has partnered with her fellow researchers to propose real-time quantitative assessment of angiogenesis based on Ultrasound Multiple Scattering (USMS) analysis from raw ultrasound data.

"Angiogenesis is recognized as a biomarker of cancer malignancy. Ultrasonic (US) imaging, super-resolution ultrasound, micro Doppler and acoustic angiography enable the imaging of vessel networks, but the information provided by these images is not quantitative," the proposal's abstract states. "The proposed USMS parameters will enable the development of biomarkers of cancer aggressiveness. We will validate our methods for cancer applications, but this novel biomedical imaging technology will find applications beyond cancer (to atherosclerosis for example)."

The proposed method essentially will provide cancer patients with a specific metric by which to gauge the danger of their prognosis.

The research team notes in the abstract that studies assessing the prognostic value of tumor angiogenesis have found a positive association between increasing microvessel densities and worsening prognosis. Using this association, they plan to measure vascular density with USMS to draw more concrete conclusions about and improve the specificity of one's cancer diagnosis.

"To verify this hypothesis, we propose to develop, optimize and validate novel ultrasound methods utilizing multiple scattering approaches. These methods will enable the quantitative characterization of the microarchitecture of angiogenesis, leading to improvements in ultrasound specificity," the abstract states.

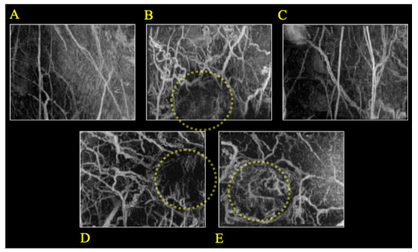


Figure 1 from Dr. Paul Dayton's Lab: Acoustic angiography images in Control (A,C) and tumor- bearing rats (B,D,E) Morphologic differences in microvascular structure are readily apparent between malignant and healthy tissue, both within and outside tumor margins, and are observed in tumors as small as 2-3 mm. Our proposed multiple scattering (MS) analysis techniques will be able to detect these differences in an automated fashion without the need for special imaging hardware such as that required for acoustic angiography or photoacoustics, enhancing malignancy detection. Data are presented as 2-D projections from 3-D data sets. Dashed lines illustrate approximate tumor boundaries. [Gessner12]

The team's research will be threefold:

- Develop and optimize a quantitative ultrasound method to assess microvascular density and anisotropy non-invasively.
- Establish the proof of concept that multiple scattering can be used to characterize angiogenesis and assess tumor malignancy in two rodent studies.
- Validate their new technology in a preliminary study on human patients, and compare the diagnostic power of the developed methods to the currently available standard point of care ultrasound.

According to the abstract, this research will dramatically increase the specificity of US imaging of angiogenesis, and enable Contrast Enhanced Ultrasound (CEUS) to become a reliable and widely used clinical tool for the diagnosis of cancer, or the evaluation of likelihood of plaque rupture. Ultimately, the methods developed will be used for diagnosis and monitoring of cancer, and could find other applications such as the prediction of plaque rupture in atherosclerosis.

Energy-X Lab Awarded Grants from DOE and NASA

$1.4 Million DOE Grant for Next-Gen Heat Pumps

Energy eXploration Laboratory (Energy-X) in collaboration with its industry partner, Carrier Global Corporation, and Oak Ridge National Laboratory (ORNL), was awarded a $1.4 million DOE grant for next-gen. heat pump systems.

Under this grant, the Energy-X lab led by Sajjad Bigham, Associate Professor in Mechanical and Aerospace Engineering at NC State University, will closely work with its industry partner and ORNL to develop a novel variable-capacity evaporator technology for improving heat pump performance, saving energy and reducing payback time.

In this project, the team will design, develop, and study next-generation evaporator technologies inspired by human lungs. This allows future evaporators operating with low global warming potential zeotropic refrigerants to properly respond to part load and off-design conditions to perform best in a heat pump system. A zeotropic refrigerant is a type of refrigerant blend composed of two or more components with different boiling points. This results in varying vapor and liquid phase compositions at equilibrium. As the zeotropic refrigerant undergoes phase changes, such as evaporation or condensation, its temperature changes due to the different boiling points of its components. This oftentimes makes the design of the evaporator technology more challenging.

The project is supported by the Building Technology Office (BTO) of the Department of Energy (DOE) under BENEFIT (Buildings Energy Efficiency Frontiers & Innovation Technologies) program. The BENEFIT program helps advance cost-effective solutions to successfully electrify buildings across the nation while also improving their energy efficiency and demand flexibility. “Exploring new ways to build and operate America’s buildings is key to cutting harmful emissions and combatting the climate crisis,” said U.S. Secretary of Energy Jennifer M. Granholm. “With this funding, the Department is providing critical new resources to teams from across the nation to transform game-changing ideas into innovative solutions, creating safer and healthier homes and buildings while cutting energy costs.”

Residential and commercial buildings are the largest energy-consuming sector of the U.S. economy, responsible for approximately 40% of the nation’s energy consumption, 74% of its electricity use, and 35% of its total carbon emissions. Estimates indicate roughly one-third, or more, of the energy used by buildings is wasted at a cost of $150 billion annually. Utilizing current technologies and developing new innovations are essential to ensuring buildings across America can quickly and more effectively improve their energy efficiency and decarbonize their on-site processes while advancing environmental and energy justice priorities.

NASA Grant for Carbon Capture in Space Systems

Energy eXploration Laboratory (Energy-X) in collaboration with its industry partner was awarded a NASA grant for carbon capture. Under this grant, the Energy-X lab led by Sajjad Bigham, Associate Professor in Mechanical and Aerospace Engineering at NC State University, will closely work with its industry partner and NASA’s Ames Research Center to develop a carbon removal system for next-generation space vehicles.

Under NASA’s Space Policy Directive-1 (i.e., Reinvigorating America’s Human Space Exploration Program), “the United States will lead the return of humans to the Moon for long-term exploration and utilization, followed by human missions to Mars and other destinations”. To accomplish this aspirational goal, next-generation space technologies are needed to support future space missions. Of many space systems, life support systems are at the heart of any human space travel. Removing carbon dioxide from the spacecraft cabin is central to the space life support systems.

Current methods of carbon dioxide removal onboard space vehicles and the International Space Station (ISS) rely on packed sorption beds filled with small desiccant beads. These systems consist of two sorption beds, one is used as an adsorber removing carbon dioxide from the cabin environment, while the other is thermally regenerated. Cycling the sorption towers between the adsorption and regeneration processes allows for a continuous carbon dioxide removal process. Fundamental issues limiting the efficiency and functionality of packed beds include high pressure drop penalties across the bed and the random packing of the granules. This leads to the air flow maldistribution of the supplied cabin air over the packed beds reducing sorption rates and the usable surface area of the packed bed system as there are inherent preferred pathways for the gas to travel. Also, packed bed sorption systems have poor thermal conductivity caused by point-to-point contacts among individual beads, resulting in inefficiency during the regeneration process.

Under this project, the team will design, develop, and study carbon removal systems made of 3D-printed zeolite-13X monoliths. The goal is to optimize carbon dioxide adsorption and regeneration processes while simultaneously reducing pressure losses experienced by the air mixture (see the figure for a representative adsorption process). The team believes that an optimized sorption system can be realized by designing 3D lattice structures with proper topology, material characteristics, and thermal conductivity. If successful, this project will advance the air revitalization system of NASA space vehicles for future Moon and Mars missions.

Narayanaswamy Awarded $1.65 Million DURIP Grant

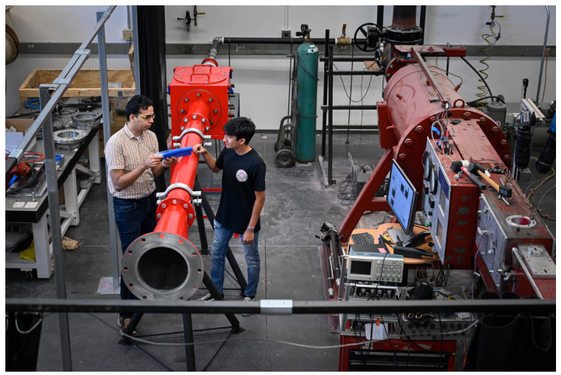
A professor at the NC State University Department of Mechanical and Aerospace Engineering was awarded a $1.65 million grant in December 2023 as a part of the Department of Defense's Defense University Research Instrumentation Program (DURIP).

Venkat Narayanaswamy is one of 281 university researchers across the country to receive a portion of the $161 million program, which will support the purchase of major equipment to augment current and develop new research capabilities relevant to the DOD at 120 institutions across 39 states in fiscal year 2024.

"DURIP awards build vital research infrastructure, advancing the exploration of knowledge and upholding the cutting-edge capabilities of our academic institutions," said Dr. Bindu Nair, director of basic research in the Office of the Under Secretary of Defense for Research and Engineering, whose mission is to continuously advance technological capabilities and innovation within the DOD. "This funding underpins the enduring scientific excellence of our universities, nurtures the development of the next STEM workforce, and catalyzes scientific innovations that will lead to unprecedented military capabilities in the years ahead."

Narayanaswamy spearheaded the development of a long duration Mach 6 wind tunnel in the Fall of 2022 with the support of an initiation grant from North Carolina State University and a prior DURIP grant. This wind tunnel facilitates foundational as well as applied hypersonics research and also fills the gap in hypersonic workforce development in Southeast USA as being one of a very few hypersonic facilities in the region.

"The goals of the proposed DURIP grant are to: (1) upgrade the altitude pressure range of the facility from the current 30 km – 40 km to 20 km – 40 km at 60% Mach 6 flight enthalpy; and (2) increase the tunnel test time from the current 10 seconds to approximately 20 seconds," Narayanaswamy states in the most recent DURIP project abstract. "These upgrades will substantially expand the range of vehicle trajectory points that could be studied in this facility and generate validation quality datasets at vehicle relevant conditions, both of which will contribute to advance the predictive capabilities of hypersonic platforms. The facility upgrade will be made using the high pressure high throughput inline electric flow heater requested in this DURIP and other infrastructure that are already available in-house."



To pursue the goals of this grant, Narayanaswamy plans to use the upgraded facility to demonstrate an axisymmetric morphing scramjet inlet/isolator design to generate adaptive thrust and deepen his team's understanding of the flow processes that impact the resulting thrust outcome from morphing.

The upgraded hypersonic facility will develop the future hypersonics work force in the southeast USA. The outreach activities developed around the facility will have several modules to disseminate research-related education to graduate, undergraduate, and school students. The graduate students working on the project will obtain research training on various DoD projects and mentor the undergraduate research assistants, and Narayanaswamy will leverage numerous mechanisms to engage undergraduate and graduate students from NC State and from other HBCU/minority serving universities in North Carolina during and beyond the project term for a wide outreach.

DOE Awards $1.6 Million to MAE-Led Research

The Department of Energy (DOE) Water Power Technologies Office announced in Summer 2023 that a project being headed by MAE researchers will be awarded more than $1.5 million as a part of an initiative to support research that will accelerate development and testing of marine energy technologies.

Dr. Matthew Bryant is the lead principal investigator for the project, titled "Co-Design of the Pumping System and Controller for a Mobile, Anchorless, Wave-Powered Desalination Platform." The project is a collaborative effort between Bryant, former MAE professor Chris Vermillion from the University of Michigan, Hosam Fathy from the University of Maryland, and Scott Willcox from Liquid Robotics.

According to the announcement from the DOE, this project will transform Liquid Robotics' autonomous, uncrewed Wave Glider into a mobile, anchor-less desalination platform.

"The objective of this research is to develop an integrated piston pump, reverse osmosis (RO) unit, tank, and corresponding mission planning and control system to enable the Liquid Robotics Wave Glider to serve as a mobile, anchorless desalination platform," the project's abstract states. "Ultimately, the resulting system will enable rapid deployment from a near-shore location, desalination of up to 1000 gallons of water, return to the near-shore deployment location for offloading of desalinated water, and immediate redeployment."

The project is one of seven that will be awarded a piece of the $10 million from the DOE, alongside projects from Binghamton University; Florida Atlantic University; Oneka Technologies USA; Sea Potential, LLC; Water Bros Desalination, LLC.

"Marine energy technologies have incredible potential to provide clean electricity as well as clean water," Acting Assistant Secretary for Energy Efficiency and Renewable Energy Alejandro Moreno said in the announcement. "These projects represent DOE's first significant investment in marine energy serving the blue economy market, and will advance technologies that can meet these needs and help achieve President Biden's goal of a net-zero-emissions economy by 2050."

These projects were selected as part of WPTO's Marine Energy Systems Innovation at Sea funding opportunity.

Brenner and Zikry Received $8.5 Million Department of Defense Grant for Extreme Materials

The U.S. Department of Defense has awarded an $8.5 million grant that will span over three years to support the establishment of a cutting-edge center focused on designing materials with extreme properties. The leads are Professor Mohammed Zikry from the Department of Mechanical and Aerospace Engineering and Professor Donald Brenner, Head of the Department of Materials Science and Engineering. Other key individuals are Professor Rajeev Gupta and Professor Bharat Gwalani from the Department of Materials Science and Engineering and Professor Tim Horn from the Department of Mechanical and Aerospace Engineering.

The grant's scope envisions collaboration with companies such as Lockheed Martin to transition fundamental materials research to advanced technologies. The primary goal is to create new materials and identify areas where their implementation is most needed. This includes areas such as hypersonic transport, nuclear power, and extraterrestrial environments, where extremes of temperature and radiation challenge the capabilities of current materials.

The grant will also serve as seed money, kickstarting a longer-term investment strategy. In addition to supporting research and development efforts, a portion of the funds will be allocated to upgrading equipment. This includes enhancements to the advanced microscopies, as well as the acquisition of high-temperature processing equipment such as Spark Plasma Sintering. Additionally, new furnaces and a Microbalance will be acquired. The effort will also include seed grant funds to grow new research opportunities in related areas.

The grant will also provide financial support for the hiring of five graduate students and five postdoctoral researchers, further augmenting the research team's capabilities. Overall, this significant grant represents an important investment in the development of advanced materials and their applications in extreme environments.

This story was originally published in Department of Materials Science and Engineering.

NC State's REACHR Team Soars with Innovative Aerospace Project

In the bustling labs of the Department of Mechanical and Aerospace Engineering at North Carolina State University, a group of senior design students, known collectively as REACHR, have been steadily pushing the boundaries of aerospace design with their ambitious project, REACHR Hero 1. Initially assembled as a 2024 aerospace engineering senior design team, REACHR set out to create not just a machine but a legacy, embodying the innovative spirit of an aerospace program that has doubled in size over the last four years.

Under the guidance of MAE Associate Teaching Professor Felix Ewere, the team—comprising students Lucas Andrews, Tobias Hullette, Brian Shi, Jose Vizcarrondo, Sebastian Perna, and Caleb Kebede—embarked on a year-long journey to design and build a hybrid aerial vehicle capable of both fixed-wing flight and vertical takeoff.

Dream Big, Fly High

"From the start, we knew we wanted to do something different," said Tobias Hullette, Project Manager and Structures Lead. "We didn't just want to build a normal RC plane. We wanted to make something that would leave a mark."

The inception of the project was as much about passion as it was about technical prowess. Brian Shi, the team's aerodynamics and financial lead, shared a story about his childhood fascination with paper airplanes that eventually steered him toward aerospace engineering.

"It might sound simple, but those paper airplanes were just the beginning for me," said Shi. "Here at NC State, we've been given the freedom to expand on those basic principles and really explore what's possible."

Engineering Innovation

The design of REACHR Hero 1 featured several groundbreaking elements, including a modular body that allowed for quick adjustments and repairs—a crucial feature in experimental aviation. The use of lightweight composite materials helped maximize the aircraft's payload capacity while maintaining agility and speed.

Sebastian Perna, the stability and controls lead, played a crucial role in integrating advanced control systems that allowed for unprecedented precision during flight. "Working on the control systems was like solving a puzzle," said Perna. "Each piece had to perfectly align to ensure not only the aircraft's performance but also its safety."

Personal Journeys, Collective Ambition

The team's creative process was notably influenced by their individual experiences and aspirations. Jose Vizcarrondo, the systems and payload lead, brought a unique perspective to the project from his military background.

"I saw this project as a chance to apply real-world knowledge to something groundbreaking," Vizcarrondo remarked. "REACHR Hero 1 isn't

just a project for us; it's the culmination of years of learning and growth."

Innovation Takes Flight

Caleb Kebede, the propulsion and communications lead, played a pivotal role in ensuring that each component functioned harmoniously. "The propulsion systems were particularly challenging," Kebede explained. "But getting them to work seamlessly within the aircraft was incredibly rewarding."

The project gained momentum as the design took shape, with each milestone bringing the team closer to realizing their vision. Perna took pride in integrating the boat hull design into the aircraft's body.

"We literally drew potatoes on a whiteboard to conceptualize the hull," laughed Perna. "But those sketches turned into a design that we're really proud of."

Collaborative Spirit

The team's collaborative spirit was a key component of their success. Regular brainstorming sessions, coupled with rigorous testing phases, fostered a dynamic environment where innovative ideas could flourish. This collaborative spirit extended beyond the team, involving faculty advisers, fellow students, and industry experts who all contributed to the project's development.

A Milestone at Gateway to Blue Skies

The REACHR team's efforts culminated in a significant achievement at the Gateway to Blue Skies competition, where they presented their project alongside teams from various universities. Their innovative design and the practical implementation of the REACHR Hero 1 not only caught the eye of the judges but also earned them accolades for their creative approach to problem-solving.

"Our presentation at the competition was the real test of our project's capabilities," Lucas Andrews, the team's simulation and manufacturing lead recalled. "To see it not only perform well but also receive recognition was incredibly validating for all the hard work we had put in."

The Sky's the Limit

As the academic year drew to a close, the scene at the first test flight of REACHR Hero 1 was one of anticipation and camaraderie. As the drone began its ascent, another senior design team played Holding Out for a Hero" by Bonnie Tyler, adding to the charged atmosphere. Upon achieving a successful flight, cheers erupted from the gathered students, TAs, and faculty, all united in their joy at Team REACHR's success.

"Watching REACHR Hero 1 take off for the first time was a moment of validation for all of us," said Andrews. "It was more than just a successful project; it was a testament to our hard work and dedication."

Despite having graduated and embarked on diverse paths, all team members remain committed to the REACHR project. Lucas is a full time Mechanical Engineer at Kearfott. Tobias is pursuing an AE Master's degree at NC State with a focus on Smart Structures and Rotorcraft Aerodynamics.Brian is pursuing an AE Master's degree at NC State with a focus on computational aerodynamics. Jose is working as an engineer with NavAir at Cherry Point Marine base, while Sebastian is continuing his studies in a doctoral program, specializing in flight dynamics. Caleb is working with a startup that develops sustainable aviation solutions.

"We're ready to take the next step, wherever that leads."

They continue to explore avenues to sustain and expand their work, ensuring the legacy of REACHR Hero 1 lives on.

The team is working closely with NCDOPS and FEMA to take Hero 1 to the next level. They are pursuing funding to continue research, testing and implementation on Ocracoke Island and The Outer Banks.

"We are excited to improve our design and system and hope it helps revolutionize modern hurricane response systems," Hullette said.

The REACHR team has not only developed a sophisticated aerospace vehicle but also paved the way for future innovations in the field. Their journey reflects the spirit of exploration and excellence that defines North Carolina State University's Department of Mechanical and Aerospace Engineering.

"REACHR Hero 1 was just the beginning," concluded Shi. "We're ready to take the next step, wherever that leads."

mechanical

senior design

Each year, seniors from the Department of Mechanical and Aerospace Engineering participate in Senior Design, in which students showcase a variety of senior design projects that they built throughout the semester.

The course is split into a Mechanical Engineering Senior Design Course and an Aerospace Engineering Senior Design Course, both of which task students with specific issues they must solve by designing and building a prototype of a product or device that could aid in a variety of different applications.

In the 2024 Mechanical Engineering Senior Design course, there were nine sections comprised of 255 total students.
Six sections worked on industry-sponsored projects, and three sections worked on departmental projects. In the fall, they worked on conceptual design through presentations, reports, and computer simulations. In the spring, the students built the prototypes. The prototypes were tested twice with the second test providing statistical data showing robustness.

There were three Senior Design days this year, Each Senior Design Day was composed of formal presentation sessions in the morning and prototype demonstration sessions in lab in the afternoon. It was overall a success. Over 90% of the prototypes worked. The others, though not completely, worked partially.

ABB's sponsored project was titled "Understanding Arc Fault Pressure Distribution within Different Arc Resistant Switchgear Plenum Configurations," and challenged students to design an instrumentation system to measure the pressure inside the switchgear, the recoil impact from the pressure shot out of the switchgear and the bending and the stress of the switchgear's components.

Caterpillar, Inc. sponsored a project titled "Caterpillar Mini Hydraulic Excavator (MHE) Storage Box," which tasked students with designing a lockable, durable, sealed, compartment that fits between the cab & firewall on 307.5 & 310 excavators, providing storage for common tools, fluids, and other items.

Corning sponsored a senior project titled "Automated Mechanical Apparatus for Testing Optical Connectors" that challenged this year's students to prototype an automated mechanical apparatus, loaded with one or more mated pairs of optical connectors, which will be subjected to a variety of automated mechanical loads (vibration, torsion, bending, tensile, impact, etc.) executed in series while optical data is collected.

Daimler Trucks North America sponsored the project titled "Pre-Paint Chassis Frame Rail Staging," wherein seniors were tasked with tackling any/all aspects of the installation process – from de-nesting, to T-Bar stabilization, and U-bar stabilization. Each aspect of the project has unique challenges that all have mechanical aspects to them Student solutions should make the task easier and/or faster while keeping the following considerations in mind: Demonstrated reduction in process time (TAKT), Demonstrated improvement in process ergonomics, Consideration of operator safety, and Demonstrated repeatability – process should be the same across all truck (frame) models.

The Pentair senior design project this year, titled "An Integrated Water Level Sensor," challenged students to design proof of concept water level sensor, with a backup sensor, that would send a signal to a solenoid valve to fill the pool until a certain level is reached.

The final industry-sponsored senior design project was proposed by Zurn, titled "Zurn Intelligent Sensor Ceramic Cartridge Thermostatic Mixing Valve," and it tasked students with designing the reliable, battery operated, efficient mechatronics subsystems for a commercial smart faucet capable of providing thermostatic controlled mixing based on user input of the temperature setting.

The first of the departmental senior design projects in 2024 was the Undergraduate Aerospace Experiment, titled "Small Closed-Loop Water Tunnel for Particle Image Velocimetry Visualization." As per the strategies outlined by the AE undergraduate curriculum committee, the incorporation of advanced flow visualization techniques is a focal point within AE experimental laboratory courses. One such technique is Particle Image Velocimetry (PIV). However, the absence of a water tunnel poses a challenge to implementing this technique. This project mandates the conceptualization and construction of a

self-contained water tunnel, subject to specific constraints. Foremost among these limitations is spatial confinement, within dimensions not exceeding 120" x 30" x 50" (length x width x height). Additional considerations encompass the test section width, set at a minimum of 6", and a maximum achievable speed of 10 m/s. Crucially, the tunnel's velocity is modifiable and quantifiable, and the entire setup is designed for portability.

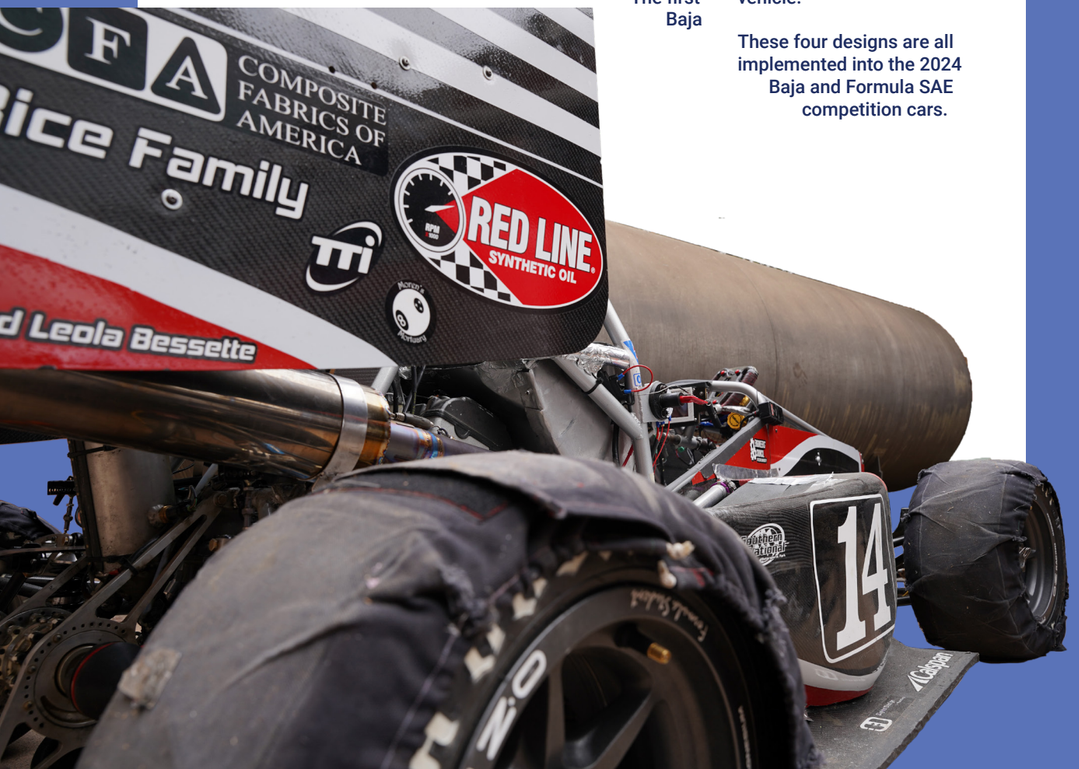
Another departmental senior design project from 2024 is the heat sink design section, in which students designed, analyzed, and optimized an additively manufactured heat sink to cool a constant power module subject to natural convection in a vertical enclosure. The teams were evaluated as having the most effective designs exploiting the design freedom allowed by additive manufacturing.

In addition to the sponsored projects, the PackMotorsports Formula and Baja SAE teams participated in their own mechanical engineering senior design projects, each of which pertain to a specific portion of their 2024 Formula or Baja vehicles.

The first Baja team Senior Design project consisted of designing Toggleable Four-Wheel Drive and Chain Optimization for their 2024 SAE competition, and the second project consisted of designing Continuously Variable Transmission Dynanomter for the same vehicle.

The Formula SAE team also participated in two design projects. The first of which was to design Pneumatic Shifting System for an Internal Combustion FSAE Car, and the second centered around designing Kinematics, Accumulator Mounting and Frame for the team's electric vehicle.

These four designs are all implemented into the 2024 Baja and Formula SAE competition cars.



aerospace

senior design

In the 2024 Aerospace Engineering Senior Design course, there were 15 teams comprised of 94 total students. Five teams were tasked with developing Inflatable Technologies, Structures, and Systems to support Lunar Operations. Four teams built fixed-wing aircrafts and four teams built multi-copter aircrafts, both of which were tasked with developing an Unmanned Aerial System to Support advancing aviation for natural disasters.

One team from each of these three sections was selected by judges as the winners of their respective sections during the annual Aerospace Engineering Senior Design Symposium on Monday, April 8. To win over the judges and show the capabilities of their designs, teams conducted 15 minute presentations in the morning and poster sessions in the afternoon – during which friends, family, colleagues and mentors came out in droves to see the seniors' hard work in action.

Aerospace Engineering Senior Design Instructor Dr. Felix Ewere presented three Awards for Outstanding Project Managers in 2024, which were awarded to three team leads that went above and beyond in the development of their projects. This year's winners were Tobias Hullette of the fixed-wing section, Matthew Yacovone of the space section, and Michael Reid of multi-copter section.

In the spacecraft section, Team Spacepack Balloonatics (Project Name: ARISE – Astronaut Recovery Inflatable Support Equipment) was declared the winner. Their team includes Izabella Sciora, Dean Bui, Malachy Kerrigan, Devin Johnson, Brooke Schubarg, Trevor Henderson and Thomas Dolson.

Team Stellar Propellers (Aircraft Name: SYZYGY) was declared the winner of the multi-copter section and their team was made up of Luke Wickelgren, Paul Randolph, Ashutosh Chandravanshi, Hayne Beard and Spencer Martindale.

In the fixed-wing section, Team REACHR (Project Name: Reconnaissance and Emergency Aircraft for Critical Hurricane Relief, Aircraft name: HERO1) was the winner. Team members included Brian Shi, Caleb Kebede, Jose Vizcarrondo, Lucas Andrews, Sebastian Perna and Tobias Hullette. Team REACHR was also nominated to compete in NASA's 2024 Blue Skies Competition, where they will present HERO 1 and their work on the competions annual theme: Advancing Aviation for Natural Disasters.

Another team was comprised of NC State's AIAA Design Build Fly (DBF) Team, whose mission in 2024 was to design and manufacture a fixed-wing Urban Air Mobility aircraft that can perform a medical transport flight and carry passengers in separate configurations.

The 2024 DBF team consisted of Emily Hayman, Alex Elchik, Ajay Pandya, Rishi Ghosh, Nathan Baker, Maya Keele and Aaron Hart. The team constructed The Wolfline, designed to be able to act as a UAM vehicle and carry flight crew, medical crew with equipment, and passengers.

One final team was comprised of the NC State High-Powered Rocketry Team, also known as "Tacho-Lycos," which each year constructs a rocket to compete in NASA's Student Launch Competition. In 2024, the team consisted of eight senior design students: Hanna McDaniel, Cameron Brown, Matthew Simpson, Braden Rueda, Franklin Rice, Joseph Alonso, Michael Wax and Shyanne Large. These students constructed their 2024 Rocket, which was taken to the compete against other teams from across the country in Huntsville, Alabama between April 10 and 14. Competition results will be announced this June.

Students Unveil New AI Applications in First-of-its-Kind Poster Session

In December, students from the NC State University Department of Mechanical and Aerospace Engineering debuted projects on new applications of Artificial Intelligence (AI) that they developed in a first-of-its-kind AI course offered at the department.

The brand new course, MAE 495 – 011 and MAE 589 – 011: Artificial Intelligence for Engineering Applications, is taught by MAE Assistant Research Professor Veeraraghava Raju Hasti, who joined the department in 2023 and specializes in interdisciplinary research at the intersection of engineering, computer science and economics – focusing on the development of transformational digital tools and technologies using physics-based and data-driven approaches.

"Our MAE students have harnessed the power of AI, showcasing innovative applications in engineering through their short-term course projects," Hasti said about this semester's projects. He continued that the cutting-edge work these students are doing in the emerging field of AI applications in engineering is comparable to that of top AI research institutions like the University of Michigan and Harvard.

Power of Ignited Minds

The Poster Session, titled "Power of Ignited Minds: Unveiling the Future of AI in Engineering," allowed students to debut their work to students, faculty and other curious minds and highlight what they believe to be the future of Artificial Intelligence in the field of engineering.

Ten posters debuted at the event, highlighting a number of different innovative applications of AI technology from AI-Based Manufacturing Systems that optimize production and cost reduction, to AI-generated Airfoil shapes for mitigating dust accumulation on Solar panels, and everything in between.

One such project from Shang-Ru Li, one of the students in the cutting-edge AI course, focuses on using AI to detect potential COVID-19 Patients. According to the project's poster presentation, the process is comprised of three core steps using Artificial or Residual Neural Networks (ResNet) to execute classification tasks on Chest X-ray images.

"A general convolutional neural network model is first utilized to ensure the feasibility of performing image classification tasks on a given dataset with three labels," The poster's abstract states. "ResNet is later used on the same dataset with two categories only, and the training weights are saved for the following transfer learning purpose. Finally, ResNet with the pre-trained weights is exploited on the ternary classification task. The result proves the usefulness of using transfer learning on an unseen category."

Another Student, Martha Crisp, presented at the poster session her research into using similar neural networks to predict air quality index.

"Popular prediction methods including linear and polynomial regression have been used to forecast an abundance of different datasets, but the nature of pollution levels reflected in Air Quality Index (AQI) datasets are too complex to be accurately modeled by these methods," Crisp's abstract states. "This research uses the Long Short-Term Memory (LSTM) model, a variation of the Recurrent Neural Network, to predict future AQI levels in Delhi, India. Upon evaluation, the R squared value of the model resulted in a 0.954 value. This close prediction is visualized against when the true and predicted values are graphed."

Hasti plans to continue to expand the AI-curriculum at MAE, and further assist students in making projects like these a reality so that researchers can further make use of the power of Artificial Intelligence.

MAE Students Excel Through MEM Program

Molly Li, a 2021 Mechanical and Aerospace Engineering graduate, and Evan Raynor, a 2023 MAE graduate, were awarded the inaugural CAMAL Advanced Manufacturing Fellow Program for their Master of Engineering Management (MEM) graduate degree. Being the first to experience the program provided both students an invaluable experience. Advanced Manufacturing is the newest concentration in the MEM program. It aims to teach the skills needed to tackle pressing manufacturing challenges using big data, automation, robotics, nanomanufacturing and 3-D printing. Members of the fellowship program even get full funding for the entirety of their graduate school education.

Both students, as members of the MEM program, are working closely with Dr. Chris Rock of the Industrial and Systems Engineering (ISE) department and Dr. Karen Daniels from the Physics Department, where they have excelled in their project where they turned theory into reality 3-D printing objects, requested by different universities, out of different materials to find the best fit. The two look to use their newfound skills to further their careers.

Molly Li sees learning as an exciting opportunity to challenge herself. Inspired by the Chinese idiom, “Learning is just like sailing against the current; if you don’t advance, you will be driven back.” She's thrilled by the challenge of testing new materials and getting hands-on experience with the latest machines. Being one of the two pioneering members of the CAMAL Advanced Manufacturing Fellow Program, Li added that “every single person, student or faculty, working in the CAMAL lab was incredibly helpful and patiently answered every one of my questions regarding anything in the lab.” Mentorship is a priority when it comes to the CAMAL program. Everybody, student or faculty, is there to help you and make sure you make the most of the opportunity.

Li's journey began with a strong foundation in engineering principles during her undergraduate studies. She “aspired to deepen [her] knowledge of additive manufacturing,” and through the fellowship, got to “work with mathematicians and physicists from UCLA, John Hopkins, and UNC-Chapel Hill, turning their theories and equations into 3D printed objects.” The MEM program offers her the perfect opportunity to apply her MAE knowledge to Advanced Manufacturing. Li is eager to utilize her experience using new technologies and working on cutting-edge research in the workforce.

Evan Raynor, also an MAE graduate and the other pioneering program member, was a perfect match for the CAMAL AM fellow program. “Ever since I began my graduate school career, I have longed for knowledge that will allow me to make a difference in the world,” said Raynor. The program’s pairing of advanced manufacturing methods along with his passion for mechanical engineering meant the program aligned perfectly with his aspirations.

For Raynor, exploring progressive methods to make things is a passion. The program's hands-on approach with top-notch technology is very important to him. The fellow program offers Raynor the perfect opportunity to expand his knowledge and expertise in Advanced Manufacturing, giving him an advantage over the competition as a manufacturing engineer at Wolfspeed post-graduation.

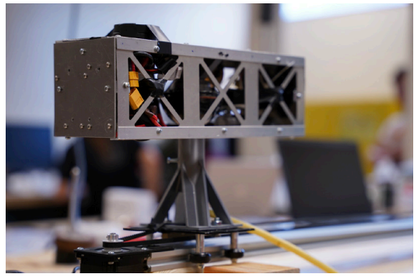
The two students were able to acquire additive and hybrid manufacturing expertise, giving them an advantage in the extremely competitive engineering field. “Not only because I get to ‘play’ with the cool machines, but also because I know the lessons and opportunities that this experience will provide me will be extremely valuable and is something I cannot get from taking classes alone” added Li. Evan and Molly’s background in MAE made the transition to working in the CAMAL Lab seamless. The experience provided the two with technical expertise, enhanced leadership, and managerial skills, making them stand out in engineering leadership.

“I have longed for knowledge that will allow me to make a difference in the world”

Aerospace Senior Design Team Wins Third at National SSA Conference

A 2023 Space Section Senior Design Team won third place at a national SmallSat Alliance (SSA) competition held in Austin, Texas last summer.

Team Space Raccoons, otherwise known as Team 1 in the 2023 senior design course, designed and built a Rubble Attachment and Conveyance CubeSat (RACC). RACC is a three-unit cubesat (a square-shaped class of miniature satellite) constructed with commercial components, was designed to capture orbital debris.



The team includes MAE students and alum Caden Bjorndahl, Joshua Boyd, Jordan Gonzaga, Jeshua Ray, Parker Rhyne, Olivia Scott, Caden Speakman and Peter Zheng.

The eight members of team Space Raccoons debuted their RACC design at the 2023 senior design symposium, where they won first place against the other teams in their section, winning the favor of the judges in design and presentation.

Now, the team has brought home a podium finish at the national level.

The SSA competition was the first of its kind and the organization plans to continue the event annually. They established the competition in 2022 to recognize innovation in the space industry and support new talent in the field.

According to the SSA website, they are comprised of the most successful and innovative companies in the US smallsat ecosystem, including satellite makers, operators, component suppliers, launch providers, ground and data analytics providers.

high-powered rocketry club (hprc)

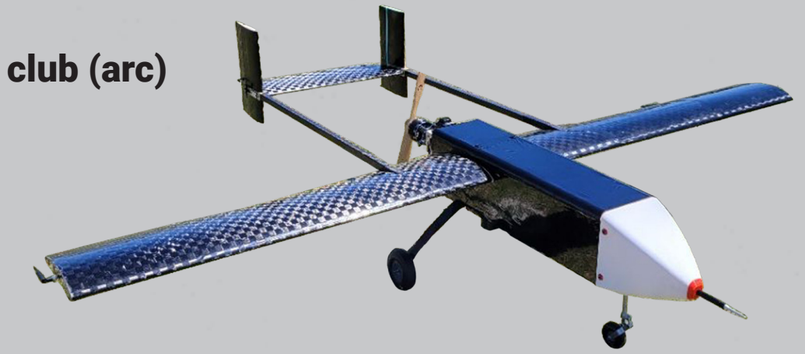
- 5th Overall

The challenge at NASA Student Launch in Huntsville, Alabama this year was to design, build, and fly a rocket that would reach an apogee of 4,050 feet, and that would contain a payload that adhered to the payload challenge. The payload challenge was to design and build a lander that was capable of retaining four team-designated STEMnauts (for which HPRC used small resin ducks), deploying from the rocket during descent, and reaching the ground safely without the use of parachutes or streamers. At competition, the rocket was only 11 feet off of the team's target apogee, wowing fellow teams and judges alike, and securing a spot in the Top 5 at NASA's 2024 Student Launch.

The team once again performed exceptionally well at competition, but it was not without their own significant challenges. Two home launch weekends were cancelled due to rain, thus forcing the team to do their required test launch on Easter Sunday - with the launch data and analysis due to NASA the very next morning at 9am. The team, of course, overcame this and made their deadline!

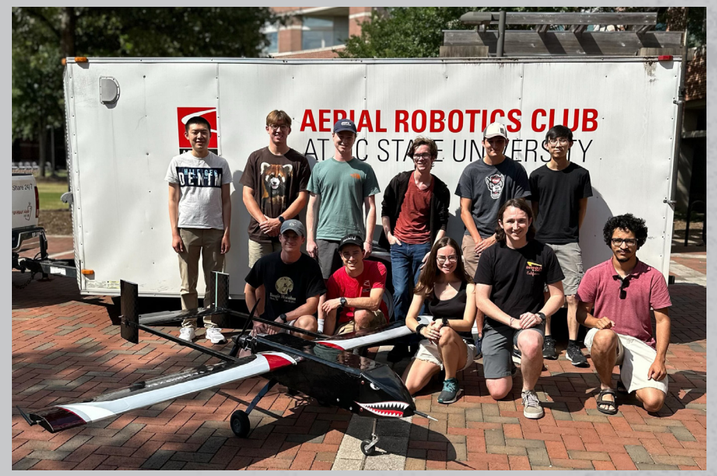
aerial robotics club (arc)

- 14th Overall
- 2nd Highest Ranked United States Team
- 4th in Mission Demonstration



Compared to the 2023 competition, the NC State Aerial Robotics club significantly improved their performance at the SUAS AUVSI Competition, rising 15 spots in the overall competition ranking. Overall, the team had a successful mission and completed the waypoint mission and dropped 4/5 payload bottles.

In the year leading up to the 2024 competition, the team developed an entirely new airframe design and manufacturing process. The new aircraft, Kavik, is an upscaled version of the previous airframe, Akela, with a carbon fiber construction. Additionally, Kavik features a new electric propulsion system. Overall, Kavik was a great success and is a testament to the countless hours put in by the team.



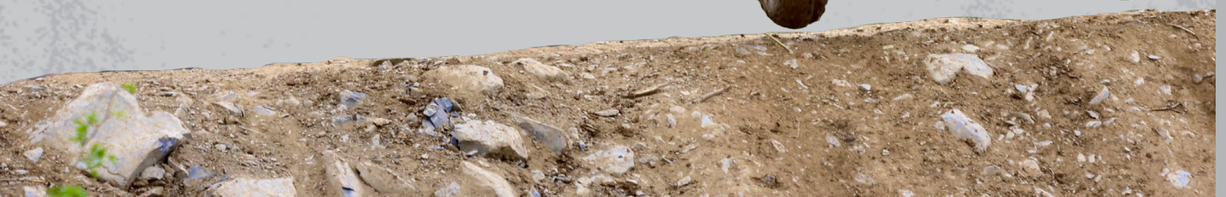
pack motorsports baja sae

- 39th Overall
- 11th in Acceleration
- 6th in Suspension and Traction
- 50th in Endurance
- 11th Acceleration
- 17th Design
- 23rd in Cost.

At competition, the 2024 Baja car passed tech inspection on the first day and was one of only four teams out of 107 to receive full points for their cost reduction report.

Out with the old, in with the Pink and Blue

To begin the year, the Pack Motorsports Baja team had 12 seniors graduate, and 7 out of our 10 subsystem leads were sophomores in 2024, making it one of the youngest teams ever in the department. The team also had their largest sponsorship total in the history of the club. The team unveiled a pink and blue car this year in commemoration of 100 years of engineering at NC State University, a tribute to the original NC State University colors.



student team

pack motorsports formula sae

- 28th Overall
- 2nd in Engineering Design Event
- 69th in Presentation Event
- 37th in Cost Event
- 7th in Acceleration
- 33rd in Skidpad
- 9th in Autocross
- DNF in Endurance due to an oil leak noticed by officials during the driver change. The car completed 5/10 laps, and likely would have been able to finish the race if not for the leak.

Down the Road

The Electric Vehicle (EV) powertrain team is currently working on tuning the motor for maximum power output and building a housing to store the large battery pack. The other subsystems on the team are ramping up design work and preparing for double the manufacturing tasks required to build two cars. The team already have an EV chassis getting under construction with the help of their sponsors at Elite Tube and Fab, and are working on having the Internal Combustion (IC) chassis started early Fall.

2023 hall of fame

Debbie Adams

Vicki Britt

Neil Hall

Susan Hudson

James Nau

Dave Olynick

Built upon their common educational foundation at NC State University, The MAE Alumni Hall of Fame was established in 2012 to inspire our current students, and to celebrate the accomplishments of our extraordinary graduates who have used their education to excel in a profession, career, or service. This nomination is based on professional and service achievement, entrepreneurship, and contributions to professional societies making this a truly noteworthy distinction.

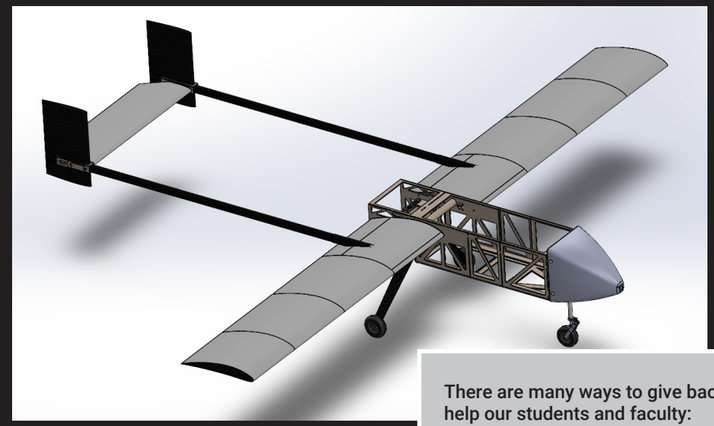
With over 12,000 MAE alumni, only 160, including this year's class, have been inducted into the MAE Hall of Fame. The MAE Department is honored to celebrate this prestigious ceremony with the 2022 class.

how to

give back

to mae

MAE engages with alumni, friends and companies because we know that strong partnerships are imperative and help fuel success. In addition to financial support, you can give back to MAE by mentoring a student, volunteering for one of our advisory boards, recruiting students to your company or partnering with faculty to support their research. By partnering with MAE, you will gain access to top students and faculty at one of the premier MAE departments in the country.



There are many ways to give back to the MAE Department that help our students and faculty:

1. By making a gift to the MAE Enhancement Fund, you are helping to fund some of the greatest needs within the department that directly support student programs and faculty research.

2. Establish an endowed scholarship, graduate fellowship or professorship that will generate support in perpetuity for our students and faculty.

3. Give a gift to name a space in Engineering Building III to help support critical research and learning experiences for our faculty and students.

4. Your company can give back by becoming a member of the MAE Corporate Partners program through sponsorship of a senior design project or by making a corporate contribution to the department.

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