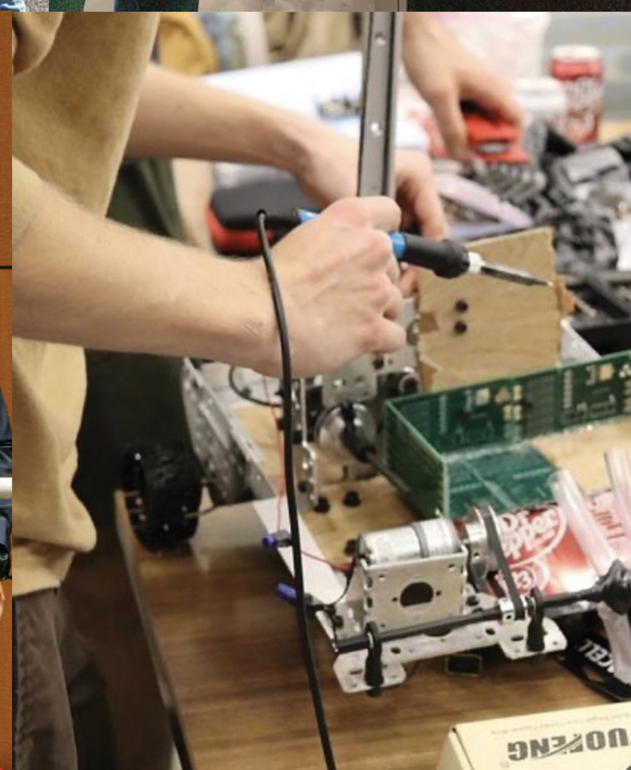
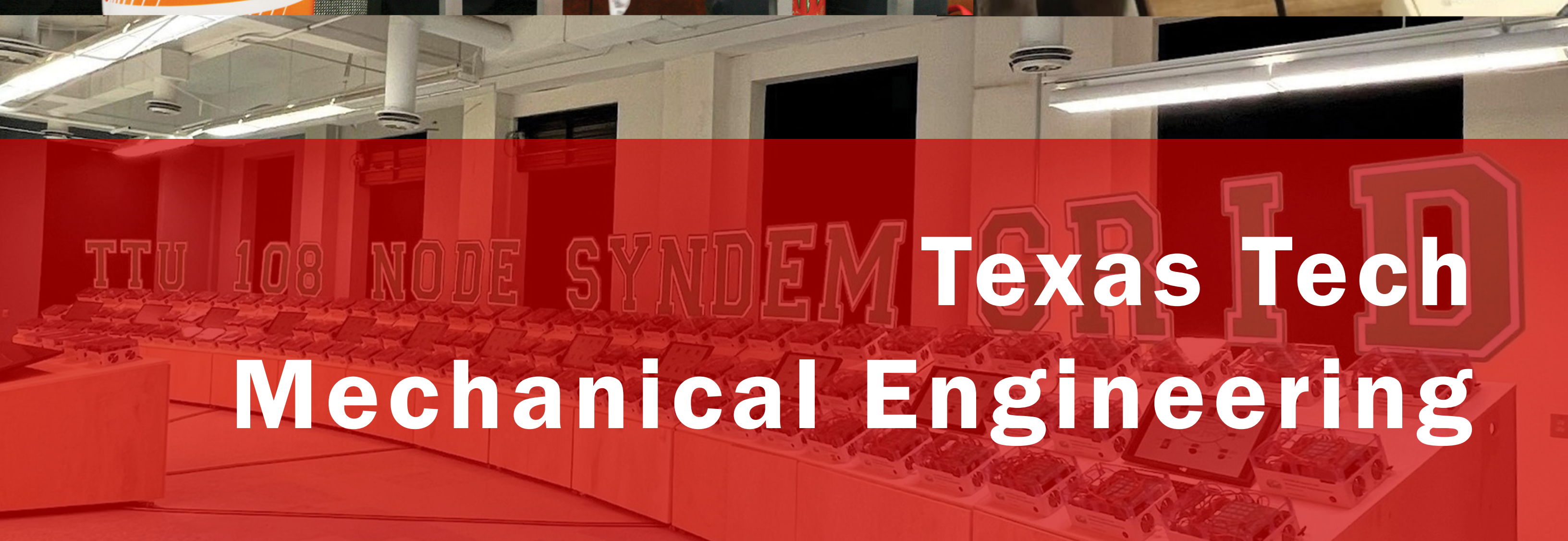
SPRING 2024

Rising to the Occasion





Texas Tech Mechanical Engineering

CHAIR'S MESSAGE

Song-Charng Kong, Ph.D.

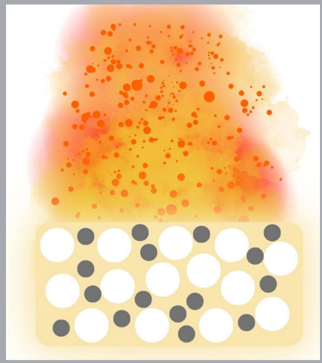
Department Chair, Don Kay Clay Cash Endowed Chair

One day in January, the ME Honors Society – Pi Tau Sigma – contacted me about helping their fellow ME students with the FE exam preparation. Interestingly, not long before that, we discussed in the Department Chairs meeting how the College would offer FE review sessions. I am so proud of our ME students that they step up voluntarily at a perfect time. As a result, the ME Department will cover course materials and related costs while the Pi Tau Sigma students will organize eight review sessions. Each session begins with one expert faculty member reviewing the fundamental principles of the respective subject and the Pi Tau Sigma students who have passed the exam, sharing their experiences and strategies in taking the exam in a timed environment.

The Department has established good working relationships with all six ME-led student organizations and supported them with proper spaces, computers, and a small amount of funds. The Raider Aerospace Society can also access the space in the Reese Technology Center, a previous Air Force airfield. Most organizations raise funds by themselves, which is part of their educational experience. You can find related articles on student org activities in the present and prior newsletters.

Many of our alumni work in the aerospace industry. Under the aerospace industry is everything mechanical. Sure enough, with the growth of the aerospace industry in Texas, the demand for aerospace engineering courses has grown among our students. With our faculty's versatility, we can offer essential aerospace engineering courses in the last few years. Building on such success, we have established the Aerospace Engineering Minor to serve students, effective Spring 2024. Please look forward to hiring Tech's ME students with an Aero E minor!

Lastly, with your generous support, we have purchased numerous new equipment for the Thermal-Fluids Laboratory. We will replace the dated apparatus in the coming year. Meanwhile, additional support is needed to renovate the laboratory infrastructure. Last year, we also renovated the computer lab (MEN 149), the graphics lab (MEN 224), and the graduate students' office (MEN 151). Additional research and student space renovations are underway on MEN's second floor. If you have a chance to visit Lubbock, please stop by the Department, and I will show you around. Please do not hesitate to contact me (sokong@ttu.edu) if you have any ideas or memories to share.



New Research

ME Faculty receive research grants for various areas of study.

Design Expo

Students turn classroom learning into real-world problem solving.

Traveling Success

ME students find success for their work in both engineering and marketing fields.

Aerospace Engineering Minor

The Department offers an Aerospace Engineering Minor. A minor in Aero E consists of two required courses – Fluid Mechanics and Control of Dynamic Systems – and four courses from the following list of electives that are offered in alternate semesters. Students may also substitute one course with internship credits in an approved aerospace engineering industry.

Aerospace Materials; Compressible Flow; Aircraft Propulsion; Aerodynamics; Aircraft Design and Structure; Combustion Engineering; Fundamentals of Rotating Machinery; Flight Dynamics and Control.

Research Grants And Awards

Recognizing Faculty and The Ongoing Work in the ME Department

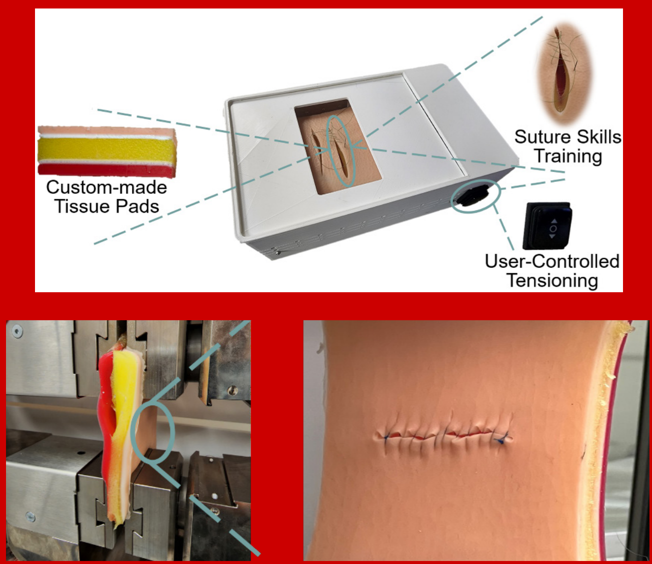
Beibei (Helen) Ren, Ph.D.
Associate Professor

Dr. Beibei (Helen) Ren recently received the Whitacre Engineering Research Award for her outstanding research done within the Mechanical Engineering Department. One of her recent research opportunities involved a grant from the National Science Foundation to develop a comprehensive theoretical framework for stability assessment and enhancement of future power systems. This focuses on varying levels of inverter-based resources and synchronous generators. Power systems are going through a paradigm change from centralized generation to distributed generation, from electric machines-based to power electronics-based. The centralized conventional power plants dominated by synchronous generators, are being replaced with millions of widely distributed energy resources, often referred to as inverter-based resources. In this project, Dr. Ren's team is responsible for both theoretical advancement of power electronic converters control and experimental validations on TTU's large-scale energy research facility, the TTU 108-Converter SYNDEM Grid, to underpin the stable operation of future power systems with large-scale penetration of power electronic converters. This work promises to transform how we assess and enhance the stability of future power systems, advancing scientific knowledge in this critical field. This is part of a multi-institution collaborative project.

Paul Egan, Ph.D.
Assistant Professor

Dr. Paul Egan was recently awarded a grant from the National Science Foundation for his team's work in creating innovative technologies for surgical preparation and simulation in the medical field. Current technology allows surgeons to practice for difficult surgeries in advance; however, they are limited in their feedback and replication of the physical body. Dr. Egan's team strives to create a better understanding of the methods used and the recreation of physical anatomy through 3D printing, mechanical testing, and machine learning. The new technology will then be used by professional surgeons with high experience and new medical students to accurately obtain information on all skill levels, so that proper advice and feedback can be given. The result of Dr. Egan's work will lead to personalized surgical procedures and individualized feedback given to surgeons to improve outcomes in the surgical field.

Dr. Ren's team is capable of testing microgrid dynamics and control strategies through their microgrid testbed composed of 108 reconfigurable converters.



Dr. Egan's team is able to test the reliability and strength of their work through mechanical testing and analysis.

Research Grants and Awards

Minliang Liu, Ph.D.
Assistant Professor

Dr. Minliang Liu has been given a grant for his research in Type B Aortic Dissection, working towards a strategic system that will help deduce when patients need therapeutic care versus medical intervention. Type B Aortic Dissection (TBAD) is a lethal disease which occurs when a tear develops in the inner lining (intimal layer) of the aorta, causing the layers of the aortic wall to separate (dissect) creating "true" and "false" lumens. Complicated TBADs with presence of either organ malperfusion or aortic rupture have a high in-hospital mortality rate and require emergent surgical or endovascular therapy. Uncomplicated TBADs have been traditionally managed with optimal medical therapy (OMT) consisting of aggressive anti-hypertensive therapy and surveillance imaging. OMT results in low in-hospital mortality rates, but dismal long-term survival rates of 48- 66%, and overall intervention-free survival rates of less than 50% secondary to aortic aneurysm formation and rupture. These poor long-term outcomes support a paradigm change in the treatment of the uncomplicated TBADs. Thus, there is an urgent and unmet clinical need for promptly identifying those uncomplicated TBAD patients that will likely fail OMT in the acute phase, and thus benefit from early intervention such as Thoracic Endovascular Aortic Repair (TEVAR). Therefore, the objective of this project is to develop a risk stratification model for predicting both failure of OMT and the optimal timing of intervention in uncomplicated TBAD patients. This project aims to develop a risk stratification model for predicting both failure of optimal medical therapy and the optimal timing of intervention for uncomplicated Type B aortic dissection patients.

Changdong Yeo, Ph.D.
Associate Professor

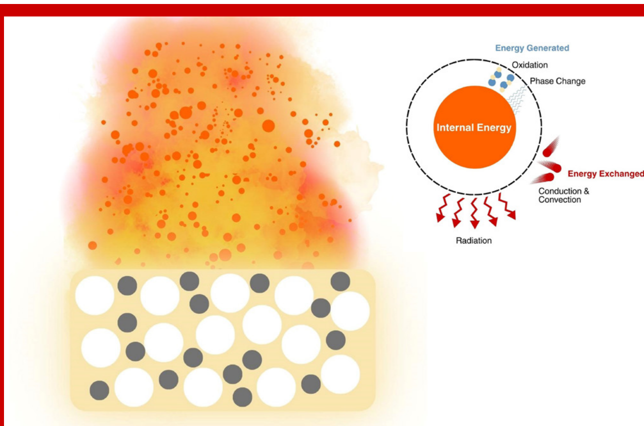
Dr. Changdong Yeo received funding from the Department of Energy (DOE)-Sandia National Laboratory for research on multi-physics and multi-scale modeling of electrical contact resistance (ECR). Modern systems (e.g., electric vehicles, airplanes, spacecrafts, and missiles/rockets) typically contain thousands of electrical connectors. An inherent requirement in the design of circuits is the ability to maintain electrical continuity, which relies on the electromechanical features as found in various types of electrical connectors. Under structural vibration and chattering, the ECR of contacting electrodes can surge such that electrical energy cannot be adequately transferred, thereby leading to critical system failures. Dr. Yeo's group and the Sandia National Laboratory team investigate the influences of structural dynamics and metal oxides of a pin-receptacle on its ECR using analytical modeling and computational simulation. The research outcome can deliver the key design rules for electrical connectors in terms of material selection, surface properties, allowable operating parameters, and structural properties, which contribute to achieving long-term reliability for these systems without ohmic loss and material degradation.

Song-Charng Kong, Ph.D.
Department Chair

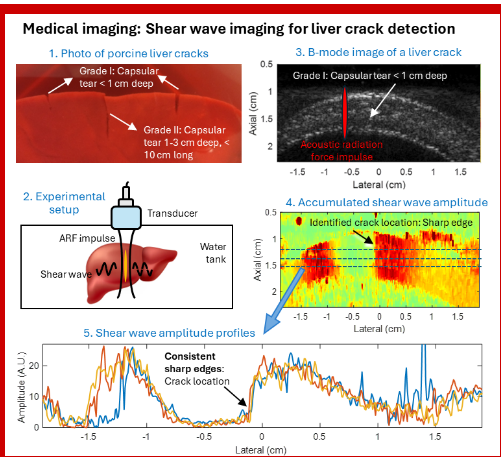
Dr. Kong's group recently received a $590,000 research grant from the Army Research Laboratory, located in Aberdeen Proving Ground, MD. The research is focused on increasing the propulsion power of the Army's drones. Such unmanned aerial systems play a vital role in the Army's military operations. The Army requires an engine that has high power density and high reliability while also being fuel flexible, capable of running on various fuels available on the battlefield. This demand has prompted the need for a new engine design that can meet these requirements. There are two main challenges: the limited space available for fuel-air mixing and combustion, and the low density and temperature of the air at high altitudes. One potential solution to achieve high power density in a small space is the use of "opposed fuel jets." This mechanism involves high-speed fuel jets impinging on each other in a confined space, thereby enhancing atomization, mixing, and combustion.

Michelle Pantoya, Ph.D.
Professor

Furthering her research in solid propellants, Dr. Pantoya has received a $1.5 million grant from the Department of Defense Applied Hypersonics Consortium to work with the Naval Air Warfare Center and streamline the effectiveness of metalized fuels used within aircraft. While solid fuels are currently being used in industry, current methods do not effectively capture all energy available, requiring the addition of energy into the system. As the propellants burn, energy associated with phase change is lost through the system and rendered useless. Dr. Pantoya's team, however, is working on a solution that will capture the energy created during phase change, allowing the propellants more power generation capabilities with the same amount of fuel. Not only will there be a more efficient use of materials, but the heat captured from the phase change will aid in the combustion process. This will help burn the fuel faster and expedite the rate at which energy is available for the aircraft to use as power. Dr. Pantoya's research is aimed to revolutionize the process in which chemical energy is converted to power, pushing to use fuel resources to their full potential.



Dr. Pantoya's team analizes the energy created through combustion, and the possible uses of the harnessed energy.



Dr. Liu's research utilizes advanced medical imaging and testing to locate tears in the liver.

Research Corner

Research in Biomedical Acoustics at TTU ME

Biomedical acoustics is one of the forefront research areas of modern medical science and technology. It harnesses the power of sound and vibration to develop new diagnostic and therapeutic methods and devices to address current challenges in healthcare. Compared with other medical diagnostic methods such as X-ray, CT, MRI, and nuclear medicine, acoustics-based methods such as ultrasound imaging have distinct advantages such as safety, low cost, and portability. As an emerging therapeutic technology, acoustic methods can provide noninvasive or minimally invasive interventions for various diseases including cancer and cardiovascular diseases.

Dr. Jingfei Liu leads the Biomedical Acoustic Research Lab, which focuses on developing novel medical techniques for both diagnosis and therapy. The group's diagnostic research focuses on developing elasticity imaging methods and physiological sound analysis methods. For example, the elasticity imaging method evaluates the tissue elasticity and utilizes the elasticity difference between healthy tissue and diseased tissue to distinguish them. Such methods can readily map cancerous tissue distribution in the human body and detect the fibrotic tissues in various organs. The group's therapy research focuses on applying focused ultrasound to enhance conventional cancer immunotherapy for cancer treatment, stimulating neural networks for treating neurological diseases, and studying the interaction of sound with microorganisms such as bacteria and viruses for potential treatment method development.

The core of the group's research is the generation, detection, and analysis of sound and vibrations in the human body. Various challenges occur in the team's research depending on the type of medical application. Fundamentally, all the challenges are rooted in the understanding and control of the interaction of biological entities, such as molecules, cells, and tissues, with sound and vibrations. To address these challenges, expertise in different mechanical engineering areas, including solid mechanics, fluid mechanics, and thermal dynamics, is needed.

Student Sucess Spotlight

Fall 2023 Design Expo

Every year, mechanical engineering students have the opportunity to put their studies into practice with their Capstone Design Projects. These culminate in the Design Expo, a semesterly exhibition where teams present the result of their efforts. Teams create logical solutions to problems and work over two semesters to attack their chosen issue. The 24 projects completed in Fall 2023 were each graded on their innovation, technicality, and presentation, with winners chosen in each category.

Aquatic Search Vessel

The overall winner of the Design Expo was the Aquatic Search Vessel (ASV), a watercraft built with the ability to search shallow waters for missing persons. Inspired by an episode of "Lone Star Law", Cameron Brown came up with the idea of building a search vessel to aide in police scans of bodies of water. While the team originally had a list of 10 ideas, narrowing down to the ASV was the obvious choice, as team member Adi Hiros stated they "wanted to make an impact, and the vessel had clear objective value." When designing the ship, a decision between a single-hull and double-hull design needed to be made. While a single hull would have been more agile and stable, it presented troubles with the depth of the keel in respect to the bodies of water the ship would be placed in. Instead, a double-hull design was chosen, as it would allow for a shallower keel, effective in lakes and rivers, where it would be most commonly used. Once built, the vessel could be controlled by a system called AR-DUPILOT, which allowed motion based on GPS imaging. Reflecting the skills of a top team, the members were able to navigate unexpected challenges: when facing telemetry unit issues in the final week, the team was able to quickly adapt and mitigate the problem. The project taught the members how to apply the engineering concepts they have spent years cultivating, as well as how to function in a work environment.

The team takes the Aquatic Search Vessel for test runs in a lake, following behind with a canoe.

Robotic Transportation Apparatus

Placing second overall in the Design Expo, the Robotic Transportation Apparatus (RTA) tackled problems found in commercial forklifts and pallet jacks. The common design includes wheels built for specific environments, making it difficult for the vehicle to be utilized in varying locations. The team designed the RTA to effectively navigate uneven surfaces, so that it may be fully capable of transporting pallets regardless of where it is being used. A belt-track system was used to increase speed and control of the vehicle across a multitude of terrains. The modularity of the design made it intriguing for commercial implementation, as well as its ability to be remotely controlled by a single operator. A job typically performed by several operators can now be completed by one controller who does not necessarily have to be physically present at the site, lessening the need for training and hiring of position specific employees. Companies will be able to lessen the risk of placing workers in labor intensive tasks by placing operators outside of the operating sphere, as well as lower operating costs by reducing the number of employees required. Costs were also reduced in the choice of materials used; the team focused on steel for parts of the forklift that would be placed under high duress, while choosing aluminum in lower stress areas to lessen the overall weight of the vehicle. The Robotic Transportation Apparatus navigated current problems in forklift transportation by revolutionizing the environment it can be used in, the control system, and the cost of materials, creating a vehicle that can be easily implemented into factories.

Scorch Cooler

The Scorch Cooler, placing first in innovation at the Design Expo, was designed with the intent of creating a mobile cooler that can be used anywhere without electricity. The team had the desire to create a cooler that would have the ability to be used for camping, in disaster relief situations, and for remote worksites. The cooling technology is built with a solution of ammonia and water as the primary coolant. As the ammonia is heated, it will evaporate from the solution, turn into condensation that will become cool, and then return to the solution. Instead of using a generator as the heating element, as seen in most coolers, a portable charcoal fire pit would be used to separate the ammonia from the water solution. The use of fire allows the cooler to be used in rugged locations without the reliance on electricity. One potential issue with using a fire pit is the possibility for the heat of the pit to interfere with the cooling effect, and it may override the system. In order to counteract this problem, the team decided to make the fire pit out of stainless steel, allowing for maximum retention of heat, so the fire pit can run at full capacity without affecting the internal temperature of the cooler. The scorch cooler found an innovative way of redesigning coolers to allow them to be used in a multitude of environments without the need for electricity.

The team presents their design to judges during the Design Expo.

Project C.A.M.E.L.

Mechanical Engineering students found resounding success at the Pantex Innovation Challenge, part of the larger iLaunch Competition at the Texas Tech Innovation Hub. The ME students and others of various majors and backgrounds formed teams to take on real-world problems provided by Pantex. Placed in a room with four hours to design a solution, the teams were tasked with finding a way to streamline the transportation of hazardous materials – in essence, make this multimillion-dollar transportation process safer. Project C.A.M.E.L. (Controlled Automated Mechanical Electronic Laborer) was then born. The C.A.M.E.L would move along a path of predetermined lanes and positions and would be full of sensors to detect sudden changes on the path. Automation of the forklift allows a driver to be completely removed from the room to a location where they can safely control the vehicle out of harms way. The team then determined that ultimate protection would come from the forklift being an entirely independent system—off the grid—to prevent it from potential cyber-attacks. Designing the forklift proved to be simple in comparison to marketing their design to a company that is known for being tightlipped. Team member Benjamin Burton explained the importance of relatively low costs and ease of manufacturing the forklift as well as its fluid integration into any warehouse. New expertise and hiring would not be required as the vehicle still operated as a normal forklift and would not require a change in staffing. Once the team moved past the preliminary stage, they pitched their idea to the company it self in the finals of the competition. After rounds of videos and presentations, Project C.A.M.E.L. was selected as the winner of the Pantex iLaunch competition due to it being the readiest for implementation.

Project C.A.M.E.L. takes home the prize of $5,000 for their innovative design.

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