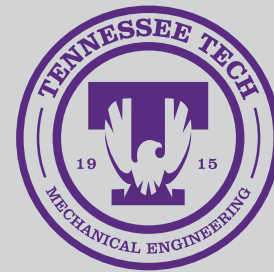


MESSENGER

Tennessee Tech Department of Mechanical Engineering

The newsletter for alumni and friends of the Department of Mechanical Engineering | Spring 2023



A Note from the Chair

Dear Alumni and Friends:

The last year has indeed been a great one for the Mechanical Engineering Department at Tech! Our undergraduate and graduate students continue to thrive and excel in industry careers and pursue advanced degrees, both here and at other schools. The quality and dedication of our faculty and staff are the main reasons for our outstanding reputation. Our faculty continues to do remarkable things in teaching, research and outreach as highlighted in this newsletter. This dynamic group makes this department a great place to work. In fact, I feel we are all a big ME family!

Our programs' successes have never been better. In this newsletter, you will find updates on our departmental news and events, faculty research, student projects, student organization happenings, changes on campus and construction updates, among other things. We are constantly trying to enhance student success through improvements in our curriculum, pedagogy and assessment. I believe student success is multifaceted - it is a holistic development of students' character and personality that include intellectual, emotional, social, ethical, physical and spiritual development. It is our duty and responsibility to help students develop these skills through a variety of curricular, extra-curricular and co-curricular programs and activities.

Their emotional and social development are equally important for developing interpersonal and leadership skills. By examining and fine-tuning access to different activities and opportunities outside the classroom, we are striving to help students develop ethically to become great citizens in addition to great engineers. To bring meaningful transformations into the engineering classroom requires movement away from the traditional lecture and exams, to teaching and learning that is process-oriented. Exposing students to case studies and engineering design projects at an early stage in their engineering education is what Drs. Sally and Andy Pardue are doing in the department as we restructure our freshman engineering experience.

Attracting financial resources from multiple sources is essential to the successful implementation of the goals of the department. In this context, some of our research active faculty have been very successful in attracting several large federal grants, and you'll see multiple articles about these programs in this newsletter.

Our enrollment has been steady at about 700 undergraduate and 70 graduate students, and our new Aerospace Engineering Concentration is off to a great start! We have over 80 students already interested in the program for fall semester 2023. The SAE Baja event held on campus in May 2022 was a big hit! I invite you to explore the "ME Department News" section on our website and current posts on social media. We exist because of you, our beloved alumni and partners in this mission. I am very grateful to you for all your support.

If you'd like to make a gift online, you can do so on the Mechanical Engineering website at <https://www.tntech.edu/engineering/programs/me/support-me.php>.

Thanks for your support, and we wish you a healthy and happy rest of 2023!

Mohan Rao, Ph.D.
Mechanical Engineering
Department Chair



New Faculty Join ME Department



Dr. Bruce W. Jo joined the ME faculty in fall 2022 as an associate professor, having previously been a faculty member in the Department of Mechanical Engineering at State University of New York, Korea and Stony Brook University. Prior to that, he worked as an assistant and associate professor at Tennessee State University from 2014-2019 and spent his first sabbatical year

at Oak Ridge National Laboratory focused on 3D/4D manufacturing technology. He has also served as a tenure-track assistant professor at Embry-Riddle Aeronautical University from 2011-2014 and Florida State University as a research associate from 2010-2011. He earned his Ph.D. in ME from Columbia University in New York in 2010, an M.S. in ME from New York University in 2006, and a B.S. in electrical engineering from Hong-iK University in 2003. His main research interests are the design and control of morphorous structures (4D printing), the design of flight control systems, and dynamics/kinematics and mechanism design of mechanical systems in the applications of aerospace, mechanical, and robotic systems.



Dr. Peng Zhang became an assistant ME professor in fall 2022, after previously serving as a research assistant professor in the Department of Mechanical and Aerospace Engineering at the New York University (NYU) Tandon School of Engineering. He received his M.S. degree in mathematics and Ph.D. degree in engineering mechanics from Virginia Tech in

2014 and 2016, respectively. His research is primarily focused on the experimental, analytical, and numerical investigations of fluid-structure interaction phenomena in engineering and biological systems.

ME Faculty News

We are excited to announce that two faculty members were granted promotions last fall. We are proud of our faculty and their many accomplishments!



Dr. Ethan Languri was promoted to associate professor.



Dr. Pinggen Chen received tenure and became an associate professor.



Recognizing Outstanding Faculty and Staff

Each year before the holidays, our student chapter of the American Society of Mechanical Engineers (ASME) asks ME students to vote for outstanding teacher, advisor and staff member within the ME Department. The winners are selected and awards presented at a ceremony after the fall semester ends. The ME Department selects a faculty member to recognize as a distinguished researcher, and all of these awards were presented in December 2022.



The 2022 Outstanding Teacher Award went to Dr. Ahmed Abounassif. Pictured left to right are ASME representative Colin Wall, Dr. Mohan Rao, and Dr. Abounassif.



Dr. Will Brookshear was honored as 2022's Outstanding Advisor.



The ME Department recognized Dr. Rory Roberts as the Distinguished Researcher for the year



The 2022 Outstanding Staff Award went to Ms. Lisa Meadows.



New View from Brown Hall

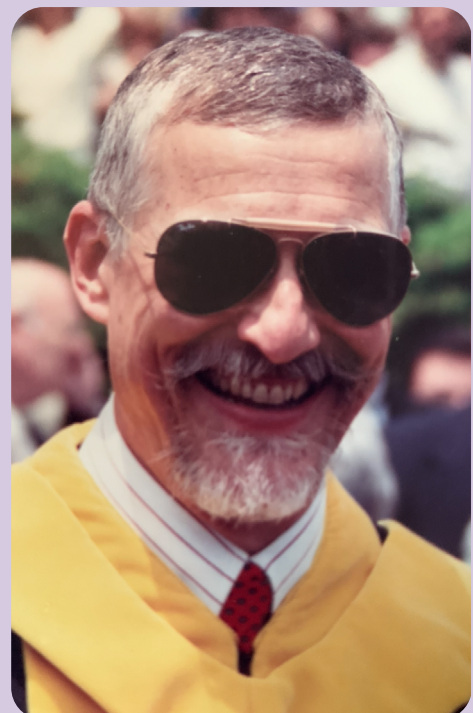
The next time you come to campus, the view from Brown Hall will also look a bit different! As part of the university's master plan to become more pedestrian friendly, a renovation project on 10th Street is underway. Improvements are being made to the street and sidewalks, and street parking on 10th will no longer be available. This project should be completed by mid-spring.

Remembering a Former Faculty Member

In fall of 2022, we learned of the passing of Dr. Robert Allen Smoak. He came to Tennessee Technological University in 1984, where he taught in the Mechanical Engineering Department. He also became a Tennessee Valley Authority Endowed Chairman for his groundbreaking research in engineering, consistently publishing his research, and contracting. He was the faculty sponsor for the Mini Baja Program now known as the Society of Automotive Engineers (SAE), leading it to regional and national acclaim. He was a featured speaker at American Society of Mechanical Engineers (ASME), Electric Power Research Institute

(EPRI), and other engineering conferences. In 2007, he was the recipient of the International Society of Automation (ISA) Power Industry Achievement Award for his contributions to the advancement of instrumentation in the power industry. He retired in 2003.

Dr. Smoak's family has requested that memorial contributions be sent to the Tennessee Tech Baja SAE Fund, c/o the Mechanical Engineering Department, Box 5014, Cookeville, TN 38505.





ME Students Design and Build Wheelchair Accessible Sink for Local Girl

At the end of this past fall semester, students in a Dynamics of Machinery class who were working on a Tech Engineering for Kids (TEK) project pulled up to nine-year-old Hayden Gribble's school in Sparta to hand-deliver their final project: a fully functioning sink that is just her size and accessible from her wheelchair.

"People learn best by doing, and my students learn best when they are putting their coursework and new engineering skills into practice," said Stephen Canfield, mechanical engineering professor at Tech. "We have a big need in Middle Tennessee for custom-designed assistive technology for children with special needs. The TEK program matches these child needs with my students learning engineering."

The class consisted of five mechanical engineering majors: Wyatt Been of Hendersonville, Tennessee; Obang Lwanmianga of Antioch, Tennessee; Meredith Nye of Jackson, Tennessee; Luke Miller of Crestwood, Kentucky; and Jessie Gray of Gallatin, Tennessee.

Canfield works with various partners in Middle Tennessee to find recommendations for children in need of engineering services. After pouring over applications from places such as school systems, Tennessee Early Intervention System, Tennessee Department of Children's Special Services, therapists, medical professionals, the Bridges program at Tech and others, he selects which children's needs would best match what the students are learning.

For Gribble, what she wanted and needed most was her own sink.

"It's something Hayden has wanted for a long time: her own sink that she can roll up to," her aunt, Stacy Scott, said. "A regular sink is hard for her to use, and she wants to be able to do it herself. She's very independent."

It proved to be the perfect challenge for the students in Canfield's class. The sink had to be adjustable to fit Gribble as she grew. It had to be able to produce water, but not be tied into a building's plumbing because she needed it to be portable. She had also requested space to be able to lay her dolls down while she changed their clothes.

"And we got that her favorite color was pink, so of course it needed to be pink," Been said.

The result was a system that worked on pumps and two jugs of water. One could be used to recycle the water if Gribble was just playing with her dolls. Another jug could be used to collect dirty water if she was using the sink to wash her hands or brush her teeth. They also created a second table with a mirror where she could lay her dolls down.

"During the early stages of the project, the team was having a difficult time in finding suitable approaches to meet the technical challenges of this project," Canfield said. "This is a normal experience in this course project, since the students are just beginning to gain knowledge and experience with practical issues in mechanical design. But after two early design reviews, the team selected a great solution and set about completing the design process and then moving to fabrication."



However, the struggles were worth it. Gribble was all smiles when Been and Lwanmianga presented the sink to her at her school and showed her aunt how it all fit together and could be taken apart for easy transportation. In addition to being a toy, the sink and tables will give Gribble more practice in exercising her hands and further developing fine motor skills, according to Larry Thompson, special education supervisor of White County Schools.

"I loved being able to work on a project that was going to have a real impact on someone's life," Gray said. "That's the whole reason I wanted to study engineering in the first place: to design and build things that will help people. I'm thankful that Tech provides an opportunity that I can work on a project like this while I'm still in school."

Gray continued, "I learned a lot about what engineering looks like outside of school with this project. Having to work

with a team, design and work through an entire project from the design to fabricating, helped me to experience the whole process from start to finish. I learned a lot about working with clients, working within a budget and working with a team."

"Our students genuinely care for others and are motivated to help others, Canfield said. "When given the chance to do this as part of their course work, the results are amazing in both learning and in helping our community. The TEK program is just one example of what makes Tennessee Tech such a great place for students and faculty to learn and grow. I am proud to be part of it."

Link to Story Video:

<https://www.youtube.com/watch?v=qc-8pPcPNiY&t=2s>

ME Hosts Another Successful Baja SAE Event



Baja teams from three different countries gathered at Tennessee Tech University's Hyder-Burks Agricultural Pavilion to compete in the Society of Automotive Engineers (SAE) Collegiate Design Series competition held last May.

Ninety-three teams were registered; and 90 teams participated at some level in the event, bringing about 1100-1200 people with them to compete. The teams came from almost every U.S. state, plus four teams from Canada and a team from Mexico.

The Baja SAE competition consists of students designing and building small off-road vehicles to be a prototype for a reliable, maintainable, ergonomic and economic production vehicle. Once on-site, each team's car went through a technical inspection process to ensure the cars were safe for competition.

The cars that passed inspection then competed in dynamic events, including a sled pull, acceleration test, land maneuverability and a traction and suspension course. The event culminated in a four-hour endurance race which included a wide variety of challenging obstacles



and rough terrain. Student teams were also judged on their business, design and overall cost presentations.

"I think the competition experience is incredibly valuable for these college students because it gives them a real hands-on project from beginning to end. They learn not just how to design the car, but also how to build before seeing how it will perform when actually put through all these tests," said Mechanical Engineering Professor Will Brookshear, who also serves as the faculty advisor for the university's Baja SAE team and was co-chair of the event's organizing committee.

"It is really exciting to have these teams from so many other colleges and universities come to Tennessee Tech to compete. It is a great experience for students to learn real-world skills in design, collaboration, teamwork, presentation and more," said Mechanical Engineering Chair Mohan Rao.

You can watch a video recap of the event at <https://www.youtube.com/watch?v=mgzvPHwypWg>. For more information on the competition and the complete list of awards and results, go to <https://www.bajasae.net/>.





Kindergartners Coming to College

It's never too early to get children interested in STEM careers, and to introduce them to the fascinating world of mechanical engineering. In fall 2021, the College of Education organized a "Kindergarten Goes to College" event, and ME was eager to help host these young guests. In 2022, this program really took off, and ME has helped host almost 200 local school children since August of

last year. The kids have been very excited to see the Formula SAE and Baja SAE cars, and every child has the opportunity to hop in and imagine driving. They also get to interact with team members and faculty representing these two student organizations and hear about what goes into the design and building of these racing vehicles.

ME Gets into the Holiday Spirit



ME brought some bright lights, fun cars and lots of Tech Pride to the 2022 Cookeville-Putnam County Christmas Parade on December 12. Both the Baja SAE and Formula SAE cars rolled down Washington Avenue and Broad Street to the Depot Museum in the historic West Side of downtown. This event was a new addition to ME's community outreach efforts, and it was a big hit with both the students who were there to represent their

organizations, as well as those who watched us in the parade. Thousands of local residents lined the parade route itself; and about 20,000 more watched as it aired live on WCTE, our local PBS station. This was the 55th annual Cookeville parade, but we believe this is the first time the Mechanical Engineering Department has participated. We are already making plans for our entry in this year's parade!



Electric Vehicle Battery Recycling Research Funded by Department of Energy

Tennessee Tech University was one of the 10 applicants awarded a part of the U.S. Department of Energy's recently released \$73.9 million in funding for research to advance technologies and processes for recycling and reusing batteries from electric vehicles.

Tech received \$4,531,642 of this funding for a project dedicated to bringing more electric vehicles and charging stations to rural areas.

"Electric vehicle batteries are designed to last the typical lifetime of the vehicle," said Pinggen Chen, Ph.D., associate professor of mechanical engineering at Tech, who is the principal investigator on the project. "For the battery, this equates to roughly 1,000 full depth of discharge cycles at a C/3 rate and a 15-year calendar life."

When a battery for an electric vehicle degrades enough that it is no longer strong enough to meet the high-performance requirements of the vehicle, it still has enough power for other, less strenuous, uses. Tech's project – titled Second-life Battery in Mobile EV Charging Application for Rural Transportation (SMART) – is to give new uses to these batteries instead of watching them end up in a landfill.

A goal of the Automotive Powertrain and Emissions Control Laboratory at Tech has been to make electric vehicles more accessible to people living in rural areas. One of the biggest obstacles to this is ensuring these vehicle owners have places to charge these electric vehicles. The solution

has been mobile charging stations.

"This project aims to address the urgent need to develop affordable mobile charging stations that can be deployed in rural America at a large scale by utilizing second-life batteries retired from electric vehicles, which cost 70-75 percent less than new battery energy storage systems of the same size," Chen said.



Undergraduate and graduate students will be assisting with the project. In addition to getting the chance to have a hand in providing solutions to real-world problems, they will also be gaining critical knowledge of lithium-ion batteries, including aging characteristics, battery state of health estimation, battery management system design and validation, mobile charging station design and deployment, and charging station network design and development.

"The students will have the opportunities to work with industry partners such as Nissan North America, Envision AESC – the leading battery manufacturers in the U.S. – and mobile charging station manufacturers, battery testing and recycling companies," Chen said.

Along with Chen, a number of other Tech faculty members are involved in the project, such as co-principal investigators: Nan Chen, Ph.D., assistant professor of electrical and computer engineering; and Joseph Ojo, Ph.D., professor of electrical and computer engineering.

They are also joined by senior personnel: Jie Cui, Ph.D., and Jiahong "John" Zhu, Ph.D., both professors of mechanical engineering; Steven Anton, Ph.D., associate professor of mechanical engineering; Ali Arzani, Ph.D., research assistant professor of the Center for Energy Systems Research; Ahmad Vassel, Ph.D., assistant professor of mechanical engineering; Syed Ali Asad Rizvi, Ph.D., assistant professor of electrical and computer engineering; and Terry Guo, Ph.D., research assistant professor at the Center for Manufacturing Research.

This funding from the U.S. Department of Energy is one of many that Chen has been able to help secure over the years. His research as either a principal or co-principal investigator while at Tech has received more than \$20 million in funding from not only the U.S. Department of Energy, but also the Tennessee Department of Transportation, Tennessee Department of Environment and Conservation, Tennessee Tech University itself, Denso, Nissan and others.

"My research team has also established strong partnership with more than 70 electric vehicle stakeholders in the nation to help underserved communities accelerate the transportation electrification in the U.S.," Chen added.



Industrial Assessment Center Receives \$2.3 Million Investment from the Department of Energy

A Tennessee Tech engineering program has received a \$2.3 million dollar investment from the United States Department of Energy.

Tech is one of 32 universities across the nation selected to take part in the DOE Industrial Assessment Centers program, offering no-cost energy efficiency recommendations to small and medium-sized manufacturers and water treatment facilities.

“Tennessee Tech is the only university in Tennessee that has had this Industrial Assessment Center for the past 15 years,” said Dr. Ethan Languri, assistant professor of mechanical engineering at Tennessee Tech. “We’ve just been selected for the next five years. Tech has a history of providing amazing education in engineering and the results speak for themselves.”

The program is designed to assist manufacturers with fewer than 500 employees. Those interested in an assessment answer a detailed questionnaire, submit energy equipment information and the past 12 months of utility costs.

“We have a team composed of faculty and students trained to go over detailed engineering data and come up with preliminary ideas where we can save them energy, reduce carbon dioxide emissions and save them money,” Languri said.

After the initial assessment, the team visits the facility utilizing state-of-the-art equipment to collect and record data, sometimes for a week or more. It takes about two months to put together a final report of suggestions and recommendations.

“We show how they are going to save in terms of energy costs, reduce carbon dioxide and it’s more secure and more sustainable,” said Languri. “We

show our equations and all of those come from our Tech students, which surprises many plant managers that we are capable to do those.”

Twenty students will take part in the program this year; two doctoral students, three master’s students and 15 undergraduates. While one goal of the program is saving companies energy and money, Languri says another goal is preparing Tech students for the future workforce.



“It’s an amazing experience for students,” said Languri. “The level of confidence after a few sessions of running those assessments as a lead student is huge. IAC students land much more secure jobs at a higher salary rate. Many have their offer a year ahead of time. They are very, very successful.”

The Tech IAC performs around 20 assessments a year, primarily in Tennessee but also in other states. After six assessments, students receive a certificate from DOE, showing qualification to be independent in terms of energy assessments.

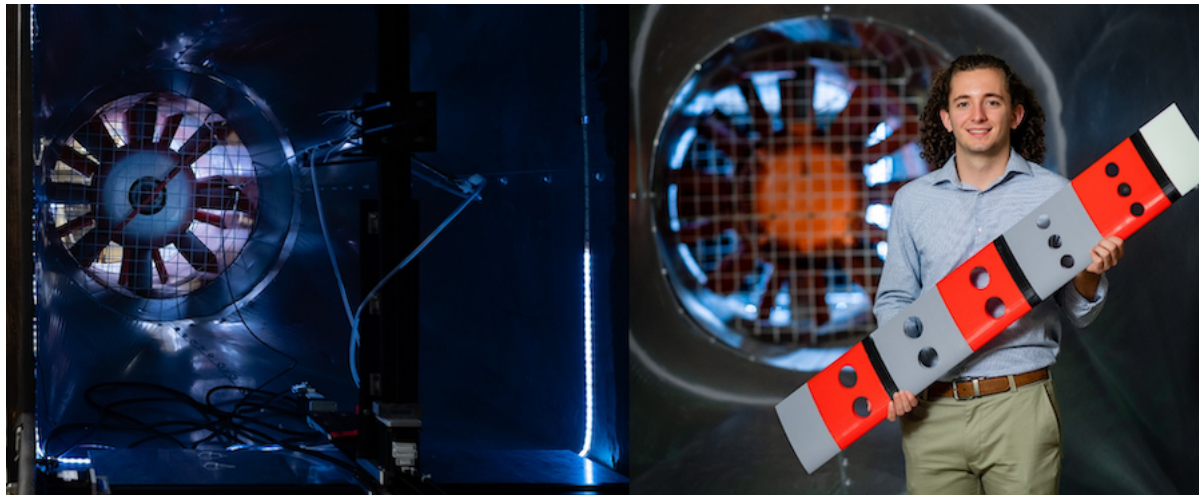
According to the DOE, the program nationwide has performed nearly 20,000 no-cost assessments, which typically identify an average of more than \$130,000 in potential annual savings for every manufacturer assessed.

“The level of professionalism and willingness that your group demonstrated during the past few months was outstanding,” said Mario Aguilera, technology development senior manager for Schott Gemtron, whose assessment was completed by the Tech IAC in July. “This assessment will be used as a reference to implement similar studies in our sister sites within the North America region.”

“It’s a program where the students have a leading role,” said Languri. “I enjoy being part of something that is not only helpful to companies and manufacturers but also does so much for our students.”



Large-Scale Wind Tunnel Will Enhance Faculty and Student Research



A new wind tunnel research facility will allow Tennessee Tech University researchers, students and industry partners to do hands-on, large-scale research that could shape developments in wind engineering, aerospace, electric vehicle research and more.

“The tunnel and facilities will increase our ability and capacity in performance computing and will also enhance teaching,” said Tech President Phil Oldham. “We continue to increase our courses in this area. In addition to new opportunities for our students and faculty researchers, the wind tunnel is another of many efforts to focus on helping the Upper Cumberland. Rural areas and businesses can transform with Tech’s help.”

The Tennessee Tech Foundation plans to purchase approximately four acres of land in Crossville, Tennessee along with existing structures that will provide teaching spaces and opportunities to work with physical models that the university’s campus does not otherwise have space for.

“A wind tunnel is exceptionally instrumental in researching any fluid-structure interaction problem,” said Assistant Professor of Mechanical Engineering Ahmad Vasselbehagh. “This includes the interactions of a fluid flow, generally air, with vehicles, birds, missiles, airplanes, spaceships, buildings, bridges, turbines, and every other manmade or natural structure located in the air or any other fluid flow.”

“Tennessee Tech and our partners will primarily use this wind tunnel for aerospace, vehicle engineering, and wind energy applications. We will also use it for developing fundamental science in several areas, particularly turbulence and aerodynamics.”

The facility will house a 140-foot-long wind tunnel with a 500-horsepower fan and a test section that is 10 feet wide, 10 feet tall, and 23 feet long. Inside the tunnel, wind speed can reach 140 miles per hour. That’s more than

double the size and wind speed capacity of the current Fluid Mechanics Research Laboratory on Tech’s campus. In the new facility, researchers will be able to explore ideas and work with actual prototypes, moving beyond limitations of working with theoretical designs or small wind tunnels that call for scaled-down testing models.

By acquiring an existing wind tunnel and moving it from its current location in Minnesota to the existing facility in Crossville, the cost savings to provide the space to the campus community are significant.

Few universities have such testing facilities, moving Tech’s aerodynamic capabilities up among the very top institutions in the nation. The tunnel will also be a significant boost to Tech’s aerospace concentration in the university’s College of Engineering and will be integrated into current courses offered at the university.

“This wind tunnel will significantly boost that program and help students better understand the topics via experimentation,” said Vasselbehagh.

Vasselbehagh, Assistant Professor of Mechanical Engineering Arman Sargolzaei, Associate Professor of Mechanical Engineering Rory Roberts and others at Tech have ongoing research projects that will be aided by the facility, including research related to artificial intelligence to aid pilots in managing flights under attack, managing aircraft turbulence and controlling aspects of drones flying close to one another.

“We will employ the wind tunnel to test and validate those studies,” Vasselbehagh said. “The wind tunnel will be instrumental to the local high-tech industry too. For instance, Whisper Aero, a local company aiming to design an electric thruster that will make drones quieter and more efficient, is a potential local industry that can benefit from this facility.”



A Campus Under Construction Brings Big Changes

The engineering area of campus is seeing major changes! The construction of the Ashraf Islam Engineering Building officially got underway last year and is scheduled to be completed in fall 2024. The image above shows the progress already being made.

In addition to this structure, another new engineering building will be coming to campus in the next few years. The Advanced Construction and Manufacturing Engineering building – the second new engineering building at Tech funded in the last two years – will be cross-disciplinary within the College of Engineering and will provide Tech students with applied skills called for directly by industry partners.

industry to complete their education post-graduation.”

The new building provides a modernization of Tech’s manufacturing facilities to better house its already modernized manufacturing equipment, Slater said. The project includes a state-of-the-art foundry, along with replacing older spaces for concrete manufacturing and materials testing.

At more than 2,600 students, the College of Engineering is Tech’s largest college, with nearly 27% of Tech’s total student body.



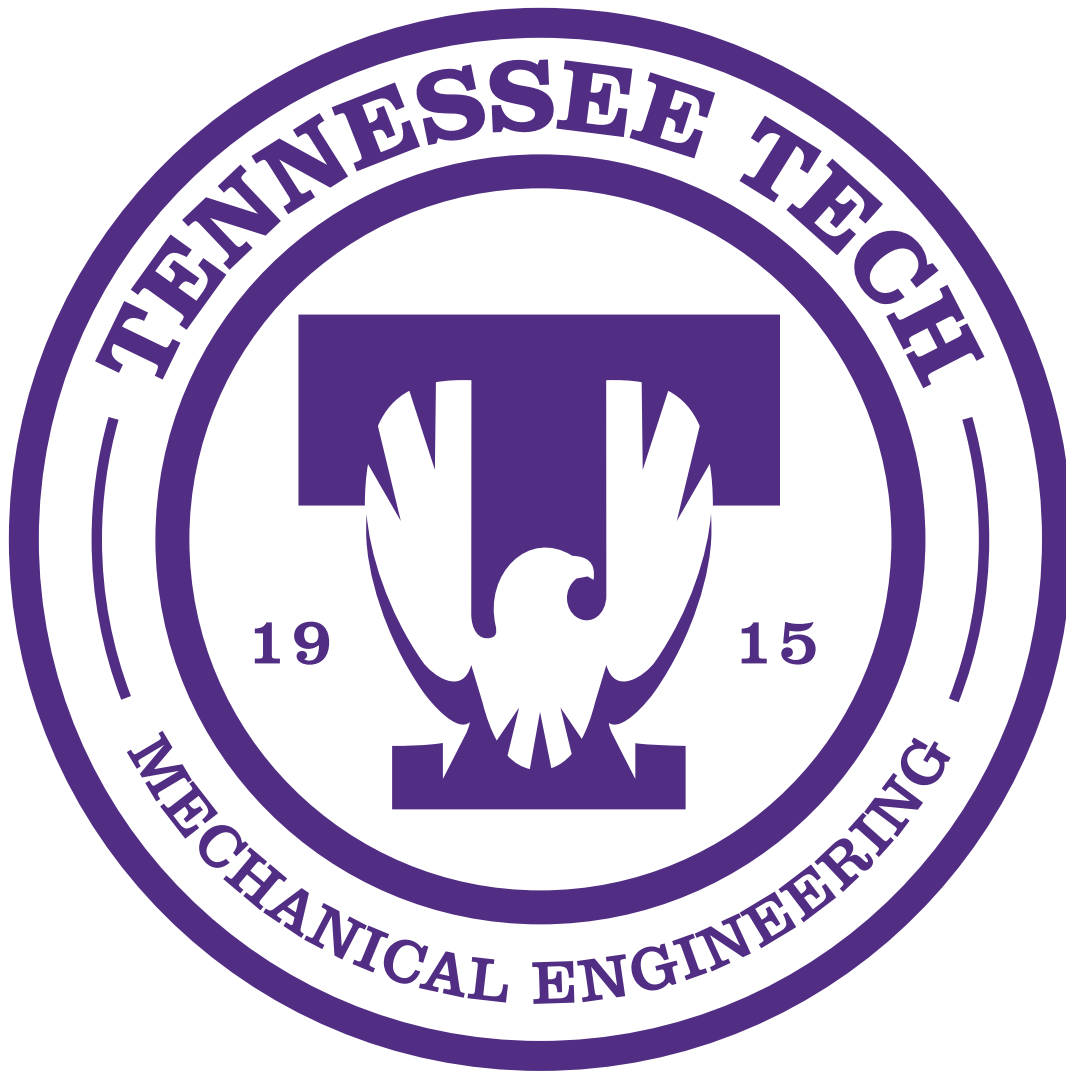
“As part of this year’s historic budget for higher education, Gov. Bill Lee and the Tennessee General Assembly invested heavily for Tech’s future students,” said Tennessee Tech President Phil Oldham. “On behalf of the entire Tech community, our faculty, staff, students and alumni, I am grateful for this support and appreciate how it will enable us to continue to serve students.”

“The Tennessee Tech College of Engineering prides itself on graduates who are trained not just in the classroom but also in environments and with equipment that matches what employers use,” said Joseph Slater, dean of the College of Engineering. “This facility will ensure our students experience real-world manufacturing and construction while they are students, instead of relying on

“Hand-in-hand these two new buildings show prospective students the entire path from concept to analysis, collaborative design, further analysis, and testing of ideas in the lab,” Slater said. “Students who experience both buildings will be able to see and understand the entire process of creation that engineering represents.”

The project budget for the Advanced Construction and Manufacturing Engineering building is \$62.4 million, with the university having to supply nearly \$5 million (of which nearly \$1.7 million must be from private giving). The initial project timeline is for nearly four years. Upon completion of the new facility, the college will vacate its space in the East Stadium structure, and Lewis Hall and the Foundry building will be demolished.





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